NOAA Technical Memorandum NMFS-NE-176

Essential Fish Habitat Source Document:

Rosette Skate, *Leucoraja garmani virginica*, Life History and Habitat Characteristics

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Northeast Fisheries Science Center
Woods Hole, Massachusetts

March 2003

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March 2003

Editorial Notes on Issues 122-152, 163, and 173-179 in the *NOAA Technical Memorandum NMFS-NE* Series

Editorial Production

For Issues 122-152, 163, and 173-179, staff of the Northeast Fisheries Science Center's (NEFSC's) Ecosystems Processes Division have largely assumed the role of staff of the NEFSC's Editorial Office for technical and copy editing, type composition, and page layout. Other than the four covers (inside and outside, front and back) and first two preliminary pages, all preprinting editorial production has been performed by, and all credit for such production rightfully belongs to, the staff of the Ecosystems Processes Division.

Internet Availability

Issues 122-152, 163, and 173-179 have been copublished, *i.e.*, both as paper copies and as Web postings. All Web postings are available at: *www.nefsc.noaa.gov/nefsc/habitat/efh*. Also, all Web postings are in "PDF" format.

Information Updating

By federal regulation, all information specific to Issues 122-152, 163, and 173-179 must be updated at least every five years. All official updates will appear in the Web postings. Paper copies will be reissued only when and if new information associated with Issues 122-152, 163, and 173-179 is significant enough to warrant a reprinting of a given issue. All updated and/or reprinted issues will retain the original issue number, but bear a "Revised (Month Year)" label.

Species Names

The NMFS Northeast Region's policy on the use of species names in all technical communications is generally to follow the American Fisheries Society's lists of scientific and common names for fishes (*i.e.*, Robins *et al.* 1991[a]), mollusks (*i.e.*, Turgeon *et al.* 1998[b]), and decapod crustaceans (*i.e.*, Williams *et al.* 1989[c]), and to follow the Society for Marine Mammalogy's guidance on scientific and common names for marine mammals (*i.e.*, Rice 1998[d]). Exceptions to this policy occur when there are subsequent compelling revisions in the classifications of species, resulting in changes in the names of species (*e.g.*, Cooper and Chapleau 1998[e]; McEachran and Dunn 1998[f]).

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[a]Robins, C.R. (chair); Bailey, R.M.; Bond, C.E.; Brooker, J.R.; Lachner, E.A.; Lea, R.N.; Scott, W.B. 1991. Common and scientific names of fishes from the United States and Canada. 5th ed. *Amer. Fish. Soc. Spec. Publ.* 20; 183 p.

[b]Turgeon, D.D. (chair); Quinn, J.F., Jr.; Bogan, A.E.; Coan, E.V.; Hochberg, F.G.; Lyons, W.G.; Mikkelsen, P.M.; Neves, R.J.; Roper, C.F.E.; Rosenberg, G.; Roth, B.; Scheltema, A.; Thompson, F.G.; Vecchione, M.; Williams, J.D. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. 2nd ed. *Amer. Fish. Soc. Spec. Publ.* 26; 526 p.

[c]Williams, A.B. (chair); Abele, L.G.; Felder, D.L.; Hobbs, H.H., Jr.; Manning, R.B.; McLaughlin, P.A.; Pérez Farfante, I. 1989. Common and scientific names of aquatic invertebrates from the United States and Canada: decapod crustaceans. *Amer. Fish. Soc. Spec. Publ.* 17; 77 p.

[d]Rice, D.W. 1998. Marine mammals of the world: systematics and distribution. *Soc. Mar. Mammal. Spec. Publ.* 4; 231 p.

[e]Cooper, J.A.; Chapleau, F. 1998. Monophyly and interrelationships of the family Pleuronectidae (Pleuronectiformes), with a revised classification. *Fish. Bull. (U.S.)* 96:686-726.

[f]McEachran, J.D.; Dunn, K.A. 1998. Phylogenetic analysis of skates, a morphologically conservative clade of elasmobranchs (Chondrichthyes: Rajidae). *Copeia* 1998(2):271-290.

FOREWORD

One of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats.

Magnuson-Stevens Fishery Conservation and Management Act (October 11, 1996)

The long-term viability of living marine resources depends on protection of their habitat.

NMFS Strategic Plan for Fisheries Research (February 1998)

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), which was reauthorized and amended by the Sustainable Fisheries Act (1996), requires the eight regional fishery management councils to describe and identify essential fish habitat (EFH) in their respective regions, to specify actions to conserve and enhance that EFH, and to minimize the adverse effects of fishing on EFH. Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." The MSFCMA requires NMFS to assist the regional fishery management councils in the implementation of EFH in their respective fishery management plans.

NMFS has taken a broad view of habitat as the area used by fish throughout their life cycle. Fish use habitat for spawning, feeding, nursery, migration, and shelter, but most habitats provide only a subset of these functions. Fish may change habitats with changes in life history stage, seasonal and geographic distributions, abundance, and interactions with other species. The type of habitat, as well as its attributes and functions, are important for sustaining the production of managed species.

The Northeast Fisheries Science Center compiled the available information on the distribution, abundance, and habitat requirements for each of the species managed by the New England and Mid-Atlantic Fishery Management Councils. That information is presented in this series of 38 EFH species reports (plus one consolidated methods report). The EFH species reports are a survey of the important literature as well as original analyses of fishery-independent data sets from NMFS and several coastal states. The species reports are also the source for the current EFH designations by the New England and Mid-Atlantic Fishery Management Councils, and understandably have begun to be referred to as the "EFH source documents."

NMFS provided guidance to the regional fishery management councils for identifying and describing EFH of their managed species. Consistent with this guidance, the species reports present information on current and historic stock sizes, geographic range, and the period and location of major life history stages. The habitats of managed species are described by the physical, chemical, and biological components of the ecosystem where the species occur. Information on the habitat requirements is provided for each life history stage, and it includes, where available, habitat and environmental variables that control or limit distribution, abundance, growth, reproduction, mortality, and productivity.

Identifying and describing EFH are the first steps in the process of protecting, conserving, and enhancing essential habitats of the managed species. Ultimately, NMFS, the regional fishery management councils, fishing participants, Federal and state agencies, and other organizations will have to cooperate to achieve the habitat goals established by the MSFCMA.

A historical note: the EFH species reports effectively recommence a series of reports published by the NMFS Sandy Hook (New Jersey) Laboratory (now formally known as the James J. Howard Marine Sciences Laboratory) from 1977 to 1982. These reports, which were formally labeled as *Sandy Hook Laboratory Technical Series Reports*, but informally known as "Sandy Hook Bluebooks," summarized biological and fisheries data for 18 economically important species. The fact that the bluebooks continue to be used two decades after their publication persuaded us to make their successors – the 38 EFH source documents – available to the public through publication in the *NOAA Technical Memorandum NMFS-NE* series.

JAMES J. HOWARD MARINE SCIENCES LABORATORY
HIGHLANDS, NEW JERSEY
SEPTEMBER 1999

JEFFREY N. CROSS, (FORMER) CHIEF
ECOSYSTEMS PROCESSES DIVISION
NORTHEAST FISHERIES SCIENCE CENTER

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INTRODUCTION

The rosette skate [*Leucoraja garmani* (McEachran 1977); formerly *Raja garmani*, see McEachran and Dunn (1998); Figure 1] occurs from Nantucket Shoals to the Dry Tortugas, Florida (Bigelow and Schroeder 1953a, b; Bullis and Thompson 1965; McEachran and Musick 1975; McEachran 1977; Stehmann and McEachran 1978). McEachran and Musick (1975) found that between Nantucket Shoals and Cape Hatteras it was most abundant in the southern section of the Chesapeake Bight. Populations north of Cape Hatteras have been considered as the subspecies *L. garmani virginica* while those between the Cape and the Dry Tortugas have been considered as *L. g. garmani*, but the two may in fact be distinct species (McEachran 1977; McEachran 2002). McEachran (1977) synonymized *L. lentiginosa* with the rosette skate but later considered the two species separate (as noted in McEachran [2002]). This report will focus mostly on *L. g. virginica*.

McEachran (2002) distinguishes rosette skates from other skates in the Gulf of Maine by its rosette color pattern. The dorsal side is buff or brown and freckled with small light and dark spots forming dark rosettes surrounding a dark central spot. The ventral side is white to yellowish white (McEachran 2002).

