NOAA Technical Memorandum NMFS-NE-127

Essential Fish Habitat Source Document:

Goosefish, *Lophius americanus*, 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

September 1999

Recent Issues

105. **Review of American Lobster (*Homarus americanus*) Habitat Requirements and Responses to Contaminant Exposures.** By Renee Mercaldo-Allen and Catherine A. Kuropat. July 1994. v + 52 p., 29 tables. NTIS Access. No. PB96-115555.

106. **Selected Living Resources, Habitat Conditions, and Human Perturbations of the Gulf of Maine: Environmental and Ecological Considerations for Fishery Management.** By Richard W. Langton, John B. Pearce, and Jon A. Gibson, eds. August 1994. iv + 70 p., 2 figs., 6 tables. NTIS Access. No. PB95-270906.

107. **Invertebrate Neoplasia: Initiation and Promotion Mechanisms -- Proceedings of an International Workshop, 23 June 1992, Washington, D.C.** By A. Rosenfield, F.G. Kern, and B.J. Keller, comps. & eds. September 1994. v + 31 p., 8 figs., 3 tables. NTIS Access. No. PB96-164801.

108. **Status of Fishery Resources off the Northeastern United States for 1994.** By Conservation and Utilization Division, Northeast Fisheries Science Center. January 1995. iv + 140 p., 71 figs., 75 tables. NTIS Access. No. PB95-263414.

109. **Proceedings of the Symposium on the Potential for Development of Aquaculture in Massachusetts: 15-17 February 1995, Chatham/Edgartown/Dartmouth, Massachusetts.** By Carlos A. Castro and Scott J. Soares, comps. & eds. January 1996. v + 26 p., 1 fig., 2 tables. NTIS Access. No. PB97-103782.

110. **Length-Length and Length-Weight Relationships for 13 Shark Species from the Western North Atlantic.** By Nancy E. Kohler, John G. Casey, Patricia A. Turner. May 1996. iv + 22 p., 4 figs., 15 tables. NTIS Access. No. PB97-135032.

111. **Review and Evaluation of the 1994 Experimental Fishery in Closed Area II on Georges Bank.** By Patricia A. Gerrior, Fredric M. Serchuk, Kathleen C. Mays, John F. Kenney, and Peter D. Colosi. October 1996. v + 52 p., 24 figs., 20 tables. NTIS Access. No. PB98-119159.

112. **Data Description and Statistical Summary of the 1983-92 Cost-Earnings Data Base for Northeast U.S. Commercial Fishing Vessels: A Guide to Understanding and Use of the Data Base.** By Amy B. Gautam and Andrew W. Kitts. December 1996. v + 21 p., 11 figs., 14 tables. NTIS Access. No. PB97-169320.

113. **Individual Vessel Behavior in the Northeast Otter Trawl Fleet during 1982-92.** By Barbara Pollard Rountree. August 1997. v + 50 p., 1 fig., 40 tables. NTIS Access. No. PB99-169997.

114. **U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 1996.** By Gordon T. Waring, Debra L. Palka, Keith D. Mullin, James H.W. Hain, Larry J. Hansen, and Kathryn D. Bisack. October 1997. viii + 250 p., 42 figs., 47 tables. NTIS Access. No. PB98-112345.

115. **Status of Fishery Resources off the Northeastern United States for 1998.** By Stephen H. Clark, ed. September 1998. vi + 149 p., 70 figs., 80 tables. NTIS Access. No. PB99-129694.

116. **U.S. Atlantic Marine Mammal Stock Assessments -- 1998.** By Gordon T. Waring, Debra L. Palka, Phillip J. Clapham, Steven Swartz, Marjorie C. Rossman, Timothy V.N. Cole, Kathryn D. Bisack, and Larry J. Hansen. February 1999. vii + 182 p., 16 figs., 56 tables. NTIS Access. No. PB99-134140.

117. **Review of Distribution of the Long-finned Pilot Whale (*Globicephala melas*) in the North Atlantic and Mediterranean.** By Alan A. Abend and Tim D. Smith. April 1999. vi + 22 p., 14 figs., 3 tables. NTIS Access. No. PB99-165029.

118. **Tautog (*Tautoga onitis*) Life History and Habitat Requirements.** By Frank W. Steimle and Patricia A. Shaheen. May 1999. vi + 23 p., 1 fig., 1 table. NTIS Access. No. PB99-165011.

119. **Data Needs for Economic Analysis of Fishery Management Regulations.** By Andrew W. Kitts and Scott R. Steinback. August 1999. iv + 48 p., 10 figs., 22 tables. NTIS Access. No. PB99-171456.

120. **Marine Mammal Research Program of the Northeast Fisheries Science Center during 1990-95.** By Janeen M. Quintal and Tim D. Smith. September 1999. v + 28 p., 4 tables, 4 app. NTIS Access. No. PB2000-100809.

NOAA Technical Memorandum NMFS-NE-127

This series represents a secondary level of scientifiic publishing. All issues employ thorough internal scientific review; some issues employ external scientific review. Reviews are -- by design -- transparent collegial reviews, not anonymous peer reviews. All issues may be cited in formal scientific communications.

Essential Fish Habitat Source Document:

Goosefish, *Lophius americanus*, Life History and Habitat Characteristics

Frank W. Steimle, Wallace W. Morse, and Donna L. Johnson

National Marine Fisheries Serv., James J. Howard Marine Sciences Lab., 74 Magruder Rd., Highlands, NJ 07732

U. S. DEPARTMENT OF COMMERCE
William Daley, Secretary
National Oceanic and Atmospheric Administration
D. James Baker, Administrator
National Marine Fisheries Service
Penelope D. Dalton, Assistant Administrator for Fisheries
Northeast Region
Northeast Fisheries Science Center
Woods Hole, Massachusetts

September 1999

Editorial Notes on Issues 122-152 in the *NOAA Technical Memorandum NMFS-NE* Series

Editorial Production

For Issues 122-152, 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 authors and acknowledgees of each issue, as well as those noted below in "Special Acknowledgments."

Special Acknowledgments

David B. Packer, Sara J. Griesbach, and Luca M. Cargnelli coordinated virtually all aspects of the preprinting editorial production, as well as performed virtually all technical and copy editing, type composition, and page layout, of Issues 122-152. Rande R. Cross, Claire L. Steimle, and Judy D. Berrien conducted the literature searching, citation checking, and bibliographic styling for Issues 122-152. Joseph J. Vitaliano produced all of the food habits figures in Issues 122-152.

Internet Availability

Issues 122-152 are being copublished, *i.e.*, both as paper copies and as web postings. All web postings are, or will soon be, available at: *www.nefsc.nmfs.gov/nefsc/habitat/efh*. Also, all web postings will be in "PDF" format.

Information Updating

By federal regulation, all information specific to Issues 122-152 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 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]).

---

[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.

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 30 EFH species reports (plus one consolidated methods report). The EFH species reports comprise 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 have understandably 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 30 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, CHIEF
ECOSYSTEMS PROCESSES DIVISION
NORTHEAST FISHERIES SCIENCE CENTER

Contents

Introduction 1
Life History 1
Habitat Characteristics 4
Geographical Distribution 5
Status of the Stocks 6
Research Needs 7
Acknowledgments 7
References Cited 7

Tables

Table 1. Summary of life history and habitat parameters for goosefish, *Lophius americanus* 10

Figures

Figure 1. The adult goosefish (or monkfish), *Lophius americanus* (from Goode 1884) 12
Figure 2. Abundance of the major prey items in the diet of goosefish from NEFSC bottom trawl survey data on food habits 13
Figure 3. Association of goosefish larvae with water temperature and bottom depth from NEFSC MARMAP surveys 14
Figure 4. Association of juvenile and adult goosefish with bottom temperature and depth from NEFSC bottom trawl surveys 15
Figure 5. Association of juvenile and adult goosefish with bottom temperature and depth from Massachusetts trawl surveys 16
Figure 6. Association of juvenile and adult goosefish with bottom temperature and depth from Rhode Island trawl surveys 17
Figure 7. The distribution and abundance and size frequency of goosefish captured during Connecticut trawl surveys 19
Figure 8. Distribution and abundance of goosefish from Newfoundland to Cape Hatteras during 1975-1994 20
Figure 9. Distribution and abundance of goosefish larvae from the NEFSC MARMAP ichthyoplankton surveys 21
Figure 10. Distribution and abundance of juvenile and adult goosefish collected during NEFSC bottom trawl surveys 24
Figure 11. Distribution and abundance of juvenile and adult goosefish collected during Massachusetts inshore trawl surveys 26
Figure 12a. Distribution and abundance of juveniles collected in Narragansett Bay during Rhode Island trawl surveys 27
Figure 12b. Distribution and abundance of adults collected in Narragansett Bay during Rhode Island trawl surveys 28
Figure 12c. Size distribution of juveniles and adults collected in Narragansett Bay during Rhode Island trawl surveys 29
Figure 13. Commercial landings, survey indices, and stock biomass of goosefish in the Gulf of Maine and Middle Atlantic 30
Figure 14. Distribution of juvenile and adult goosefish during high and low abundance periods from NEFSC bottom surveys 31

INTRODUCTION

The goosefish (*Lophius americanus*; Valenciennes 1837), the common name recognized by the American Fisheries Society (Robins *et al*. 1991), or monkfish, the name used in commerce, is a large, slow-growing, bottom-dwelling anglerfish (Lophiiformes) (Figure 1). "Angler" is an older common name for this fish. The goosefish occurs from the southern and eastern parts of the Grand Banks, (Newfoundland) and the northern side of the Gulf of St. Lawrence, to the east coast of Florida (to about 29^{o} N), but is common only north of Cape Hatteras (North Carolina). It was once considered indistinct from the European angler (*L. piscatorius*; e.g., Connolly 1920). Specimens noted in the literature from the Caribbean and Gulf of Mexico (e.g., Bigelow and Schroeder 1953; Jean 1965) were probably misidentified (Caruso 1983). South of Cape Hatteras, it is sympatric with the black-lined goosefish (*L. gastrophysus*) in deep water (Caruso 1983; Armstrong *et al*. 1992). Gabriel (1992) included goosefish in a cold water group composed of American plaice (*Hippoglossoides platessoides*), redfish (*Sebastes* spp.), witch flounder (*Glyptocephalus cynoglossus)*, cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and pollock (*Pollachius virens*), although others suggested affinities with species from warmer temperate waters (Jean 1965; Scott and Scott 1988; Brown *et al*. 1996).

In U.S. waters, the species is managed under the Northeast Multispecies Fishery Management Plan of the New England Fishery Management Council (NEFMC 1993). The population is currently managed as two stocks (north and south of the central axis of Georges Bank), although there are few biological differences between stocks. This Essential Fish Habitat source document provides information on the life history and habitat requirements of goosefish inhabiting U.S. waters.

LIFE HISTORY

The goosefish is a solitary ambush predator of invertebrates and fish. It grows to about 140 cm total length (TL), although few are found greater than 100 cm TL, and can weigh up to about 22 kg (Bigelow and Schroeder 1953). Females attain a larger size than males; males typically live about 9 years and females about 11 years (Armstrong *et al*. 1992; Hartley 1995). The species has several unusual aspects to its life history, including releasing its eggs in long, floating, mucus veils.

EGGS

The eggs are relatively large (1.6-1.8 mm) and are shed within buoyant, ribbon-like, non-adhesive, mucoid veils or rafts that may be 6-12 m long and 0.15 to 1.5 m wide and weigh > 5 kg (Connolly 1920; Martin and Drewry 1978; Armstrong *et al*. 1992). The method of fertilization has not been observed or reported. The egg veils float freely at the surface and are subject to the actions of wind, currents, and waves. Individual eggs, shed from the mucus veil, were also reported to be buoyant (Connolly 1920). The mucus veil manner of egg production is thought to be unique among fishes. The veils could contain obnoxious or toxic substances to repel potential predators and can offer some protection from predation on individual eggs (Armstrong *et al.* 1992). The time to hatching ranges from 6-7 days at 15^{o}C to approximately 100 days at 5^{o}C (Scott and Scott 1988).

LARVAE

Newly hatched larvae (2.5-4.5 mm TL) remain protected in the open egg chamber within the egg veil for 2-3 days after hatching (Connolly 1920; Dahlgren 1928) and, upon release, are pelagic. When released from their egg chamber, the larvae float with their yolk sac upwards. The yolk is normally absorbed by the time the larvae are 6-8 mm. Connolly (1920), Fahay (1983), and Caruso (in prep.) describe larval development. The larvae are quite different in appearance from the adult; they are laterally flattened with elongated dorsal and pectoral fin rays.

Goosefish larvae are a common component of the ichthyoplankton community in the Middle Atlantic Bight and southern New England areas. Larval goosefish in the Middle Atlantic Bight belong to a continental shelf assemblage that includes the larvae of bluefish (*Pomatomus saltatrix*), hakes (*Urophycis* spp.), butterfish (*Peprilus triacanthus*), cunner (*Tautogolabrus adspersus*), and several flatfish species (Cowen *et al*. 1993). More recently, Grothues and Cowen (1999) redefined the Middle Atlantic Bight shelf assemblage, to which the goosefish is associated, to include only: yellowtail flounder (*Limanda ferruginea*), Atlantic mackerel (*Scomber scombrus*), witch flounder, fourspot flounder (*Paralichthys oblongus*), and glacier lanternfish (*Benthosema glaciale*). Sherman *et al.* (1984) listed goosefish as a minor contributor (1.1% of total larvae) in the spring larval fish assemblage in the Middle Atlantic Bight, although it was probably collected in other seasons at lower abundance levels.

An ongoing U.S. Army Corps of Engineers beach replenishment study of the shore zone of north-central New Jersey collected 149 goosefish larvae from summer 1996 ichthyoplankton net tows through the surf zone; 142 of these larvae were collected in June 1996 (D. Clark, U.S. Army Corps of Engineers, CEWES-ER-C, Vicksburg MS, personal communication). It was the third most abundant larva to be collected, composing 8.1% of the total number of fish larvae collected that year, and occurred in 36.4% of the 1996 ichthyoplankton tows. However, only one goosefish larva was collected from the surf zone in 1995.

Larval to juvenile transition occurs at 5-10 cm TL when the elongate fins and body gradually assume the adult form (Fahay 1983) and may take several weeks to months (Connolly 1920; Wood 1982). This morphological transformation coincides with the transition from a pelagic to a benthic existence; the areas or habitats in which this transition occurs are poorly known.

JUVENILES

Juveniles are dorsally flattened, similar to the adult form, with the large mouth for a life on the seabed. Caruso (in prep.) reported collecting juveniles in trawls at sizes as small as 76 mm TL and slightly above 100 mm TL. The size of juvenile goosefish (64-76 mm TL) captured in the fall can represent growth during their first season. Scott and Scott (1988) reported a slightly lower young-of-the-year, pre-winter growth at 59 mm TL in northern waters. They suggested that juveniles 100-114 mm TL collected in late summer could be in their second year. Wood (1982) stated that goosefish grow about 100 mm per year. However, Armstrong *et al.* (1992) reported faster growth rates, i.e., goosefish reach a mean length of 168 mm TL in the first year and a mean of 420 mm TL at age 3. Hartley (1995) gives lengths-at-age at 1 year as 120-139 mm TL for Gulf of Maine fish. Armstrong *et al.* (1992) reported little difference in growth between the sexes until about 4 years of age, after which female growth was greater.

