STOCK ASSESSMENT AND FISHERY EVALUATION (SAFE Report) REPORT

And

Affected Environment (EA) the 2012-2013 Skate Specification Package

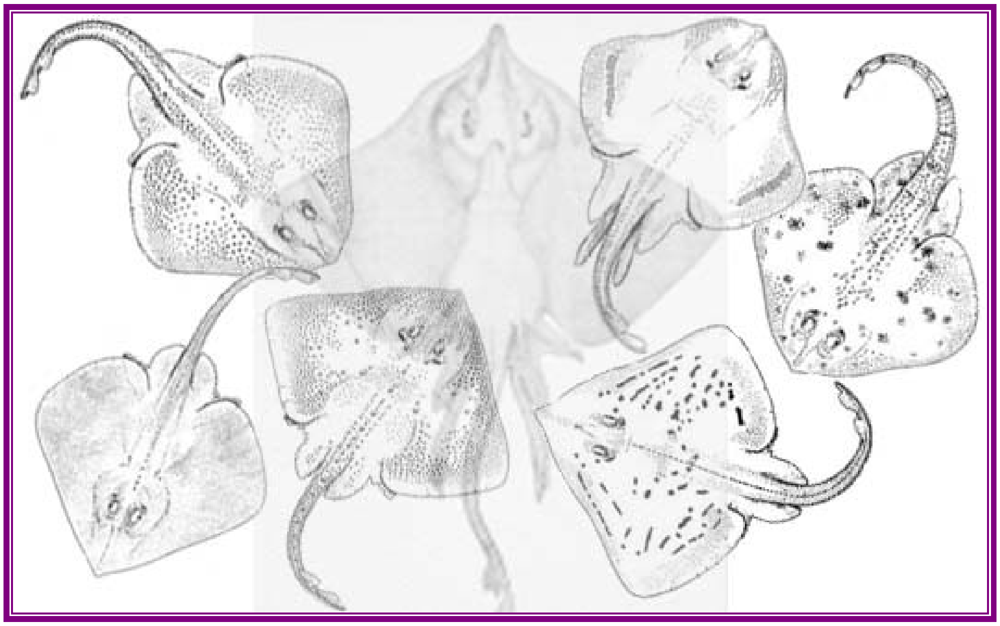
Section 7.2 Description of the Biological Environment

Section 7.5.1 Description of the Fishery

Section 7.5.4.2 Skate Prices

2010

This document is work in progress. Only updated or currently relevant sections have been included in this copy. Other data in this report will be added later.



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

June 2010

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7.0 SAFE Report

7.1 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 Environmental Assessment (EA) for the 2012-2013. Since the document serves as Section 7 of the EA 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 Environmental Assessment associated with the 2012-2013 specifications package.

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	
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

SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	GENERAL DISTRIBUTION	SIZE AT MATURITY cm (TL)	OTHER COMMON NAMES
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.

7.2 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

7.2.1 Species Distribution

Maps of biomass distribution are included in Section 7.2.3, 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).

7.2.2 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.

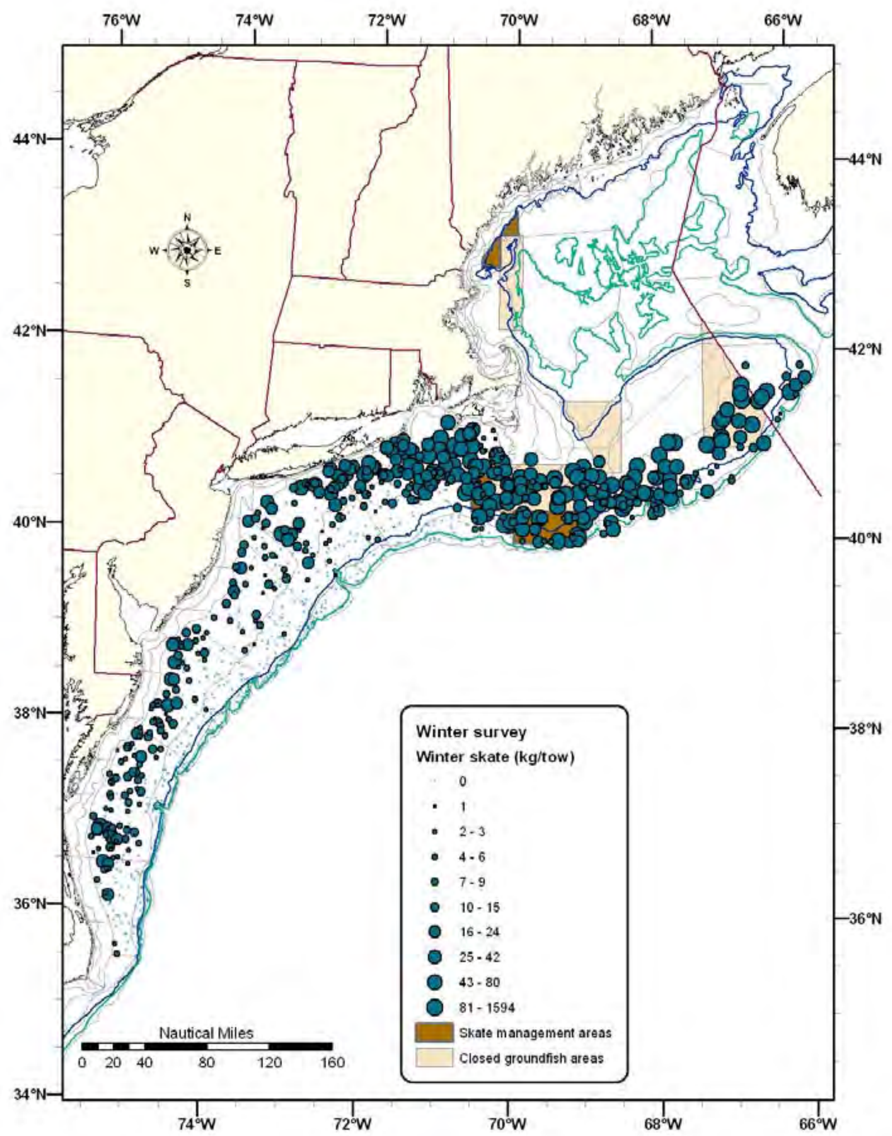
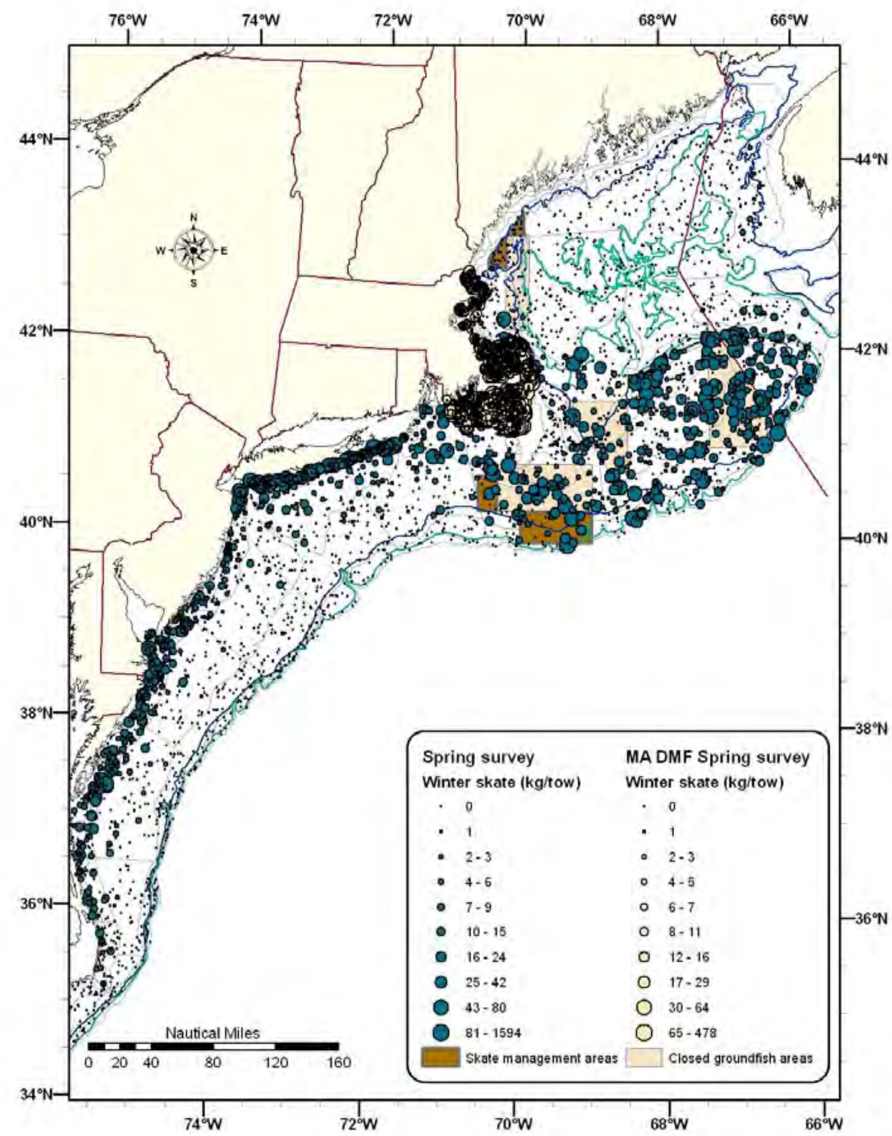
7.2.3 Research Survey Data

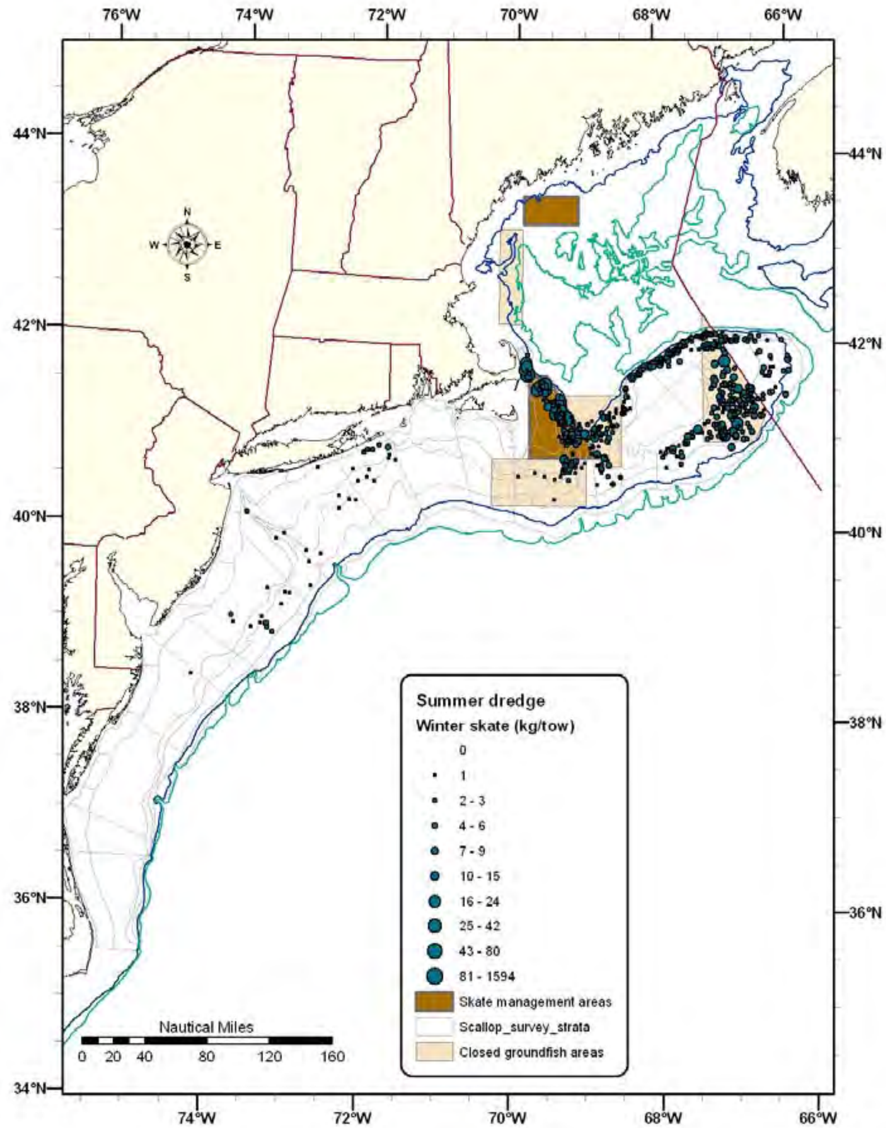
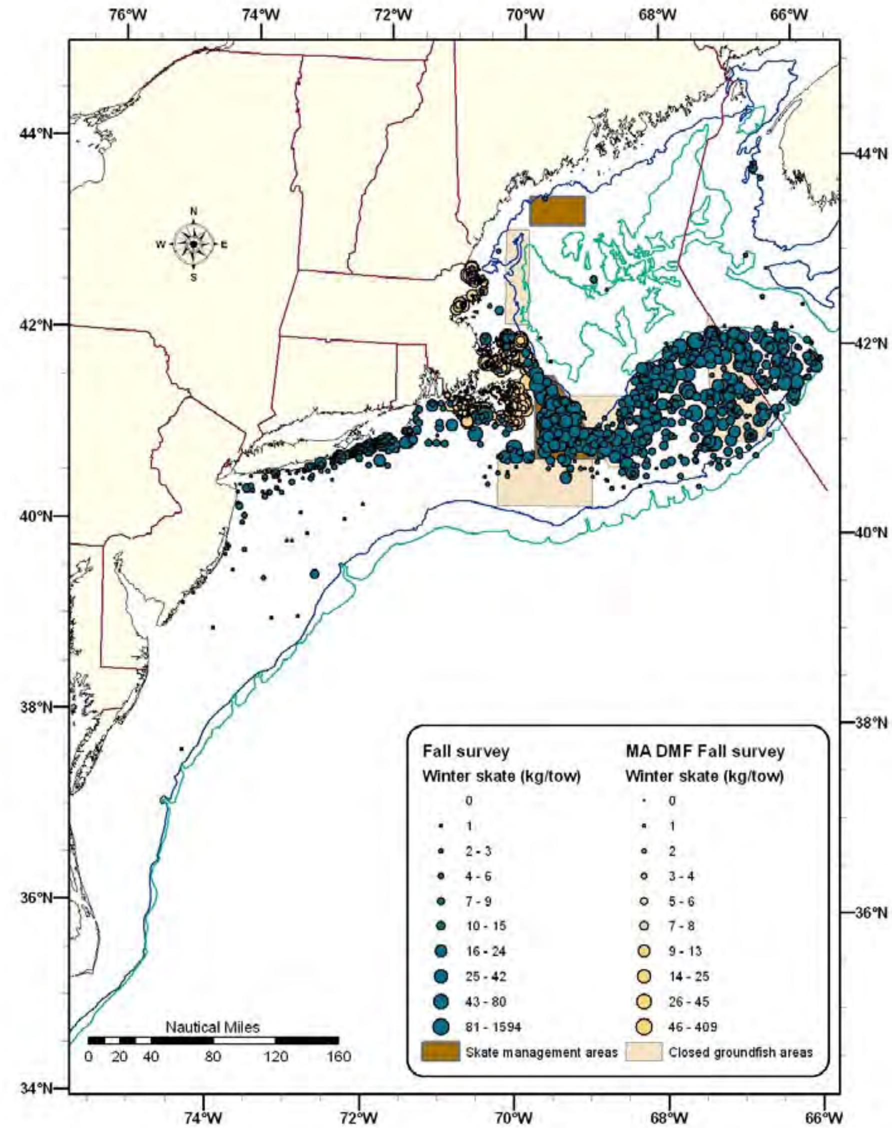
This section presents data collected through seasonal NEFSC trawl surveys and state research surveys. Information has been updated through the 2005 autumn survey and the 2006 spring survey.

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.

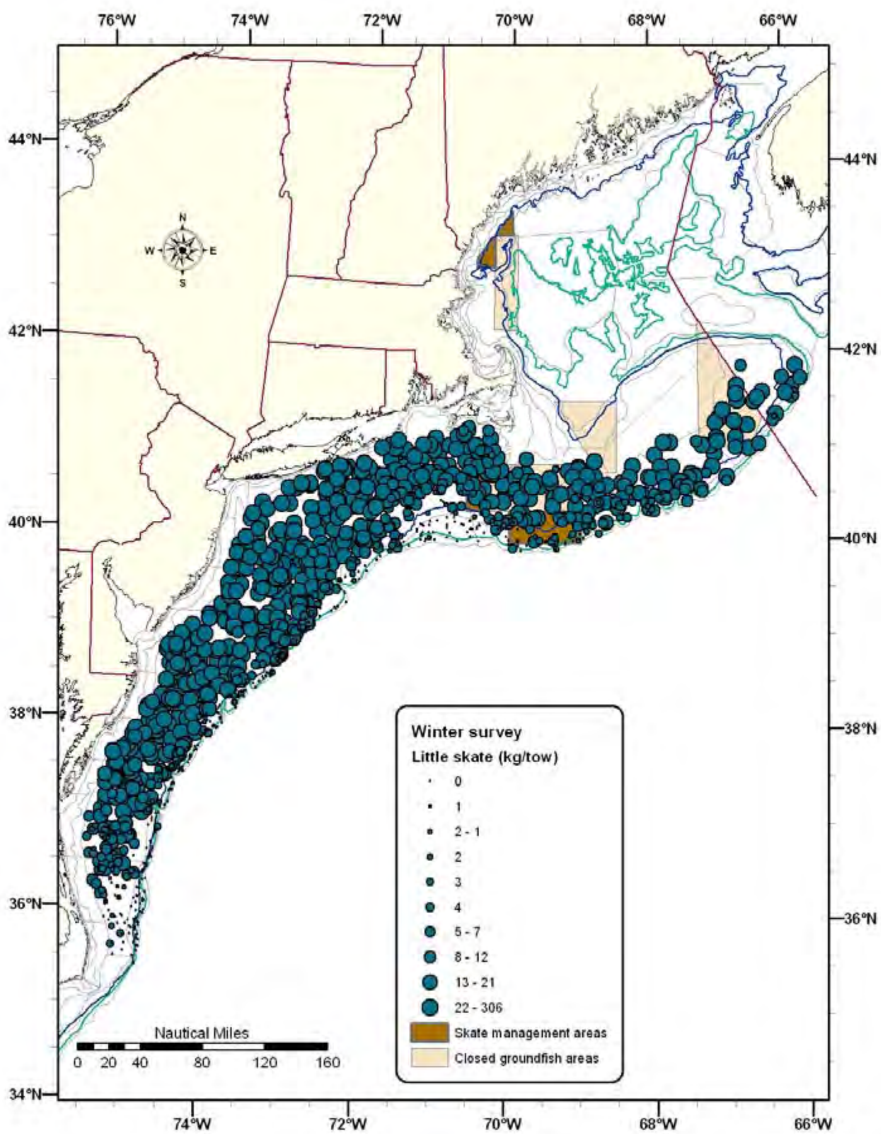
Map 1. Winter skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

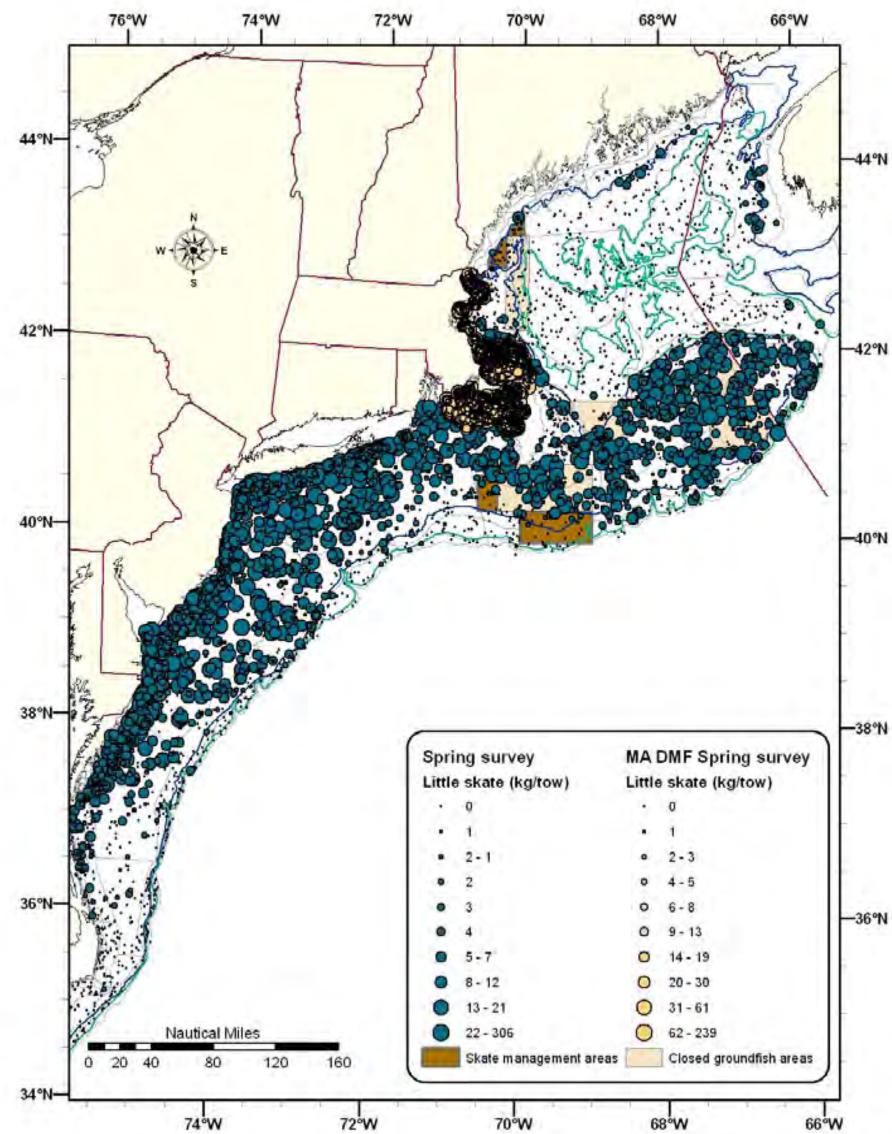
Winter (Feb/Mar)	Spring (Apr/May)
	