LIFE HISTORY

The single fertilized egg is encapsulated in a leathery, amber-colored egg capsule. The egg capsules are rectangular in shape, 37-43 mm long and 26-30 mm wide, with a moderately short horn at each corner (McEachran 1970). The horns are shorter than the remainder of the capsule and the posterior horns are longer than the anterior horns. The walls of the capsule are smooth but have longitudinal striations. North of Cape Hatteras the egg capsules are found in mature females year-round but are most frequent during the summer (McEachran 1970).

Rosette skate grow to a maximum known size of 44.5 cm TL, and maximum size and size at maturity increase with latitude (McEachran 1977). McEachran (1977) reported that north of Cape Hatteras rosette skate matures between 33.5-43.9 cm TL and south of the Cape it matures between 25.0-31.4 cm TL. Based on the predictive equations from Frisk *et al*. (2001) and the Northeast Fisheries Science Center (NEFSC) survey maximum observed length of 57 cm TL, L_{mat} is estimated at 46 cm TL and A_{mat} is estimated at 4 years (Northeast Fisheries Science Center 2000b).

The major prey items of rosette skate include the shrimp *Crangon septemspinosa*, *Cancer* and galatheoid crabs, amphipods, polychaetes, copepods, cumaceans, squids, octopods, and small fishes (Stehmann and McEachran 1978; Bowman *et al*. 2000; Figure 2).

GEOGRAPHICAL DISTRIBUTION

Bigelow and Schroeder (1953a) and McEachran (2002) consider this species rare in the Gulf of Maine. The only reason that Bigelow and Schroeder (1953a) mention it is that one specimen was found in 1950 at 95 m depth southeast of the Nantucket Lightship (40°05′ N, 69°22′ W). McEachran and Musick (1975), using data obtained from the 1967-1970 NEFSC bottom trawl surveys, found no rosette skate on the eastern slope of Georges Bank. NEFSC bottom trawl surveys from other years (see below) did catch them on the southern edge of Georges Bank. Schroeder (1955) found it to be fairly abundant from the eastern slope of Georges Bank to Cape Charles, Virginia. Struhsaker (1969) found that rosette skate was very abundant along the outer continental shelf from Cape Hatteras to Florida. In the Straits of Florida it is found on Pourtates Terrace (Staiger 1970).

JUVENILES

NEFSC bottom trawl surveys [see Reid *et al*. (1999) for details] captured juvenile ($\leq$ 45 cm TL) rosette skate year-round, mostly along the outer continental shelf. (Note that winter and summer distributions are presented as presence/absence data, precluding a discussion of abundances.) In winter, large concentrations of juveniles were found between the 60 and 200 m depth contours from the Hudson Canyon to Cape Hatteras. A few were found on the southern edge of Georges Bank and near Cape Cod (Figure 3). In spring they were also found offshore in low numbers from the Hudson Canyon to Cape Hatteras. A few were found on the 200 m depth contour near southern New England and in the Gulf of Maine near the Bay of Fundy (Figure 4). Very few were present in summer, mostly near the 200 m depth contour near Cape Hatteras, as well as near the Hudson Canyon and on the outer continental shelf near southern New England (Figure 5). In the fall, rosette skate juveniles were again concentrated on the outer continental shelf from the Hudson Canyon to south of Cape Hatteras (Figure 6). A few were found near southern New England.

ADULTS

The overall numbers and presence of adult rosette skate ($\geq$ 46 cm TL) collected during the NEFSC bottom trawl surveys were much lower than for juveniles; only a few individuals were found on the outer continental shelf near the 200 m depth contour near the Hudson Canyon or Cape Hatteras (Figures 7-9). (Again, winter distributions are presented as presence/absence data, precluding a discussion of abundances; there were no adults present in the summer surveys.)

HABITAT CHARACTERISTICS

Information on the habitat requirements and preferences of rosette skate (based on both the pertinent literature and the most recent NEFSC and state surveys) are presented here and summarized in Table 1.

Rosette skate is found on soft bottoms, including sand to mud bottoms (Bullis and Thompson 1965; Struhsaker 1969), mud with echinoid and ophiuroid fragments, and shell and pterpod ooze (Staiger 1970).

It occurs from 33-530 m but is most common between 74-274 m (Bigelow and Schroeder 1953b; Bullis and Thompson 1965; Schroeder 1955; McEachran and Musick 1975). In the southern part of its range rosette skate may have a more limited depth range (Bigelow and Schroeder 1953b). It has been reported from the eastern slope of Georges Bank to Cape Charles, Virginia at < 366 m (Schroeder 1955). On the Chesapeake Bight, McEachran and Musick (1975) found it between 33-196 m and generally > 73 m. It appeared to move shoreward in the summer. Between Cape Hatteras and Georgia it was found at depths between 66-123 m, off Georgia and northern Florida it occurred at 77-155 m, and from northern Florida to the Straits of Florida it was found mostly at depths between 183-366 m (McEachran and Musick 1975). Staiger (1970) reported that rosette skate was found between the 119-366 m isobaths on Pourtales Terrace, and north of Pourtales Terrace it was found in 183 m up the coast of Florida.

The spring and fall distributions of juvenile rosette skate relative to bottom depth based on 1963-2002 NEFSC bottom trawl surveys from the Gulf of Maine to Cape Hatteras are shown in Figure 10. In spring their depth range was spread between 31-400 m, while in the fall they were found from 11-500 m, with around 35-40% at 101-140 m.

Bigelow and Schroeder (1953b) reported its temperature range as 5.3-15°C. On the Chesapeake Bight, McEachran and Musick (1975) found it between 6-17°C but was most abundant at temperatures between 9-13°C. Between Cape Hatteras and Georgia it was found at 17°C, off Georgia and northern Florida it was found between 11-19°C, and from northern Florida to the Straits of Florida it was captured at 17°C (McEachran and Musick 1975). Edwards *et al*. (1962) captured it off Winter Quarter (37°34′ - 37°50′ N) at 11-13°C and off Albermarle Sound, North Carolina at 12-14°C. It is found in warmer water in the southern part of its range (Bigelow and Schroeder 1953b).

The spring and fall distributions of juvenile rosette skate relative to bottom water temperature based on NEFSC bottom trawl surveys are also shown in Figure 10. In spring their temperature range was between 5° to about 21°C, with most between 10-12°C. In the fall juvenile rosette skate were found over a temperature range of approximately 6-24°C, with the majority between 12-14°C.

The spring and fall distributions of juvenile rosette skate relative to salinity based on NEFSC bottom trawl surveys are again shown in Figure 10. During spring they were found over a salinity range of 32-36 ppt with the majority at 35-36 ppt. In the fall they were found over a salinity range of 31-36 ppt, with around 50% at 36 ppt.

(There is insufficient data to discuss the seasonal distributions of adult rosette skate relative to bottom temperature, depth, and salinity.)

STATUS OF THE STOCKS

The following section is based on Northeast Fisheries Science Center (2000a, b).

The principal commercial fishing method used to catch all seven species of skates [rosette, clearnose (*Raja eglanteria*), little (*Leucoraja erinacea*), barndoor (*Dipturus laevis*), winter (*Leucoraja ocellata*), thorny, (*Raja eglanteria*), smooth (*Malacoraja senta*)] is otter trawling. Skates are frequently taken as bycatch during groundfish trawling and scallop dredge operations and discarded recreational and foreign landings are currently insignificant, at < 1% of the total fishery landings.

Skates have been reported in New England fishery landings since the late 1800s. However, commercial fishery landings, primarily from off Rhode Island, never exceeded several hundred metric tons until the advent of distant-water fleets during the 1960s. Landings are not reported by species, with over 99% of the landings reported as “unclassified skates.” Skate landings reached 9,500 mt in 1969, but declined quickly during the 1970s, falling to 800 mt in 1981 (Figure 11). Landings have since increased substantially, partially in response to increased demand for lobster bait, and more significantly, to the increased export market for skate wings. Wings are taken from winter and thorny skates, the two species currently used for human consumption. Bait landings are presumed to be primarily from little skate, based on areas fished and known species distribution patterns. Landings for all skates increased to 12,900 mt in 1993 and then declined somewhat to 7,200 mt in 1995. Landings have increased again since 1995, and the 1998 reported commercial landings of 17,000 mt were the highest on record (Figure 11).