ADULTS

Adults spend most of their time resting on the bottom, often in a depression or partially covered in sediment. They favor open sandy bottoms upon which they can partially bury to support their ambushing method of predation. Movement is by slow swimming or by using their sturdy pectoral fins to "walk." However, they have been reported at the surface, often after a storm (Connolly 1920), and prey on sea birds (Bigelow and Schroeder 1953). Growth rates reported by Scott and Scott (1988) for the following sizes and otolith bands are 79 cm (9 bands), 94 cm (10 bands), and one fish 102 cm (12 bands) (Connolly 1920). After rapid growth (10-11 cm/yr) as juveniles, the annual growth of adults slows to about 7-8 cm/yr (Armstrong *et al.* 1992). They also suggested that growth can be slower in colder waters north of Cape Cod. This was not the case in another study where there was little difference in von Bertalanffy growth parameters between fish from the Gulf of Maine and Georges Bank (Northeast Fisheries Science Center 1992).

Wilk *et al.* (1978) examined 939 goosefish (60-1350 mm TL) collected in the New York Bight in 1974-1975 and developed the following length-weight relationships (log W = a + b log L): Log W = -4.065 + 2.735 (log L) for males, Log W = -4.349 + 2.842 (log L) for females, and Log W = -4.594 + 2.928 (log L) for both sexes, where W = whole weight (g), L = total length (mm), and *a* and *b* are fitted constants. Almeida *et al.* (1995) give a length (TL, mm) to total weight (TW, g) relationship for the sexes combined as: $TW = 0.0000410 * TL^{2.849}$.

REPRODUCTION

Both sexes of goosefish begin to mature at about 30 cm TL. Most males are mature at about 50 cm TL and most females are mature at about 60 cm TL (Almeida *et al.* 1995), which corresponds to about 4 years of age for males and 5 years for females (Wood 1982). Estimates of median length at 50% maturity are 32.0-43.3 cm TL for males and 36.1-48.0 cm TL for females; lengths at maturity are slightly higher in northern waters (Armstrong *et al.* 1992; Almeida *et al.* 1995; Hartley 1995; NEFMC 1997). Hartley (1995) reported median lengths at maturity for Gulf of Maine fish as 32 cm TL for males and 36 cm TL for females. However, Caruso (in prep.) reported that only a few fish were mature at < 76 cm TL. Size-at-age data in Armstrong *et al.* (1992) suggest that the age at maturity in recent years has declined to about 3 years for males and 3-4 years for females. Hartley (1995) reviewed length-at-maturity studies and found that from 1975 to 1993 the length at maturity for females decreased from about 45 cm to 36 cm TL, possibly in response to changes in population abundance and exploitation rates.

Spawning occurs from spring through early fall with a peak in May-June (Wood 1982; Armstrong *et al.* 1992). Regionally, goosefish spawn in the early spring off the Carolinas, in May-June in the Gulf of Maine, and into September in Canadian waters (Scott and Scott 1988; Hartley 1995). Peak gonadosomatic indices (GSI) occurred in March-June for males and in May-June for females (Armstrong *et al.* 1992). Spawning locations are not well known, but are thought to be on inshore shoals to offshore (Connolly 1920; Wood 1982; Scott and Scott 1988).

Armstrong *et al.* (1992) reported that fecundity ranges from 300,000 to 2,400,000 eggs for females between 61 and 105 cm TL. They described the relationship of total length (TL mm) to fecundity by the equation: Fecundity = 4,495.04(TL) - 2,403,814.8. Connolly (1920) and Berrill (1929) also estimated that the number of eggs in a single veil ranged from about 1.3 to 3.2 million.

FOOD HABITS

Larvae feed on zooplankton, including copepods, crustacean larvae, and chaetognaths (Bigelow and Schroeder 1953). Small juveniles (5-20 cm TL) start eating fish, such as sand lance (*Ammodytes* spp.), soon after they settle to the bottom, but invertebrates, especially crustaceans such as red (bristle-beaked) shrimp (*Dichelopandalus leptocerus*) and squid, can make up a large part of their diet. The consumption of invertebrates decreases among larger juveniles (20-40 cm TL) and goosefish > 40 cm TL eat few invertebrates (Armstrong *et al*. 1996).

In the Northeast Fisheries Science Center (NEFSC) food habits database, the diet of goosefish about 30 to 120 cm TL (n=1,108) was 60-95% fish by volume. Interestingly, the 1973-1980 data suggest an increased use of fish with increasing TL, while the 1981-1990 data suggest a decreased use of fish with increasing TL; however, the stomach examination methods differed between the two periods (Reid *et al.* 1999). There was little variation in major contributors to the diets over different seasons or areas, although mollusks (mostly squid) were only important south of Georges Bank. Diets can vary regionally and seasonally, depending on what is available as prey (Bigelow and Schroeder 1953).

Goosefish are opportunistic feeders; prey found in their stomachs include a variety of benthic and pelagic species. Goosefish collected during the NEFSC bottom trawl survey consumed primarily crustaceans ("arthropods"), squid ("molluscs"), and fish (Figure 2). Goosefish eat spiny dogfish (*Squalus acanthias*), skates (*Raja* spp.), eels, sand lance, herring, Atlantic menhaden (*Brevoortia tyrannus*), smelt (Osmeridae), mackerel (*Scomber* spp.), weakfish (*Cynoscion regalis*), cunner, tautog (*Tautoga onitis*), black sea bass (*Centropristis striata*), butterfish, pufferfish, sculpins, sea raven (*Hemitripterus americanus*), searobins (*Prionotus* spp.), silver hake (*Merluccius bilinearis*), Atlantic tomcod (*Microgadus tomcod*), cod, haddock, hake (*Urophycis* spp.), witch and other flounders, squid, large crustaceans, and other benthic invertebrates (Field 1906; Bigelow and Schroeder 1953; Wood 1982; Sedberry 1983; Vinogradov 1984; Armstrong *et al*. 1996). Goosefish can also eat sea birds and diving ducks (Bigelow and Schroeder 1953) and will attack non-living objects, such as lobster trap floats (Connolly 1920). Cannibalism (non-kin, inter-cohort) is important and perhaps explains the apparent high mortality of smaller males (Armstrong *et al*. 1992; 1996). Larger goosefish eat larger prey (Sedberry 1983) and often have empty stomachs (Armstrong *et al*. 1996). In the NEFSC diet database for 1973-1990, 50-70% of the stomachs of goosefish 20-110 cm TL were empty, but only 1-20% of the stomachs of those about 120 cm TL were empty.

Goosefish catch their prey by ambush or in a sudden rush. The rapid opening of the large mouth creates a vacuum and the prey are caught on needle-like, backward-curving teeth (Armstrong *et al*. 1996; Gosline 1996). Like most anglerfish, a small, dangling, lure-like appendage above the mouth is used to attract small fish. This lure can be only effective in shallow, adequately lighted waters (Gosline 1996). Bigelow and Schroeder (1953) reported that a goosefish meal could equal half its body weight.

PREDATION

Adult goosefish have few enemies (Wood 1982). However, smaller fish are cannibalized and swordfish (*Xiphias gladius*) have been reported to eat goosefish (Scott and Scott 1988). In the NEFSC food habits database, goosefish (number consumed also in parentheses) were eaten by: spiny dogfish (12), thorny skate (*Raja radiata*, 2), goosefish (2), smooth dogfish (*Mustelus canis*, 2), cod (2), sandbar shark (*Carcharhinus plumbeus*, 1), and dusky shark (*C. obscurus*, 1). The frequency of occurrence of goosefish in stomachs was < 2% for these predator species. Stillwell and Kohler (1993), however, reported that goosefish made up 16.1% of the total volume of food in 20 sandbar sharks stomachs examined from the Middle Atlantic Bight.

MIGRATION

Goosefish make seasonal onshore-offshore migrations in response to thermal conditions. In the Gulf of Maine, > 20 cm TL goosefish move and stay offshore to avoid cold coastal conditions in the winter-spring, and return inshore as coastal waters warm in the summer and fall (Jean 1965; Scott and Scott 1988; Hartley 1995). Besides temperature, availability of prey could also be a factor in movements in this area. However, small < 20 cm TL Gulf of Maine and Middle Atlantic Bight goosefish respond oppositely to seasonal conditions, moving and staying inshore in the winter-spring and offshore in the summer-fall (Almeida *et al.* 1995; Hartley 1995). The goosefish in the Middle Atlantic Bight may be avoiding overly warm inshore summer conditions and taking advantage of a residual cold pool that stays on the mid- to outer shelf (Edwards *et al.* 1962; Woods 1982).

STOCK STRUCTURE

North American and European *Lophius* were once considered to be a single species. However, *Lophius americanus* and *L. piscatorius* are now considered separate, although closely-related, species (Berrill 1929; Grant and Leslie 1993; Caruso, in prep.). There is no evidence of distinct North American stocks of *L. americanus*. For management purposes, the species is separated into a northern component, from the Gulf of Maine to northern Georges Bank, and a southern component from central Georges Bank to the Middle

Atlantic Bight (Almeida *et al.* 1995).

HABITAT CHARACTERISTICS

Goosefish live in the water column during the egg and larval stages and shift to a benthic existence during their juvenile and adult stages. The characteristics of the habitats inhabited by goosefish are summarized in this section and in Table 1.

EGGS

For most or all of this life stage, the eggs occur within the mucus veil in the upper part of the water column. Severe weather can damage the veil and release isolated eggs. Eggs were collected near Cape Lookout, North Carolina in March and April (Bigelow and Schroeder 1953), in May off Cape Hatteras, and off southern New England, but not after September. Incubation proceeds at temperatures as low as about 4°C to about 18°C or higher (Caruso, in prep.). Hatching was estimated to take 100 days at 5°C and 6-7 days at 15°C; the upper temperature limit for normal was 17-18°C (Scott and Scott 1988).

LARVAE

In the NEFSC Marine Resources Monitoring, Assessment and Prediction (MARMAP) ichthyoplankton survey, larvae were first collected over deeper (> 300 m), offshore waters in the Middle Atlantic Bight during March-April; later, larvae were most abundant across the continental shelf at depths between 30 to 90 m (Figure 3). Larvae were most abundant at integrated water column temperatures between 10-16°C, although there was one collection at 4°C in January. Peak catches generally occurred at 11-15°C regardless of the month or area (Figure 3).

JUVENILES

In the NEFSC bottom trawl survey, juvenile goosefish were collected at bottom water temperatures between 3-13°C in spring and autumn; abundance peaked at about 5-6°C in spring and about 8-12°C in fall (Figure 4). Juvenile goosefish were not collected at temperatures > 13°C and at depths < 20 m, such as inshore along the Middle Atlantic Bight and on the center of Georges Bank. In the Gulf of Maine, Hartley (1995) reported that juveniles were collected from 2.3°C (< 20 cm TL fish in winter) to 7.6°C (< 34 cm TL fish in fall). Peak catches in the Massachusetts survey occurred at 5-7°C in spring and 8-12°C in autumn (Figure 5). The bimodal temperature distribution is evident in Figure 5, particularly in autumn. This is the result of cooler temperatures north of Cape Cod and warmer temperatures south of the Cape. This can also be seen in the NEFSC bottom trawl survey data, but only for spring (Figure 4). The few juvenile goosefish that were collected in Narragansett Bay during the Rhode Island trawl survey (1990-1996) were caught at temperatures ranging from 3-19°C (Figure 6). Few goosefish were collected in Long Island Sound during the Connecticut trawl survey; most of these appeared to be juveniles that were collected only in the spring at 8-18°C, from 10-40 m in depth, and at salinities between 26-29 ppt (Figure 7).

In the NEFSC bottom trawl survey, about 50% of all juvenile goosefish were caught between 25 and 99 m in spring and autumn with peak abundance at about 50-75 m (Figure 4). In the Massachusetts bottom trawl survey, juvenile goosefish occurred in shallower water in the spring (to 5 m) and deeper (> 20 m) in the fall (Figure 5). In the Gulf of Maine, juveniles < 20 cm TL and juveniles 20-34 cm TL had slightly different mean seasonal depth preferences (Hartley 1995). In the winter-spring, the smallest juveniles were commonly collected in mean depths of 91-177 m, while larger juveniles were collected in mean depths of 113-182 m. During summer-fall, the smallest fish were commonly collected at deeper mean depths, 167-182 m compared to 120-150 m for larger juveniles. In Narragansett Bay, juveniles were usually collected only in > 30 m during all seasons (Figure 6).

Hartley (1995) found that all stages of goosefish were mostly collected at mean salinities of between 32.6 and 33.9 ppt in the Gulf of Maine.

Scott and Scott (1988), referencing Connolly (1920), state that newly settled juveniles seek protection among algae covered rocks. Richards (1963a) collected one 19.5 cm goosefish in January in Long Island Sound on a 9 m deep, sand-shell bottom. The distribution of goosefish in Long Island Sound (Figure 7) suggests that juveniles occurred most frequently in the deeper, silty basins (Reid *et al*. 1979).

ADULTS

In the NEFSC bottom trawl survey, adult goosefish were collected at bottom water temperatures between 0-24°C and were most abundant between 4-14°C (Figure 4). Adults were commonly collected at spring temperatures of 6-8°C and 11-12°C and at autumn temperatures of 9-11°C. Hartley (1995) found that adult abundance peaked at mean bottom temperatures of 5-8°C. Peak catches in the Massachusetts survey had a bimodal temperature distribution, which was the result of cooler temperatures north of Cape Cod and warmer temperatures south of the Cape (Figure 5). In Narragansett Bay, adult goosefish were only collected in the spring and summer at temperatures between 7-14°C (Figure 6). Excessively cold water or a rapid drop in coastal temperatures might be fatal; Sherwood *et al*. (1901) reported fall mortalities of adults near Woods Hole, Massachusetts. Hartley (1995) speculated that these "kills" could also be explained as a result of post-spawning stress.

In the NEFSC bottom trawl survey, adults were more abundant in deeper waters (to 500 m) in the spring (Figure 4). Adults were most abundant between 50-99 m and rarely occurred below 200 m in the autumn. In the Gulf of Maine, adults > 34 cm TL fish occurred at mean depths of 130-140 m from summer through winter and at 206 m in the spring (Hartley 1995). In the Massachusetts bottom trawl survey, adults were common in < 35 m of water in the spring and at 20-60 m in the fall (Figure 5). In Narragansett Bay, adult goosefish were only collected at 32 m where the Bay meets Rhode Island Sound (Figure 6). No adults were collected in the Connecticut trawl survey in Long Island Sound.

Salinity preferences vary seasonally, but adults occur between about 30-36 ppt with the mean at about 33.5 ppt (Hartley 1995).

Adults were found on hard sand, pebbly-gravel bottoms, mixed sand and shell, and mud in the Gulf of Maine (MacDonald *et al*. 1984; Caruso, in prep.) and they preferred clay and mud over sand and gravel on the Scotian Shelf (Scott 1982).