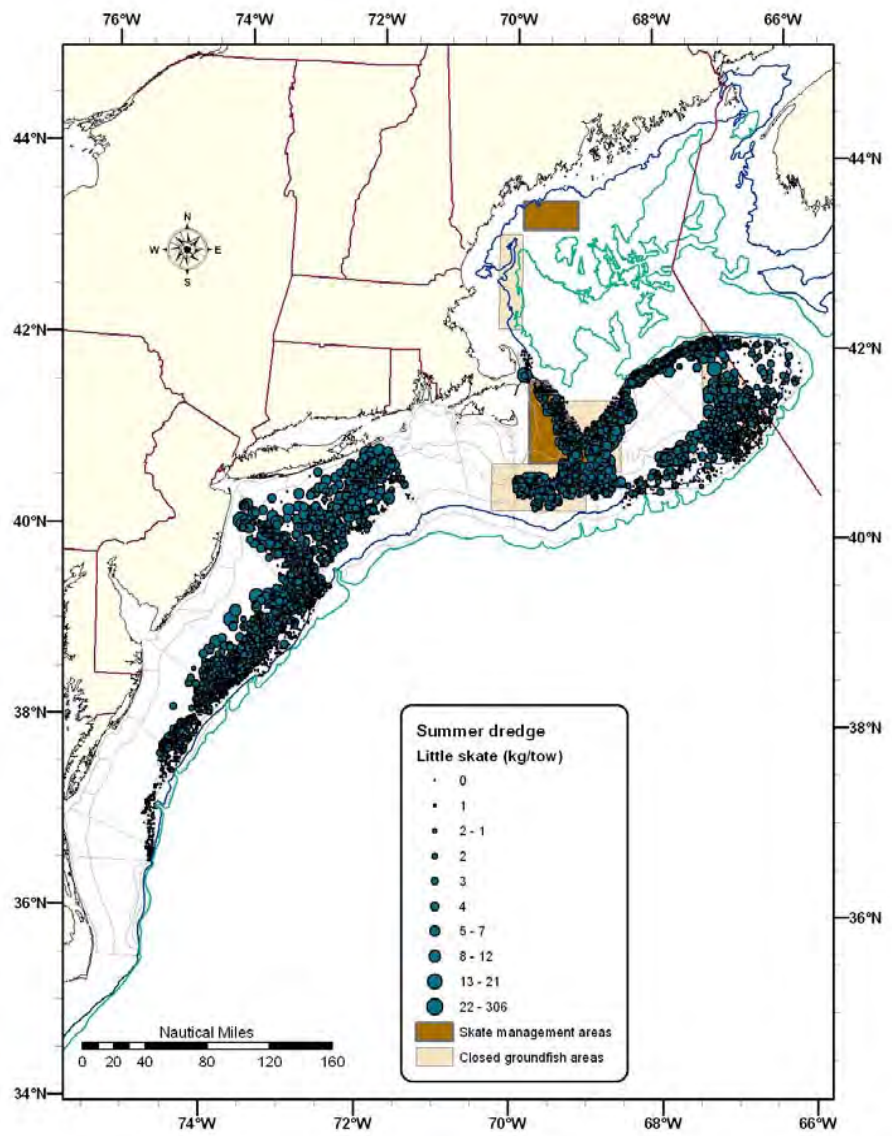
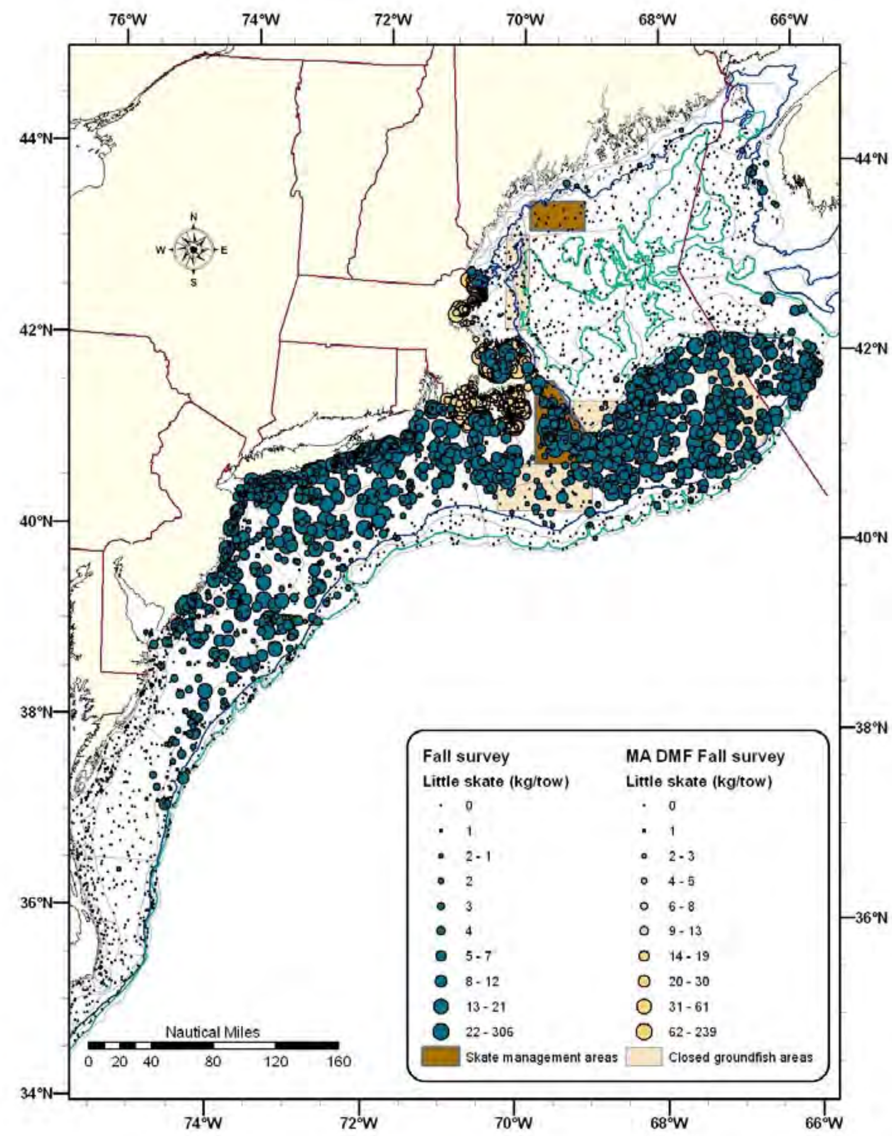
Summer (Jul/Aug)	Autumn (Sep/Oct)
	

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.

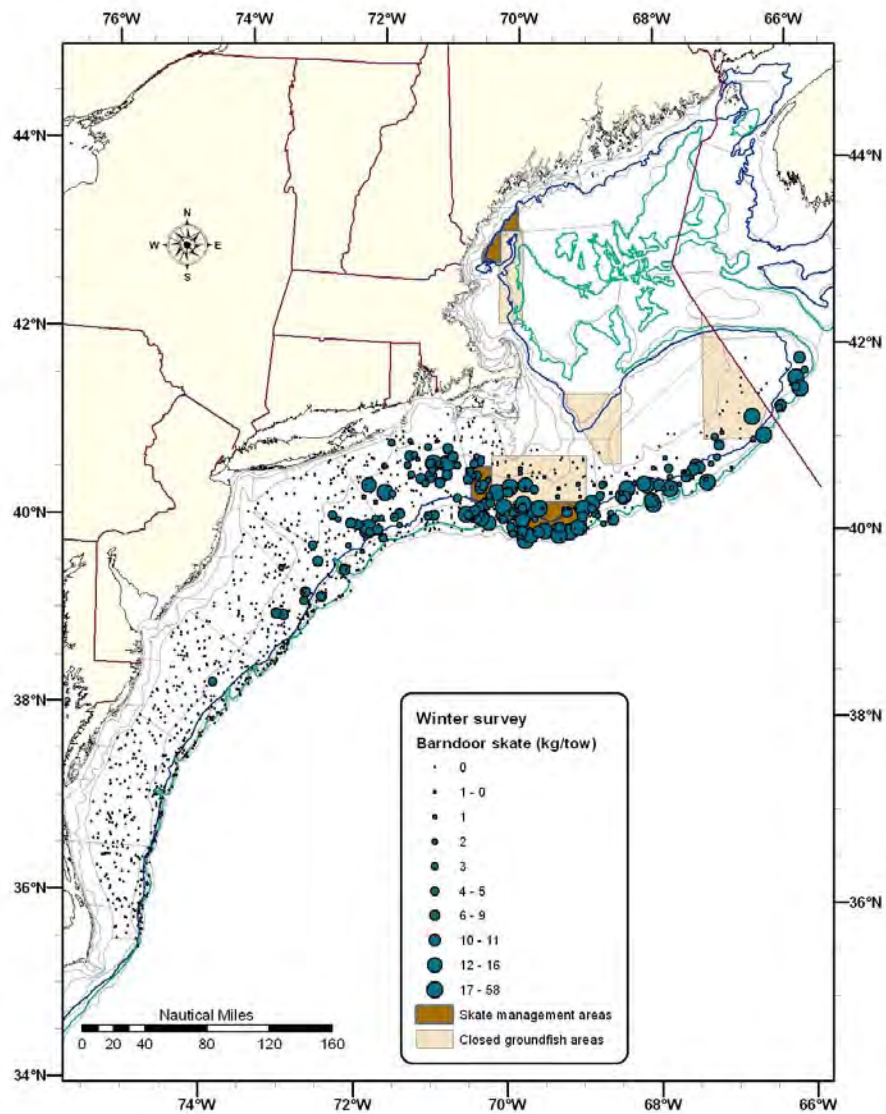
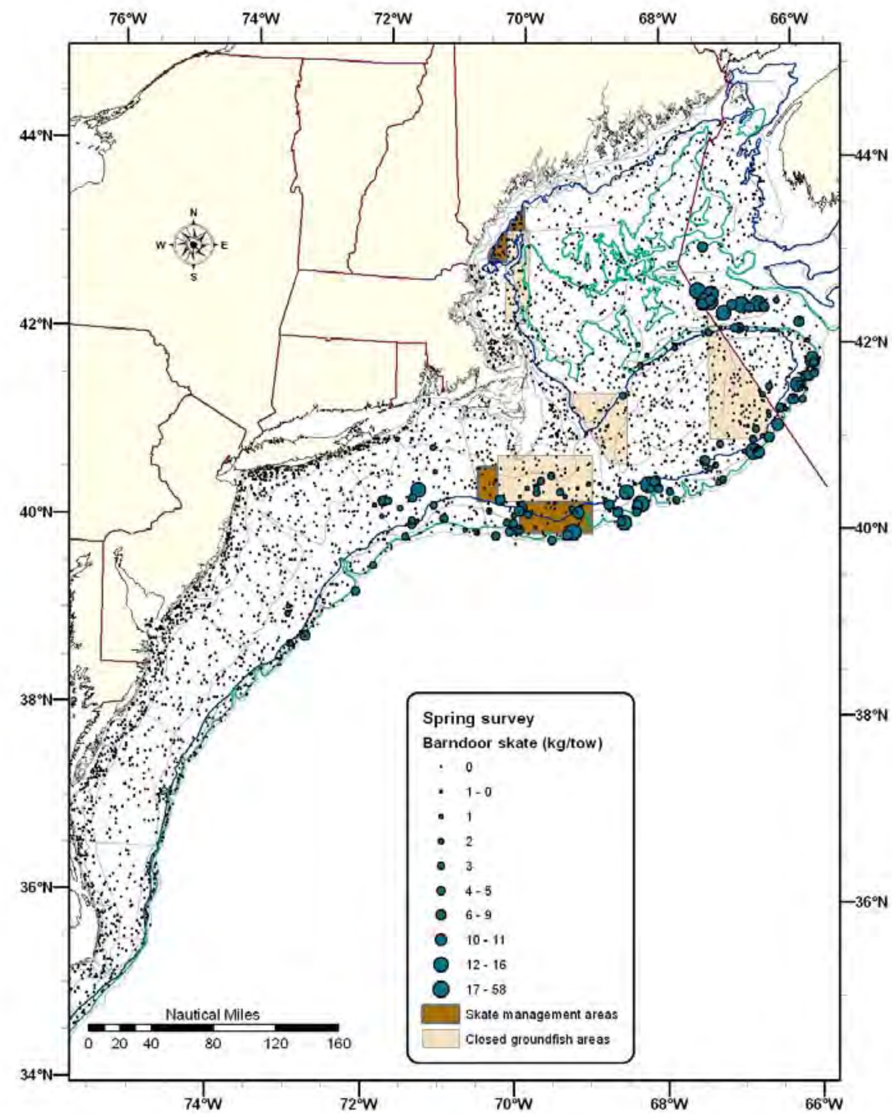
Winter (Feb/Mar)	Spring (Apr/May)



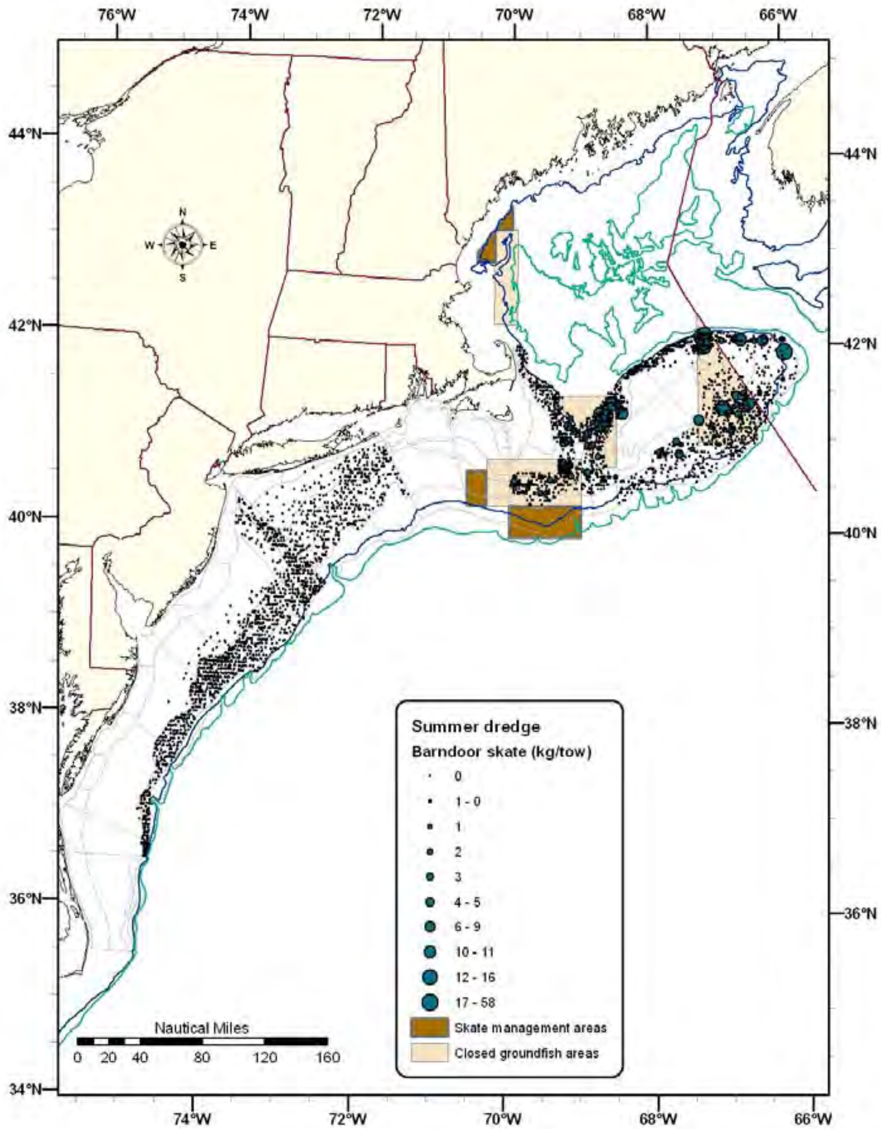


Summer (Jul/Aug)	Autumn (Sep/Oct)
	

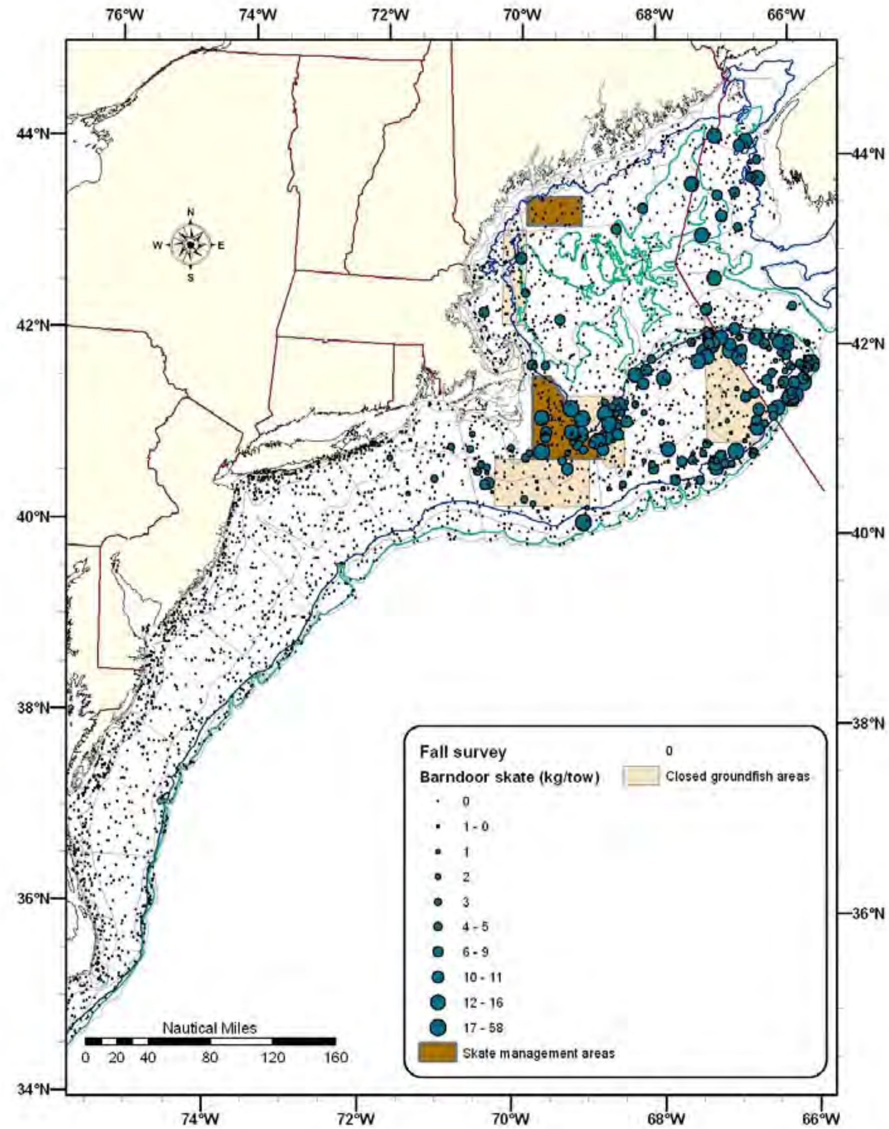
Map 3. Barndoor skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

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

Summer (Jul/Aug)

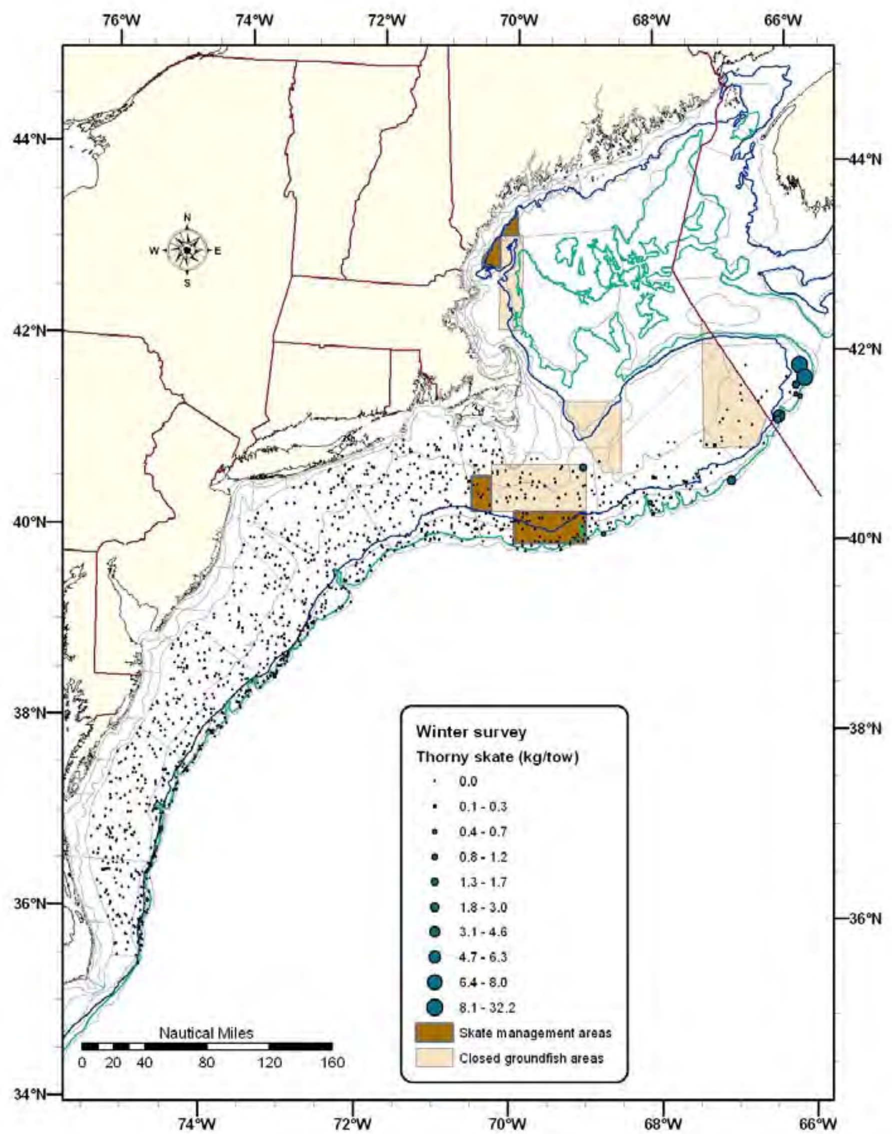


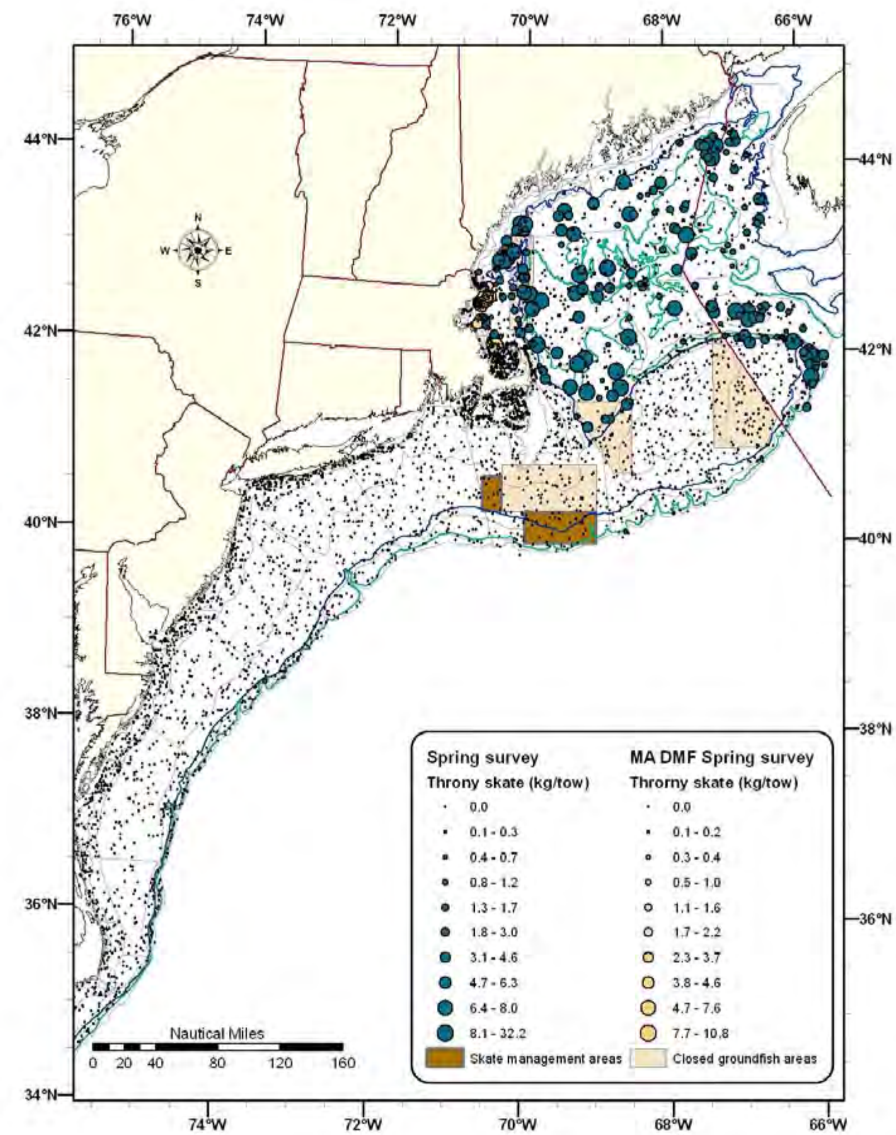
Autumn (Sep/Oct)