The biomass for the seven skate species is at a medium level of abundance. For the aggregate complex, the NEFSC spring survey index of biomass was relatively constant from 1968-1980, then increased significantly to peak levels in the mid- to late 1980s. The index of skate complex biomass then declined steadily until 1994, but has recently increased again. The large increase in skate biomass in the mid- to late 1980s was dominated by little and winter skate. The survey index of rosette skate biomass was at a peak during 1975-1980, before declining through 1986 (Figure 11). The abundance of rosette skate has been increasing since 1986 (Figure 11), although the recent increase in aggregate skate biomass

has been due to an increase in all the small sized skates (< 100 cm max. length: rosette, clearnose, little, and smooth), primarily little skate. Rosette skate is not considered to be overfished (Northeast Fisheries Science Center 2000a, b).

RESEARCH NEEDS

Imprecise reporting of fishery statistics where several skate species are lumped together under one category (e.g., "unclassified skates" or "skates spp.") can mask basic changes in community structure and profound reduction in populations of larger, slower growing species (Dulvy *et al*. 2000; Musick *et al*. 2000). Thus, it is important to have fishery-independent data on skates where the individual species are reported. In addition, for rosette skate there are still questions regarding the taxonomy of the various east coast populations, and studies of stock structure are needed to identify if there are any unit stocks.

Northeast Fisheries Science Center (2000b) also suggests the following research needs:

- More life history data is needed, as well as more studies on age, growth, maturity, and fecundity.
- Explore possible stock-recruit relationships by examination of NEFSC survey data.
- Investigate trophic interactions between skate species in the complex, and between skates and other groundfish.
- Investigate the influence of annual changes in water temperature or other environmental factors on shifts in the range and distribution of the species in the skate complex, and establish the bathymetric distribution of the species in the complex in the northwest Atlantic.
- Investigate historical NEFSC survey data from the R/V Albatross III during 1948-1962 when they become available, as they may provide valuable historical context for long-term trends in skate biomass.

ACKNOWLEDGMENTS

The authors thank Barry Shafer, John McCarthy, Tom Finneran, and Annette Kalbach for producing the maps and graphics. Thanks also to Claire Steimle and Judy Berrien for literature reviews and interlibrary loans. Frank Almeida and Kathy Sosebee of the NEFSC Woods Hole provided much needed information, input, and reviews.

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Table 1. Summary of habitat parameters for rosette skate, based on the pertinent literature and most recent NEFSC surveys[1].

Depth	Temperature	Substrate/Salinity	Prey
Occurs from 33-530 m but is most common between 74-274 m. In southern part of its range rosette skate may have a more limited depth range. Reported from eastern slope of Georges Bank to Cape Charles, Virginia at < 366 m. On the Chesapeake Bight, found it between 33-196 m and generally > 73 m; appeared to move shoreward in summer. Between Cape Hatteras and Georgia it was found between 66-123 m, off Georgia and northern Florida occurred at 77-155 m, from northern Florida to the Straits of Florida was found mostly at depths between 183-366 m. On Pourtales Terrace found between 119-366 m isobaths, north of Pourtales Terrace found in 183 m up the coast of Florida. Spring and fall distributions of juveniles relative to bottom depth based on 1963-2002 NEFSC bottom trawl surveys from Gulf of Maine to Cape Hatteras: *Spring*. Range spread between 31-400 m. *Fall*. Range of 11-500 m, around 35-40% at 101-140 m.	Reported temperature range of 5.3-15°C. On the Chesapeake Bight, captured between 6-17°C but most abundant between 9-13°C. Between Cape Hatteras and Georgia found at 17°C, off Georgia and northern Florida found between 11-19°C, from northern Florida to the Straits of Florida captured at 17°C. Captured off Winter Quarter (37°34′ - 37°50′ N) at 11-13°C and off Albermarle Sound, North Carolina at 12-14°C. Found in warmer water in the southern part of its range. Spring and fall distributions of juveniles relative to bottom water temperature based on 1963-2002 NEFSC bottom trawl surveys from Gulf of Maine to Cape Hatteras: *Spring*. Range of between 5° to about 21°C, most between 10-12°C. *Fall*. Range of approximately 6-24°C, majority between 12-14°C.	Soft bottoms, including sand to mud bottoms, mud with echinoid and ophiuroid fragments, and shell and pterpod ooze. Spring and fall distributions of juveniles relative to salinity based on 1963-2002 NEFSC bottom trawl surveys from Gulf of Maine to Cape Hatteras: *Spring*. Range of 32-36 ppt, majority at 35-36 ppt. *Fall*. Range of 31-36 ppt, with around 50% at 36 ppt.	Polychaetes, copepods, cumaceans, amphipods, the shrimp *Crangon septemspinosa*, *Cancer* and galatheoid crabs, squids, octopods, and small fishes.

[1] Bigelow and Schroeder (1953b); Schroeder (1955); Edwards *et al*. (1962); Bullis and Thompson (1965); Struhsaker (1969); Staiger (1970); McEachran and Musick (1975); Stehmann and McEachran (1978); Bowman *et al*. 2000; 1963-2002 NEFSC trawl surveys.

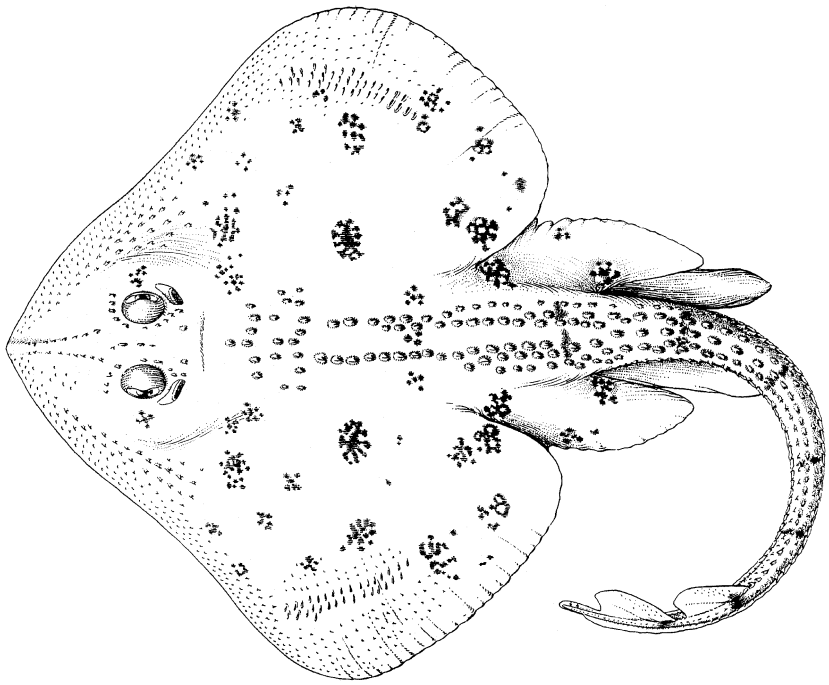

Figure 1. The rosette skate, *Leucoraja garmani virginica* (McEachran 1977), male, from Bigelow and Schroeder (1953b).