GEOGRAPHICAL DISTRIBUTION

The goosefish occurs from the southern and eastern parts of the Grand Banks (Newfoundland) and the northern side of the Gulf of St. Lawrence to the east coast of Florida (to about 29^o N), but is common only north of Cape Hatteras (Figure 8). This section is a summary of several surveys of the distribution and relative abundance of goosefish life history stages [methods are summarized in Reid *et al.* (1999)].

EGGS

Spawning has been reported in Canadian waters (Connolly 1920), the Gulf of Maine (Hartley 1995), and south of Cape Cod (Armstrong *et al*. 1992). However, the eggs were only occasionally caught in the NEFSC MARMAP ichthyoplankton survey from the Gulf of Maine to North Carolina. Eggs were not collected in Sandy Hook Bay (Croker 1965) and only rarely in Long Island Sound (Merriman and Sclar 1952; Wheatland 1956), but they have been reported in open coastal bays and sounds in low numbers (Smith 1898; Herman 1963; Caruso, in prep.).

LARVAE

The NEFSC MARMAP ichthyoplankton survey (1977-1987) captured goosefish larvae throughout much of the survey area (Figure 9). Most larvae were collected south of Cape Cod to Cape Hatteras. The ICNAF data for Canadian waters do not alter this conclusion (Hartley 1995). Significant numbers of larvae were captured from April to September and peak abundance occurred in June and July. Larvae occurred off North Carolina and near the 200 m isobath in April. By May, the larvae were widespread on the shelf from North Carolina to southern New Jersey, and by June, they were found off southern New England. In July, the larvae were concentrated off New Jersey to just south of Cape Cod; a few were collected on Georges Bank. The numbers of larvae declined during August and September and were scattered from New Jersey to Georges Bank and into the Gulf of Maine.

Although larvae were widely collected in the Middle Atlantic Bight, they are not common and are seldom found inshore. Kendall and Naplin (1981) collected 63 larvae (0.6/m^3) in the New York Bight in July 1974. Hildebrand and Schroeder (1928) and Pearson (1941) collected larvae near the mouth of Chesapeake Bay in May-June. Five larvae/post-larvae were collected during May (1979-1980) in estuaries near Parramore and Cedar Islands, Virginia (Cowan and Birdsong 1985); 5-8 mm larvae were collected in May 1960 at the mouth of Chesapeake Bay (Virginia Institute Marine Sciences 1961). Larvae were not reported in ichthyoplankton surveys of Delaware Bay (Wang and Kernehan 1979), Delaware coastal bays (Scotton 1970), the Gulf of Maine, Cape Cod, or on Georges Bank (Fish 1925; Colton and Byron 1977). They are reported to occur in Long Island Sound and the Hudson-Raritan estuary by Wheatland (1956) and Dovel (1981), but not in Sandy Hook Bay (Croker 1965), Block Island Sound, or Narragansett Bay (Merriman and Sclar 1952; Herman 1963). A relatively large number of goosefish larvae (149) were collected during the summer (mostly in July) 1996 in a study of the surf zone along the New Jersey coast (D. Clark, US Army Corps of Engineers, CEWES-ER-C, Vicksburg MS, personal communication).

JUVENILES

Bean (1888) reported that young goosefish occurred mid-shelf off Long Island, and Smith (1898) collected ≥ 10 cm TL individuals in traps near Vineyard Sound, MA. In the NEFSC bottom trawl survey, juvenile goosefish (< 43 cm TL) were concentrated offshore (> 60 m) from Maryland to Georges Bank and nearshore off southern New England in winter (Figure 10); they were not collected at the shallowest depths (< 20 m) or the coldest temperatures (< 3^{o}C). In spring, juvenile goosefish were widespread on the shelf with concentrations off southern New England and offshore in the Middle Atlantic Bight. Few fish occurred on the shallows of Georges Bank, Nantucket Shoals, or inshore in the Middle Atlantic Bight. Again, goosefish avoided the coldest water and shallowest depths. By summer, juvenile goosefish were most abundant along the western half of the Gulf of Maine and off southern New England. Their autumn distribution was similar to that in spring. Hartley (1995) reported that immature goosefish were ubiquitous in the Gulf of Maine in spring and autumn 1992-1993. Juveniles were approximately four times more abundant than adults in the Massachusetts bottom trawl survey and occurred almost exclusively north of Cape Cod in the cooler waters (Figure 11).

Juveniles are rarely reported in most estuarine surveys from North Carolina to Maine (Derickson and Price 1973; Epperly 1984; Cowan and Birdsong 1985; Jury *et al*. 1994). Only three juveniles (23-35 cm TL) were collected in the Hudson-Raritan estuary trawl survey (1990-1996) and then only in the winter (S. Wilk, NMFS, NEFSC, James J. Howard Marine Sciences Laboratory, Highlands, NJ, personal communication). In Narragansett Bay, juveniles (< 43 cm TL) were collected in low numbers in all seasons (Figure 12a, c). In the Connecticut trawl survey of Long Island Sound, juveniles were rarely collected and only in the central Sound (Figure 7).

ADULTS

Adult goosefish are most common in continental shelf waters less than 668 m; they occur south of New England in waters as deep as 800 m (Schroeder 1955; Schaefer 1967; Markle and Musick 1974; Armstrong *et al*. 1992). In the early 1950s, Schroeder (1955) reported that goosefish were common between 50-450 fathoms throughout its range during summer. A few years later, Fritz (1965) found that autumn catches from New Jersey to Nova Scotia were low and averaged ≤ 4 goosefish per 5.5 hr trawl tow. He found them mostly on the periphery of Georges Bank and southeast of Nova Scotia.

In the NEFSC bottom trawl survey, adult goosefish occurred offshore in the winter (Figure 10). In the spring they were found in deeper waters off Virginia, inshore along the New York Bight, and offshore off southern New England, Georges Bank, and Gulf of Maine. Adult goosefish were most abundant in the Gulf of Maine during the summer and off southern New England and northwest Georges Bank in the fall. Few large fish are reported below 400 m (possibly a NEFSC survey depth limit factor) and they are absent from shallow areas on Georges Bank. Adults also occur in inshore Gulf of Maine in the summer, fall, and winter, and are widely distributed in deeper water in the spring (Almeida *et al*. 1995; Hartley 1995). Wenner (1978) reported that goosefish were collected in Norfolk Canyon to depths of 600 m, but were most common between 200-400 m.

Colvocoresses and Musick (1984) considered goosefish to be ubiquitous across the shelf in the Middle Atlantic Bight and associated with silver hake (*Merluccius bilinearis*), fourspot flounder, spiny dogfish, and red hake (*Urophycis chuss*). de Sylva *et al*. (1962) reported that goosefish were commonly taken by trawlers well up in Delaware Bay in the winter, although it was sometimes found there in moribund condition. Breder (1922) reported that a few were collected in the fall in the Hudson-Raritan estuary. Richards (1963b) collected two 61 cm TL goosefish in central Long Island Sound during September and January. Caruso (in prep.) reported that goosefish congregate beneath shoals of herring, and Wood (1982) suggested that food availability could affect seasonal distributions, at least in the Middle Atlantic Bight.

In the Massachusetts bottom trawl survey in the spring, adult goosefish occurred throughout the survey area except in Buzzards Bay and Nantucket Sound (Figure 11**)**. Adults, like juveniles, were not abundant anywhere in the survey area (maximum catch was 6 fish). Autumn catches of adults were mainly north and east of Cape Cod. The seasonal change in distribution in the Gulf of Maine (inshore in summer and offshore in winter) is evident in the Massachusetts data. Adults were widely distributed in spring north and south of Cape Cod and had no temperature preference. In autumn, adults were distributed north of the Cape and thus occur in cooler waters. In spring, adults were found at all depths but were most abundant between 30 and 60 m. In autumn, adults were found at all depths with a peak at 30 m. Adults were collected at the mouth of Narragansett Bay in low abundance in the spring and summer during the Rhode Island bottom trawl survey (Figure 12b, c).

STATUS OF THE STOCKS

Goosefish were once considered bycatch and "trash fish" in trawls, scallop dredges, and on hook and line. Until the early 1970s, those that were landed were mostly processed for fishmeal, although they were long considered a delicacy in Europe. Since the 1970s, goosefish tails began appearing more frequently in markets and restaurants. Landings increased significantly after 1972, almost doubling for a few years (Wood 1982), and reached 19,000 metric tons (mt) in the 1990s (Idoine 1995). Recently, an oriental export market has developed for goosefish livers (Almeida *et al*. 1995).

Goosefish stocks and the average size caught have declined dramatically as the harvests have increased (Idoine 1995; Figure 13). The NEFSC autumn trawl index for goosefish declined sharply over the past 15 years for the northern and southern stocks (Idoine 1995; Northeast Fisheries Science Center 1997; NEFMC 1997). The peak in survey catches occurred during 1977-1981 and record low catches have occurred since 1992.

Comparisons were made between the distribution of juvenile and adult goosefish between a period of high population abundance (1977-1981) and a period of low abundance (1992-1996). The two areas of high juvenile abundance in 1977-1981 (southern New England and the Middle Atlantic) showed a dramatic decline in abundance by 1992-1996 (Figure 14). Catches of juveniles increased on Georges Bank and in the Gulf of Maine between these periods. In recent years, adults are nearly absent in the spring survey from areas of traditional high abundance south of Cape Cod. The highest catches are now in the Gulf of Maine. The stocks of this species are currently considered overfished, which for goosefish is defined as NEFSC survey catches less than 33% of the mean abundance index for the period 1963-1994 (National Marine Fisheries Service 1997).

RESEARCH NEEDS

- The scarcity of eggs and larvae in the Gulf of Maine, and eggs (veiled or unveiled) in ichthyoplankton studies, in general, needs attention (Caruso, in prep.).
- Better estimates of abundance and distribution are needed beyond the continental shelf break. i.e., deeper than 350 m (Northeast Fisheries Science Center 1992).
- Better age and growth data, especially for the Middle Atlantic Bight, are needed for both sexes (Northeast Fisheries Science Center 1992).
- The possibility of critical spawning areas should be investigated.
- Better information is needed on the egg incubation period and early larval development.
- The duration of the pelagic larval phase needs better estimation; larval prey need to be determined.
- More information is needed about the habitat and survival requirements of recently settled juveniles.
- The role of the mucus veil in egg incubation and protection is poorly known.
- Are the occasional adult mortalities found on beaches in the fall mostly post-spawned females?
- How important is the surf zone in the Middle Atlantic Bight for goosefish larvae?

ACKNOWLEDGMENTS

This report was a team effort. We thank Claire Steimle, Judy Berrien and Rande Ramsey-Cross for literature searches and loans. We also thank Peter Berrien and Stuart Wilk for searching the MARMAP and Hudson-Raritan estuary databases for egg, larvae, and juvenile occurrences. Additional thanks to Arnold Howe (Massachusetts Department of Marine Fisheries) and Frank Almeida (Northeast Fisheries Science Center) for comments and suggestions.

REFERENCES CITED

Almeida, F.P., D-L. Hartley and J. Burnett. 1995. Length-weight relationships and sexual maturity of goosefish off the northeast coast of the United States. N. Am. J. Fish. Manage. 15: 14-25.

Armstrong, M.P., J.A. Musick and J.A. Colvocoresses. 1992. Age, growth and reproduction of the goosefish, *Lophius americanus* (Pisces: Lophiiformes). Fish. Bull. (U.S.) 90: 217-230.

Armstrong, M. P., J. A. Musick and J. A. Colvocoresses. 1996. Food and ontogenetic shifts in feeding of the goosefish, *Lophius americanus.* J. Northwest Atl. Fish. Sci. 18: 99-103.

Bean, T.H. 1888. Report on fishes observed in Great Egg Harbor Bay, New Jersey, during the summer of 1887. Bull. U.S. Fish. Comm. 7: 129-154.

Berrill, N.J. 1929. The validity of *Lophius americanus* Val. as a species distinct from *L. piscatorius* Linn., with notes on the rate of development. Contrib. Can. Biol. Fish. New Ser. 4 (12): 143-155.

Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Widl. Serv., Fish. Bull. 53. 577 p.

Breder, C.M., Jr. 1922. The fishes of Sandy Hook Bay. Zoologica 2(15): 330-351.

Brown, S.K., R. Mahon, K.C.T. Zwanenburg, K.R. Buja, L.W. Chaflin, R.N. O'Boyle, B. Atkinson, M. Sinclair, G. Howell, and M.E. Monaco. 1996. East coast of North America groundfish: Initial explorations of biogeography and species assemblages. National Oceanic and Atmospheric Administration, Silver Spring, Maryland and Dep. Fisheries and Oceans, Dartmouth, Nova Scotia. 111 p.

Caruso, J.H. In preparation. The goosefishes or monkfishes. Family Lophiidae. *In* B.B. Collette and G. Klein-MacPhee eds. Bigelow and Schroeder's fishes of the Gulf of Maine, Smithsonian Institution Press, Washington, D.C. 25 p.

Caruso, J.H. 1983. The systematics and distribution of the lophiid anglerfishes: II. Revisions of the genera *Lophiomus* and *Lophius*. Copeia 1983(1): 11-30.

Colton, J.B., Jr. and R.R. Byron. 1977. Gulf of Maine-Georges Bank ichthyoplankton collected on ICNAF larval herring surveys September 1971-February 1975. NOAA Tech. Rep. NMFS SSRF-717. 35 p.

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

Connolly, C.J. 1920. Histories of new food fishes: III. The angler. Bull. Biol. Board Can. 3: 1-17.

Cowan, J.H., Jr. and R.S. Birdsong. 1985. Seasonal occurrence of larval and juvenile fishes in a Virginia Atlantic coast estuary with emphasis on drums (Family Sciaenidae). Estuaries 8: 48-59.

Cowen, R.K., J.A. Hare, and M.P. Fahay. 1993. Beyond hydrography: Can physical processes explain larval fish assemblages within the Middle Atlantic Bight? Bull. Mar. Sci. 53: 567-587.

Croker, R.A. 1965. Planktonic fish eggs and larvae of Sandy Hook estuary. Chesapeake Sci. 6: 92-95.

Dahlgren, U. 1928. The habits and life history of *Lophius*, the anglerfish. Nat. Hist. 28: 18-32.

Derickson, W.K and K.S. Price, Jr. 1973. The fishes of the shore zone of Rehobeth and Indian River bays, Delaware. Trans. Am. Fish. Soc. 102: 552-562.

de Sylva, D.P., F.A. Kalber, Jr. and C.N. Shuster. 1962. Fishes and ecological conditions in the shore zone of the Delaware River estuary, with notes on other species collected in deeper waters. Univ. Del. Mar. Stat. Inform. Ser. Publ. No. 5. 164 p.

Dovel, W.L. 1981. Ichthyoplankton of the lower Hudson estuary, New York. N.Y. Fish Game J. 28: 21-39.

Edwards, R.L., R. Livingstone and P.E. Hamer. 1962. Winter water temperatures and an annotated list of fishes - Nantucket Shoals to Cape Hatteras: Albatross III Cruise No. 126. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. 397. 31 p.