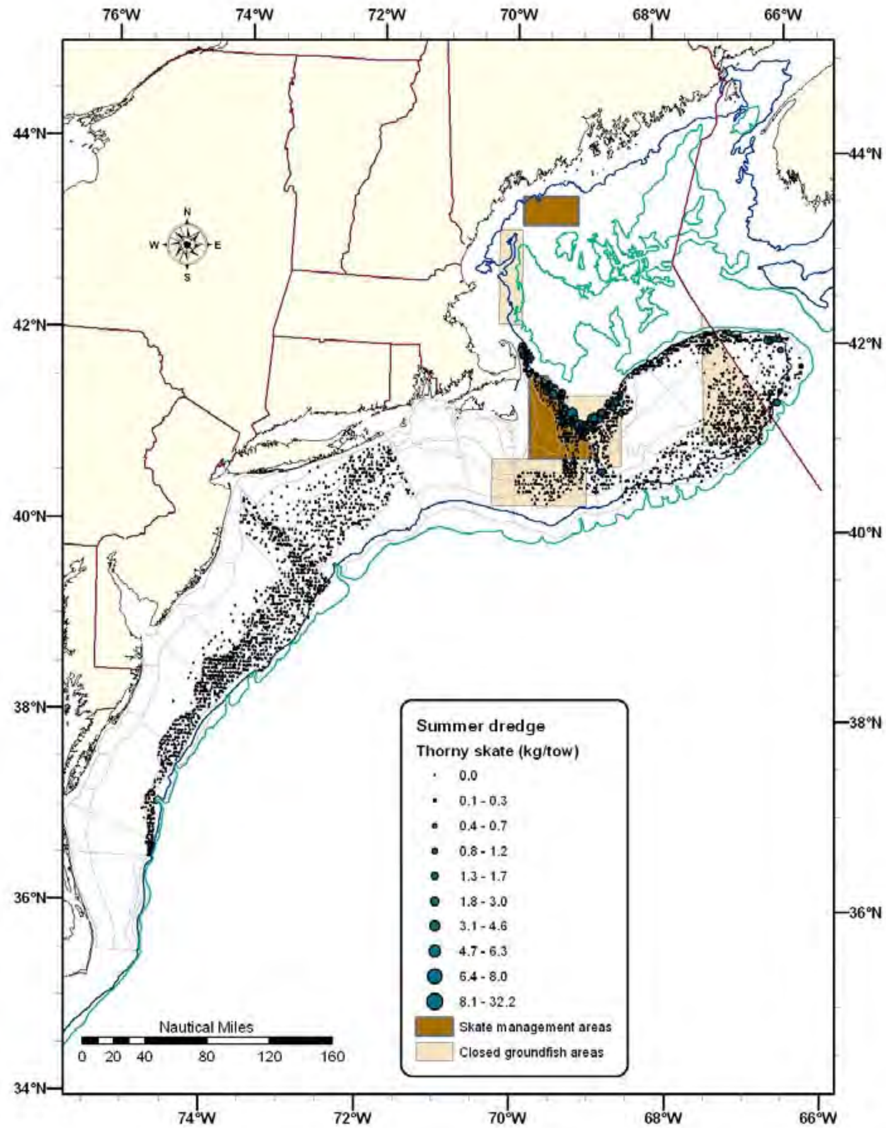
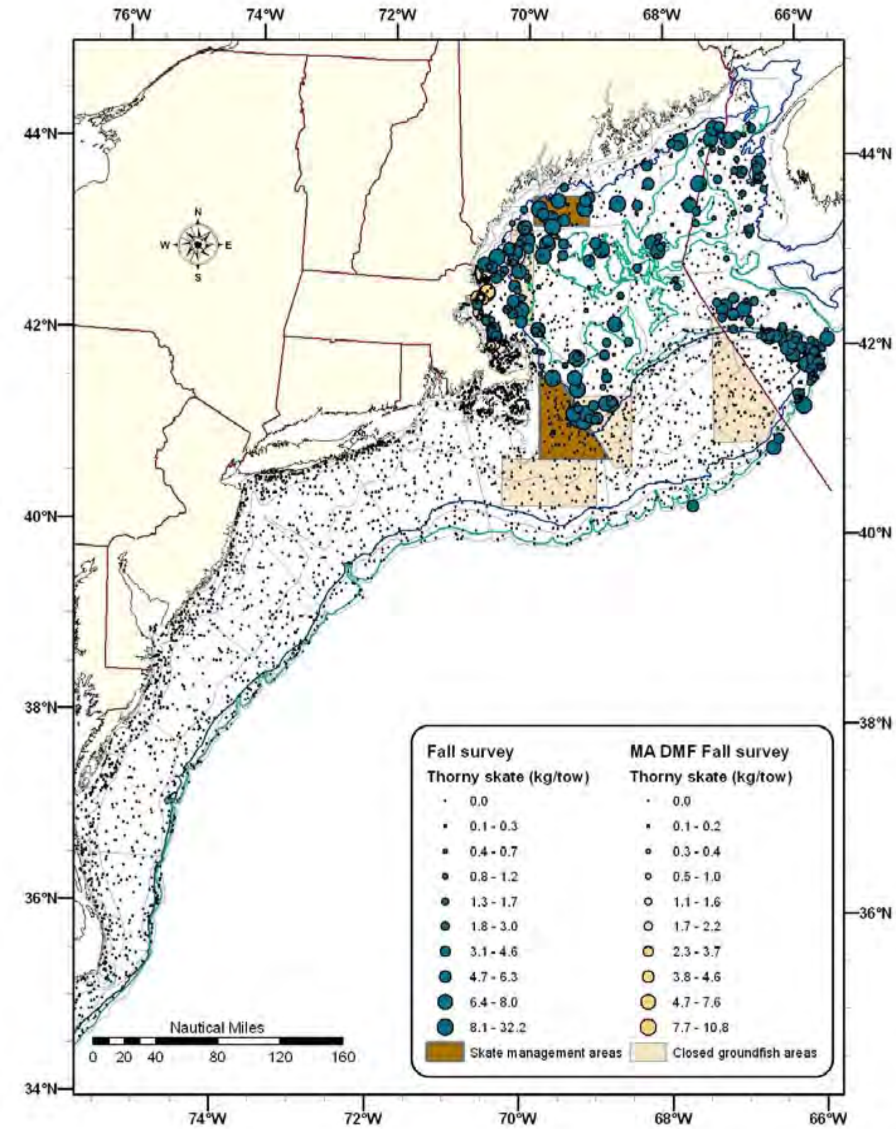


Map 4. Thorny skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

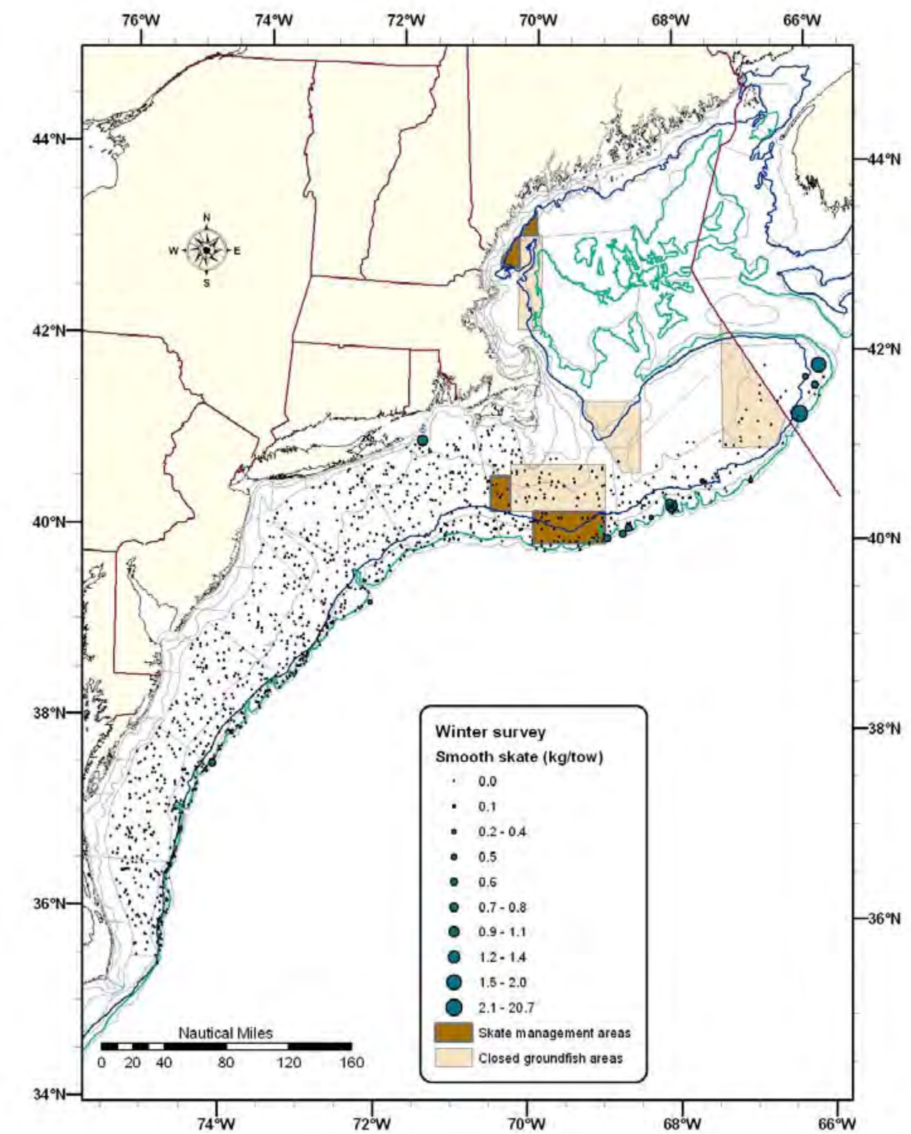
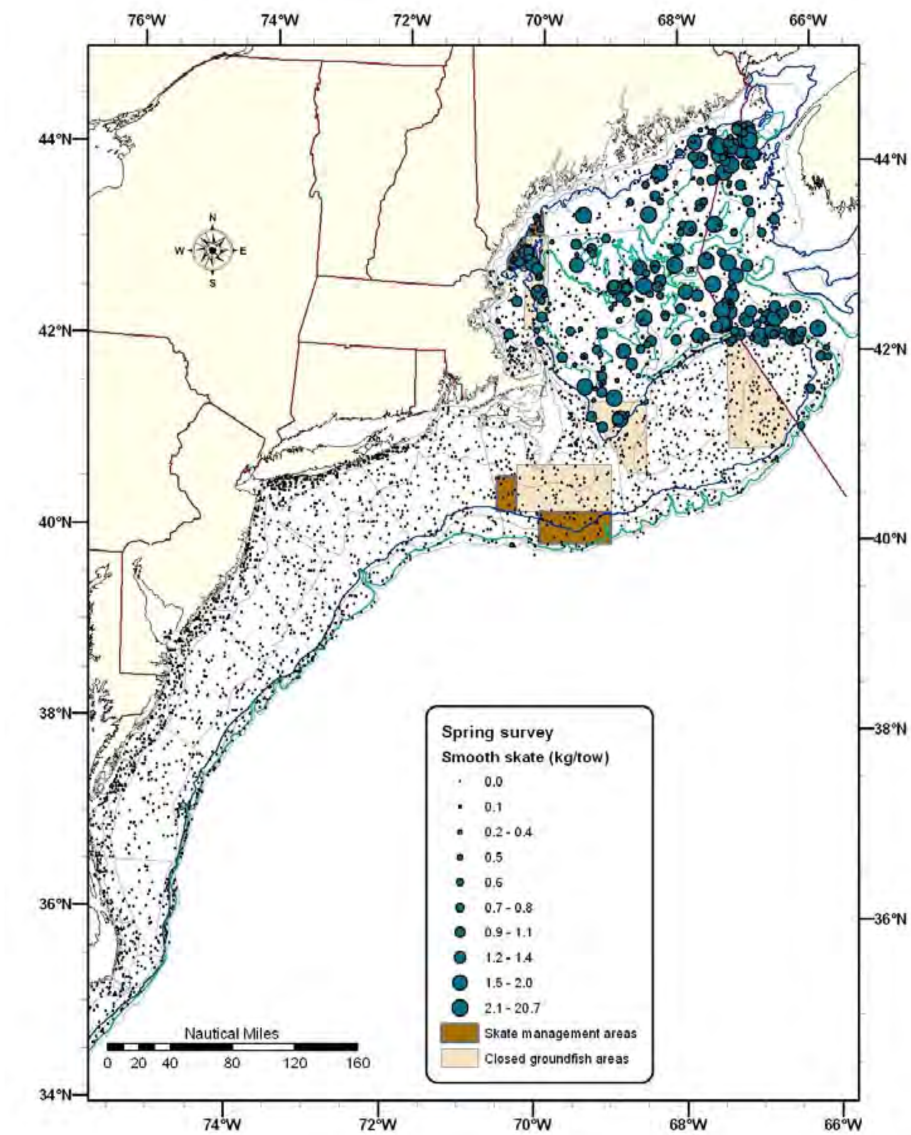
Winter (Feb/Mar)	Spring (Apr/May)



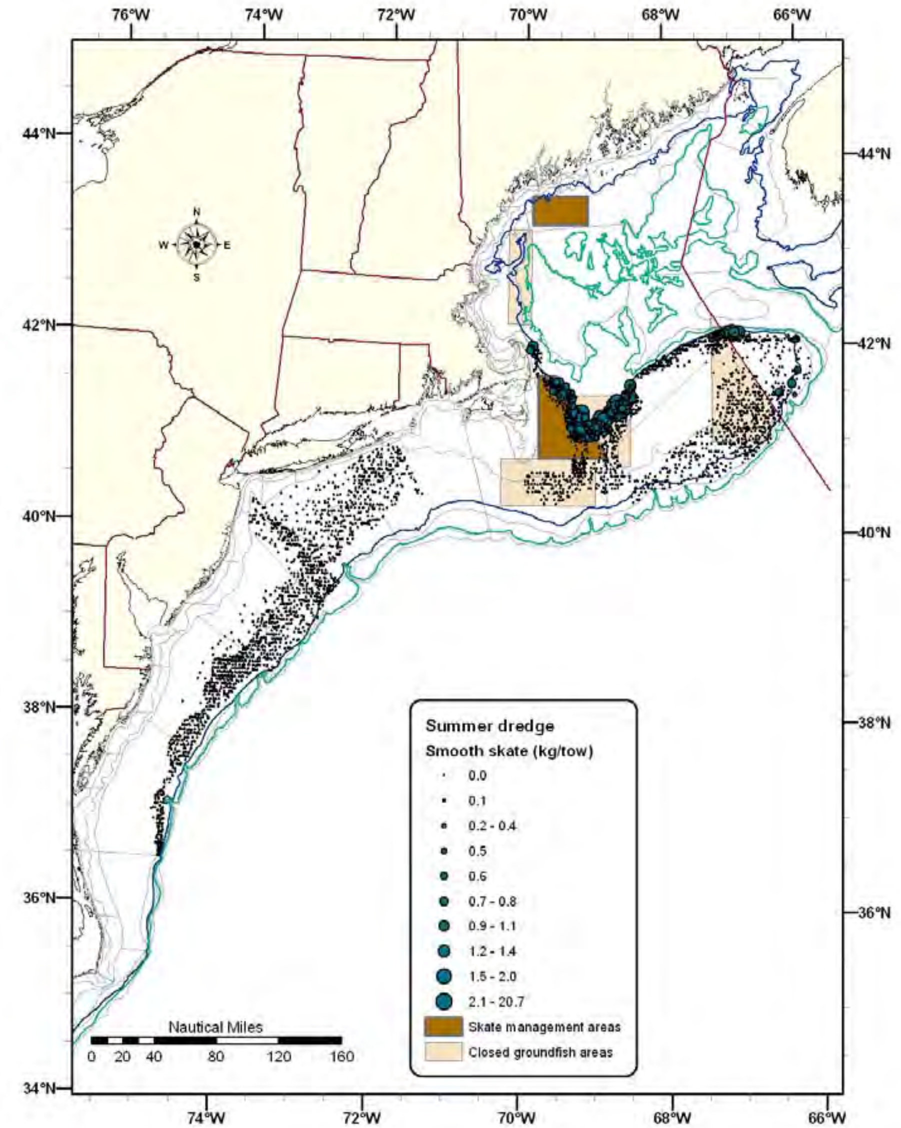


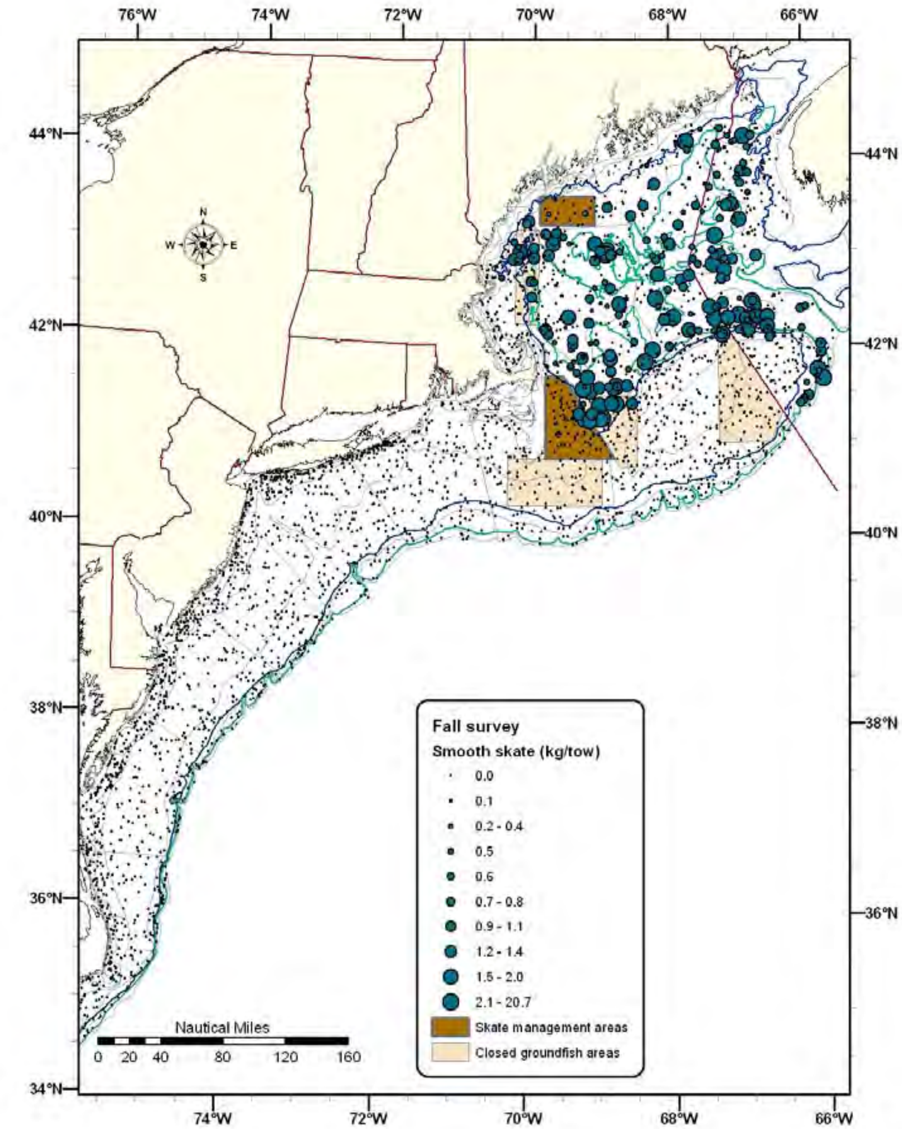
Summer (Jul/Aug)	Autumn (Sep/Oct)
	

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)
	