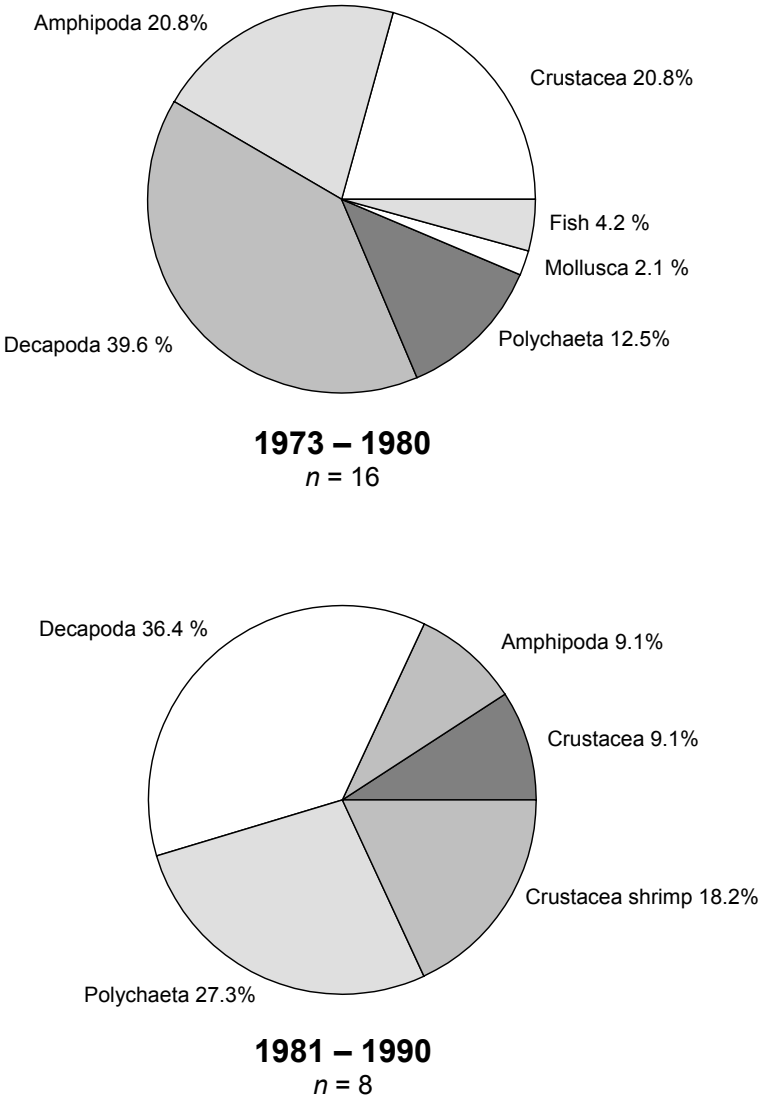

Figure 2. Abundance (% occurrence) of the major prey items of rosette skate collected during NEFSC bottom trawl surveys from 1973-1980 and 1981-1990. Methods for sampling, processing, and analysis of samples differed between the time periods [see Reid *et al.* (1999) for details].

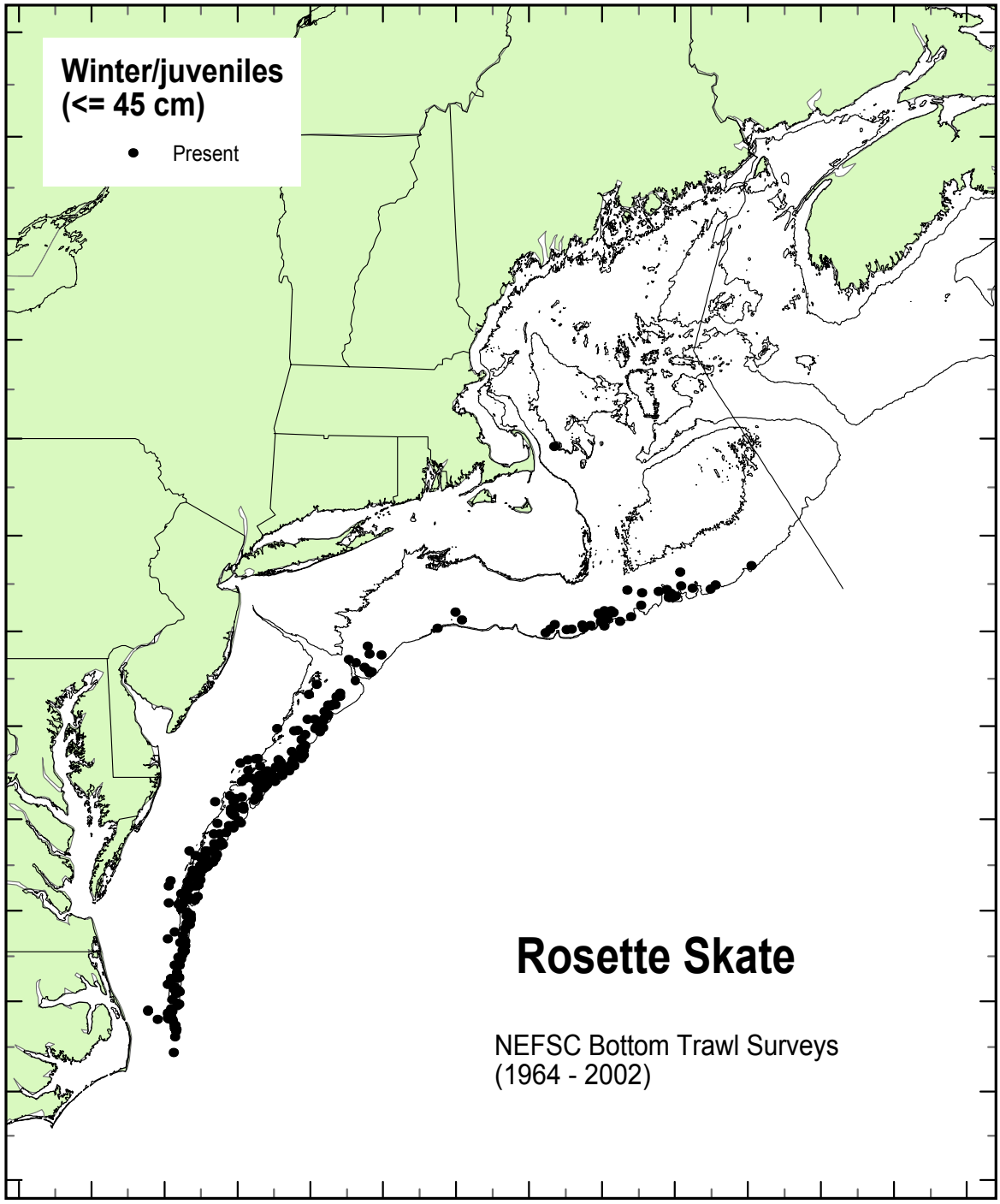

Figure 3. Distribution of juvenile rosette skate collected during winter NEFSC bottom trawl surveys [1964-2002, all years combined; see Reid *et al.* (1999) for details]. Survey stations where juveniles were not found are not shown.