Epperly, S.P. 1984. Fishes of Pamlico-Albermarle Peninsula, N.C., area utilization and potential impacts. North Carolina Dep. Nat. Resour. Comm. Devel., Div. Mar. Fish., Spec. Sci. Rep. No. 42. 129 p.

Fahay, M.P. 1983. Guide to the early stages of marine fishes occurring in the western North Atlantic Ocean, Cape Hatteras to the southern Scotian Shelf. J. Northwest Atl. Fish. Sci. 4: 1-423.

Field, I.A. 1906. Unutilized fishes and their relation to the fishing industries. U.S. Bur. Fish. Rep. Commissioner Fish. Spec. Pap. Bur. Fish. Doc. No. 622. 50 p.

Fish, C.J. 1925. Seasonal distribution of the plankton of the Woods Hole region. Bull. U.S. Bur. Fish. 41: 91-179.

Fritz, R.L. 1965. Autumn distribution of groundfish species in the Gulf of Maine and adjacent waters, 1955-1961. Serial Atlas of the Marine Environment, Folio 10. American Geographical Society, NY. 48 p.

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

Goode, G.B. 1884. The fisheries and fishery industries of the United States. Section I: Natural history of useful aquatic animals. Govt. Print. Office, Washington, DC. Plates.

Gosline, W.A. 1996. Structures associated with feeding in three broad-mouthed, benthic fish groups. Environ. Biol. Fishes 47: 399-405.

Grant, W.S. and R.W. Leslie. 1993. Biochemical divergence and biogeography of anglerfish of the genus *Lophius* (Lophiformes). J. Zool. 231: 465-485.

Grothues, T.H. and R.K. Cowan. 1999. Larval fish assemblages and water mass history in a major faunal transition zone. Continent. Shelf Res. 19: 1171-1198.

Hartley, D-L. 1995. The population biology of the goosefish, *Lophius americanus*, in the Gulf of Maine. M.S. thesis, Univer. of Mass., Amherst, MA. 142 p.

Herman, S.S. 1963. Planktonic fish eggs and larvae of Narragansett Bay. Limnol. Oceanogr. 8: 103-109.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Bull. U.S. Bur. Fish. 43(1): 366 p.

Idoine, J. 1995. Goosefish. *In* Conservation and Utilization Division, Northeast Fisheries Science Center eds. Status of the fishery resources off the northeastern United States for 1994. p. 82-83. NOAA Tech. Mem. NMFS-NE-108.

Jean, Y. 1965. Seasonal distribution of monkfish along the Canadian Atlantic mainland. J. Fish. Res. Board Can. 22: 621-624.

Jury, S.H., J.D. Field, S.L. Stone, D.M. Nelson and M.E. Monaco. 1994. Distribution and abundance of fishes and invertebrates in North Atlantic estuaries. ELMR Rep. No. 13. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD. 221 p.

Kendall, A.W. Jr. and N.A Naplin. 1981. Diel-depth distribution of summer ichthyoplankton in the Middle Atlantic Bight. Fish. Bull. (U.S.) 79: 705-726.

MacDonald, J.S., M.J. Dadswell, R.G. Appy, G.D. Melvin and D.A. Methven. 1984. Fishes, fish assemblages, and their seasonal movements in lower Bay of Fundy and Passamaquoddy Bay, Canada. Fish. Bull. (U.S.) 82: 121-139.

Markle, D.F. and J.A. Musick. 1974. Benthic-slope fishes found at 900 m depth along a transect in the western N. Atlantic Ocean. Mar. Biol. 26: 225-233.

Martin, F.D. and G.E. Drewry. 1978. Development of fishes of the Mid-Atlantic Bight: An atlas of egg, larval and juvenile stages. Vol. 6: Stromateidae through Ogcocephalidae. U.S. Fish Wildl. Serv. Biol. Serv. Prog. FWS/OBS 78/12. 416 p.

Merriman, D. and R.C. Sclar. 1952. The pelagic fish eggs and larvae of Block Island Sound. *In* G.A. Riley *et al*. eds. Hydrographic and biological studies of Block Island Sound. p. 165-219. Bull. Bingham Oceanogr. Collect. 13(3).

National Marine Fisheries Service. 1997. Report to Congress. Status of fisheries of the United States: Report on the status of fisheries of the United States. September 1997. [Homepage of the National Marine Fisheries Service]. [Online]. Available: http://www.nmfs.gov/sfa/Fstatus.html.

[NEFMC] New England Fishery Management Council. 1993. Final amendment #5 to the Northeast Multispecies Fishery Management Plan incorporating the supplemental environmental impact statement.

Vol. 1. September 1993. NEFMC. [Saugus, MA.] 361 p.

[NEFMC] New England Fishery Management Council. 1997. Draft supplemental environmental impact statement for draft amendment 9 to the Multispecies Fishery Management Plan to regulate monkfish. February 1997. NEFMC. [Saugus, MA.] 186 p.

Northeast Fisheries Science Center. 1992. Report of the Fourteenth Northeast Regional Stock Assessment Workshop (14th SAW). Northeast Fish. Sci. Cent. Ref. Doc. 92-07. 140 p. + appendix.

Northeast Fisheries Science Center. 1997. Report of the 23rd Northeast Regional Stock Assessment Workshop (23rd SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 97-05. 191 p.

Pearson, J.C. 1941. The young of some marine fishes taken in lower Chesapeake Bay, Virginia, with special reference to the gray sea trout, *Cynoscion regalis* (Bloch). Fish. Bull. (U.S.) 50: 79-102.

Reid, R., F. Almeida, and C. Zetlin. 1999. Essential fish habitat source document: Fishery independent surveys, data sources, and methods. NOAA Tech. Mem. NMFS-NE-122. 39 p.

Reid, R.N., A.B. Frame, and A.F. Draxler. 1979. Environmental baselines in Long Island Sound, 1972-73. NOAA Tech. Rep. NMFS SSRF-738. 31 p.

Richards, S.W. 1963a. The demersal fish population of Long Island Sound. I. Species composition and relative abundance in two localities, 1956-57. Bull. Bingham Oceanogr. Collect. 18(2): 5-31.

Richards, S.W. 1963b. The demersal fish population of Long Island Sound. II. Food of the juveniles from a sand-shell locality (Station 1). Bull. Bingham Oceanogr. Collect. 18(2): 32-72.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea and W.B. Scott. 1991. Common and scientific names of fishes from the United States and Canada. 5th ed. American Fisheries Society, Spec. Publ. 20. Bethesda, MD. 183 p.

Schaefer, R.H. 1967. Species composition, size and seasonal abundance of fish in the surf waters of Long Island. N.Y. Fish Game J. 14: 1-46.

Schroeder, W.C. 1955. Report on results of exploratory otter-trawling along the continental shelf and slope between Nova Scotia and Virginia during the summers of 1952 and 1953. Deep-Sea Res. 3 (Suppl.): 358-372.

Scott, J.S. 1982. Selection of bottom type by groundfishes of the Scotian Shelf. Can. J. Fish. Aquat. Sci. 39: 943-947.

Scott, W.B. and M.G. Scott. 1988. Atlantic fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219. 731 p.

Scotton, L.N. 1970. Occurrence and distribution of larval fishes in the Indian River and Rehobeth bays, June 1968-March 1970. M.S. thesis. Univer. of Delaware, Newark DE. 72 p.

Sedberry, G.R. 1983. Food habits and trophic relationships of a community of fishes on the outer continental shelf. NOAA Tech. Rep. NMFS-SSRF-773. 56 p.

Sherman, K., W. Smith, W. Morse, M. Berman, J. Green and L. Ejsymont. 1984. Spawning strategies of fishes in relation to circulation, phytoplankton production, and pulses in zooplankton off the northeastern United States. Mar. Ecol. Prog. Ser. 18: 1-19.

Sherwood, G.H. and V.N. Edwards. 1901. Notes on the migration, spawning, abundance, etc., of certain fishes in 1900. Bull. U.S. Fish. Comm. 21: 27-33.

Smith, H.M. 1898. The fishes found in the vicinity of Woods Hole. Bull. U.S. Fish. Comm. 17: 85-111.

Stillwell, C.E. and N.E. Kohler. 1993. Food habits of the sandbar shark *Carcharhinus plumbeus* off the U.S. northeastern coast, with estimates of daily ration. Fish. Bull. (U.S.) 91: 138-150.

Vinogradov, V.I. 1984. Food of silver hake, red hake and other fishes of Georges Bank and adjacent waters, 1968-74. Northwest Atl. Fish. Organ. (NAFO) Sci. Counc. Stud. 7: 87-94.

Virginia Institute Marine Sciences. 1961. Fishes and fish larvae collected from Atlantic plankton cruises of R/V Pathfinder December 1959-December 1960. Virginia Inst. Mar. Sci. Fish. Lab. Spec. Sci. Rep. 26.

Wang, J.C.S. and R.J. Kernehan. 1979. Fishes of the Delaware estuaries: a guide to the early life histories. EA Communications, Towson, MD. 410 p.

Wenner, C.A. 1978. Making a living on the continental slope and in the deep sea: life history of some dominant fishes of the Norfolk Canyon area. Ph.D. dissertation. Coll. William and Mary, Williamsburg, VA. 294 p.

Wheatland, S.B. 1956. Pelagic fish eggs and larvae. *In* G.A. Riley *et al*. eds. Oceanography of Long Island Sound, 1952-1954. p. 234-314. Bull. Bingham Oceanogr. Collect. 15.

Wilk, S.J., W.W. Morse and D.E. Ralph. 1978. Length-weight relationships of fishes collected in the New York Bight. Bull. N.J. Acad. Sci. 23: 58-64.

Wood, P.W., Jr. 1982. Goosefish, *Lophius americanus*. *In* M.D. Grosslein and T.R. Azarovitz eds. Fish distribution. p. 67-70. MESA New York Bight Atlas Monograph 15. N.Y. Sea Grant Institute, Albany, NY.

Table 1. Summary of life history and habitat parameters for goosefish, *Lophius americanus*. (MAB = Middle Atlantic Bight; SNE = southern New England; GB = Georges Bank; GOM = Gulf of Maine).

Life Stage	Time of Year	Size and Growth	Geographic Location	Habitat	Substrate
Eggs	March - September, south to north, peak in June.	1.6-1.8 mm diameter; hatch in 7-100 days	Rarely collected, inner to mid continental shelf, SNE, and MAB; not in estuaries.	Upper water column, see notes	(pelagic)
Larvae	March - September, south to north, peak in June-July.	2.5-4.5 mm at hatching; transition to juvenile at 5-10 cm	Mainly mid-shelf in SNE and MAB; few on GB, in GOM or inshore (but see note).	Upper to lower water column, at depths of 15 to > 1000 m; mostly 30-90 m.	(pelagic)
Juveniles	All months	6.4 to ~43 cm TL; can grow ~10-15 cm TL/yr.	GOM: offshore in summer/fall, inshore in winter/spring; southern GB, SNE: mostly mid to outer shelf; MAB: mostly outer shelf	Seabed, > 20 m, peak abundance at 40-75 m.	Mud to gravelly sand, algae, and rocks.
Adults	All months	43 to ~120-140 cm; grow ~7-8 cm/yr.; females grow faster than males. No difference in growth between GOM and MAB.	GOM: offshore in spring, inshore in summer fall; SNE/MAB: inshore in winter, offshore in summer fall	Seabed, 1-800 m, most 50-99 m, sometimes at surface. GOM: 130-206 m.	Mud to gravelly sand, algae and rocks.
Spawning Adults	February - August, south to north; peak in May.	Maturity at ~32 cm (males), 36 cm females.	Mid-continental shelf off SNE and MAB, some in GOM.	Same as adults.	Same as adults (?).

Table 1. cont'd.

Life Stage	Temperature	Salinity	Prey	Predators	Notes
Eggs	4-18°C or higher				Contained in long mucus veils that float near or at surface.
Larvae	6-20°C, most in 11-15°C		Probably zooplankton.		A recent study collected 149 larvae in the surf along central NJ in summer 1996.
Juveniles	2-24°C, most 3-13°C; cooler in GOM.	GOM: 30-36 ppt; mean 33.5 ppt	Small fish, shrimp, and squid; the proportion of fish increases with fish size.	Various sharks, skates, cod, and monkfish.	
Adults	Seasonally variable, 0-24°C; mostly 4-14°C.	GOM: 30-36 ppt; mean 33.5 ppt	Mostly fish, some crustaceans, mollusks, and occasionally seabirds; varies with availability.	Some of those listed for juveniles.	Cold water or post-spawning mortalities reported in fall.
Spawning Adults	Same as adults (?).	Same as adults (?)	Same as adults (?)	Same as adults (?)	In GOM, size-at-maturity decreased from 45 cm to 36 cm since 1975.

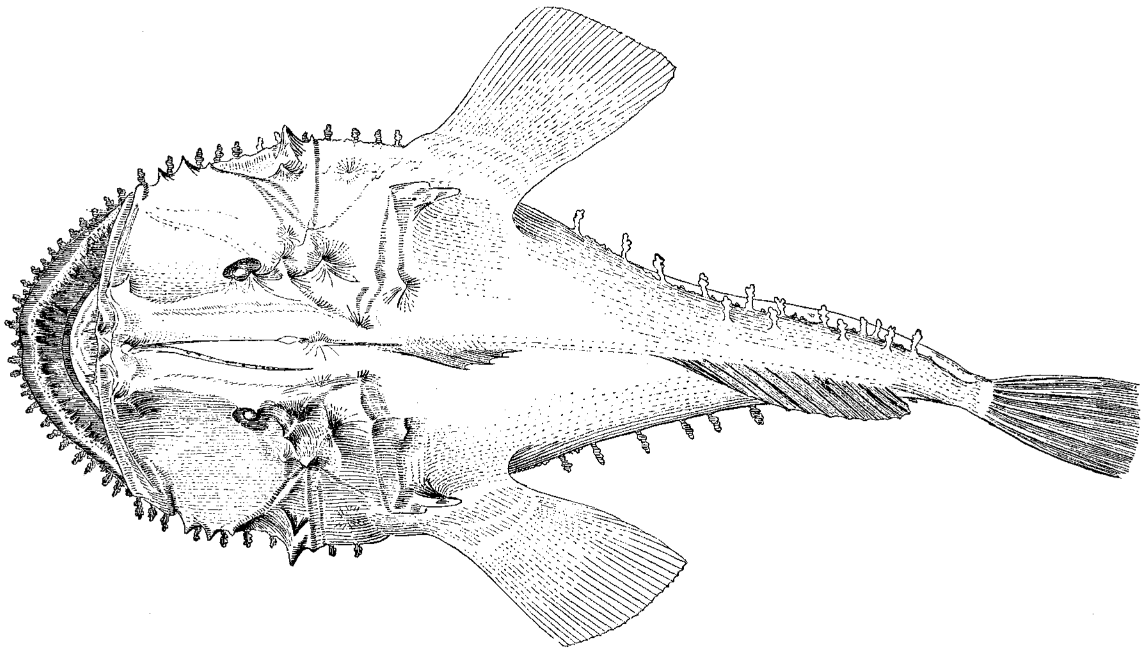
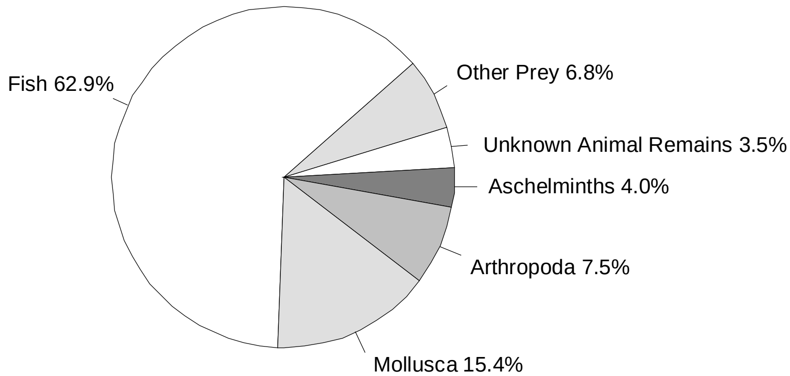