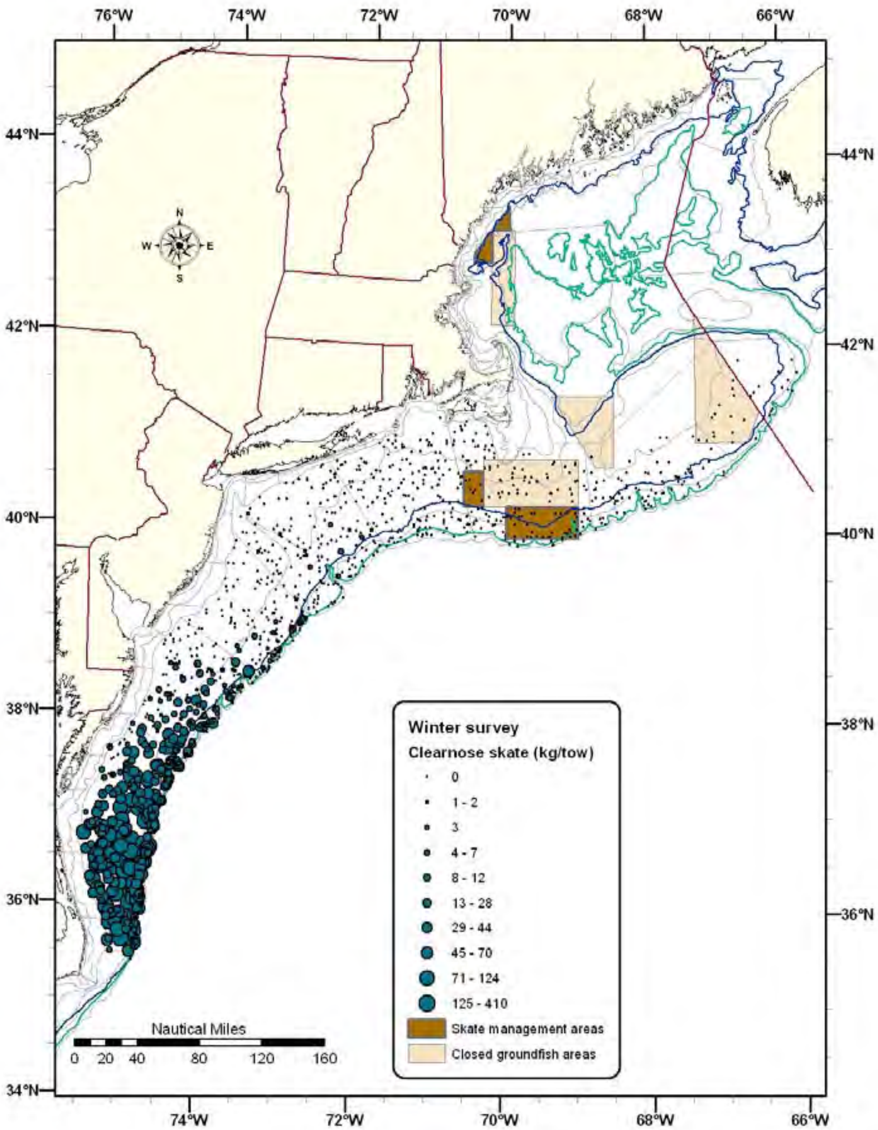
Summer (Jul/Aug)	Autumn (Sep/Oct)

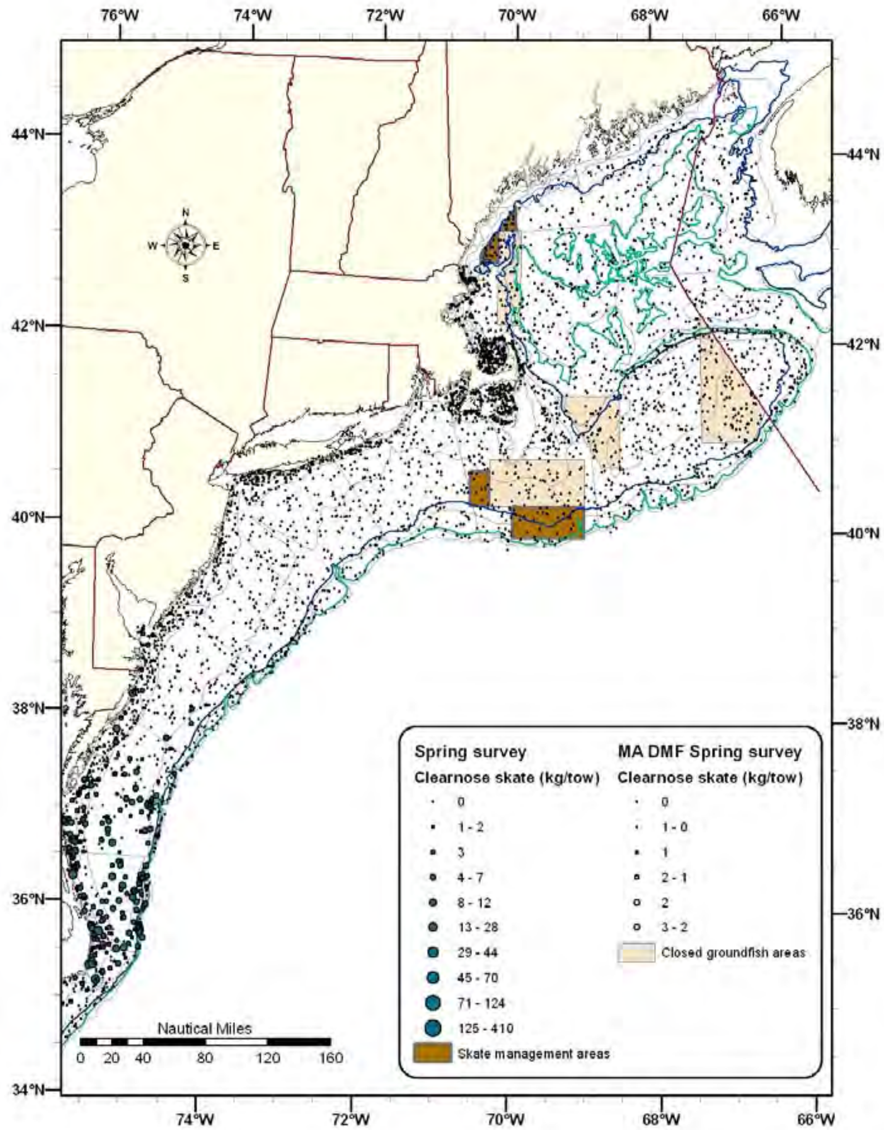


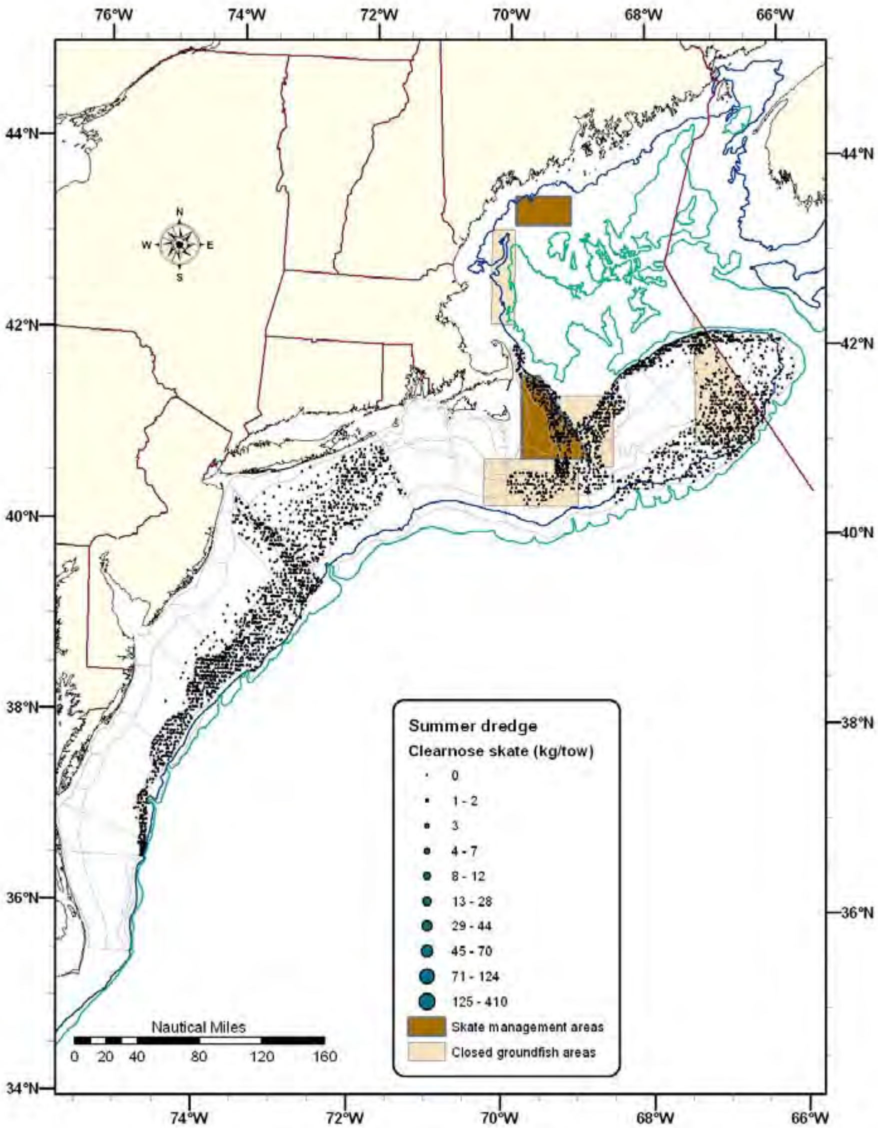
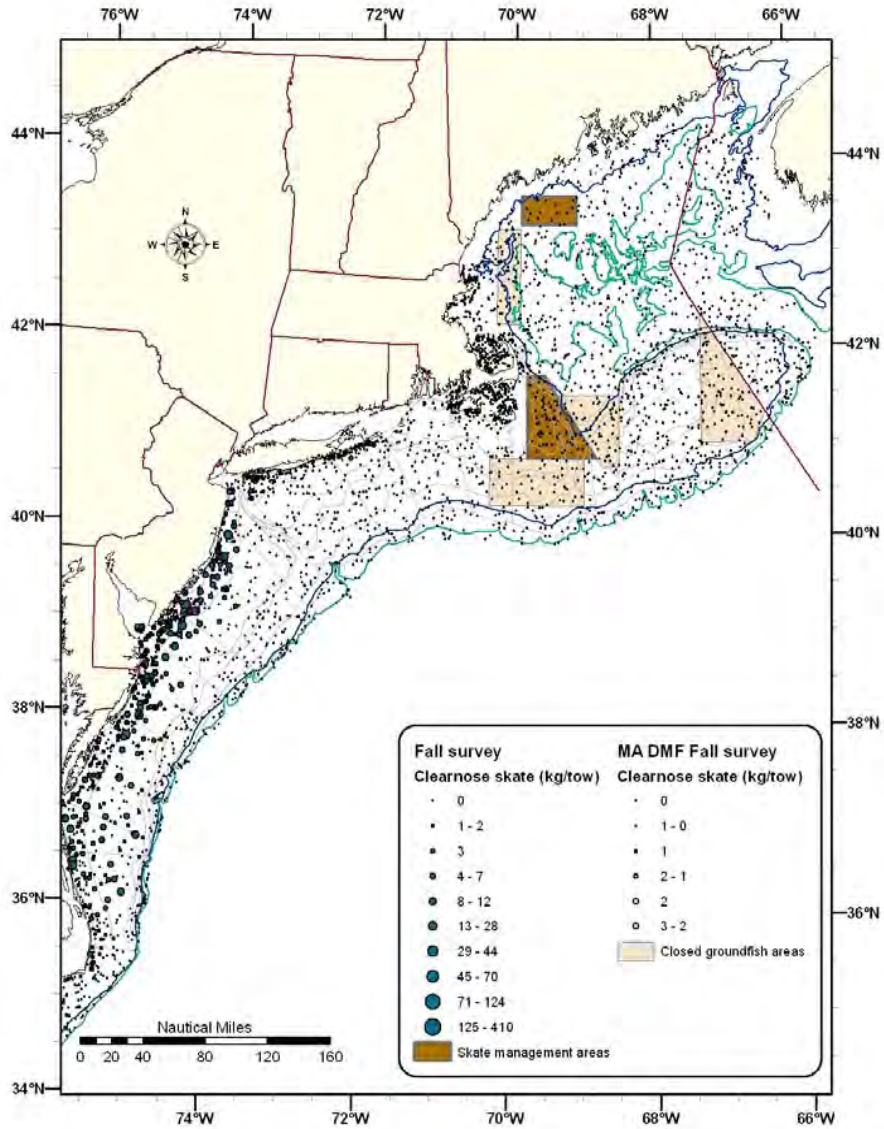


Map 6. Clearnose skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

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

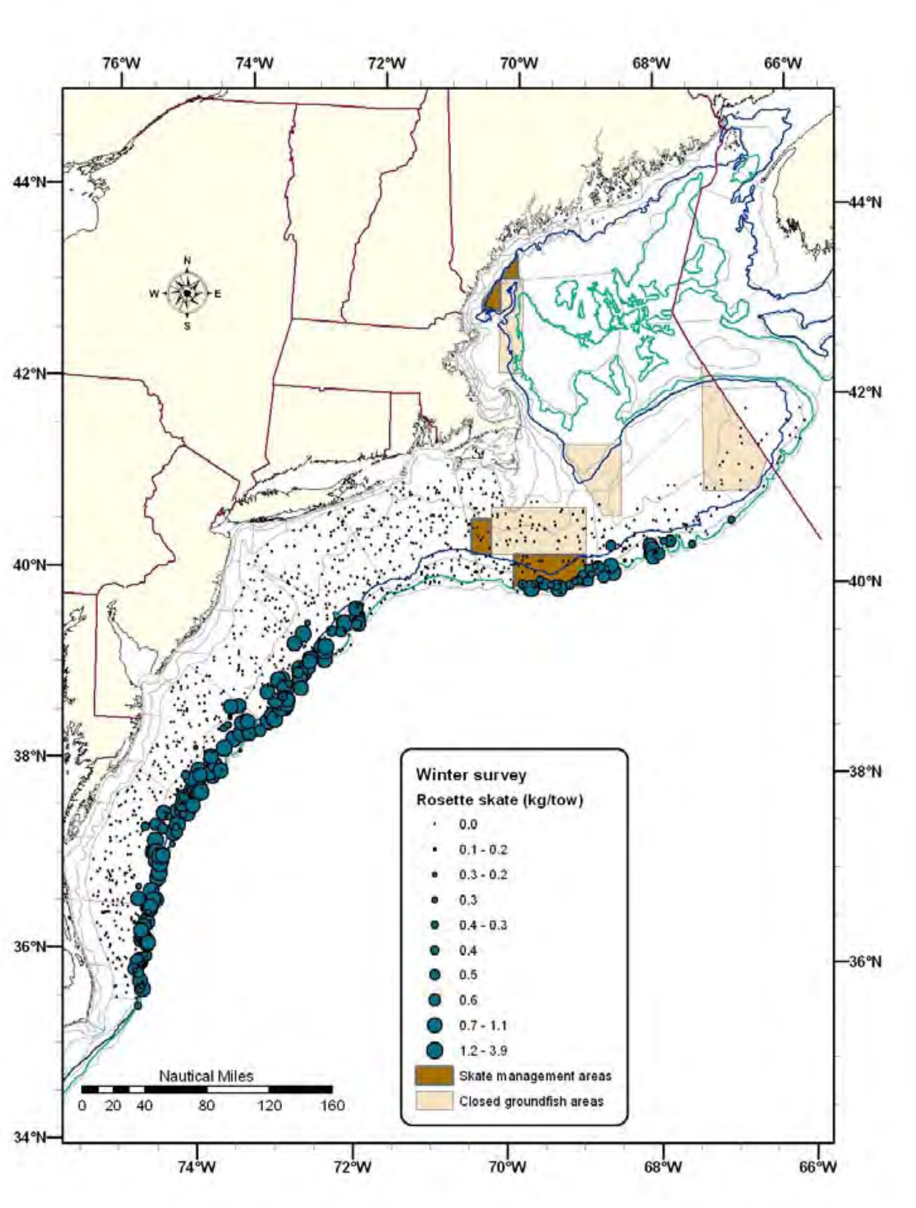




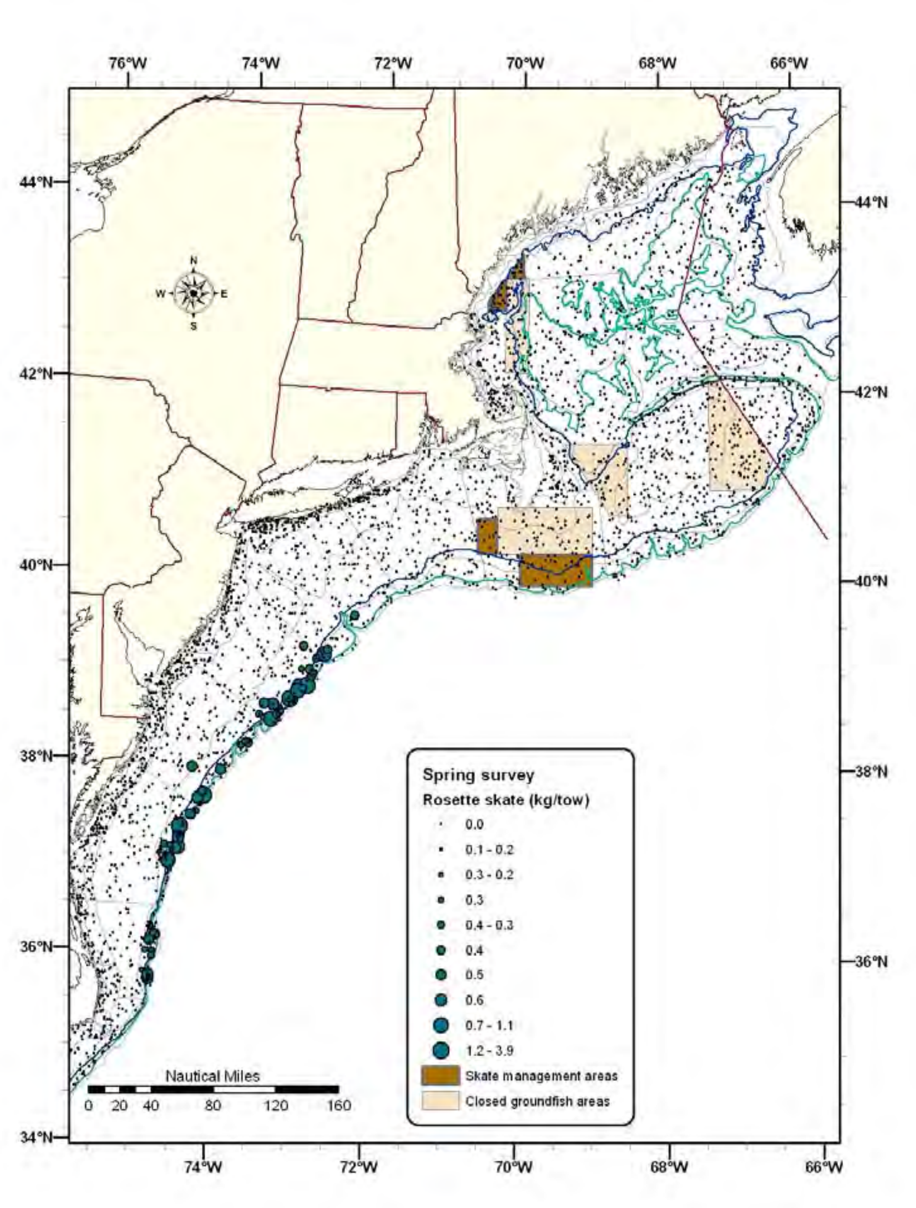
Summer (Jul/Aug)	Autumn (Sep/Oct)
	

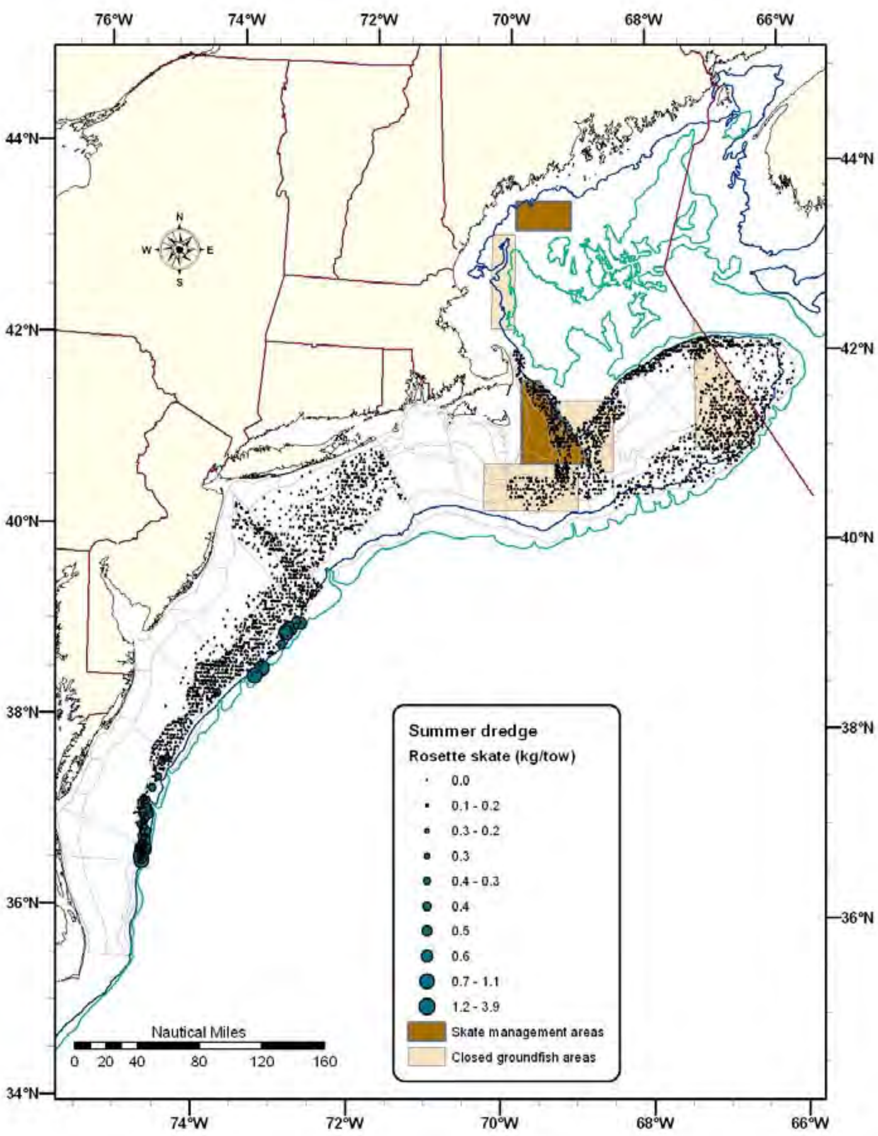
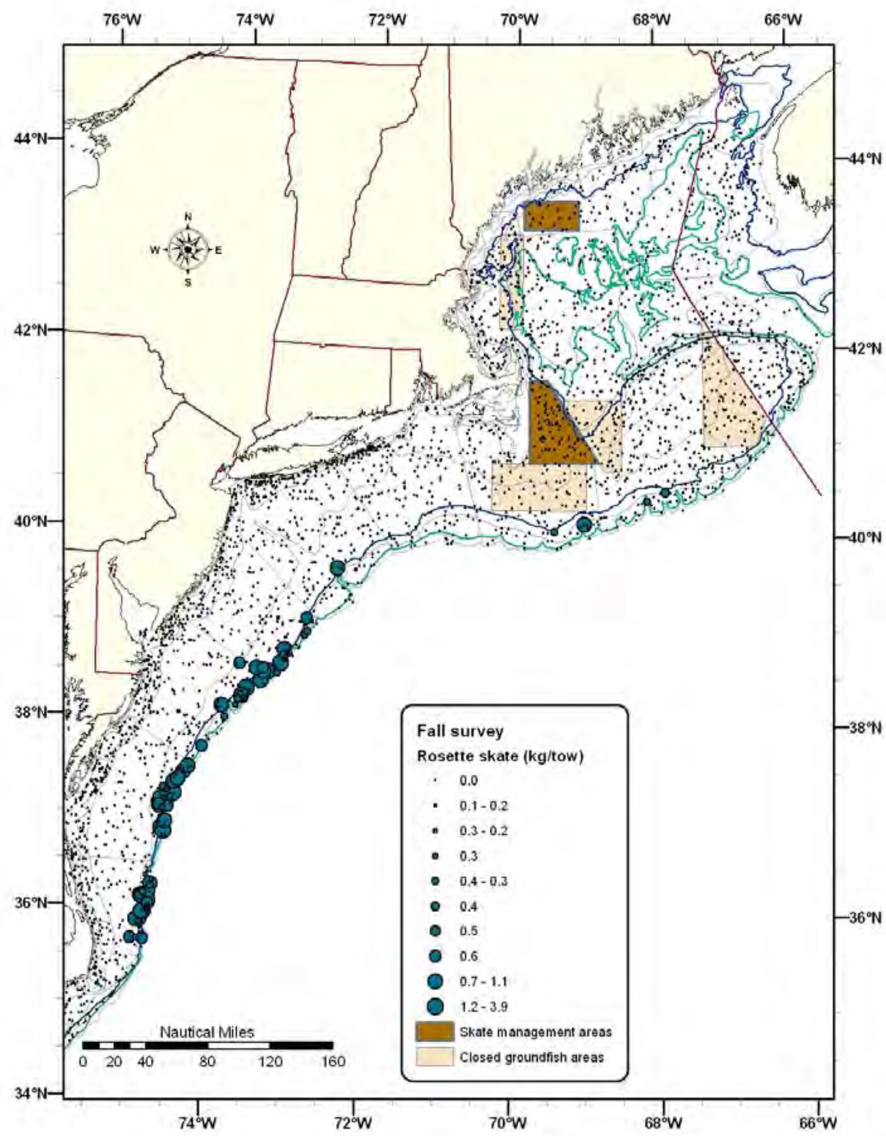
Map 7. Rosette skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

Winter (Feb/Mar)



Spring (Apr/May)



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

7.2.4 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.