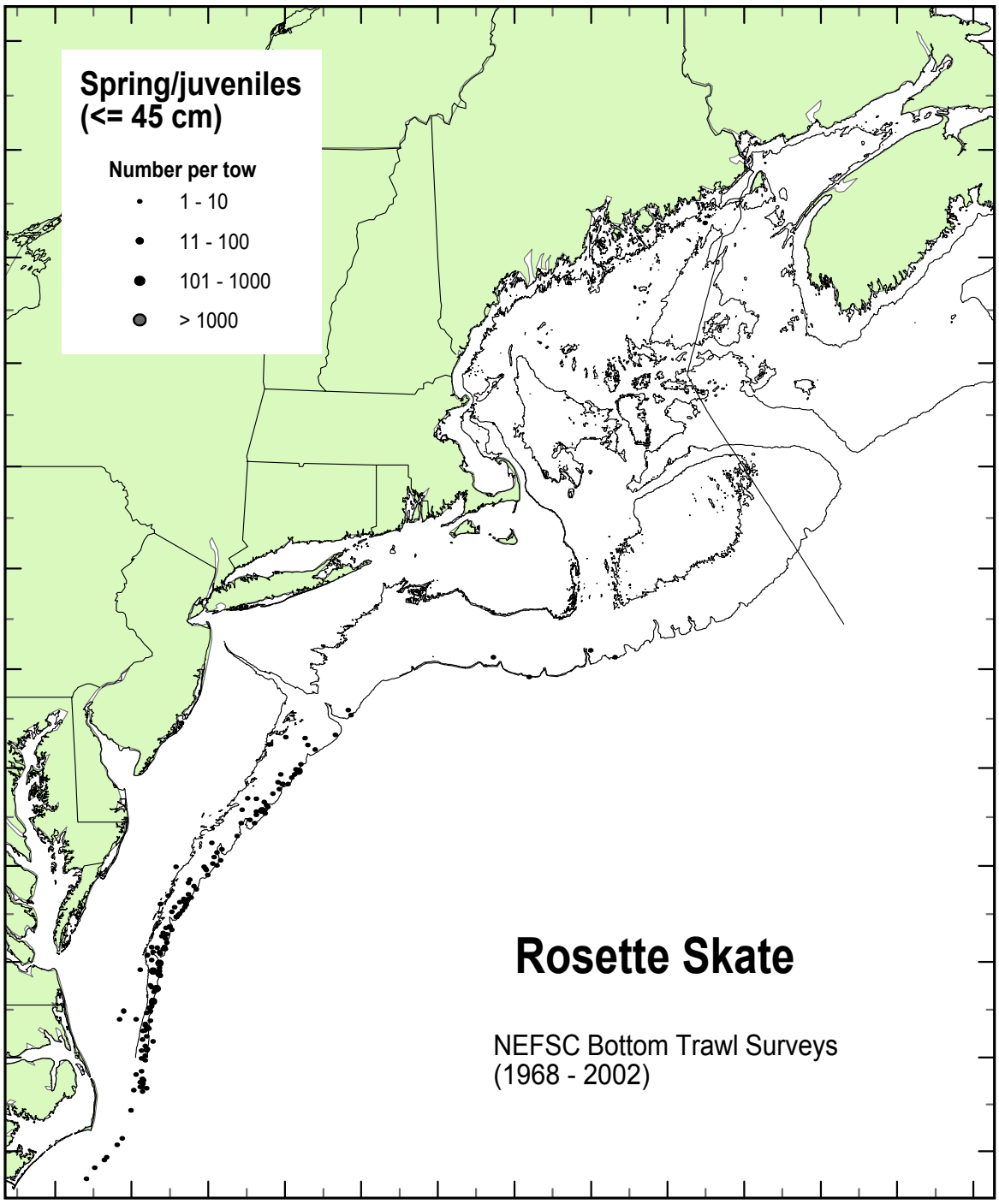

Figure 4. Distribution and abundance of juvenile rosette skate collected during spring NEFSC bottom trawl surveys [1968-2002, all years combined; see Reid *et al.* (1999) for details].

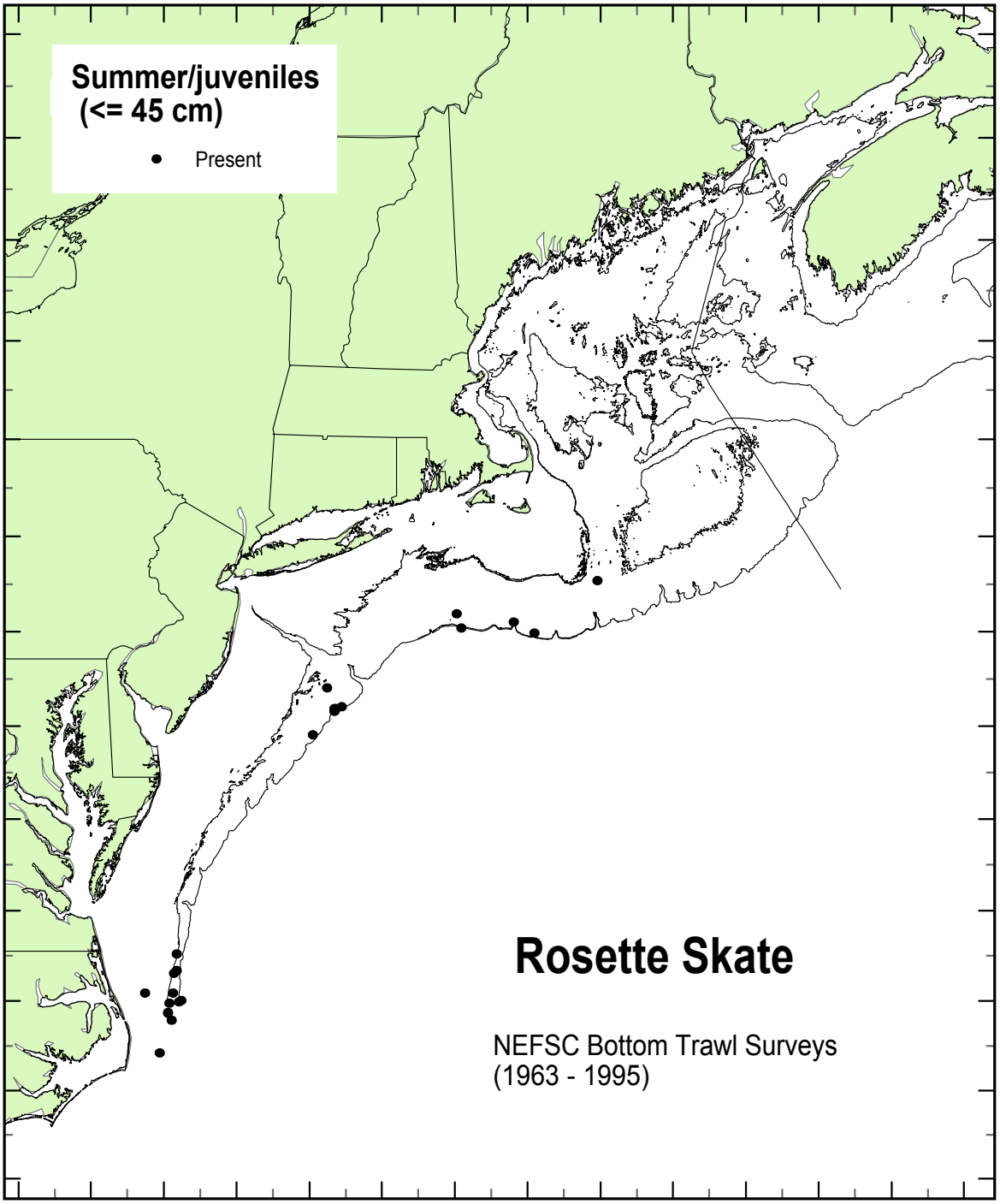

Figure 5. Distribution of juvenile rosette skate collected during summer NEFSC bottom trawl surveys [1963-1995, all years combined; see Reid *et al.* (1999) for details]. Survey stations where juveniles were not found are not shown.