Figure 1. The adult goosefish (or monkfish), *Lophius americanus* (from Goode 1884).

a) 1973-1980

n = 348



b) 1981-1990

n = 412

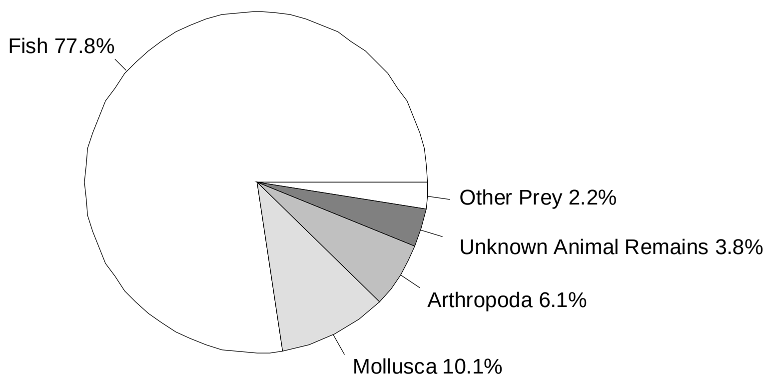


Figure 2. Abundance (% occurrence) of the major prey items in the diet of goosefish from NEFSC bottom trawl survey data on food habits for 1973-1980 and 1981-1990. The category “animal remains” refers to unidentifiable animal matter. Methods for sampling, processing, and analysis of samples differed between the time periods [see Reid *et al.* (1999) for details].

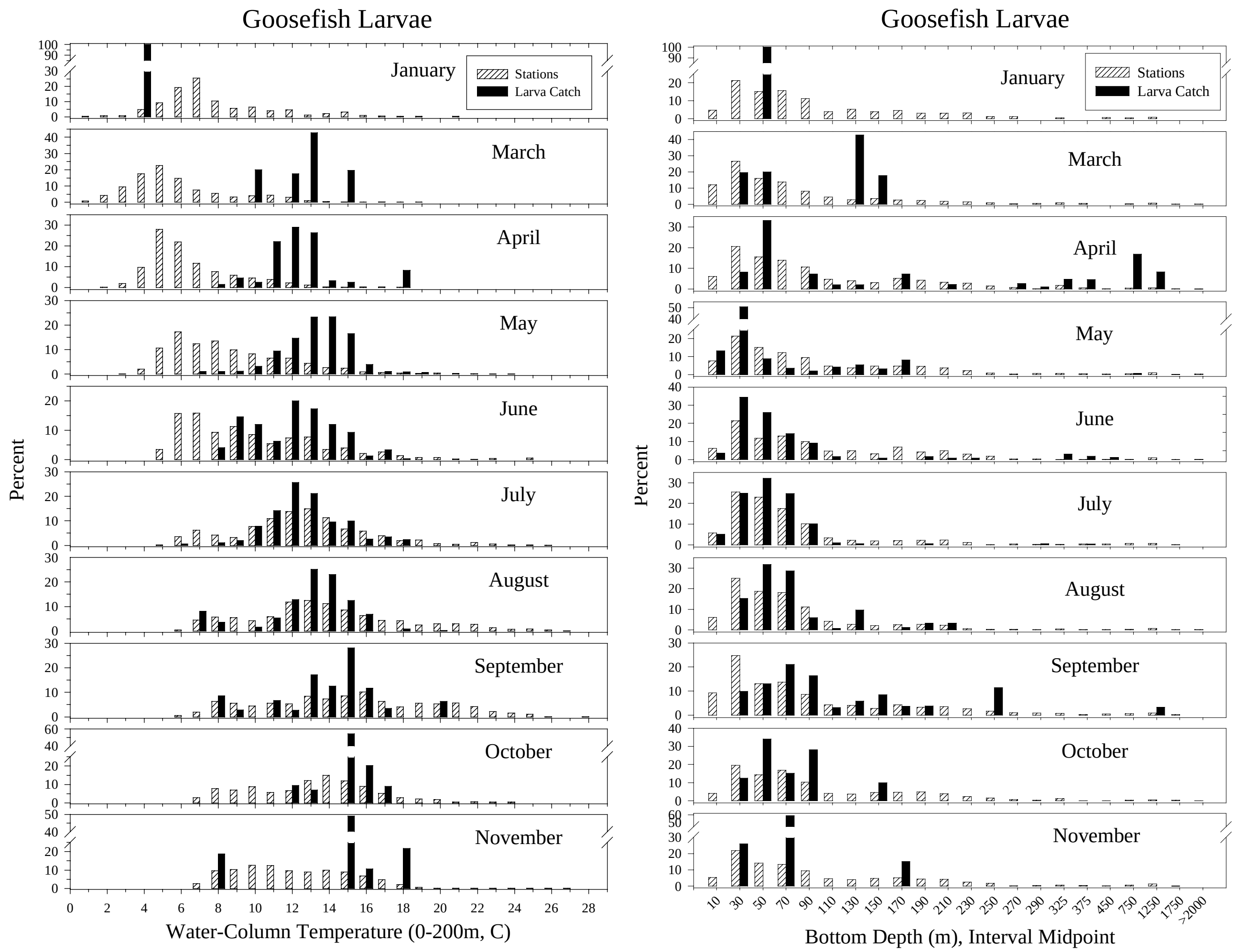


Figure 3. Association of goosefish larvae with integrated water column temperature (to a maximum of 200 m) and bottom depth from the NEFSC MARMAP ichthyoplankton surveys, 1977-1987, by month for all years combined. Open bars represent the proportion of all stations which were surveyed, while solid bars represent the proportion of the sum of all standardized catches (number/10 m^2).

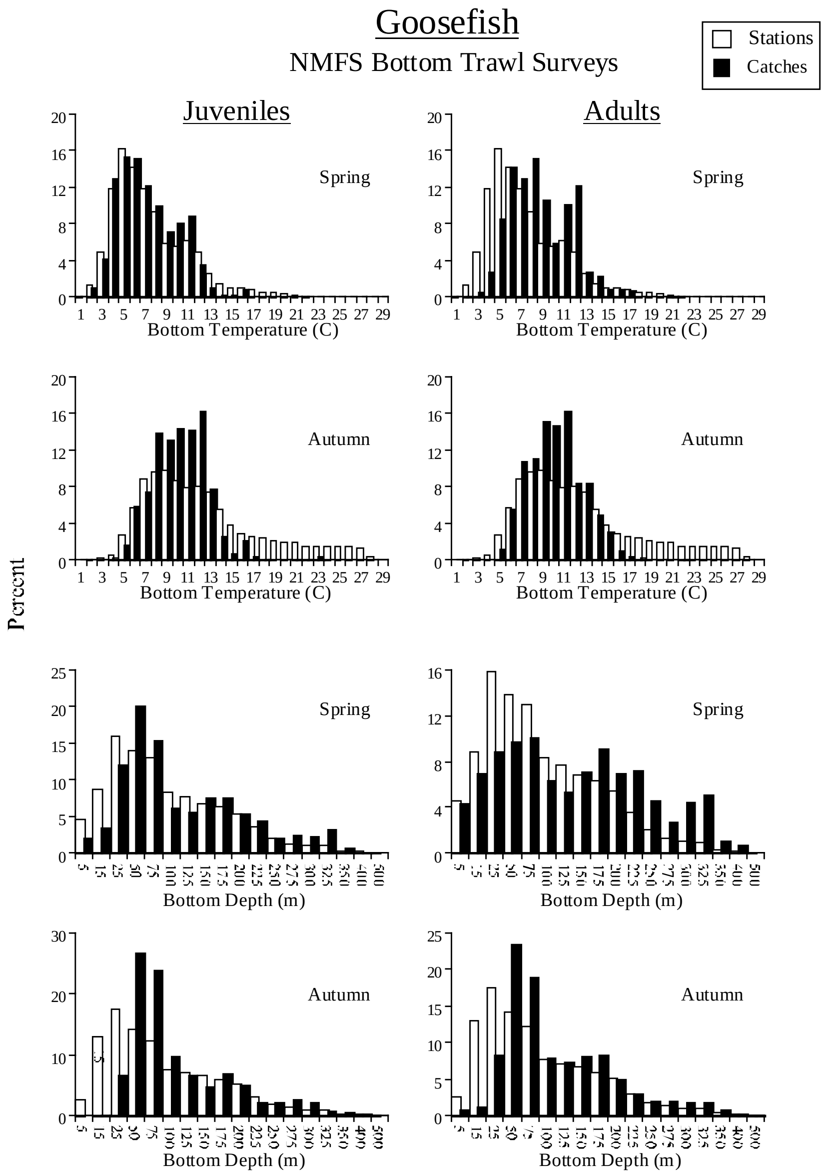


Figure 4. Association of juvenile and adult goosefish with bottom water temperature and depth from the NEFSC bottom trawl surveys, 1963-1997, by season for all years combined. Open bars represent the proportion of all stations which were surveyed, while solid bars represent the proportion of the sum of all standardized catches (number/10 m^2).

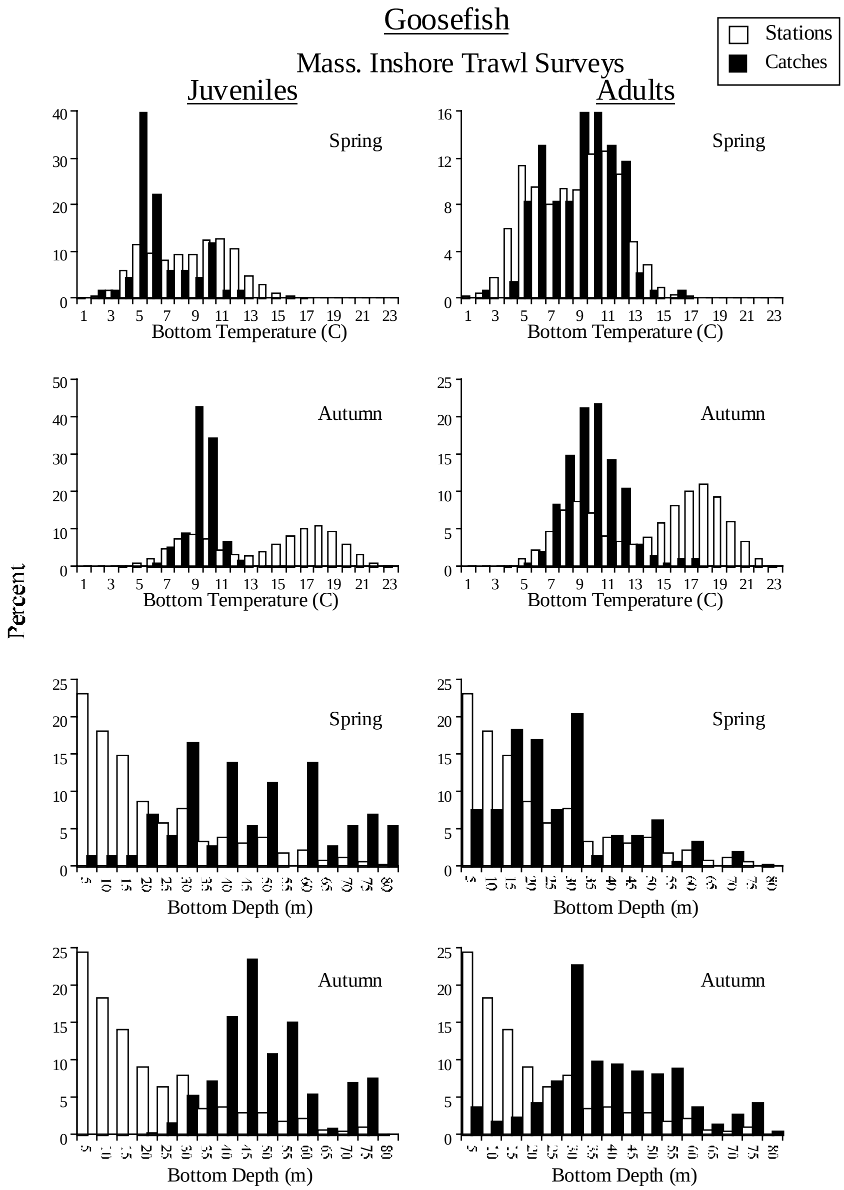


Figure 5. Association of juvenile and adult goosefish with bottom water temperature and depth from the Massachusetts bottom trawl surveys, spring and autumn 1978-1996. Open bars represent the proportion of all stations which were surveyed, while solid bars represent the proportion of the sum of all standardized catches (number/10 m^2).