7.2.4.1 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_∞ = 121.8 cm TL, t_o = -1.418; calculated estimates for female winter skates were: k = 0.059, L_∞ = 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.

7.2.4.2 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).

7.2.4.3 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.

7.2.4.4 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.

7.2.4.5 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.

7.2.4.6 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.

7.2.4.7 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.

7.2.5 Feeding habits

The level of gadids and flatfish have declined since the 1970s while elasmobranchs have increased in number (NEFSC, 1998). Availability of prey or the removal of predation may contribute to this phenomenon (Fogarty & Murawski, 1998). Grosslein et al (1980) and Nelson (1993) identified a high dietary overlap between yellowtail flounder and little skate. This overlap appeared higher when both species were small and declined with increasing size, thus reducing the overall competition between the species (Nelson, 1993). Garrison & Link (2000) constructed dietary guilds in the Northeastern United States, including flatfishes and skates. Small to medium little skates were allocated to the amphipod/shrimp guild along with four-spot flounder, windowpane and yellowtail flounder. Little skates shifted to piscivores with increasing size. Winter flounder was allocated to the benthivores guild. Little skate comprises a large proportion of the percentage of biomass in the species composition of seasonal spatial assemblages on Georges Bank (Garrison, 2000). Garrison (2000) does not support the hypothesis of the decline in gadids and flatfish allowing the observed increase in elasmobranchs because strong exploitative competition doesn't appear to drive Georges Bank dynamics. Link et al (2002) discuss the potential high competitive overlap between flatfishes and skate but note body morphology and secondary prey preferences and availability may mitigate this competition. The level of competition between skates and flatfishes is an area that requires more work but is also difficult to achieve. To identify competition the following must be met: "spatiotemporal overlap, similarity of resource utilization, limiting resources and notable population impacts of the interaction" (Link et al., 2002). These factors contribute to the difficulty of proving competition exists in the field. Winter flounder were found to comprise only a small component (<0.1%) of diet for 1 or 2 skate species despite the skate complex potential to remove a comparable amount of certain prey species as directed fisheries can (Link & Sosebee, 2008).

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

7.2.5.1 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.

7.2.5.2 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.

7.2.5.3 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.

7.2.5.4 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.

7.2.5.5 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.

7.2.5.6 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.

7.2.5.7 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.

7.2.6 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.

7.2.6.1 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.

7.2.6.2 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 75^{th} 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.

7.2.6.3 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.

7.2.6.4 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.

7.2.6.5 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.

7.2.6.6 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.

7.2.6.7 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 75^{th} 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.

7.2.6.8 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.

7.5 Economic 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.

7.5.1 Description of Directed Skate Fisheries

7.5.1.1 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.

7.5.1.1.1 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 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.

7.5.1.1.2 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 7.5.1.3.6 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.

7.5.1.1.3 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.

7.5.1.1.4 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.

7.5.1.2 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 32).

Table 32. 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 7.5.1.3.6 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).

7.5.1.3 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).

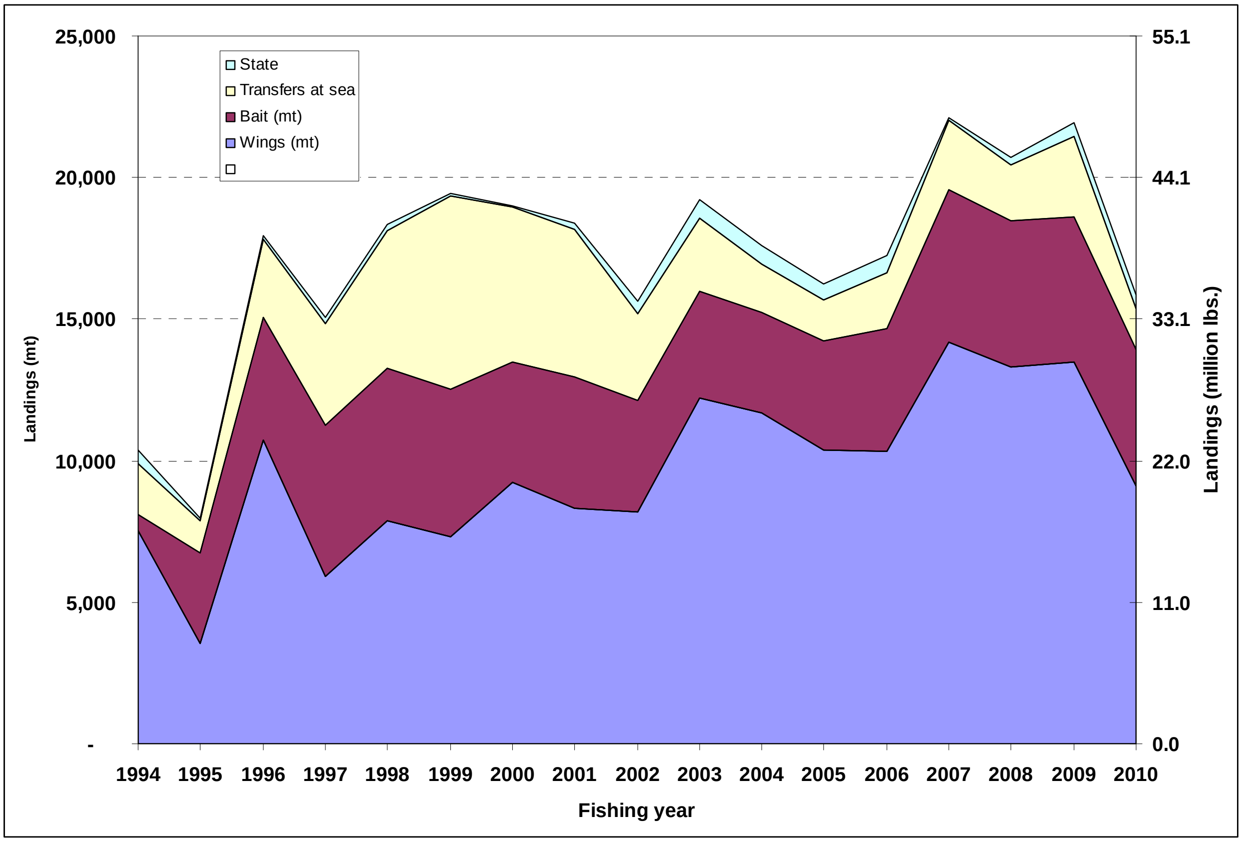
Note that NMFS estimates commercial skate landings from the dealer weighout database and reports total skate landings according to *live weight* (i.e., the weight of the whole skate). This means that a conversion factor is applied to all wing landings so that the estimated weight of the entire skate 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).

7.5.1.3.1 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).

Amendment 3 was implemented on June 16, 2010, near the beginning of the 2010 fishing year. Landings from 2009 to 2010 decline by 28% to 15,836 mt, largely from reductions in the wing fishery. Skate transfers at sea for bait, reported on VTRs, also declined by 50% to 1,427 mt. State landings in the figure below include landings reports by dealers which have no or aggregate federal permit numbers, but for actual monitoring purposes, the NE Regional Office determines whether the vessel has a federal permit at the time of landing. State landings in the figure below are henceforth underestimated, compared to TAL monitoring data.

Figure 8. Annual U.S. skate landings (mt), 1994 – 2010 fishing years. The Skate Complex FMP was implemented in 2003.



7.5.1.3.2 Landings by fishery

Federal permitted seafood dealers report skate landings by intended market, recorded with either a disposition or utility code. Although slight differences occur (and the disposition code began in 1996), nearly all of the skate landings are recorded as 'bait' or 'food or unknown' and the two codes agree in the vast majority of cases. In addition, vessel operators report landings and transfers at sea (dealer=000002) by vessel trip reports (VTR) since 1994.

Skate landings reported for the food market began at least as early as 1963, with 26,000 lbs. of landings (Table 33). Wing landings rose to 35 million pounds in 2003 and then varied between 24.5 and 32.5 million pounds since then, before declining to 22.2 million pounds in 2010. Over the period 1995-2006 (the period used in Amendment 3 to allocate landings to wing and bait fisheries), wing landings averaged 73.2% of total skate landings. From 1995-2009, before Amendment 3 implementation, wing landings averaged 72.5% of total landings.

Reported bait landings increased rapidly from the first reports in 1983 to 12.2 million pounds in 1992, before declining to relatively low levels from 1995-2003. During this time, it appeared that reported transfers at sea of skates for bait replaced the bait landings reported to dealers, peaking at 15 million pounds in 2000. Bait landings reported by dealers increase by about 10% to 10.0 million pounds during fishing year 2010. Bait landings reported by dealers accounted for 6.7 of total skate landings during 1995-2006 and 9.8% of landings during 1995-2009. Transfers of sea of skates for bait averaged 20.1 %

of total skate landings during 1995-2006 and 17.7% of total skate landings during 1995-2009. Taken together, the bait landings sold to dealers or transferred at sea averaged 26.8% of total skate landings during 1995-2006 and 27.5% during 1995-2009.

On a price per whole pound basis[1], skate prices for wings were two to two and half times those paid by dealers for bait (Table 33). In 2010, however, bait prices increased to $0.25 per pound, while prices for wings increased slightly to $0.23 per whole pound (or $0.52 for wings). It should be noted that in 2010, skate wing prices varied considerably as the supply of skate wings changed in response to skate possession limit changes.

Table 33. Fishing year landings and price per live pound by fishery. Source NMFS dealer SAFIS and VTR files.

	Bait			Transfers at sea		Wings			Total Landings,
Fishing year	Landings, lbs live wt	Percent	Price per lb.	Landings, lbs live wt	Percent	Landings, lbs live wt	Percent	Price per lb.	lbs live wt
1963		0%				26	100%	$0.04	26
1964		0%				89	100%	$0.04	89
1965		0%				76	100%	$0.04	76
1966		0%				127	100%	$0.04	127
1967		0%				87	100%	$0.04	87
1968		0%				84	100%	$0.05	84
1969		0%				136	100%	$0.05	136
1970		0%				132	100%	$0.06	132
1971		0%				162	100%	$0.07	162
1972		0%				180	100%	$0.07	180
1973		0%				176	100%	$0.08	176
1974		0%				223	100%	$0.08	223
1975		0%				277	100%	$0.10	277
1976		0%				291	100%	$0.13	291
1977		0%				331	100%	$0.12	331
1978		0%				821	100%	$0.12	821
1979		0%				1,562	100%	$0.14	1,562
1980		0%				854	100%	$0.13	854
1981		0%				733	100%	$0.14	733
1982		0%				1,506	100%	$0.08	1,506
1983	92	4%	$0.59			1,988	96%	$0.06	2,080
1984	18	1%	$0.06			1,801	99%	$0.06	1,818
1985	114	7%	$0.05			1,612	93%	$0.07	1,725
1986	277	11%	$0.05			2,221	89%	$0.08	2,498
1987	81	2%	$0.06			4,525	98%	$0.08	4,606
1988	9,019	67%	$0.05			4,343	33%	$0.08	13,362
1989	9,105	57%	$0.05			7,007	43%	$0.10	16,112
1990	10,554	41%	$0.05			15,421	59%	$0.10	25,976
1991	12,195	46%	$0.05			14,140	54%	$0.09	26,335
1992	12,068	44%	$0.06			15,182	56%	$0.13	27,250
1993	1,923	11%	$0.07			15,370	89%	$0.16	17,293
1994	1,019	5%	$0.06			17,864	95%	$0.28	18,883
1995	3,883	20%	$0.21	3,980	21%	11,197	59%	$0.22	19,060
1996	23	0%	$0.12	2,525	7%	33,451	93%	$0.19	35,999
1997	97	0%	$0.06	6,115	19%	25,255	80%	$0.14	31,467
1998	654	2%	$0.06	7,890	21%	29,033	77%	$0.13	37,578
1999	145	0%	$0.10	10,752	28%	27,716	72%	$0.12	38,613
2000	50	0%	$0.12	15,040	33%	29,832	66%	$0.13	44,922
2001	1,184	3%	$0.16	12,050	29%	27,832	68%	$0.11	41,066
2002	665	2%	$0.21	11,564	29%	27,091	69%	$0.13	39,319
2003	865	2%	$0.08	6,753	16%	35,736	82%	$0.13	43,353
2004	7,417	18%	$0.08	5,717	14%	27,616	68%	$0.17	40,750
2005	8,086	22%	$0.10	3,777	10%	24,546	67%	$0.20	36,409
2006	6,870	19%	$0.09	3,158	9%	26,711	73%	$0.25	36,739
2007	9,247	19%	$0.09	4,256	9%	33,979	72%	$0.22	47,482
2008	9,130	20%	$0.10	5,448	12%	30,739	68%	$0.20	45,317
2009	9,050	20%	$0.11	4,350	9%	32,486	71%	$0.20	45,886
2010	10,012	26%	$0.25	6,280	16%	22,247	58%	$0.23	38,539
1995-2006		6.7%			20.1%		73.2%		
1995-2009		9.8%			17.7%		72.5%		

Nearly all skate bait landings are landed in whole form (Table ???). Some dealers have reported landings of wings for the bait market, but these reports may either be inaccurate or represent landings of wings that cannot be marketed for food. On the other hand, since 1995 a significant amount of landings for the skate wing market (reported as 'food or unknown' on dealer reports were landed in whole form, presumably cut shoreside with the carcasses either sold as bait or disposed as unmarketable. This practice (landing whole skates for the wing market) seemed to be more prevalent from 1995 to 2003, but it appears to coincide with a period of low landings reports by dealers. Thus some of these landings of whole skates for the wing market were probably really destined for the skate market and not reported or coded accurately on the dealer reports. It would be difficult to distinguish the difference in the dealer report data without making assumptions.

[1] Skate landings reported as wing landings are converted using an accepted ratio of 2.27.

Table 34. Skate landings by fishery and product form.

	Bait		Bait Total	Food or unknown		Food or unknown Total
FISHING_YEAR	Whole	Wings		Whole	Wings	
1963				26		26
1964				89		89
1965				76		76
1966				127		127
1967				87		87
1968				84		84
1969				136		136
1970				132		132
1971				162		162
1972				180		180
1973				176		176
1974				223		223
1975				277		277
1976				291		291
1977				331		331
1978				821		821
1979				1,562		1,562
1980				854		854
1981				733		733
1982				392	1,113	1,506
1983	92		92	242	1,746	1,988
1984	18		18	83	1,717	1,801
1985	114		114	177	1,435	1,612
1986	277		277	197	2,024	2,221
1987	81		81	86	4,439	4,525
1988	9,019		9,019	168	4,175	4,343
1989	9,102	3	9,105	674	6,333	7,007
1990	10,554		10,554	370	15,052	15,421
1991	12,061	134	12,195	657	13,483	14,140
1992	11,945	123	12,068	378	14,805	15,182
1993	1,906	17	1,923	684	14,686	15,370
1994	1,017	3	1,019	560	17,304	17,864
1995	3,843	40	3,883	3,172	8,025	11,197
1996	23		23	9,587	23,864	33,451
1997	97		97	11,812	13,443	25,255
1998	654	0	654	11,293	17,740	29,033
1999	113	32	145	11,504	16,213	27,716
2000	50		50	9,338	20,495	29,832
2001	1,183	1	1,184	9,159	18,673	27,832
2002	638	27	665	8,589	18,501	27,091
2003	865		865	8,345	27,391	35,736
2004	7,412	5	7,417	1,182	26,433	27,616
2005	8,003	84	8,086	1,222	23,324	24,546
2006	6,853	17	6,870	2,970	23,741	26,711
2007	9,246	0	9,247	2,603	31,376	33,979
2008	9,130		9,130	2,358	28,381	30,739
2009	9,050	0	9,050	2,590	29,897	32,486
2010	9,417	595	10,012	1,014	21,233	22,247

7.5.1.3.3 Landings by State

Table 35 presents commercial landings of skates by individual states from 2003 – 2010. Massachusetts and Rhode Island continue to dominate the skate fishery, averaging about 20 – 30 million lb annually across the time series. Skate landings from Massachusetts and Rhode Island comprised 80-94% of the total reported annual skate landings during this period. Rhode Island landings have remained fairly consistent but declined in 2009 and 2010, while Massachusetts landings have increased significantly since 2000, before dropping in 2010. 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 (no listed due to confidentiality) reported minimal skate landings for the time series.

From 2009 to 2010, bait landings increased by 7 percent, mostly from increases in RI where bait landings increased by 10%. Wing landings, on the other hand, declined by 33% to 22 million pounds, mostly in MA. Wing landings in RI were about the same as they were in 2009, but less than half of the amounts in 2003 to 2010. It may be that the utility code reported by dealers for landings in RI (where most bait landings occur) were misclassified before 2009. Skate wing landings in NJ and NY increased by 22 and 42 percent, respectively.

Table 35. U.S. skate landings (thousands lbs) by state, 2003-2010. *Source: NMFS Dealer reports.*

		Fishing year								
Fishery	**State**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Change**
Bait	CT	690	6	620	413	419			320	
	MA			1	32	129	592	2,043	1,603	-22%
	MD	45	0	5	10			0	8	4755%
	NJ	129	5	16			60	349	511	46%
	RI	0	17	33	57	301	1,943	6,594	7,246	10%
	VA	1	0	6		15	13	64	9	-85%
Bait Total		865	28	682	512	864	2,608	9,050	9,697	7%
Wing	CT	292	905	153	151	126	1,455	956	224	-77%
	MA	20,054	23,766	20,523	23,511	29,868	26,134	23,541	12,075	-49%
	MD	15	10	22	17	53	107	173	52	-70%
	ME	103	26	4	7	68	9	6	10	72%
	NC	1	1	0	0	1	11	4	17	366%
	NH	25	24	20	26	11	12	15	7	-50%
	NJ	855	776	794	963	1,326	1,579	2,174	2,661	22%
	NY	767	420	375	515	776	942	1,458	2,076	42%
	RI	13,582	9,003	10,024	8,036	10,111	8,323	4,349	4,341	0%
	VA	82	71	65	24	122	137	366	584	59%
Wing Total		35,776	35,003	31,981	33,251	42,461	38,708	33,041	22,048	-33%
Grand Total		36,640	35,031	32,663	33,763	43,325	41,316	42,090	31,745	-25%

7.5.1.3.4 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 36. 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). This mis-identification in the landings declined in 2010 but still remains problematic.

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 37, 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 68-75% 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 35, but declined in 2010 mostly from Amendment 3 regulations.

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 37, the price for whole skates averaged $0.07-0.12 per lb, and the price for skate wings averaged $0.33-0.60 per lb. The price (unadjusted) for whole skates has remained relatively constant, whereas the price for skate wings has been increasing since 2001, but leveled off since 2006. Prices for wings in 2010 averaged $0.52 and the wing landings were 68% of the total.

Table 36. 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. Total live weight of skate landings by reported species code in the dealer SAFIS database, 2007 v 2010.