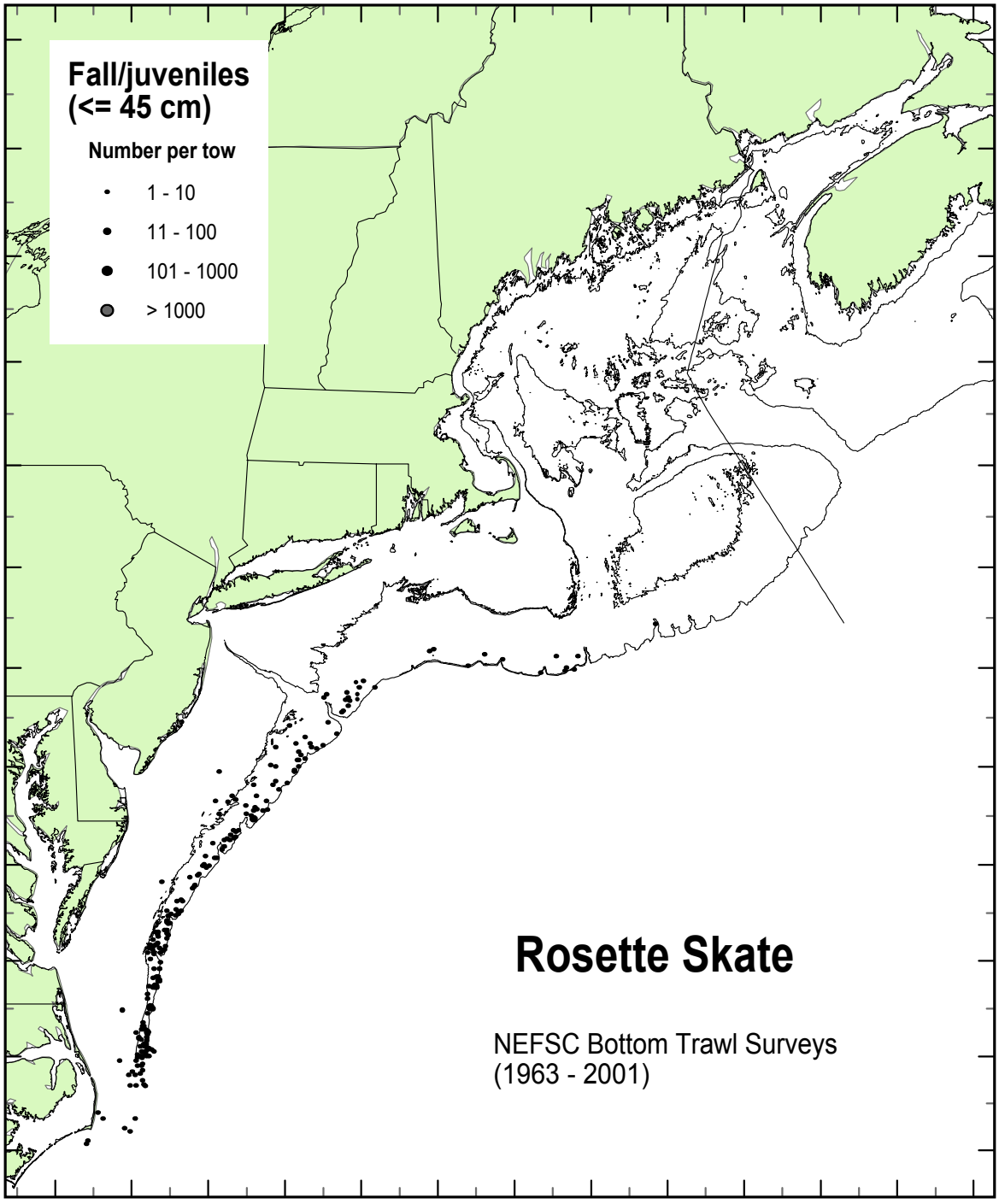

Figure 6. Distribution and abundance of juvenile rosette skate collected during fall NEFSC bottom trawl surveys [1963-2001, all years combined; see Reid *et al.* (1999) for details].

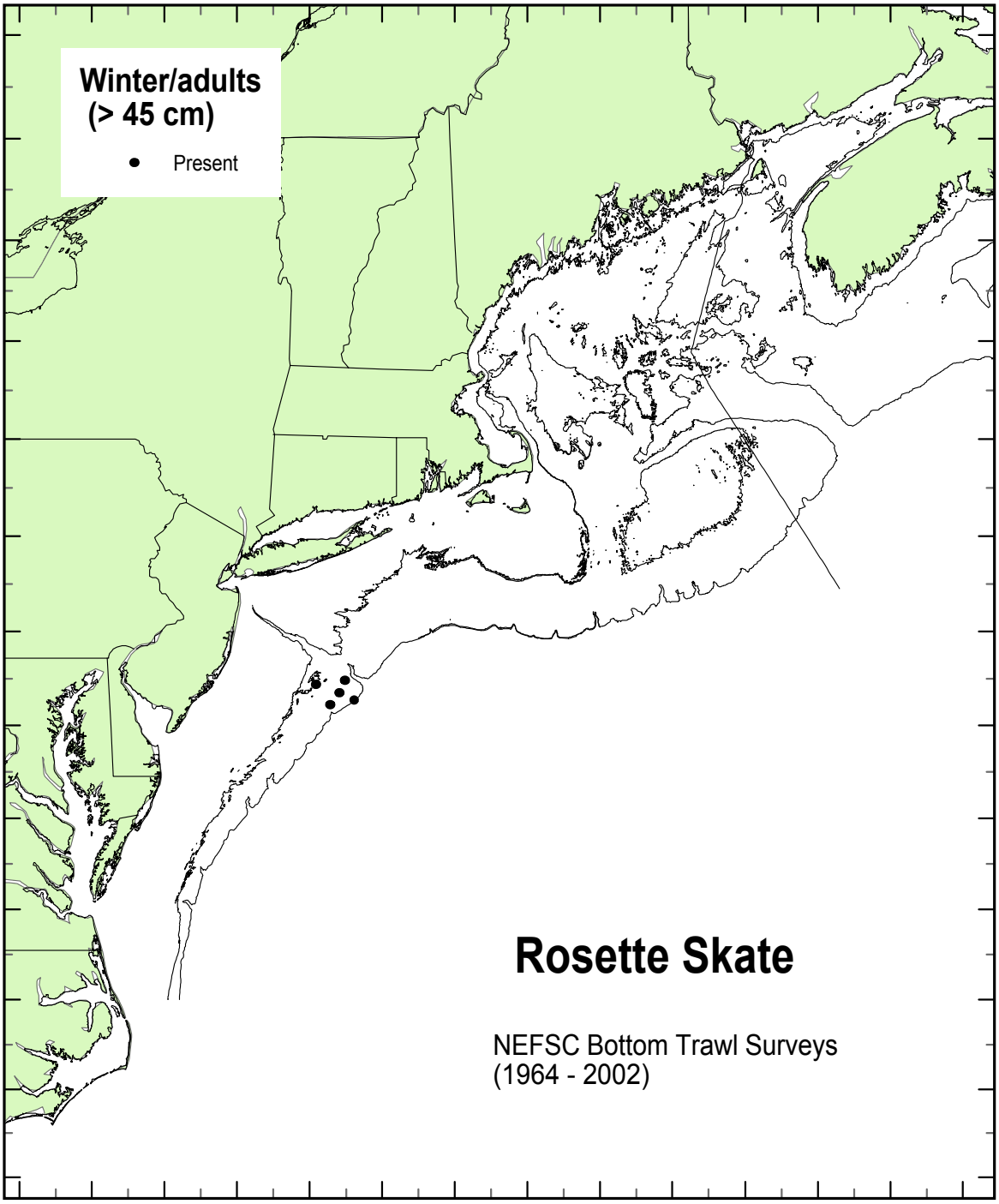

Figure 7. Distribution of adult rosette skate collected during winter NEFSC bottom trawl surveys [1964-2002, all years combined; see Reid *et al.* (1999) for details]. Survey stations where adults were not found are not shown.

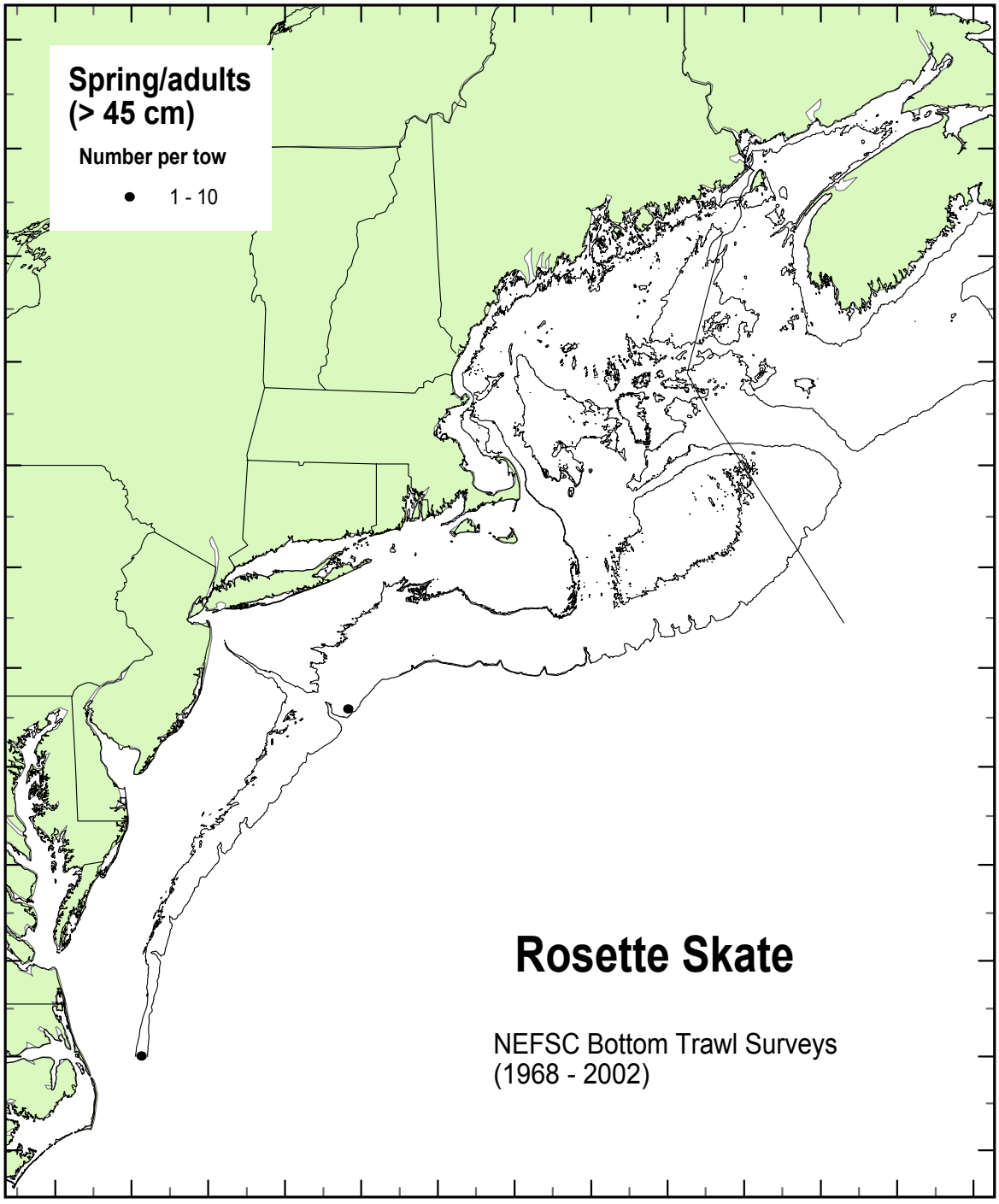

Figure 8. Distribution and abundance of adult rosette skate collected during spring NEFSC bottom trawl surveys [1968-2002, all years combined; see Reid *et al.* (1999) for details].