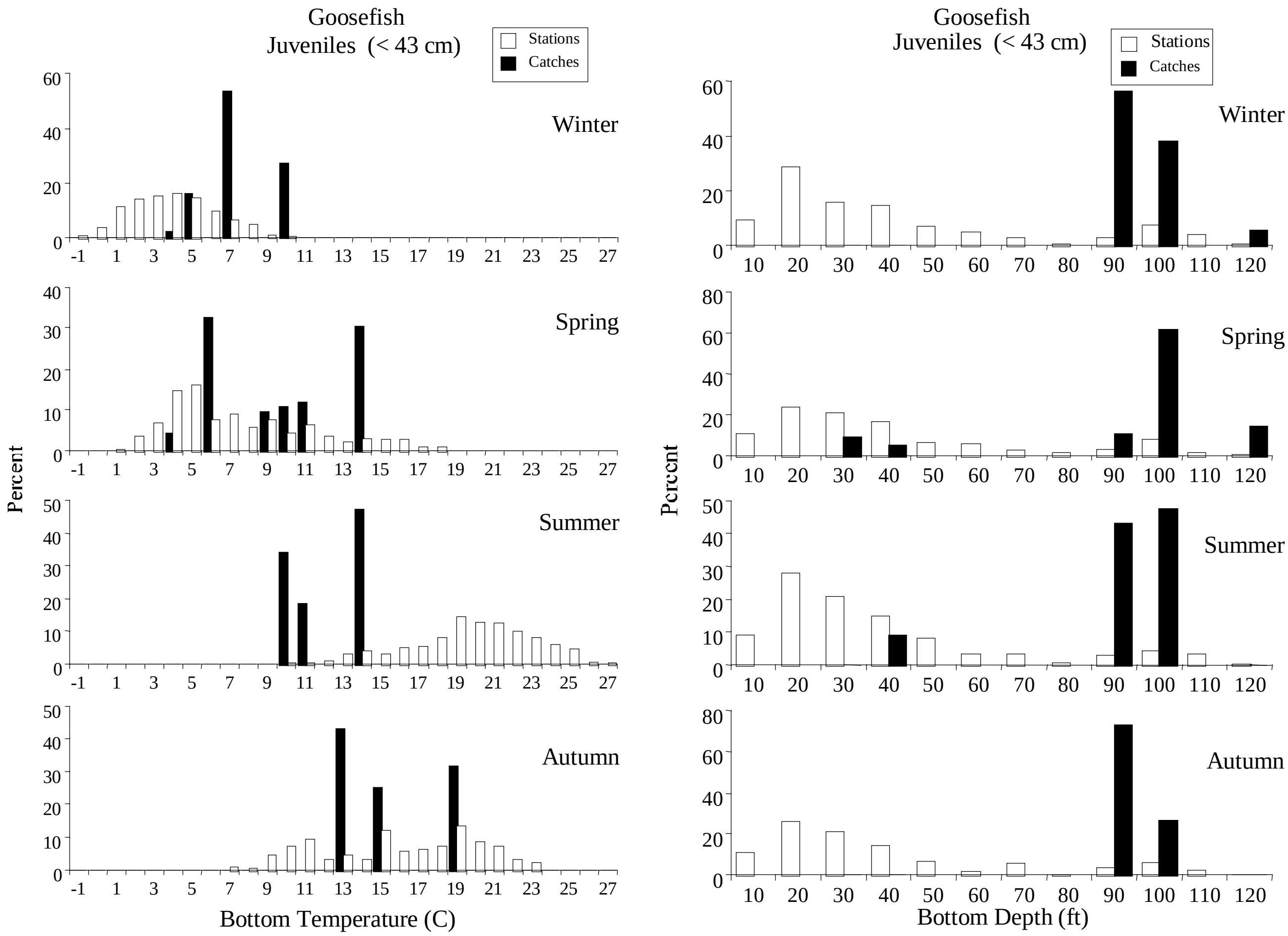
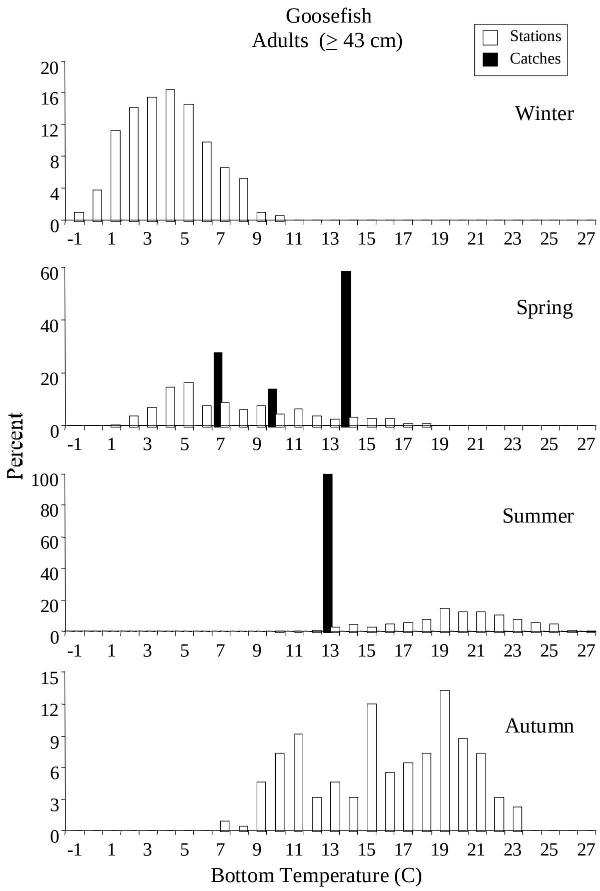


Figure 6. Association of juvenile and adult goosefish with bottom temperature and depth from the Rhode Island bottom trawl surveys in Narragansett Bay, spring and autumn 1990-1996. Open bars represent the proportion of all stations which were surveyed, while solid bars represent the proportion of the sum of all standardized catches (number/10 m^2).



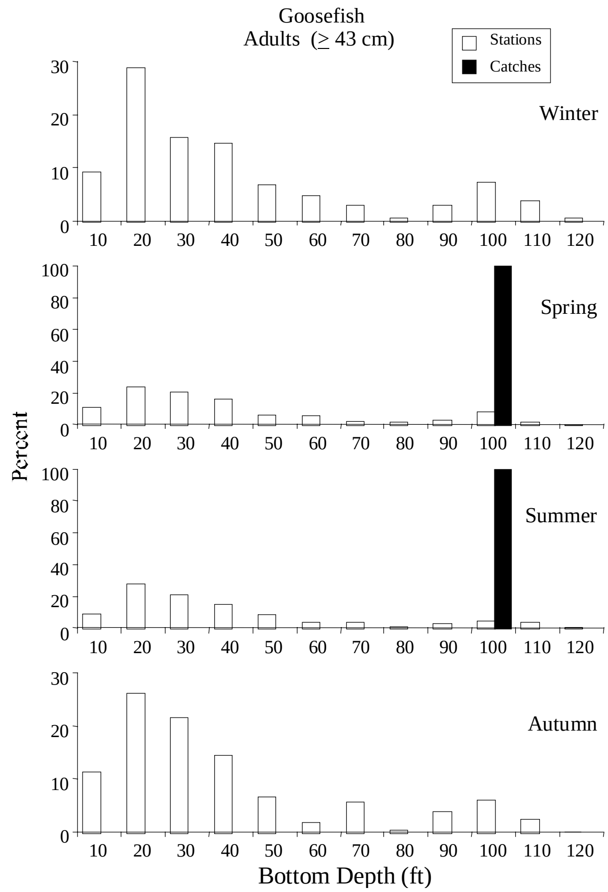
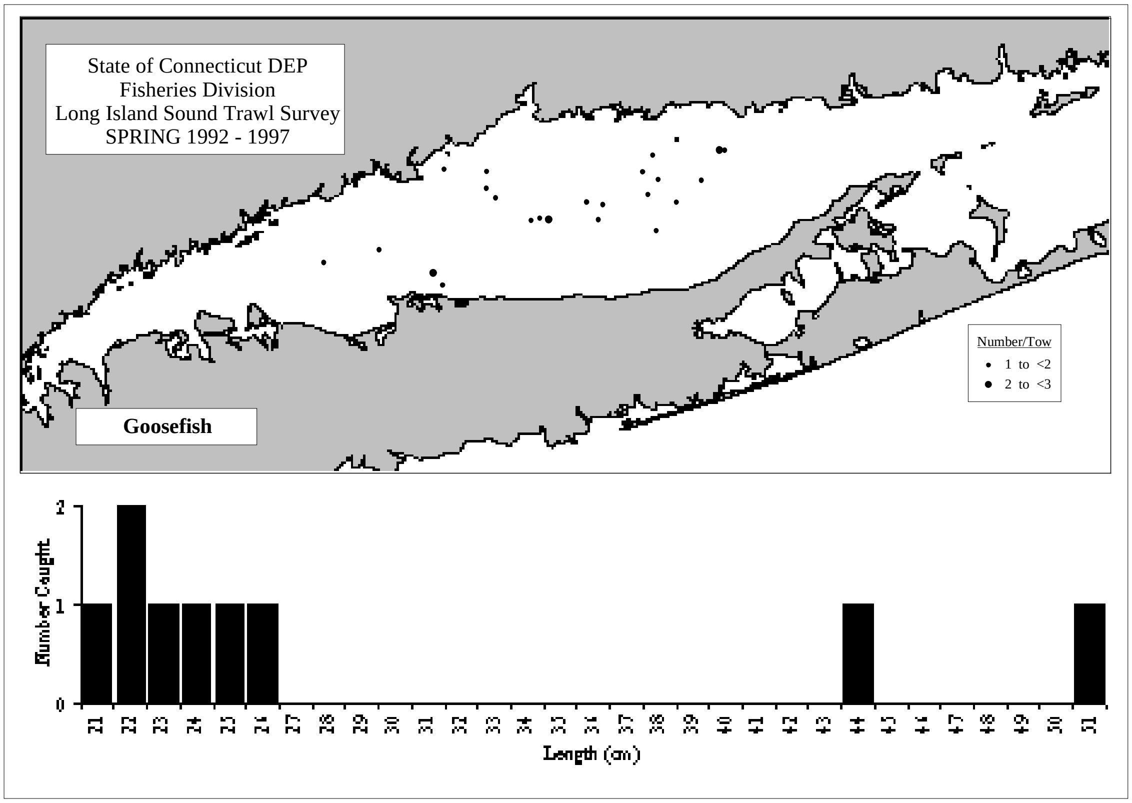


Figure 6. cont'd.



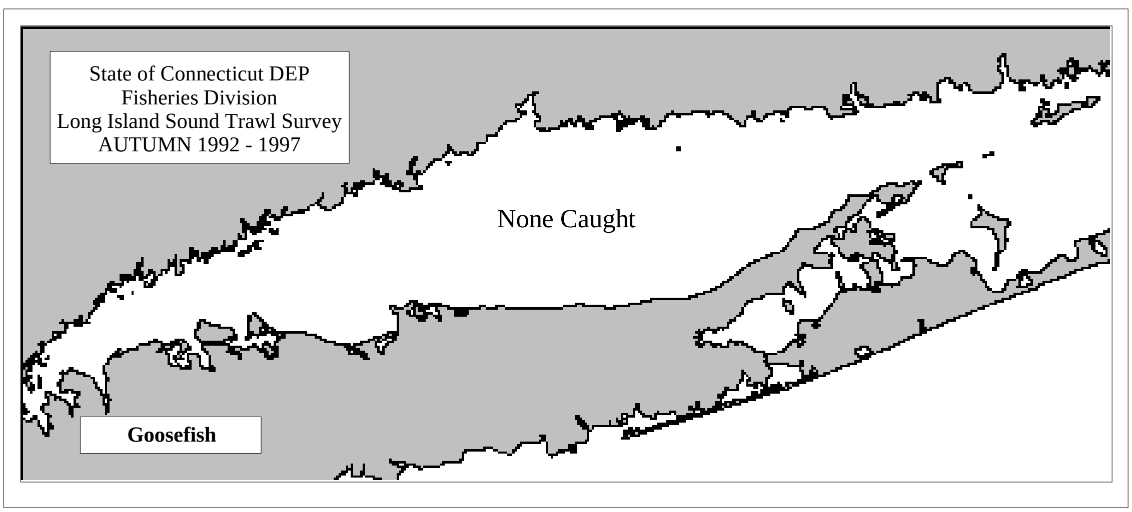
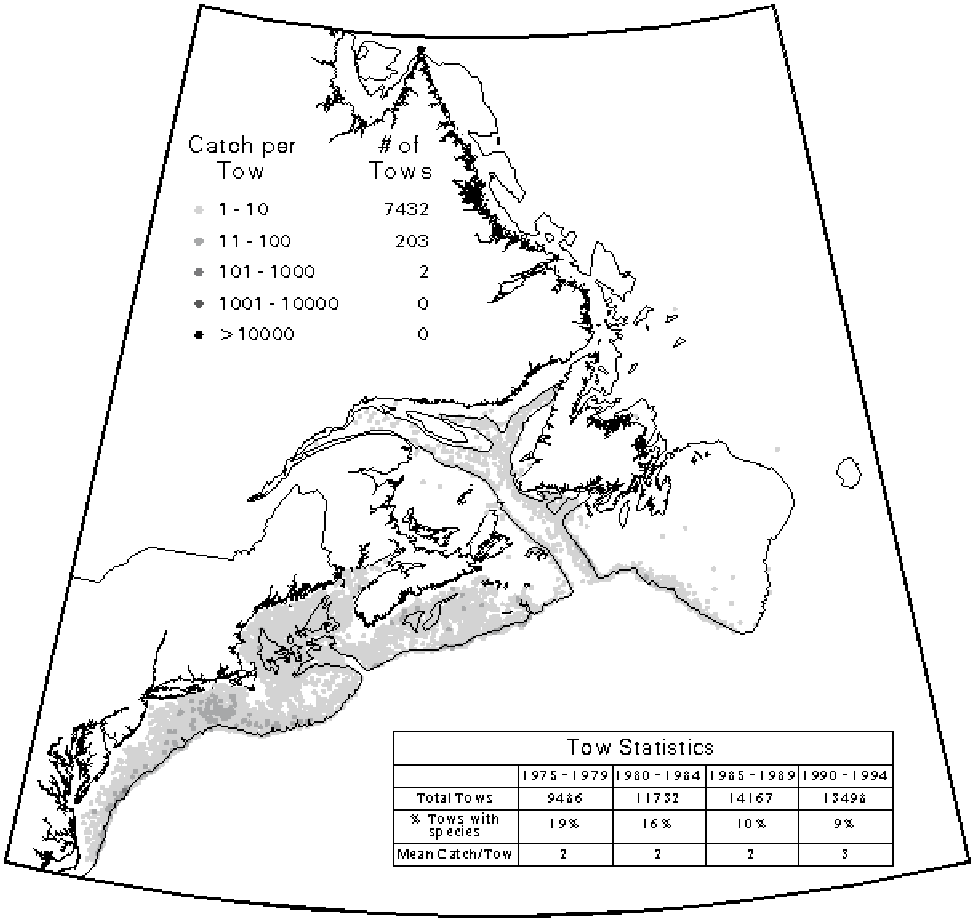


Figure 7. The distribution and abundance and size frequency distribution of goosefish captured in Long Island Sound during the Connecticut bottom trawl surveys, 1992-1997 [see Reid *et al.* (1999) for details].



Tow Statistics				
	1975 - 1979	1980 - 1984	1985 - 1989	1990 - 1994
Total Tows	9486	11732	14167	13498
% Tows with species	19%	16%	10%	9%
Mean Catch/Tow	2	2	2	3

Figure 8. Distribution and abundance of goosefish from Newfoundland to Cape Hatteras during 1975-1994. Data are from the U.S. NOAA/Canada DFO East Coast of North America Strategic Assessment Project (http://www-orca.nos. noaa.gov/projects/ ecnasap/ecnasap_table1.html).