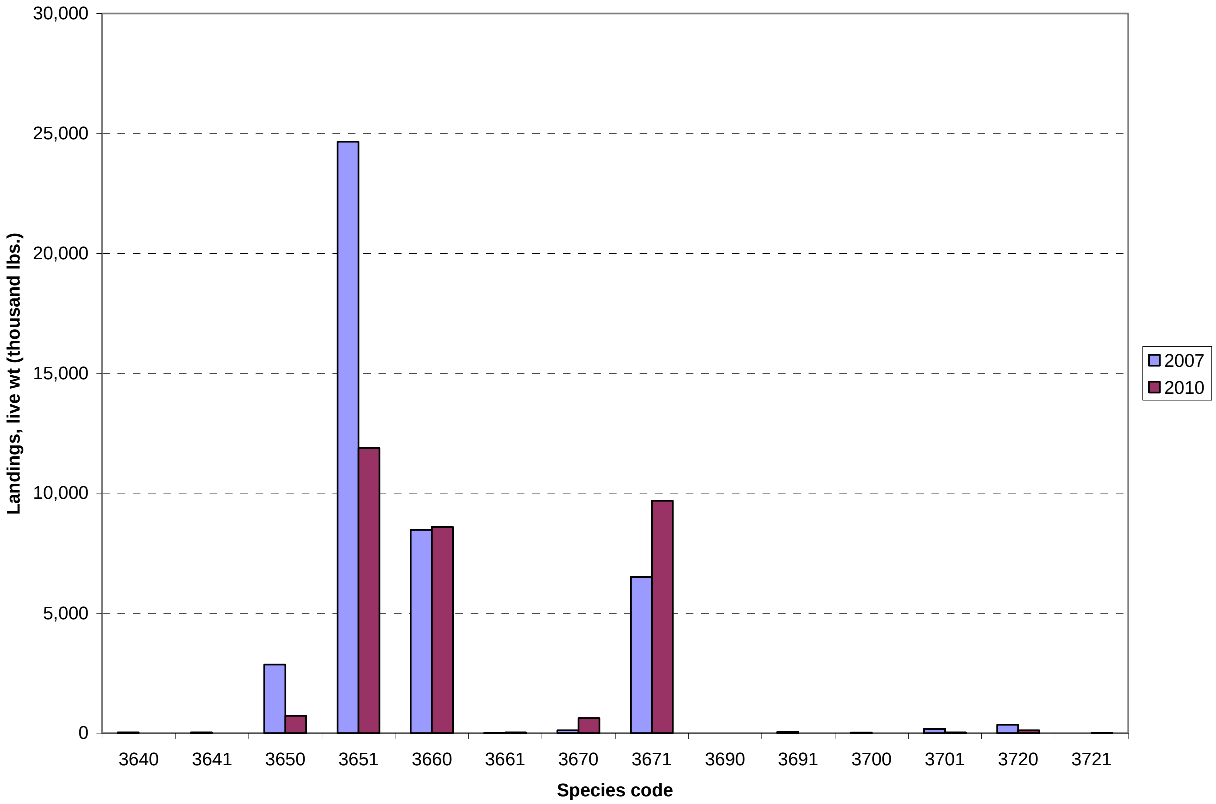


Table 37. Annual skate landings and revenue by landed form (2003-2010). *Source: Dealer SAFIS Database, NMFS*

Fishing year	Landed form	Landed weight (lb)	Live weight (lb)	Revenue (thousands)
2003	Whole	9,206,764	9,206,764	$687
	Wings	12,085,113	27,433,455	$3,928
2003 Total		21,291,877	36,640,219	$4,615
2004	Whole	8,598,935	8,598,935	$696
	Wings	11,643,823	26,431,730	$4,602
2004 Total		20,242,758	35,030,665	$5,298
2005	Whole	9,249,365	9,249,365	$993
	Wings	10,314,129	23,413,404	$4,793
2005 Total		19,563,494	32,662,769	$5,786
2006	Whole	10,054,924	10,054,924	$981
	Wings	10,444,049	23,708,338	$6,258
2006 Total		20,498,973	33,763,262	$7,240
2007	Whole	11,866,957	11,866,957	$1,129
	Wings	13,858,174	31,458,515	$7,230
2007 Total		25,725,131	43,325,472	$8,360
2008	Whole	11,488,141	11,488,141	$1,137
	Wings	13,139,784	29,827,729	$6,013
2008 Total		24,627,925	41,315,870	$7,150
2009	Whole	11,653,816	11,653,816	$1,213
	Wings	13,408,047	30,436,670	$6,305
2009 Total		25,061,863	42,090,486	$7,518
2010	Whole	10,076,697	10,076,697	$1,233
	Wings	9,545,274	21,668,234	$4,926
2010 Total		19,621,971	31,744,931	$6,159

7.5.1.3.5 Landings by Gear

Table 38 presents annual skate landings (2003-2010) from the dealer SAFIS database by gear type and by market category as a percentage of the annual total. Otter trawl is the primary gear used to land skates. Approximately 43-73% of the total skate landings during this period were captured by trawl gear. About 25-30% of the skates caught with otter trawls are landed for the lobster bait market, with the other 70-75% landed for the wing market (Table 38). Almost all skates caught for the lobster bait fishery are caught with a trawl. Gillnets are the secondary gear used to land skates. Almost all skates that are caught with gillnets are landed as wings. Between 2003 and 2010, 95-98% of the total gillnet landings of skates were wings (Table 38). Gillnet landings of skates increased over the time series, representing 25% of the total landings in 2003, but up to 47% of the total in 2010.

Other gears in which skates are consistently caught include traps, hook gear (including longlines), and scallop dredges. The overall contribution of skate landings from gears other than trawl and gillnets is relatively insignificant.

Table 38. Annual (fishing year) skate landings (live weight, thousands lbs) by gear type and market category as a percentage of total skate landings. *Source: Dealer SAFIS Database, NMFS*

Gear type	Landed form	Data	2003	2004	2005	2006	2007	2008	2009	2010
Trawls	Whole	Landings live wt (thousand lbs)	8,799	8,341	8,547	9,674	11,389	10,719	10,506	9,191
		Percent	24%	24%	26%	29%	26%	26%	25%	29%
	Wings	Landings live wt (thousand lbs)	18,072	15,105	13,708	11,904	17,494	14,018	12,799	4,311
		Percent	49%	43%	42%	35%	40%	34%	31%	14%
Trawls Landings live wt (thousand lbs)			26,871	23,446	22,255	21,578	28,883	24,737	23,305	13,502
Trawls Percent			73%	67%	68%	64%	67%	60%	56%	43%
Gill nets	Whole	Landings live wt (thousand lbs)	406	163	371	293	310	582	903	837
		Percent	1%	0%	1%	1%	1%	1%	2%	3%
	Wings	Landings live wt (thousand lbs)	9,216	9,252	7,855	10,830	13,434	13,687	15,847	15,050
		Percent	25%	27%	24%	32%	31%	33%	38%	47%
Gill nets Landings live wt (thousand lbs)			9,622	9,416	8,226	11,124	13,744	14,269	16,749	15,887
Gill nets Percent			26%	27%	25%	33%	32%	35%	40%	50%
Unknown	Whole	Landings live wt (thousand lbs)	0	31	193	40	151	144	232	21
		Percent	0%	0%	1%	0%	0%	0%	1%	0%
	Wings	Landings live wt (thousand lbs)	6	665	760	466	440	1,997	1,597	2,221
		Percent	0%	2%	2%	1%	1%	5%	4%	7%
Unknown Landings live wt (thousand lbs)			7	696	953	506	592	2,141	1,829	2,242
Unknown Percent			0%	2%	3%	2%	1%	5%	4%	7%
Dredges	Whole	Landings live wt (thousand lbs)	0	22	124	28	13	8	1	1
		Percent	0%	0%	0%	0%	0%	0%	0%	0%
	Wings	Landings live wt (thousand lbs)	18	300	971	460	67	45	36	27
		Percent	0%	1%	3%	1%	0%	0%	0%	0%
Dredges Landings live wt (thousand lbs)			18	322	1,095	488	80	52	37	28
Dredges Percent			0%	1%	3%	1%	0%	0%	0%	0%
Other nets	Whole	Landings live wt (thousand lbs)	1	0	7	0		29	8	6
		Percent	0%	0%	0%	0%	0%	0%	0%	0%
	Wings	Landings live wt (thousand lbs)	8	613	25	1	1	0	1	0
		Percent	0%	2%	0%	0%	0%	0%	0%	0%
Other nets Landings live wt (thousand lbs)			9	613	32	1	1	29	10	7
Other nets Percent			0%	2%	0%	0%	0%	0%	0%	0%
Longlines	Whole	Landings live wt (thousand lbs)		0	1	2	3	3	2	4
		Percent	0%	0%	0%	0%	0%	0%	0%	0%
	Wings	Landings live wt (thousand lbs)	79	378	54	29	11	13	25	24
		Percent	0%	1%	0%	0%	0%	0%	0%	0%
Longlines Landings live wt (thousand lbs)			79	378	54	32	14	16	27	28
Longlines Percent			0%	1%	0%	0%	0%	0%	0%	0%

7.5.1.3.6 Landings by port

Table 39 present annual skate wing landings (from the dealer SAFIS database) by port for 2003-2010. The top 15 ports in 2003-2009 represented over 93% of the total skate landings in the region. In 2010, the top 15 ports contributed to only 88% of skate wing landings, suggesting that the top ports may have been impacted more by the Amendment 3 regulations than ports with lower skate wing landings. New Bedford suffered a 72% decline in reported landings for the skate wing market.

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

2003-2010	2010
1. Point Judith	1. Point Judith
2. Tiverton	2. Newport
3. New Bedford	3. Fall River
4. Newport	4. Chatham
5. Stonington	5. Belford

Currently, the top ports landing skate wings are:

2003-2010	2010
1. New Bedford	1. Chatham
2. Chatham	2. New Bedford
3. Point Judith	3. Point Judith
4. Boston	4. Gloucester
5. Barnegat Light	5. Barnegat Light

New Bedford, MA and Chatham still dominate skate landings, averaging over 43% of the total skate landings in 2010. New Bedford and Chatham dominate skate wing landings, and Point Judith dominates skate bait landings. Between 2003-2010, an average of 97% of New Bedford's skate landings were classified as wings. All of New Bedford's 2010 landings were classified as wings. An average of 78% of Point Judith's skate landings were classified as whole skates (Table 39). Wing landings as a percentage in Point Judith increased to 33% in 2009 and 2010. Since 2000, skate wing landings in Provincetown, MA have declined, while landings in Chatham, MA have increased substantially.

Table 39. Annual skate landings (live weight, thousands lbs) for top 15 ports by market category and as a percentage of total skate landings (2003-2010). *Source: Dealer SAFIS Database, NEFSC*

Port	State		2003	2004	2005	2006	2007	2008	2009	2010	Change
NEW BEDFORD	MA	Landings live wt (thousand lbs)	13,611	16,001	14,583	15,025	20,406	16,948	15,207	4,193	-72%
		Percent	38%	46%	46%	45%	48%	44%	46%	19%	
CHATHAM	MA	Landings live wt (thousand lbs)	4,757	5,997	4,522	6,212	7,334	6,675	5,884	5,261	-11%
		Percent	13%	17%	14%	19%	17%	17%	18%	24%	
POINT JUDITH	RI	Landings live wt (thousand lbs)	10,111	5,779	5,540	5,100	5,663	4,864	2,140	2,694	26%
		Percent	28%	17%	17%	15%	13%	13%	6%	12%	
TIVERTON	RI	Landings live wt (thousand lbs)	2,381	2,383	2,884	1,658	2,540	995	120	121	1%
		Percent	7%	7%	9%	5%	6%	3%	0%	1%	
NEWPORT	RI	Landings live wt (thousand lbs)	299	319	1,078	1,022	1,597	1,488	694	624	-10%
		Percent	1%	1%	3%	3%	4%	4%	2%	3%	
BARNEGAT LIGHT/LONG BEACH	NJ	Landings live wt (thousand lbs)	383	313	375	244	489	536	1,258	1,639	30%
		Percent	1%	1%	1%	1%	1%	1%	4%	7%	
GLOUCESTER	MA	Landings live wt (thousand lbs)	534	360	326	347	455	561	772	1,859	141%
		Percent	1%	1%	1%	1%	1%	1%	2%	8%	
LITTLE COMPTON	RI	Landings live wt (thousand lbs)	752	510	258	221	302	798	1,241	713	-43%
		Percent	2%	1%	1%	1%	1%	2%	4%	3%	
BOSTON	MA	Landings live wt (thousand lbs)	441	680	538	709	781	697	525	344	-34%
		Percent	1%	2%	2%	2%	2%	2%	2%	2%	
HAMPTON BAYS	NY	Landings live wt (thousand lbs)	303	155	84	175	362	377	508	522	3%
		Percent	1%	0%	0%	1%	1%	1%	2%	2%	
POINT PLEASANT	NJ	Landings live wt (thousand lbs)	235	138	143	158	227	286	483	696	44%
		Percent	1%	0%	0%	0%	1%	1%	1%	3%	
OTHER CONNECTICUT	CT	Landings live wt (thousand lbs)		0			19	1,366	737	62	-92%
		Percent	0%	0%	0%	0%	0%	4%	2%	0%	
MONTAUK	NY	Landings live wt (thousand lbs)	169	103	102	150	234	202	541	644	19%
		Percent	0%	0%	0%	0%	1%	1%	2%	3%	
FALL RIVER	MA	Landings live wt (thousand lbs)	194	246	22	520	299	741	30	4	-87%
		Percent	1%	1%	0%	2%	1%	2%	0%	0%	
WESTPORT	MA	Landings live wt (thousand lbs)	209	172	182	84	111	190	463	44	-91%
		Percent	1%	0%	1%	0%	0%	0%	1%	0%	

7.5.1.3.7 Landings by Day-at-Sea Program (to be updated)

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 40). 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 40). 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 12). Virtually all of the skate landings in the Multispecies B DAS program are landed for the wing market (Figure 10).

Table 40. 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 11). As noted above, gillnets are also the primary gear for skate wings in the B DAS program.

Figure 10. Skate Bait and Wing landings by Multispecies A and B vessels, 2000-2007.

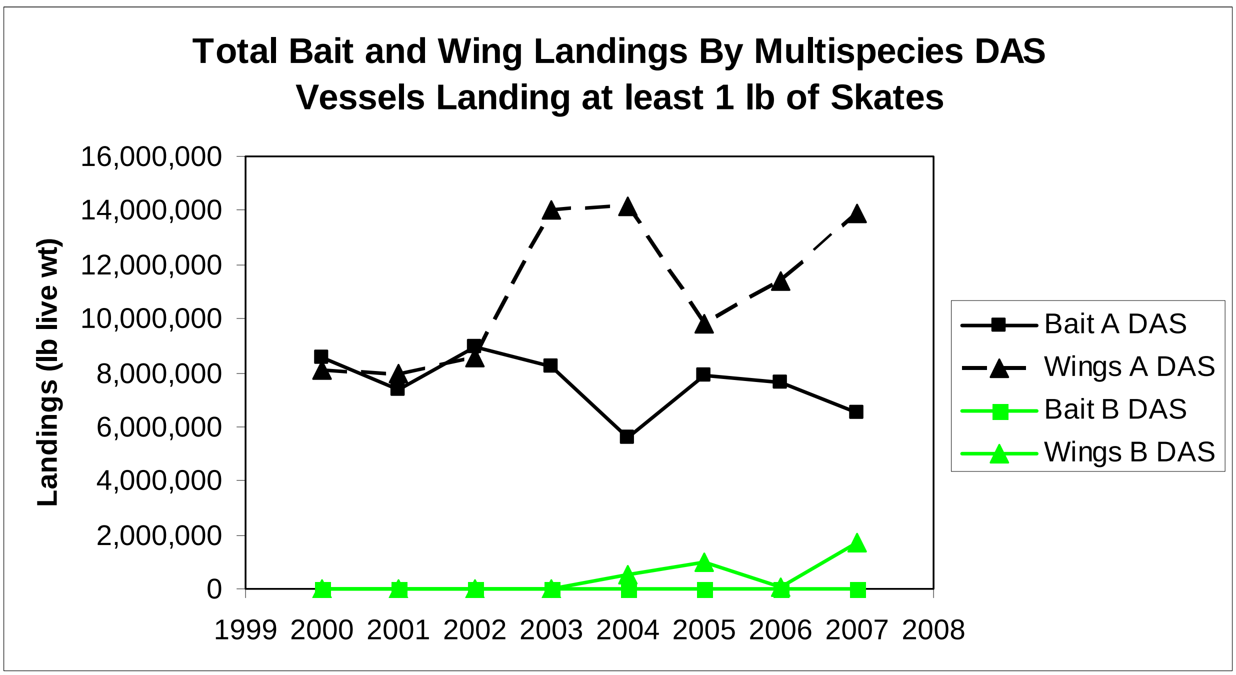


Figure 11. Skate Wing landings by gear type on Multispecies A DAS, 2000-2007

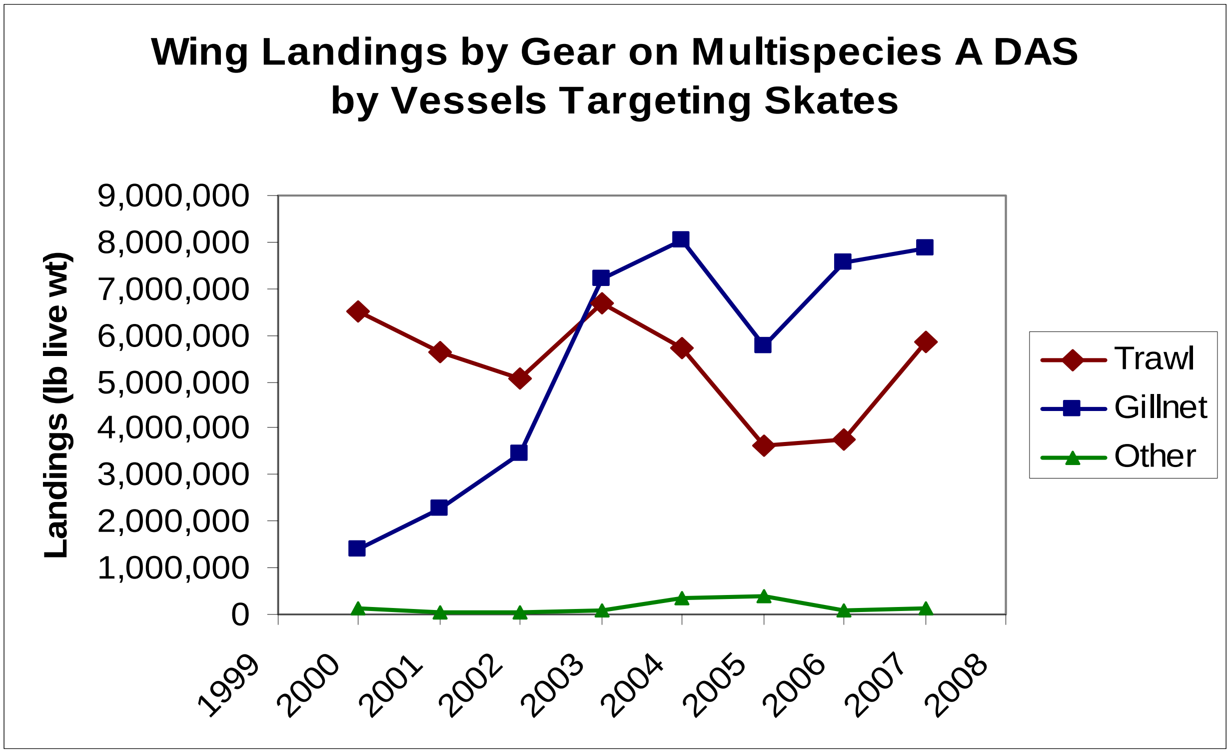
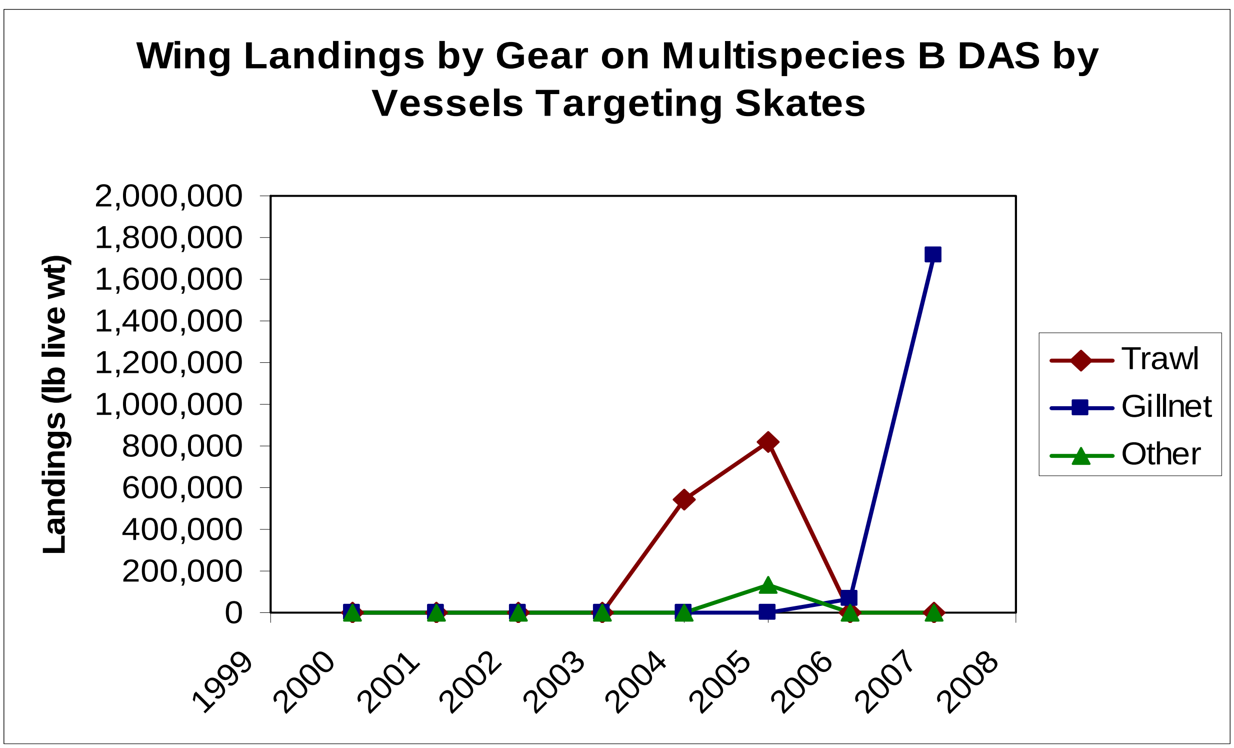


Figure 12. Skate Wing landings by gear type on Multispecies B DAS, 2000-2007.



7.5.1.4 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 ??? , 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.

According to landings data, assigned to statistical fishing area with matching VTR reports, the majority of skate wing landings from vessels using trawls are caught on Georges Bank and landed in MA (Table 39???). These wing landings fell off dramatically in 2010, much more than in other states or other areas, possibly related to new skate and groundfish rules. Nearly all of the skate wing landings decrease occurred in New Bedford by vessels using trawls, a pattern not reflected nearly as dramatically in other ports in MA or elsewhere.

Skate wing landings in MA by vessels using gillnets were more evenly split, 60% from Georges Bank and 30% from Southern New England (Table 39???). And despite the reduced possession limit for vessels using a gillnet while using a Category B Multispecies DAS[2] and the Amendment 3 skate possession limits, the landings by vessels using gillnets declined relatively little in 2010. In fact significant landings in RI and NY from Southern New England waters remained nearly steady and in NJ from the Mid-Atlantic waters actually increased in 2010.