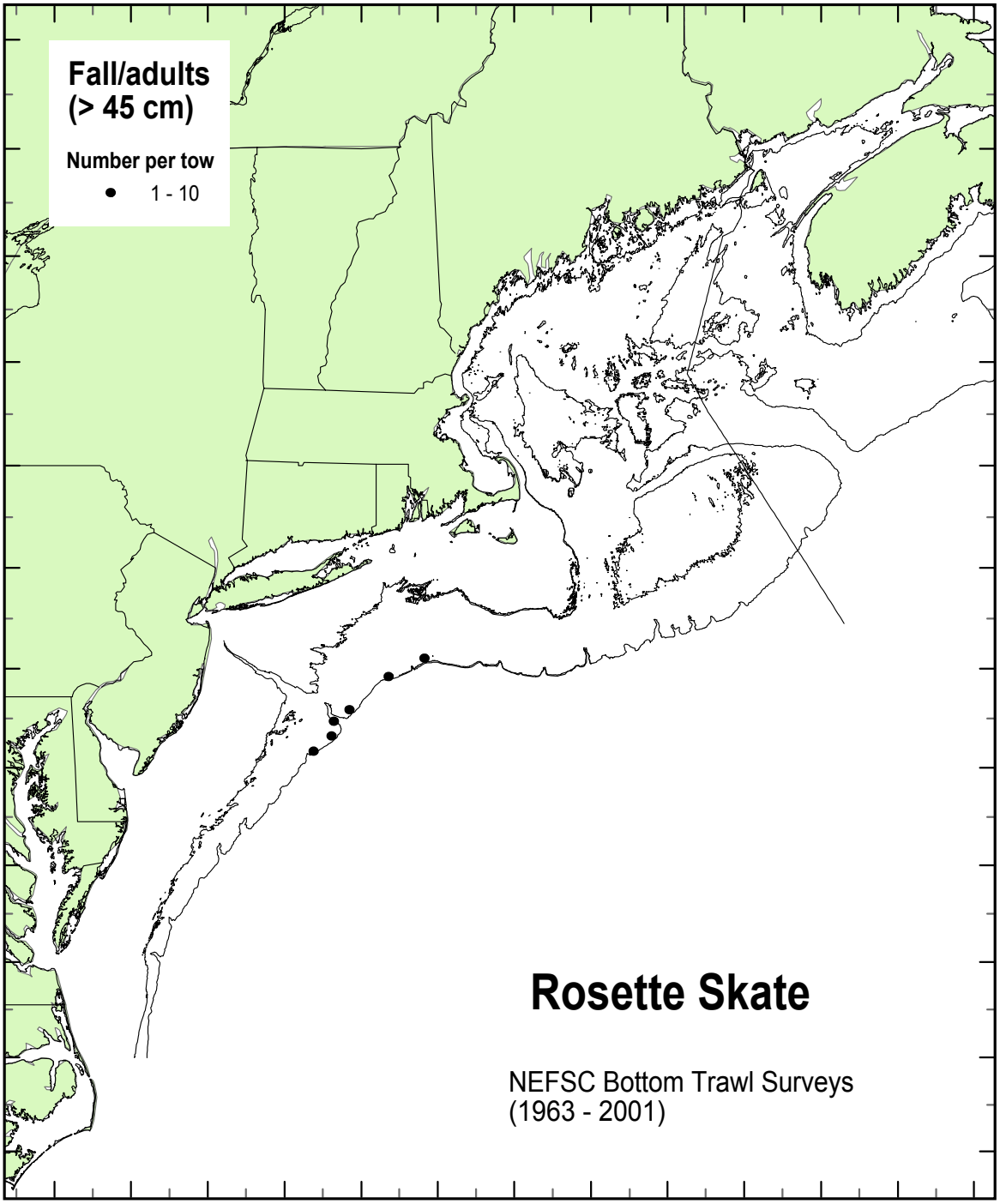

Figure 9. Distribution and abundance of adult rosette skate collected during fall NEFSC bottom trawl surveys [1963-2001, all years combined; see Reid *et al.* (1999) for details].

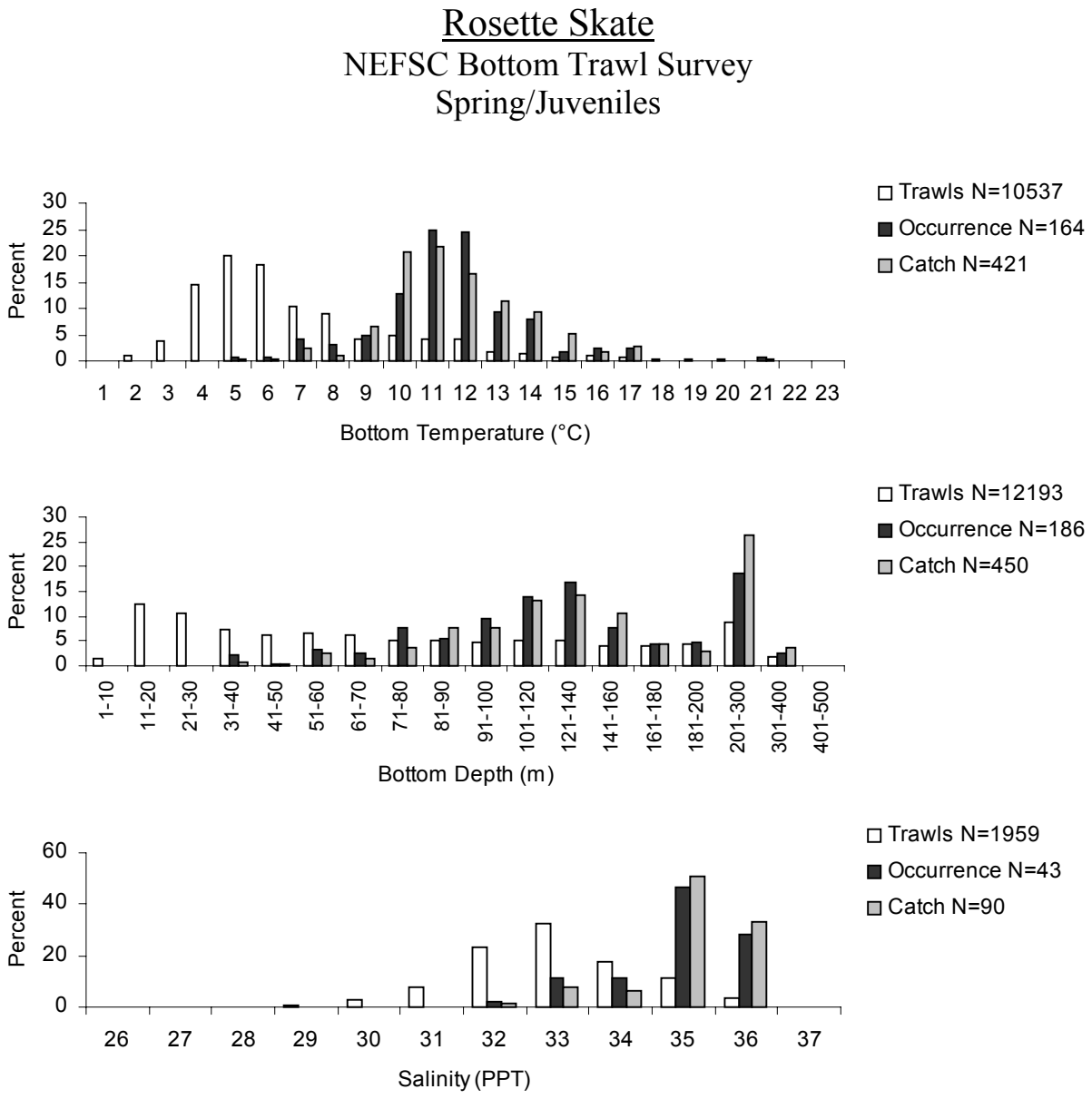

Figure 10. Spring and fall distributions of juvenile rosette skate and trawls relative to bottom water temperature, depth, and salinity based on NEFSC bottom trawl surveys (1963-2002; all years combined). White bars give the distribution of all the trawls, black bars give the distribution of all trawls in which rosette skate occurred, and gray bars represent, within each interval, the percentage of the total number of rosette skate caught.