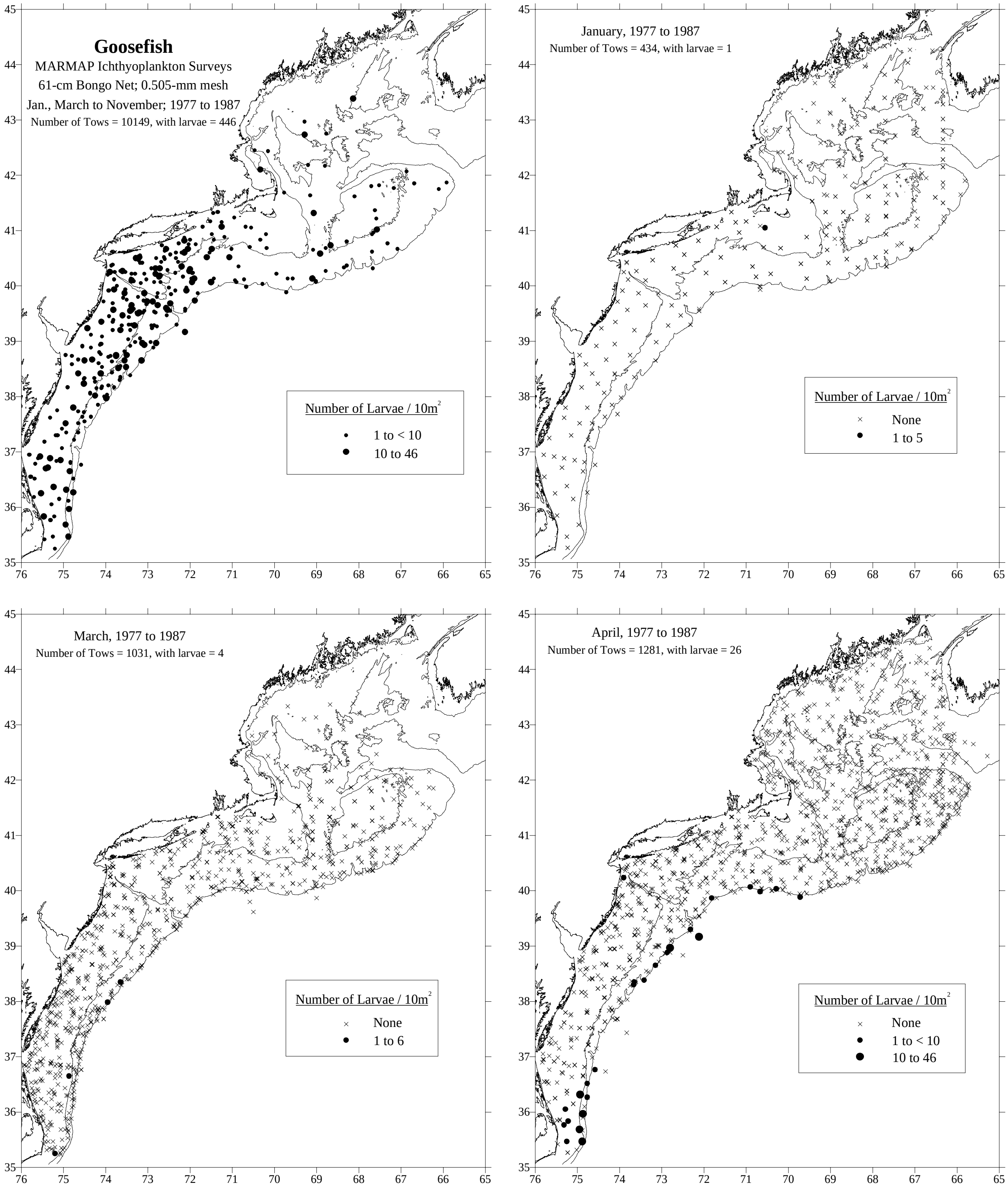


Figure 9. Distribution and abundance of goosefish larvae (overall and monthly) from the NEFSC MARMAP ichthyoplankton surveys, 1977-1987 [see Reid *et al.* (1999) for details].

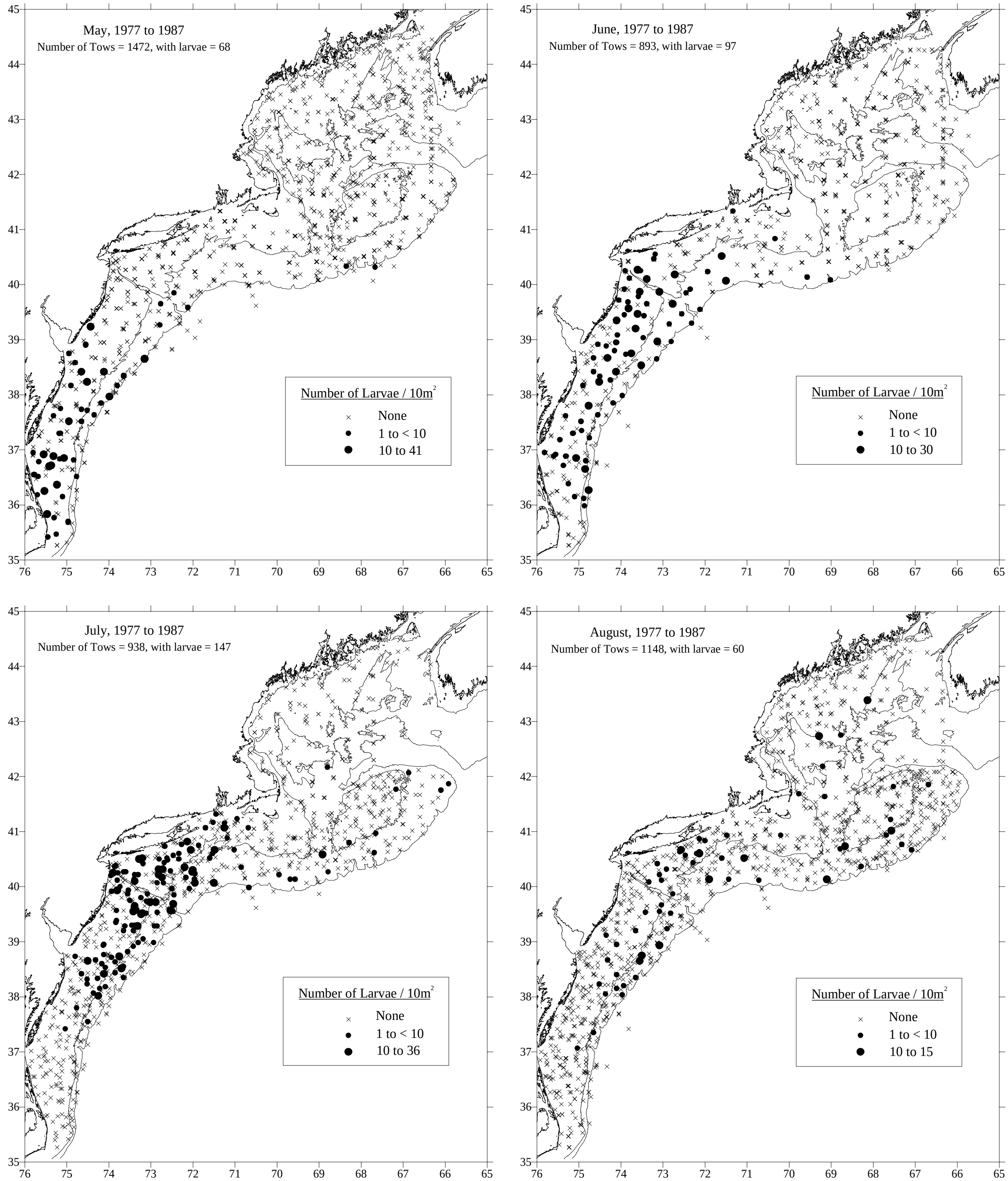
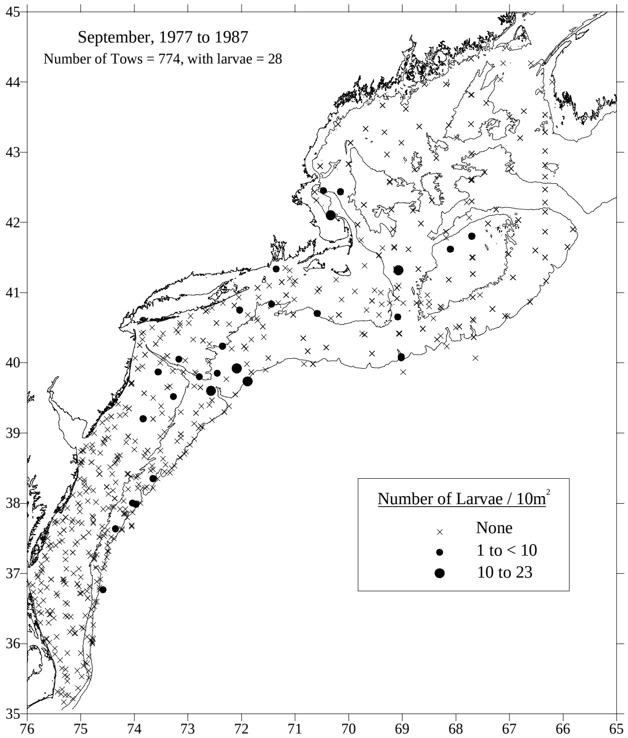
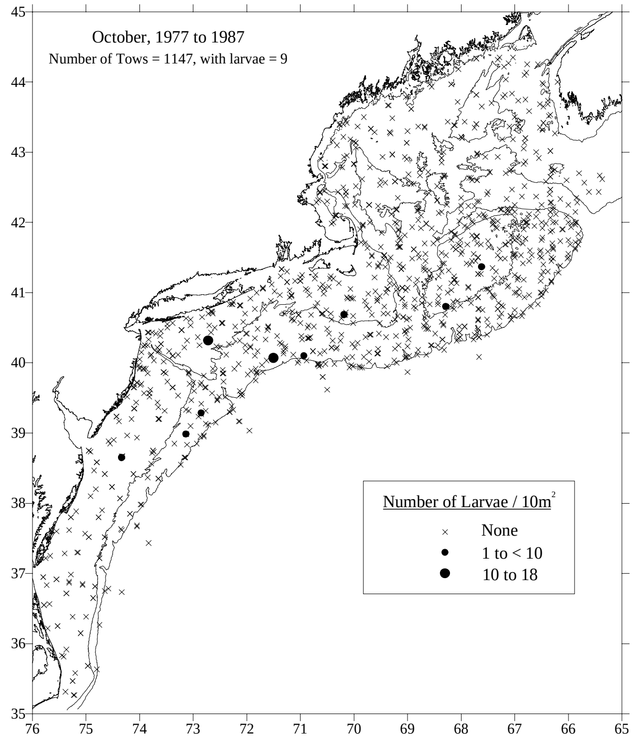


Figure 9. cont'd.





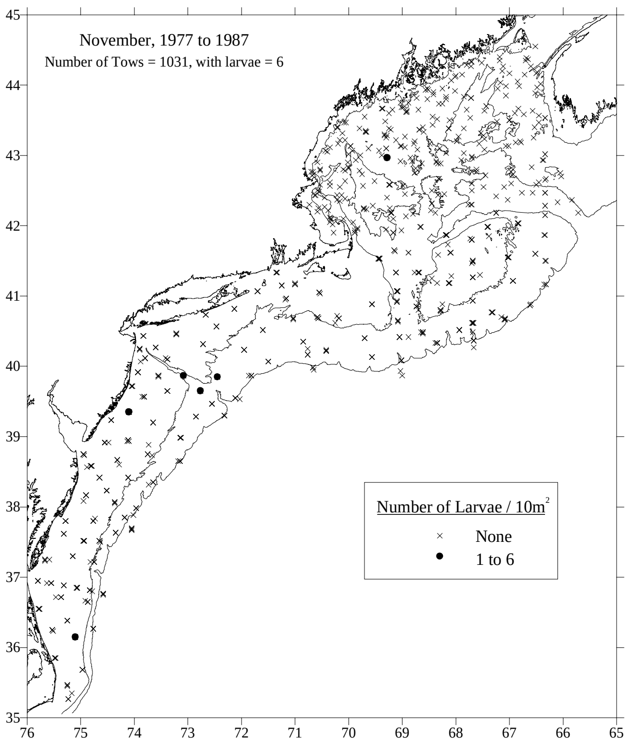


Figure 9. cont'd.