Some whole skate landings in MA from the Gulf of Maine and RI from Southern New England waters were reported for vessels using gillnets (Table 40???). These landings were either relatively stable in 2010 or increased by about 200,000 lbs and most of these landings were probably landed in whole form for the wing market, with carcasses being sold for bait. Most of the whole skate landings for the bait market come from Southern New England waters (Table 40??) and are caught by vessels using trawls. MA landings primarily come from Southern New England waters and dropped by about 2/3rds in 2010. The majority of whole skate landings by trawl vessels occurred in RI from Southern New England waters and declined by about 15% from fishing year 2009 to 2010.

[2] Amendment 3 reduced the possession limit for gillnet vessels on a Category B DAS from 20,000 lbs. to 220 lbs. of skate wings.

Table 41. Skate wing landings (live wt, thousand lbs.) for vessels using trawls and gillnets by fishing year, state, and area.

		Trawls								Trawls Total	Gill nets								Gill nets Total
STATEABB	REGION	2003	2004	2005	2006	2007	2008	2009	2010		2003	2004	2005	2006	2007	2008	2009	2010	
CT	Georges Bank	52				2	1	6	0	62									
	Gulf of Maine							0		0			1				13	25	39
	Mid-Atlantic			1			0	0	0	1						2	1	1	4
	Southern New England	84	90	114	23	21	60	48	37	477	112	43	38	74	4	26	194	109	601
	Unknown				53	47	1		5	107				2	32	11	99	28	172
CT Total		136	90	114	76	71	62	55	43	647	112	43	39	76	36	38	307	163	815
MA	Georges Bank	11,489	12,567	10,399	10,240	14,909	11,473	10,452	2,052	83,581	4,509	5,486	4,057	6,482	9,192	7,505	6,399	5,581	49,211
	Gulf of Maine	663	310	386	356	311	442	626	210	3,305	243	123	179	277	230	135	441	920	2,548
	Mid-Atlantic	1	30	0		4	85	31	1	151	4	7	27	90	25	6	53		212
	Southern New England	1,031	988	1,458	250	597	530	74	48	4,976	1,914	1,372	1,904	1,931	1,899	2,871	3,150	2,213	17,254
	Unknown	1	364	108	76	25	31	12	539	1,156	15	291	148	509	59	197	275	323	1,816
MA Total		13,185	14,259	12,351	10,922	15,846	12,562	11,194	2,851	93,169	6,686	7,278	6,316	9,288	11,405	10,713	10,318	9,037	71,041
MD	Mid-Atlantic	5	4	14	7	14	23	107	18	191	5	5	3	6	12	6	22	24	84
	Unknown								0	0					0	1	0	12	12
MD Total		5	4	14	7	14	23	107	19	192	5	5	3	6	12	7	23	36	96
ME	Georges Bank	19	18	2	6	64	8		5	124	3								3
	Gulf of Maine	76	7	1	1	3	0	6	0	94	4	0	1	0	0		0		5
	Southern New England														0				0
	Unknown					0			5	5		1							1
ME Total		95	25	3	7	68	9	6	10	223	8	1	1	0	0		0		10
NC	Mid-Atlantic															0			0
	Unknown						3		5	8	1	1	0		0	8	4	10	25
NC Total							3		5	8	1	1	0		0	9	4	10	25
NH	Georges Bank	3			0	0				3	0		0		0				0
	Gulf of Maine	9	9	5	11	7	8	5	2	55	10	14	15	11	4	3	9	4	71
	Mid-Atlantic													0			0		1
	Unknown	0	0	0	0		0		0	1	2	1	0	1	0	0	0	0	5
NH Total		12	9	5	11	7	8	5	2	59	12	15	15	12	4	3	9	4	76
NJ	Gulf of Maine			0					0	0		1			1	5	7		14
	Mid-Atlantic	82	70	35	60	115	102	169	192	825	534	397	474	409	721	845	1,563	1,770	6,713
	Southern New England	2	2	1	1	0	5	1	1	13	24	4	7	9	5	7	106	32	196
	Unknown	0	0	0	0	0		1	128	130	47	54	4	1	6	1	11	396	520
NJ Total		84	72	36	61	116	107	171	322	968	606	456	485	419	733	858	1,688	2,198	7,442
NY	Georges Bank	0	0			1		3	1	5					0		0		0
	Gulf of Maine	1			1		8		0	10					16	0	3	6	25
	Mid-Atlantic	11	3	6	7	14	8	19	4	73	98	50	54	51	40	53	79	44	467
	Southern New England	210	62	62	133	178	211	234	240	1,329	400	58	75	126	395	297	738	697	2,785
	Unknown	0	13	4	2	12	14	17	142	204	16	137	24	95	16	217	58	186	749
NY Total		223	79	72	142	204	242	274	387	1,622	513	244	153	271	467	568	878	932	4,026
RI	Georges Bank	215	142	301	149	400	237	411	57	1,911	0	2		1			0	8	11
	Gulf of Maine		2	0	1		0	2	0	5					1	0	1	0	2
	Mid-Atlantic			2	2	16	2	3	2	27		0	0	0		7	2		9
	Southern New England	4,099	424	810	524	752	753	562	301	8,225	1,219	1,128	754	695	663	1,384	2,062	1,986	9,891
	Unknown		0	0	1	0	0	2	295	299	0	18	24	54	1		211	106	414
RI Total		4,314	568	1,113	676	1,169	992	980	655	10,467	1,220	1,148	778	750	665	1,391	2,276	2,100	10,328
VA	Gulf of Maine																	2	2
	Mid-Atlantic	18	0	0	1	0	11	7	7	45	54	55	60	9	106	96	344	426	1,148
	Southern New England						0	1		1									
	Unknown								10	10		5	6	0	6	5		140	162
VA Total		18	0	0	1	0	11	8	17	56	54	59	66	9	111	100	344	568	1,312

Table 42. Whole skate landings (live wt, thousand lbs.) for vessels using trawls and gillnets by fishing year, state, and area.

		Trawls								Trawls Total	Gill nets								Gill nets Total
STATEABB	REGION	2003	2004	2005	2006	2007	2008	2009	2010		2003	2004	2005	2006	2007	2008	2009	2010	
CT	Georges Bank		0	1	2			0	0	3									
	Mid-Atlantic			0						0	0								0
	Southern New England	690	772	601	394	23			335	2,814	43	5	17	6	0				71
	Unknown				11	379	0		2	392					18				18
CT Total		690	772	602	407	401	0	0	337	3,210	43	5	17	6	18				89
MA	Georges Bank	55	30	46	197	48	55	17		449	23	0	6	55	1	5	4	1	95
	Gulf of Maine	7	6	53	66	8	29	44	3	216	1	0	6	2	28	240	262	566	1,104
	Mid-Atlantic						4			4							3	0	3
	Southern New England	1	226	24	2,172	2,258	2,749	3,178	701	11,308		2	97	82	59	84	9		332
	Unknown		20	2	40	127	89	152	300	729		6	42	49	20	31	157	19	323
MA Total		62	283	124	2,476	2,441	2,926	3,391	1,003	12,706	24	8	150	187	108	360	435	585	1,858
MD	Mid-Atlantic	5	1	9	14	1			4	33	0	0	0	0					0
	Unknown	45				19	22		1	86	0				1	3			4
MD Total		50	1	9	14	19	22		4	119	0	0	0	0	1	3			4
ME	Gulf of Maine										0								0
	Unknown											0							0
ME Total											0	0							0
NC	Unknown								2	2				0	1				1
NC Total									2	2				0	1				1
NH	Gulf of Maine											0					0	0	0
	Unknown																0		0
NH Total												0					0	0	0
NJ	Georges Bank				3					3									
	Mid-Atlantic	163	233	67	423	455	650	616	496	3,104	0	0	13	1		0	0	0	14
	Southern New England	0		3		2	1	0	0	7									
	Unknown	129	0						103	233			0						0
NJ Total		293	234	70	427	457	651	616	599	3,347	0	0	13	1		0	0	0	15
NY	Georges Bank		0				0	1	0	1					2				2
	Gulf of Maine								0	0					0				0
	Mid-Atlantic		0		1	1	2	1	0	6		1	7	0	5	0	3		16
	Southern New England	3	5	31	34	26	13	12	23	147	4	11	53	32	38	19	7	5	168
	Unknown				0	1	0	19	6	26		31				2	0	1	34
NY Total		3	6	31	35	28	16	33	29	180	4	42	60	32	44	21	10	6	220
RI	Georges Bank	131	15	57	124	16	22	142	0	506	17								17
	Gulf of Maine								4	4									
	Mid-Atlantic				6	4		37	11	57									
	Southern New England	7,560	7,023	7,651	6,172	8,007	7,054	6,183	5,280	54,929	317	104	130	68	136	197	433	224	1,609
	Unknown		0		2	7	16	33	1,916	1,974		3	0		2		20	22	47
RI Total		7,691	7,038	7,708	6,303	8,034	7,091	6,394	7,211	57,470	334	107	130	68	139	197	452	246	1,673
VA	Mid-Atlantic	10	8	2	13	9	13	72	6	132		0			0	1	4		6
	Unknown	1								1					1				1
VA Total		10	8	2	13	9	13	72	6	133		0			1	1	4		6
DE	Mid-Atlantic											0							0
DE Total												0							0

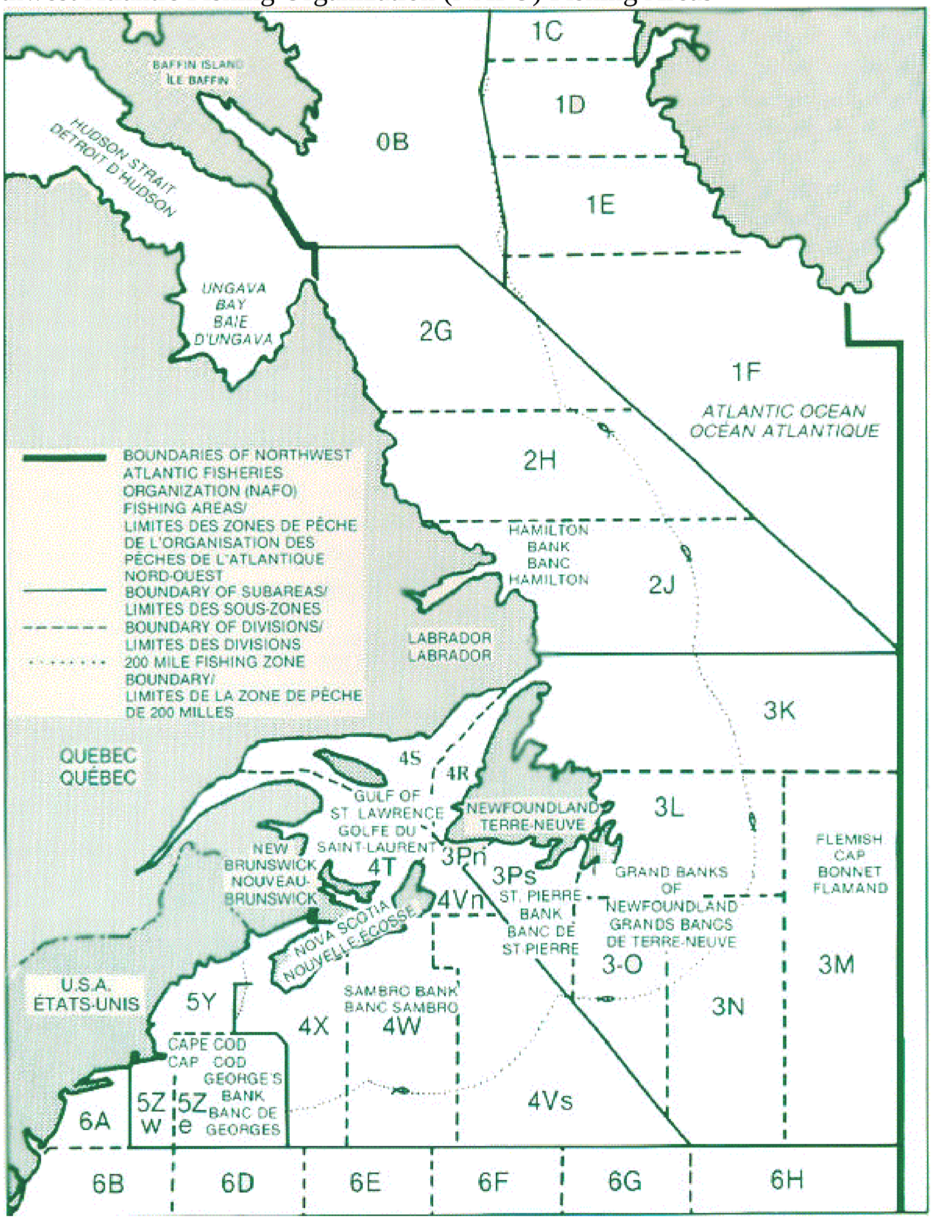
7.5.1.5 Canadian skate landings

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 4200 mt in 1994, to 1100 mt 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 43). 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 43. Estimated winter skate removals (tons) from NAFO Areas 4VsW, 1999-2004 (Swain et al. 2006).

Calendar year	Skate catch (mt)
1999	592
2000	358
2001	235
2002	278
2003	39
2004	233

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 44 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 44. 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)

Total Canadian landings had a similar trend as described above, but since 1997 most of the landings happened in Newfoundland and Labrador. Total skate landings (see table below) since last updated in Kulka et al. (2007) remained relatively stable, between 1,000 and 1,500 mt, nearly all in the Newfoundland and Labrador province, probably having little in common with the skate stocks along the US coastline. Skate landings in the contiguous Nova Scotia province and in particularly from the Scotia/Fundy region declined from 250 – 800 mt during 1998-2007 to negligible amounts in 2008 and 2009.

Table 45. Canadian skate landings (mt, whole) by calendar year, province, and region. Source: Canada Dept. of Fisheries and Oceans: http://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm.

	NS			NB			PE	QC	NL	Atlantic
	S-F	Gulf	Total	S-F	Gulf	Total	Total	Total	Total	Total
1990	112	1	113	-	-	-	-	1	12	125
1991	1,109	3	1,112	-	-	-	-	1	22	1,135
1992	377	1	378	0	-	0	0	1	117	496
1993	238	-	238	-	1	1	8	0	76	323
1994	2,704	29	2,733	-	1	1	14	15	3,630	6,393
1995	1,797	0	1,797	0	1	1	27	4	4,419	6,249
1996	2,090	0	2,090	0	0	0	19	14	1,777	3,901
1997	1,497	0	1,497	0	-	0	5	10	2,862	4,373
1998	678	0	678	0	0	0	0	11	2,297	2,986
1999	765	0	765	0	0	0	4	8	2,325	3,101
2000	479	0	479	0	0	0	0	6	1,580	2,065
2001	453	0	453	0	0	0	0	4	2,171	2,628
2002	490	0	490	0	0	0	0	6	2,488	2,984
2003	380	0	380	0	0	0	0	11	2,210	2,601
2004	503	0	503	0	0	0	0	26	1,402	1,931
2005	257	0	257	0	0	0	0	22	1,510	1,789
2006	105	0	106	0	0	0	0	6	1,162	1,274
2007	254	0	254	0	0	0	0	5	1,278	1,538
2008	64	0	64	0	0	0	0	4	995	1,063
2009	36	0	37	0	0	0	0	8	1,085	1,129
2010	Not yet available									

Provinces
NS = Nova Scotia
NB = New Brunswick
PE = Prince Edward
QC= Quebec
NL = Newfoundland and Labrador

Regions
S-F = Scotia-Fundy
Gulf = Gulf of St. Laurence

7.5.1.6 Recreational skate catches

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 46 and Table 49. Recreational skate catches between 2000 and 2009 ranged from 1.4 million fish in 2001 to 3.3 million fish in 2003 (Table 46). Recreational skate catch estimates have declined since 2006 to 1.8 million fish.

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 48. The vast majority of skates caught by recreational anglers are therefore considered released alive, but do not account for post-release mortality caused by hooking and handling.

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 to 2009. 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 (Table 49).

Reliability of skate recreational catch estimates from MRFSS is a concern. Many summaries given in the table below include estimates with a proportional standard error (PSE) of 0.2 or more, indicating that they are not well estimated. In particular, this applies to landings and dead discards (A+B1), even for coastwide annual summaries. 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. 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 46. Recreational skate (Family Rajidae) catch (A+B1+B2; thousand fish) on Atlantic Coast, 1981-2009. 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. Source NMFS Marine Recreational Fisheries Statistics (MRFSS): http://www.st.nmfs.noaa.gov/pls/webpls/MR_HELP.SPECIES. Estimates with proportional standard error (PSE) of 0.20 or less (available via the above website) are considered more reliable than those with higher PSEs.

Year	PRIVATE/RENTAL	SHORE	BEACH/BANK	MAN MADE	PARTY/CHARTER	CHARTER	PARTY	Grand Total
1981	150	0	24	39	15	0	0	229
1982	193	0	17	24	46	0	0	279
1983	359	0	153	26	17	0	0	555
1984	316	0	24	32	32	0	0	404
1985	883	0	11	34	12	0	0	940
1986	331	222	0	0	18	0	0	572
1987	738	39	42	3	14	0	0	837
1988	604	90	9	4	20	0	0	726
1989	266	58	51	3	29	0	0	407
1990	521	115	2	5	33	0	0	675
1991	494	58	3	7	35	0	0	597
1992	344	96	10	31	43	0	0	524
1993	642	190	20	40	39	0	0	931
1994	902	190	77	144	43	0	0	1,355
1995	481	116	62	48	59	0	0	767
1996	625	235	75	76	14	0	0	1,025
1997	804	181	88	98	46	0	0	1,217
1998	451	120	36	67	31	0	0	705
1999	344	112	181	69	7	0	0	712
2000	977	114	207	323	20	0	0	1,641
2001	937	193	126	121	45	0	0	1,422
2002	1,408	287	104	117	50	0	0	1,965
2003	2,267	507	150	242	99	0	0	3,265
2004	1,693	379	370	116	65	0	0	2,624
2005	1,557	652	173	252	0	74	24	2,732
2006	2,067	385	92	141	0	149	31	2,864
2007	1,616	427	111	84	0	48	17	2,303
2008	1,402	281	65	70	0	50	12	1,881
2009	1,268	294	215	48	0	56	4	1,886
Grand Total	24,640	5,342	2,498	2,262	832	378	87	36,039

Table 47. Recreational catch (A+B1+B2; thousand fish) by state, 2003-2009.

STATE	2003	2004	2005	2006	2007	2008	2009	Grand Total
CONNECTICUT	125	39	35	70	57	182	45	553
DELAWARE	137	150	160	166	78	116	86	893
EAST FLORIDA	1	1	5	4	2	3	2	17
GEORGIA	3	0	3	0	1	1	2	10
MAINE	1	0	3	0	0	0	0	3
MARYLAND	65	25	27	56	20	55	32	279
MASSACHUSETTS	175	347	126	149	162	146	214	1,319
NEW HAMPSHIRE	12	15	19	13	82	8	0	150
NEW JERSEY	1,482	761	731	1,032	677	651	782	6,117
NEW YORK	629	442	613	806	708	352	292	3,843
NORTH CAROLINA	440	566	528	287	235	164	288	2,508
RHODE ISLAND	53	86	66	67	112	156	51	591
SOUTH CAROLINA	28	20	4	5	18	3	5	84
VIRGINIA	115	172	413	207	151	44	85	1,186
Grand Total	3,265	2,624	2,732	2,864	2,303	1,881	1,886	17,554

Table 48. Recreational catch (total, 2007-2009) by species, mode, and distance from shore. 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.

STATE	A+B1	B2		A+B1	B2		A+B1	B2		
CONNECTICUT	6	278	284	0	0	0	0	0	0	284
DELAWARE	1	151	152	0	99	99	0	30	30	280
EAST FLORIDA	0	5	5	0	2	2	0	0	0	7
GEORGIA	0	3	3	0	1	1	0	0	0	4
MARYLAND	0	68	68	4	31	35	0	5	5	107
MASSACHUSETTS	31	277	308	2	189	191	0	23	23	522
NEW HAMPSHIRE	0	1	1	0	90	90	0	0	0	91
NEW JERSEY	2	710	712	0	1,134	1,134	0	264	264	2,110
NEW YORK	27	419	447	0	789	789	0	118	118	1,353
NORTH CAROLINA	0	75	75	0	608	608	0	4	4	687
RHODE ISLAND	10	98	108	4	199	204	0	7	7	319
SOUTH CAROLINA	1	14	15	0	12	12	0	0	0	27
VIRGINIA	3	236	239	2	38	40	0	1	1	280
Grand Total	81	2,334	2,415	13	3,192	3,204	0	451	451	6,070

Table 49. Recreational catch **(A+B1+B2; thousand fish)** by species, mode, and distance from shore. The "All" category includes catches identified by species.

STATE	Clearnose	Little	Smooth	Thorny	Winter	All	Grand Total
CONNECTICUT	0	0	0	0	0	284	284
DELAWARE	171	0	0	0	0	280	451
EAST FLORIDA	32	0	0	0	0	7	39
GEORGIA	0	0	0	0	0	4	4
MARYLAND	97	0	0	0	0	107	204
MASSACHUSETTS	0	60	0	0	0	522	582
NEW HAMPSHIRE	0	5	0	0	2	91	97
NEW JERSEY	1,005	312	0	0	27	2,110	3,454
NEW YORK	60	106	48	0	41	1,353	1,608
NORTH CAROLINA	5	0	0	0	0	687	692
RHODE ISLAND	0	14	0	0	1	319	335
SOUTH CAROLINA	3	0	0	0	0	27	30
VIRGINIA	392	0	0	0	0	280	672
Grand Total	1,764	497	48	0	71	6,070	8,450

7.5.1.7 Discards

Commercial fishery discard estimates of skates, for all species combined, were calculated as 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).

Total estimated discards for 2010 were 37,548 mt (see table below). Discards increased by 6.7% over the 2009 estimates. Some of the increase may have occurred due to the lower skate wing possession limit, particularly from September 3 to December 31, 2010 when the possession limit was 500 lbs. Changes in the estimated discards may also have been mitigated by reduced landings and effort by multispecies (groundfish) sector vessels.

Discard estimates from the Data Poor Stocks Working Group (DPWS) were updated and errors in the tables corrected. The ratio-estimator used in this assessment is based on the methodology described in Rago et al. (2005) and updated in Wigley et al 2007. It relies on a d/k ratio where the kept component is defined as the total landings of all species within a “fishery”. A fishery is defined as a homogeneous group of vessels with respect to gear type (longline, otter trawl, shrimp trawl, sink gill net, and scallop dredge), quarter (months 1-4, 5-6, 7-8, 9-12), and area fished (GOM, GB, SNE, MA). Mesh size was not used to split out otter trawl trips or sink gill net trips. All trips were included if they occurred within this stratification regardless of whether or not they caught skates.