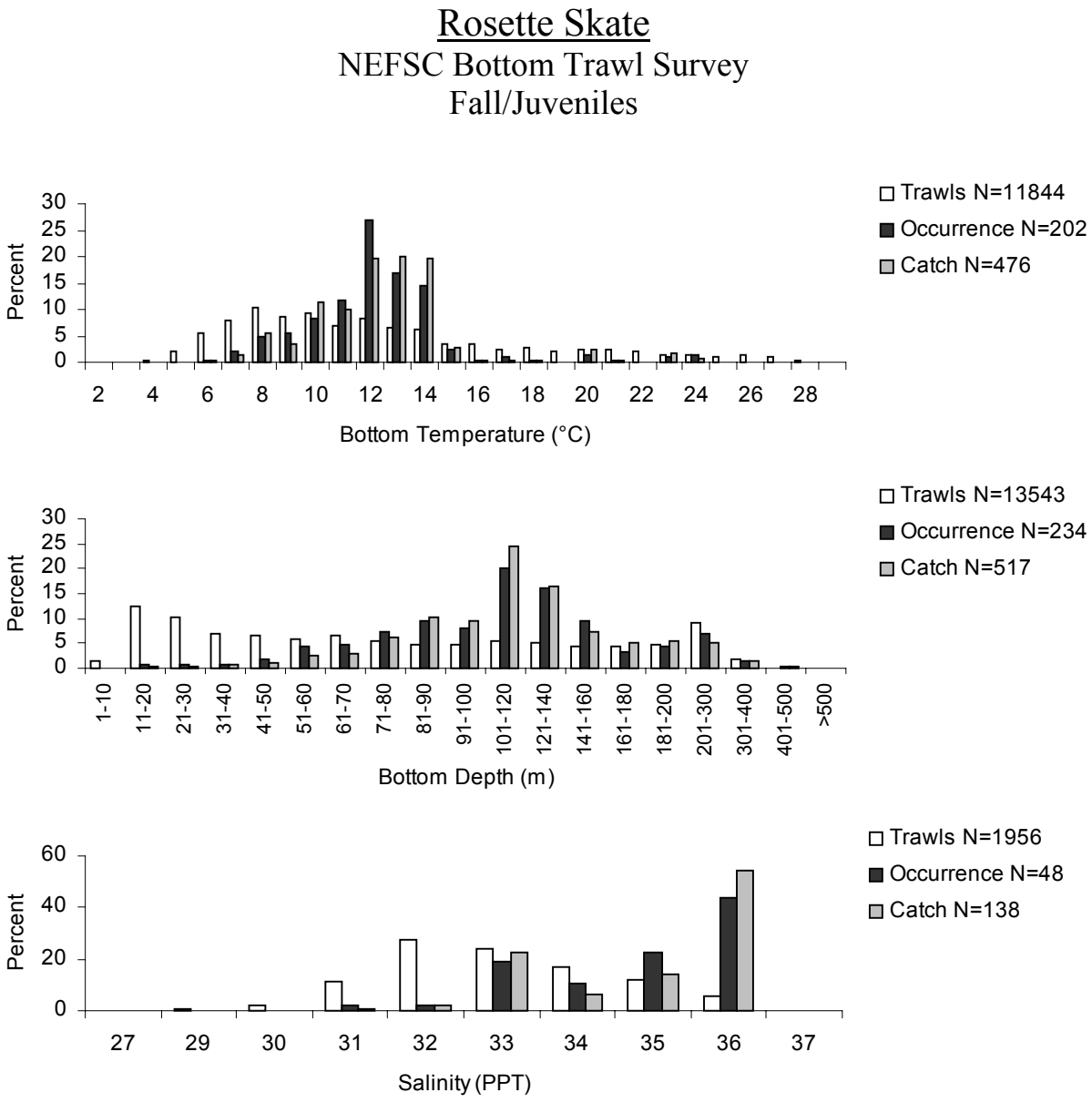

Figure 10. cont'd.

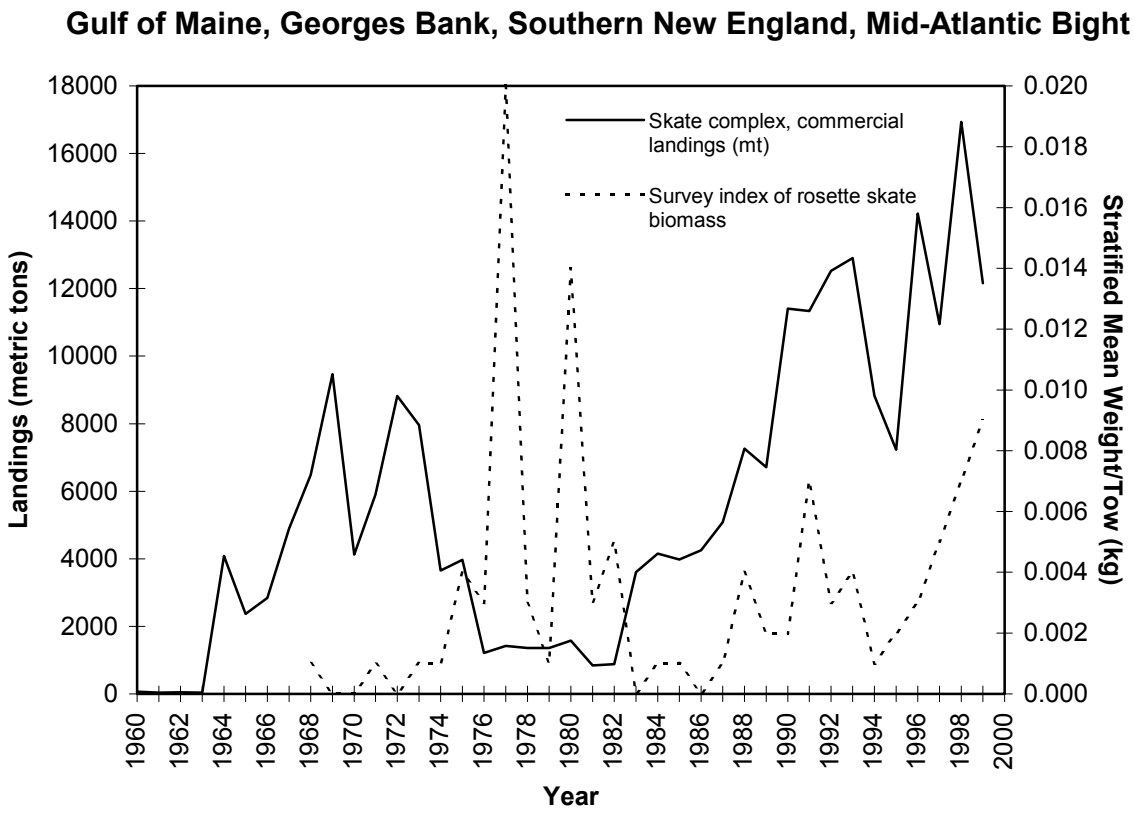

Figure 11. NEFSC spring survey index of rosette skate biomass and commercial landings of the seven species skate complex from the Gulf of Maine to the Mid-Atlantic Bight.

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