The discard ratio for skates in stratum h is the sum of discard weight over all trips divided by sum of kept weights over all trips:

$$\hat{R}_h = \frac{\sum_{i=1}^{n_h} d_{ih}}{\sum_{i=1}^{n_h} k_{ih}} \qquad (1)$$

where d_{ih} is the discards for skates within trip i in stratum h and k_{ih} is the kept component of the catch for all species. R_h is the discard rate in stratum h. The stratum weighted discard to kept ratio is obtained by weighted sum of discard ratios over all strata:

$$\hat{R} = \sum_{h=1}^{H} \left(\frac{N_h}{\sum_{h=1}^{H} N_h} \right) \hat{R}_h \qquad (2)$$

The total discard within a strata is simply the product of the estimate discard ratio R and the total landings for the fishery defined as stratum h, i.e., $D_h=R_hK_h$. The total landings were updated to include landings of all species sold over-the-side as bait.

Missing cells were imputed using averages of existing cells. If information existed in the same area fished, the annual average discard ratio was applied in the missing cells. If the information was missing in the area fished, but available in the region (i.e. SNE and MA or GOM and GBK), then the annual average for that region was applied. There were some cases for the longline fishery in which the entire year was averaged for all areas or for a span of 12 years (1993-2004).

To hindcast the discard estimates back to 1964, a three-year average (the earliest three years of data) of the discards of skates/landings of all species was used. Estimated discards by fishery, region and half year for 1964-2010 are summarized in Table 50 to **Error! Reference source not found.**.

In 2010, Amendment 16 to the Northeast Multispecies (Groundfish) Management Plan required an increase in observer coverage to monitor discards of groundfish. This was done with At-Sea-Monitors (ASM), whose responsibilities were slightly different than for regular observers (OB). A comparison was made between the discard rates of these ASM trips and OB trips. Given that most of the rates are similar, using these data should not bias the discard estimates. A comparison was also made between these groundfish trips, and non-groundfish trips using the same gear in the same time period and region. These were also similar enough to be combined in a single analysis of skate discards, with the larger differences between the two sampling programs that appear to result from low sample sizes for non-groundfish trips.

A final comparison for 2010 was between “otter” trawl, the “Ruhle” trawl and the “haddock separator” trawl to see if these three gear types could be combined. The ratios of the three gears are different. However, it appears that not all records in the database have the correct gear type, given that the number of trips observed is almost equal to the number of trips in the dealer database for the Ruhle and haddock separator trawls. Therefore, for estimating skate discards the Skate PDT decided to include the Ruhle and haddock separator trawls in the otter trawl category at this time.

Estimated total skate discards (dead and surviving) by gear type, half year, and region are summarized in the tables below. For the Gulf of Maine/Georges Bank region (Table 50), discards mainly arise from fishing by otter trawl vessels, although an appreciable amount are also discarded by scallop dredge vessels, presumably fishing on the Northern Edge of Georges Bank. Total discards peaked at 64,082 mt in the first half year during 1981, fell to 12,380 mt in 1995, and rose again to 27,143 mt in 2004. Estimated discards in 2010 were 18,328 mt.

In the Southern New England/Mid-Atlantic region, skate discards are more evenly split between vessels using otter trawls and scallop dredges, in both the first and second half years (Table 51). And somewhat more discards occur from vessels using sink gill nets than occur in the Gulf of Maine/Georges Bank region, most likely from differences in the amount of fishing effort. Total skate discards peaked at 73,886 mt in 1994, declined to 10,252 mt in 2001, increased again to 27,200 mt in 2003. Since 2003, total skate discards ranged between 13,500 and 19,400 mt.

Table 50. Estimated discards (mt) of skates (all species) by gear type taken in the Gulf of Maine-Georges Bank region, 1964-2010.

			Half 1						Half 2				
Year	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Total Half 1	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Total Half 2	Grand Total
1964	441	37,255	0	12	5,882	43,589	471	22,824	0	7	6,539	29,841	73,430
1965	491	38,321	0	17	2,294	41,123	609	24,329	0	5	599	25,541	66,663
1966	373	39,624	0	26	751	40,773	572	22,374	0	7	1,504	24,458	65,231
1967	318	30,462	0	22	582	31,383	379	19,148	0	8	2,294	21,829	53,212
1968	252	26,067	0	37	737	27,093	345	18,036	0	10	1,649	20,040	47,134
1969	272	25,173	0	32	1,011	26,488	523	15,909	0	6	1,934	18,372	44,860
1970	298	22,927	0	22	1,234	24,481	479	15,208	0	7	1,887	17,582	42,062
1971	458	21,746	0	21	1,767	23,993	715	14,941	0	8	1,452	17,116	41,108
1972	462	19,491	0	31	1,248	21,233	765	12,401	0	13	1,715	14,894	36,126
1973	553	19,548	0	31	1,793	21,924	749	13,558	0	15	1,496	15,818	37,743
1974	593	17,687	0	58	1,060	19,398	691	11,947	0	24	1,410	14,071	33,469
1975	660	15,631	280	61	1,327	17,959	713	11,792	37	26	2,025	14,593	32,552
1976	450	15,157	66	99	1,677	17,449	407	12,139	0	37	3,113	15,696	33,145
1977	332	19,662	39	169	3,321	23,524	338	14,148	0	47	7,174	21,707	45,230
1978	539	23,070	0	189	4,030	27,829	372	14,383	0	66	7,886	22,707	50,535
1979	741	22,771	26	156	5,292	28,986	593	16,612	0	67	8,446	25,719	54,704
1980	816	28,570	21	189	7,424	37,020	183	18,066	0	96	6,969	25,314	62,333
1981	325	29,786	99	258	8,268	38,735	114	15,643	0	93	9,497	25,347	64,082
1982	293	26,789	124	91	5,650	32,948	86	19,496	7	83	7,923	27,595	60,544
1983	282	29,695	115	116	4,847	35,055	106	16,467	22	69	5,650	22,314	57,369
1984	294	27,882	152	123	3,515	31,967	22	13,640	53	94	4,352	18,161	50,128
1985	252	22,242	225	115	2,350	25,184	60	10,748	70	81	4,717	15,676	40,860
1986	309	19,142	252	170	4,036	23,908	58	8,856	83	87	6,203	15,288	39,196
1987	510	15,330	288	140	3,927	20,196	193	8,272	46	85	7,568	16,165	36,361
1988	536	17,091	183	162	6,206	24,177	230	8,410	46	90	9,991	18,767	42,944
1989	481	18,497	73	48	6,392	25,491	185	8,727	17	92	11,097	20,118	45,609
1990	343	23,476	208	347	7,324	31,699	182	9,910	71	73	15,213	25,449	57,147
1991	1,064	11,624	243	99	9,870	22,900	260	8,680	44	113	10,371	19,468	42,368
1992	1,285	8,056	247	162	8,930	18,680	727	2,848	0	56	10,931	14,562	33,243
1993	57	4,528	35	119	4,541	9,279	22	11,482	1	65	4,951	16,520	25,799
1994	14	4,912	11	130	2,278	7,346	25	10,153	1	72	2,026	12,277	19,623
1995	25	7,492	8	209	397	8,130	26	2,317	1	259	1,647	4,249	12,380
1996	21	7,509	26	284	820	8,660	21	1,189	8	65	3,002	4,285	12,944
1997	20	3,683	34	110	1,832	5,679	21	3,571	4	16	3,193	6,805	12,484
1998	17	4,228	6	50	2,595	6,897	24	15,062	0	56	4,110	19,254	26,151
1999	19	2,840	3	98	1,235	4,195	21	7,197	0	110	2,966	10,295	14,489
2000	11	4,495	4	121	1,975	6,605	22	7,605	0	740	1,375	9,742	16,347
2001	15	19,283	0	188	514	19,999	16	6,275	0	153	554	6,998	26,997
2002	17	11,100	1	135	923	12,176	42	5,784	0	199	2,023	8,047	20,223
2003	32	11,689	8	253	1,820	13,803	4	9,858	0	153	1,962	11,977	25,780
2004	3	11,512	4	269	271	12,059	10	13,838	0	218	1,017	15,083	27,143
2005	91	9,468	2	399	594	10,554	54	12,851	0	204	2,212	15,321	25,875
2006	193	8,043	0	173	1,070	9,480	17	9,350	1	294	2,407	12,069	21,549
2007	46	10,708	0	378	872	12,005	27	11,205	0	363	3,419	15,013	27,018
2008	62	5,919	2	149	1,594	7,725	17	7,959	0	302	2,175	10,452	18,177
2009	56	6,784	1	538	905	8,284	46	11,295	0	198	902	12,441	20,725
2010	143	7,393	0	94	296	7,926	46	9,038	0	274	1,043	10,402	18,328

Table 51. Estimated discards (mt) of skates (all species) by gear type taken in the Southern New England-Mid-Atlantic region, 1964-2010.

		Half 1						Half 2			
Year	Line Trawl	Otter Trawl	Sink Gill Net	Scallop Dredge	Total Half 1	Line Trawl	Otter Trawl	Sink Gill Net	Scallop Dredge	Total Half 2	Grand Total
1964	0	16,916	0	1	16,917	0	12,929	0	488	13,416	30,333
1965	0	20,746	0	2,120	22,866	0	15,053	0	7,230	22,283	45,149
1966	0	23,680	0	5,327	29,007	0	11,657	0	3,998	15,655	44,662
1967	0	26,886	0	2,362	29,248	0	13,933	0	1,741	15,674	44,923
1968	0	30,741	0	3,069	33,810	0	13,895	0	2,474	16,369	50,179
1969	2	30,557	0	1,349	31,907	1	11,827	0	673	12,501	44,408
1970	2	21,694	0	394	22,090	0	10,272	0	454	10,726	32,815
1971	2	13,419	0	93	13,514	0	4,979	0	747	5,726	19,240
1972	2	13,272	0	734	14,009	1	6,373	0	478	6,852	20,861
1973	13	15,425	0	413	15,851	4	6,227	0	170	6,402	22,253
1974	34	19,170	0	692	19,895	13	5,279	0	968	6,260	26,155
1975	34	9,882	0	1,062	10,978	13	5,131	0	2,025	7,169	18,147
1976	19	7,688	0	2,225	9,933	11	7,804	0	3,906	11,721	21,653
1977	10	7,639	0	3,388	11,038	4	7,169	0	1,323	8,496	19,534
1978	214	12,605	0	3,969	16,788	192	8,389	0	4,140	12,721	29,509
1979	97	16,229	0	3,530	19,857	191	10,770	0	2,880	13,841	33,698
1980	193	11,730	0	2,384	14,307	156	10,958	0	2,318	13,432	27,739
1981	203	13,828	0	1,121	15,152	158	10,028	0	964	11,149	26,301
1982	134	17,088	0	1,634	18,857	88	17,764	0	2,661	20,512	39,369
1983	114	20,196	0	3,811	24,121	76	15,883	0	4,417	20,376	44,498
1984	91	21,023	0	5,179	26,293	54	17,034	0	3,985	21,073	47,366
1985	63	18,452	0	4,442	22,956	83	12,401	0	3,171	15,655	38,611
1986	112	18,225	0	3,272	21,609	91	17,119	0	4,053	21,263	42,873
1987	116	21,129	0	8,591	29,835	95	15,105	0	8,355	23,555	53,391
1988	90	18,544	0	8,176	26,810	17	13,960	0	6,268	20,245	47,054
1989	55	19,166	0	13,218	32,439	26	11,537	0	5,279	16,843	49,282
1990	41	26,989	0	11,014	38,044	34	25,810	0	4,600	30,444	68,489
1991	110	11,258	0	8,638	20,006	63	21,176	0	5,478	26,717	46,723
1992	361	5,097	107	5,628	11,194	377	16,761	51	7,157	24,346	35,540
1993	13	3,466	93	5,329	8,900	6	10,309	45	7,217	17,577	26,478
1994	6	60,588	135	3,821	64,550	3	6,148	155	3,030	9,336	73,886
1995	3	15,501	234	8,336	24,074	4	9,385	91	18,198	27,677	51,752
1996	7	8,089	135	7,540	15,771	6	24,611	66	8,466	33,149	48,920
1997	10	2,950	282	9,230	12,471	8	3,213	76	3,141	6,438	18,910
1998	8	22,495	167	4,223	26,893	9	5,074	195	4,334	9,612	36,505
1999	4	970	500	5,959	7,433	3	2,430	139	4,989	7,560	14,993
2000	3	2,422	60	3,233	5,719	4	9,435	53	3,335	12,826	18,545
2001	5	1,861	216	3,253	5,336	6	2,163	52	2,695	4,916	10,252
2002	4	1,076	256	5,165	6,501	65	3,880	2,265	5,674	11,883	18,385
2003	6	6,226	269	6,093	12,594	6	8,204	290	6,107	14,606	27,200
2004	6	2,911	181	4,960	8,059	1	7,847	280	3,060	11,188	19,246
2005	0	4,718	638	5,485	10,840	0	6,345	355	2,401	9,100	19,941
2006	2	2,551	686	4,658	7,897	0	2,966	68	2,527	5,562	13,459
2007	0	4,047	663	4,924	9,635	0	5,566	408	3,804	9,778	19,413
2008	49	4,748	1,172	3,479	9,448	48	4,745	406	2,764	7,963	17,411
2009	76	3,745	913	3,148	7,882	129	3,785	339	2,335	6,588	14,470
2010	125	2,040	963	7,786	10,915	163	2,831	1,070	4,240	8,304	19,219

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.

During the development of 2012-2013 ABC specifications, the Skate PDT was presented with new research data collected by Dr. James Sulikowski and Dr. John Mandelman showing that post capture mortality of discarded skates on commercial length tows by vessels using standard otter trawls was much lower than had been assumed[3]. These data included mortality that occurred during capture and on deck processing, as well as post release mortality of skates held in underwater cages for ??? hours. For data collected so far, the average discard mortality rate was 0.20 for little skate and 0.12 for winter skate. At this time, data were insufficient to estimate discard mortality for other skates. The Skate PDT recommended that the Council use these mortality rates only for little and winter skate discard estimates captured in trawls. Thus the average discard mortality rate applied from year to year varies from the proportion of little and winter skates discarded by vessels using trawls.

The table below shows the trends in reported landings, total discards, and catch. Whichever discard mortality assumption is used, the trend in discards is about the same, increasing to a peak in the 1980s and early 1990s, declining through 1999-2001, increasing in the mid to late 2000s, and then near current levels since 2008. Discards before 1987 were more than 90% of total catch, but declined as landings began increasing, settling in the 40-60% range since 1999 (or 30 to 56% range since 1996 if a variable mortality rate is applied).

Assuming a 50% discard mortality rate, dead discards increased about 1,000 mt from 2008-2009 levels to 18,774 mt, or 56% of total catch. Assuming a variable discard mortality rate based on recent research data, dead discards increased by nearly 3,000 mt over 2009 levels to 12,374 mt, or 46% of total catch. The higher amount with the variable mortality rate reflects a greater proportion of skates estimated to be barndoor skate and a lower proportion of discard estimates on vessels using trawls.

[3] Before Amendment 3, the Council used a working range of skate discard mortality between 25 and 50%. But for Amendment 3, the Council had to chose a value to set Total Allowable Landings limits and to monitor the amount of dead discards. Based on published literature, mainly for other skates in other countries, the Council's SSC decided to assume a 50% mortality rate.

Table 52. Skate catch and discard mortality.

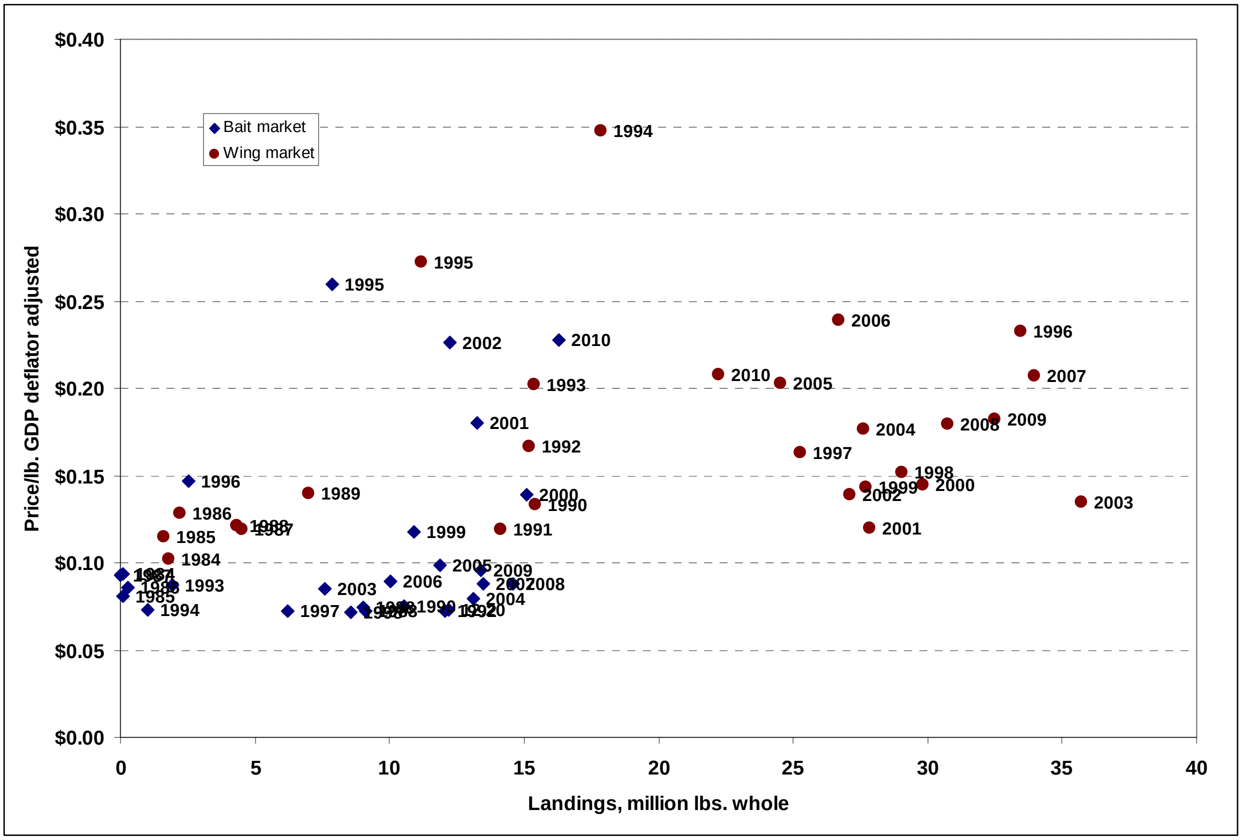
Year	Landings (thousand mt)	Total discards (mt)	Dead discards			
			50% mortality	Discard rate	Variable mortality	Discard rate
1968	38	97,313	48,656	100%	26,721	100%
1969	62	89,268	44,634	100%	22,576	100%
1970	60	74,878	37,439	100%	20,328	100%
1971	74	60,348	30,174	100%	18,191	100%
1972	82	56,988	28,494	100%	16,269	100%
1973	80	59,996	29,998	100%	17,216	100%
1974	101	59,624	29,812	100%	16,823	99%
1975	125	50,699	25,350	100%	15,198	99%
1976	132	54,798	27,399	100%	17,289	99%
1977	150	64,764	32,382	100%	20,329	99%
1978	373	80,045	40,022	99%	24,345	98%
1979	708	88,402	44,201	98%	25,900	97%
1980	387	90,072	45,036	99%	25,737	99%
1981	333	90,383	45,192	99%	25,482	99%
1982	683	99,913	49,957	99%	25,381	97%
1983	943	101,867	50,933	98%	26,143	97%
1984	825	97,494	48,747	98%	24,906	97%
1985	785	79,471	39,736	98%	20,835	96%
1986	1,133	82,069	41,034	97%	23,024	95%
1987	2,089	89,752	44,876	96%	27,453	93%
1988	6,061	89,999	44,999	88%	27,118	82%
1989	7,308	94,890	47,445	87%	29,700	80%
1990	11,782	125,636	62,818	84%	37,971	76%
1991	11,956	89,091	44,545	79%	32,697	73%
1992	12,365	68,783	34,391	74%	25,678	67%
1993	7,847	52,277	26,138	77%	17,855	69%
1994	8,566	93,509	46,754	85%	23,383	73%
1995	6,840	64,133	32,066	82%	21,915	76%
1996	15,184	61,866	30,933	67%	19,178	56%
1997	11,499	31,394	15,697	58%	11,497	50%
1998	13,466	62,658	31,329	70%	17,009	56%
1999	12,638	29,483	14,742	54%	10,689	46%
2000	13,555	34,893	17,447	56%	10,415	43%
2001	13,161	37,245	18,623	59%	9,994	43%
2002	12,590	38,609	19,304	61%	13,101	51%
2003	16,628	52,981	26,491	61%	15,728	49%
2004	15,891	46,390	23,195	59%	12,071	43%
2005	14,802	45,817	22,908	61%	13,602	48%
2006	15,233	35,009	17,504	53%	11,199	42%
2007	19,627	46,432	23,216	54%	14,475	42%
2008	18,722	35,583	17,791	49%	11,682	38%
2009	19,166	35,196	17,598	48%	9,570	33%
2010	14,691	37,548	18,774	56%	12,374	46%

More recently and until 2010, PPI-adjusted prices for skate wings have risen (Figure 19) 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 $0.17 per pound.[4] Average skate wing prices in 2007 rose to nearly $0.21 per pound and the 2007 skate wing landings were the 2nd highest on record. Quantities of skate wing landings and prices in 2008 and 2009 were nearly the same as in 2007. But in 2010, the quantity of skate wings declined, but inflation adjusted prices increased to near $0.21 per pound, from $0.18 to $0.19 per pound in 2008-2009. And although there were seasonal price spikes related to short-term supply and changes in skate possession limits, the ex-vessel price was not very responsive to decreases in supply. Most of the skate wing landings are sent to foreign markets where the US product competes with other sources and substitute goods. With respect to skate wing prices, the US may be more of a price-taker for a foreign market whose prices is determined by other seafood supply.

PPI-adjusted prices for whole skates, most of which are landed to supply bait to the lobster fishery, have been relatively stable, except for 1995, 2001, and 2002. Except for three years[5], whole skate prices have been generally less than $0.15 per pound and annual landings in recent years have been around 10-15 million lbs. Including transfers at sea (for all years since 1994), skate bait landings in 2010 increase to a record 16.3 million pounds. Inflation adjusted prices however was the second highest on record, nearly $0.23 per pound. And unlike previous years, the price per whole pound of skates was actually higher for skates destined for the bait market than for skates destined for the wing market, whereas the ratio since 2004 has been about 2:1 in favor of wing prices.

4 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.
5 The higher prices in 1995 and 1996 may have been influenced by mis-reported (or erroneously recorded) landings of skate wings.

Figure 19. GDP deflator adjusted annual prices for skate wing and bait landings compared to quantity landed (whole weight).



7.5.4.3 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.

7.5.4.4 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 – 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 20. 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 20). Skate wings revenues were less than $25 thousand in all other states.