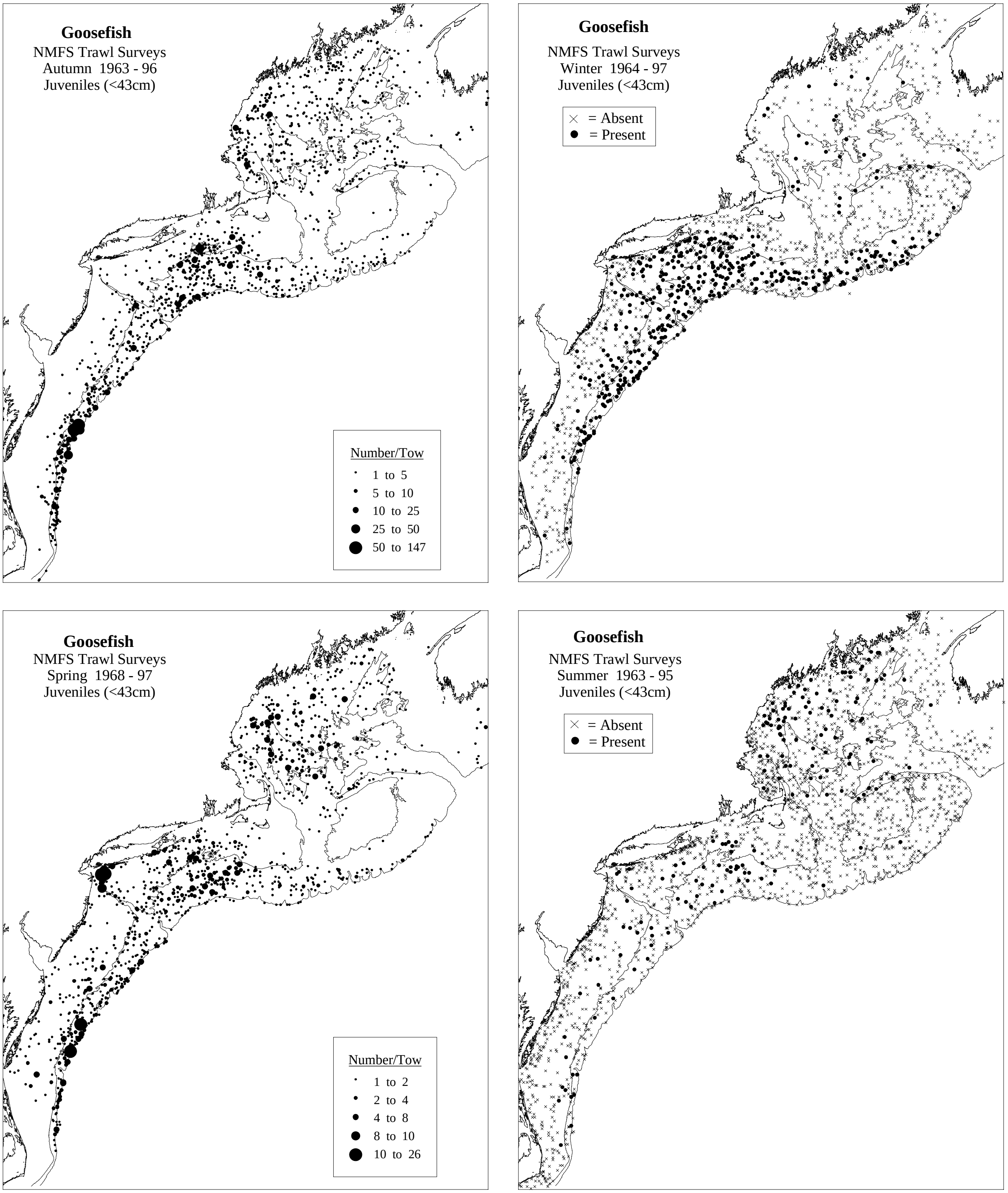
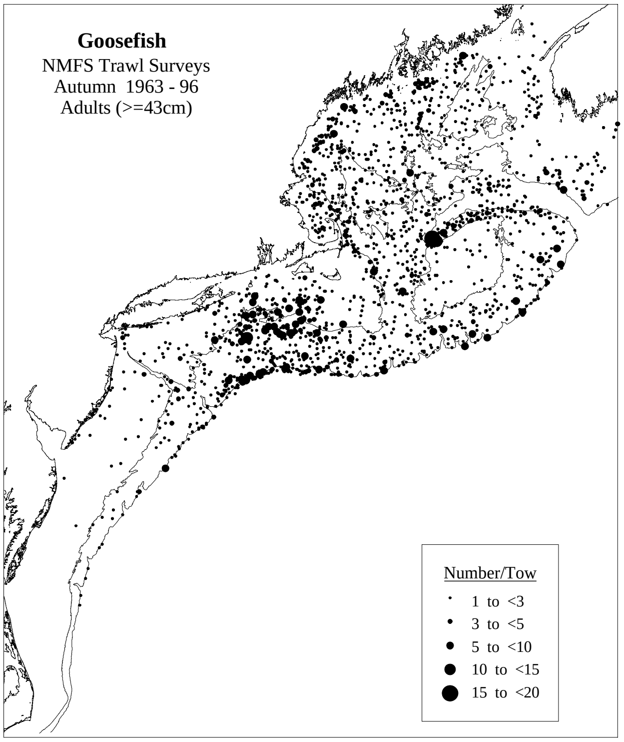
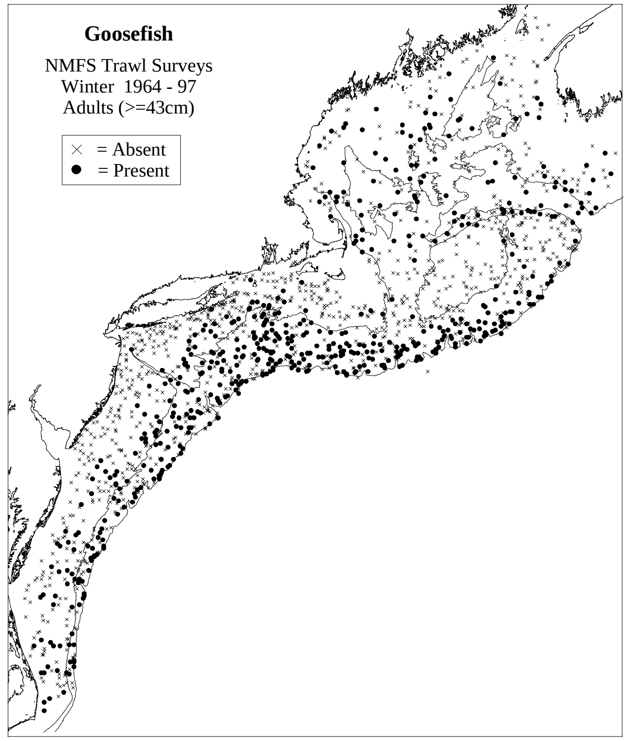
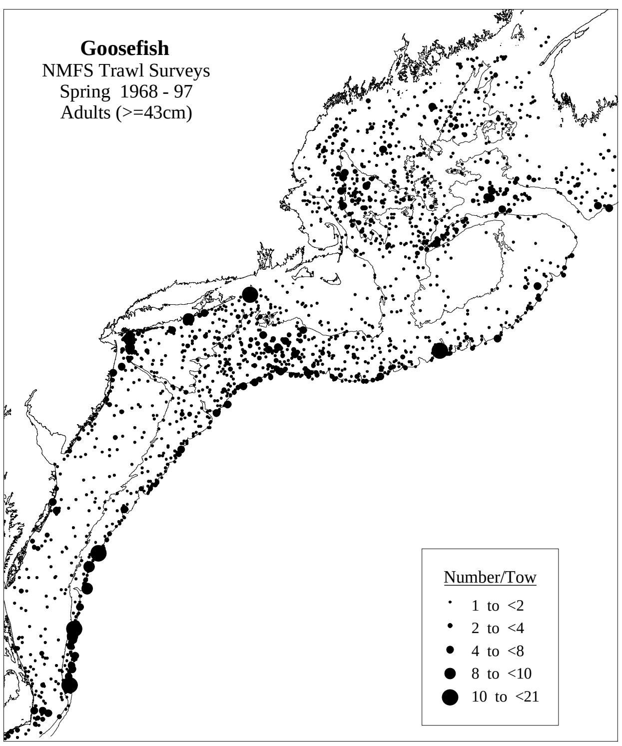


Figure 10. Distribution and abundance of juvenile and adult goosefish collected during NEFSC bottom trawl surveys during all seasons, 1963-1997. Densities are represented by dot size in spring and fall plots, while only presence and absence are represented in winter and summer plots [see Reid *et al.* (1999) for details].







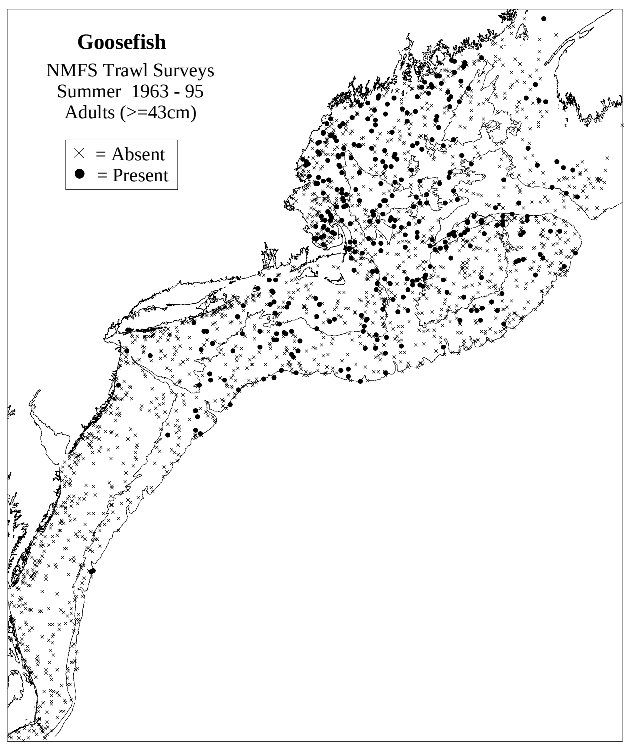


Figure 10. cont’d.

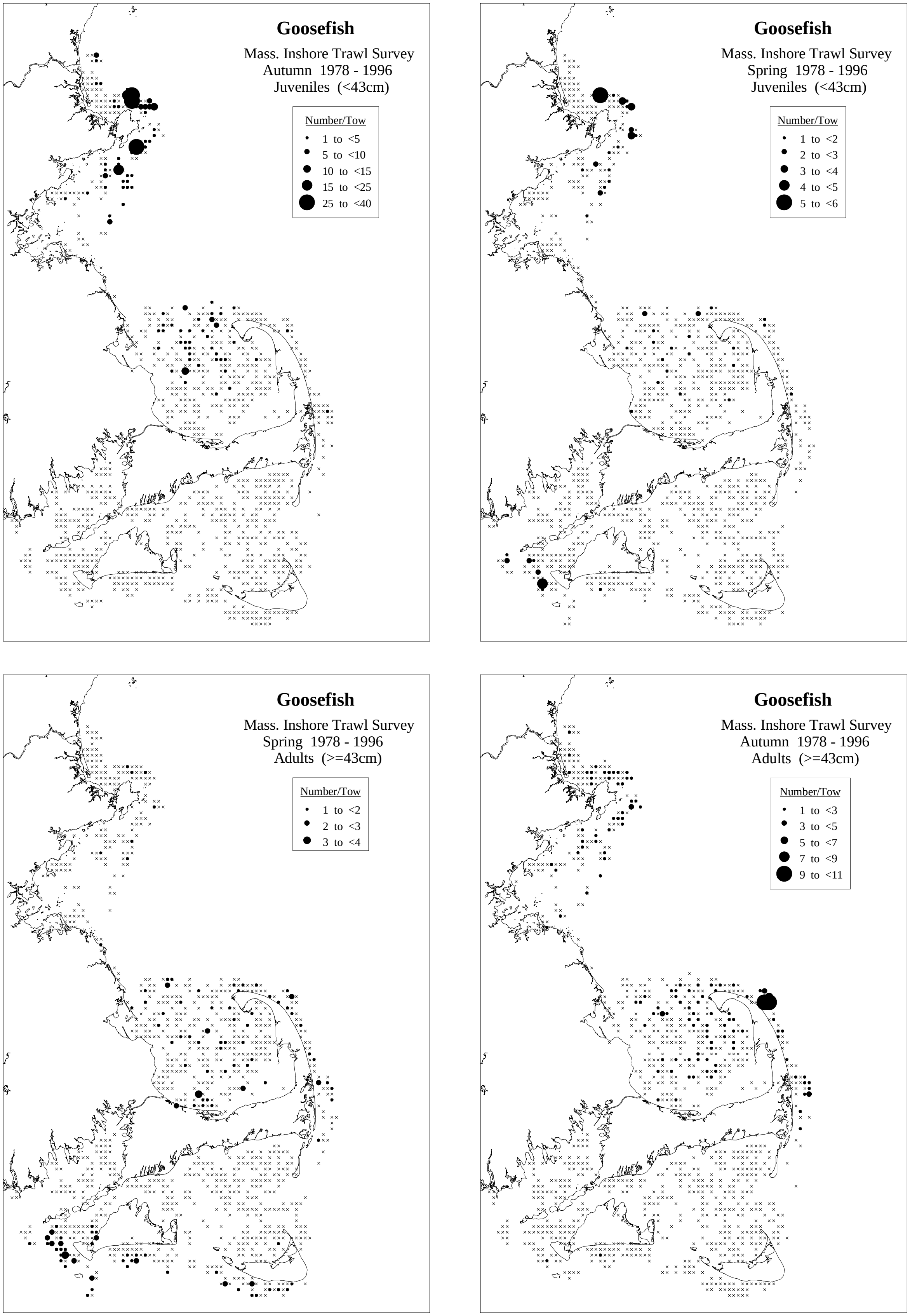


Figure 11. Distribution and abundance of juvenile and adult goosefish collected during spring and autumn Massachusetts inshore trawl surveys, 1978-1996 [see Reid *et al.* (1999) for details].

Goosefish Juveniles (< 43 cm)

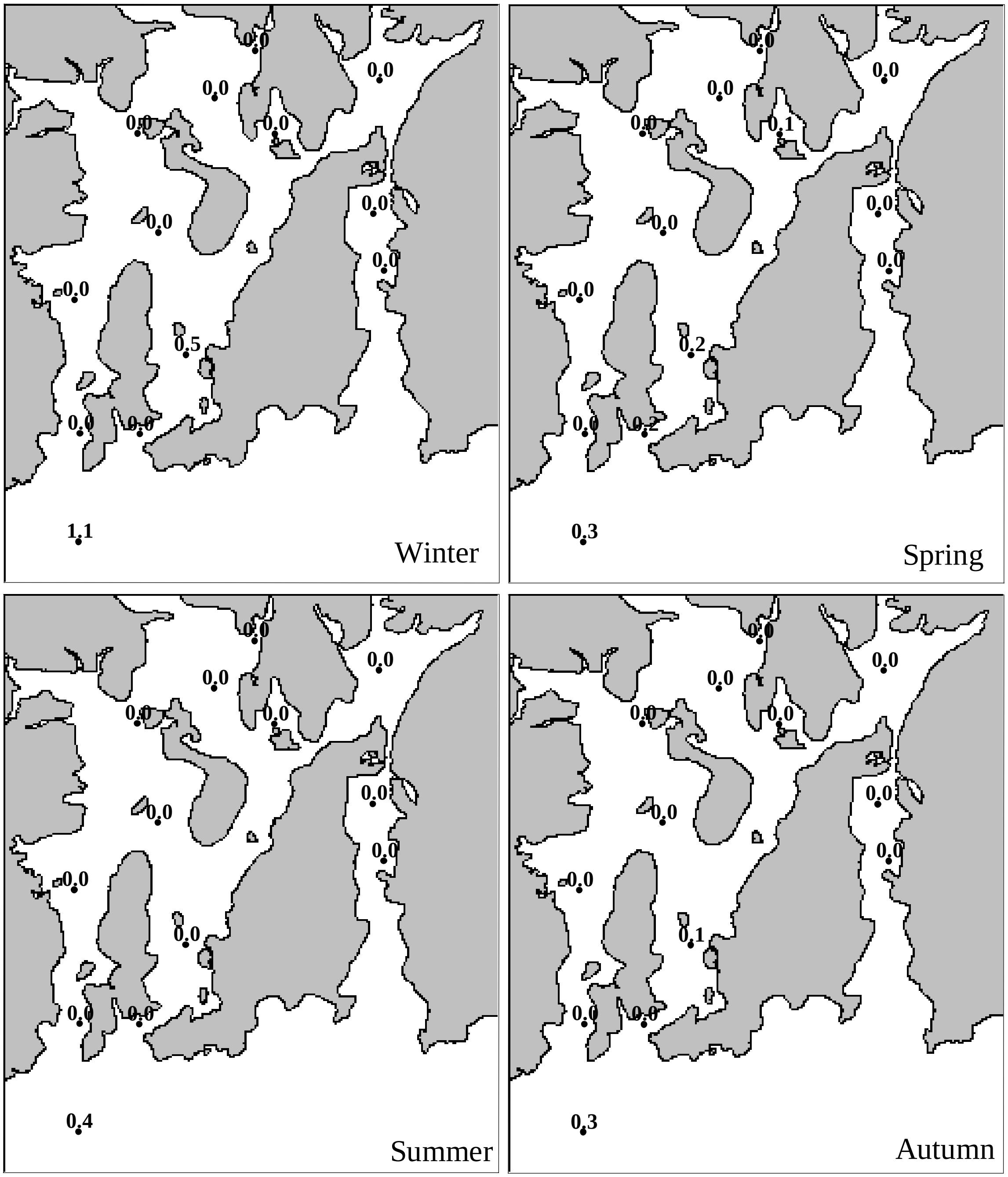


Figure 12a. Distribution and abundance of juvenile goosefish collected in Narragansett Bay during Rhode Island bottom trawl surveys, 1990-1996. The numbers shown at each station are the average catch per tow rounded to one decimal place [see Reid *et al.* (1999) for details].

Goosefish Adults (≥ 43 cm)

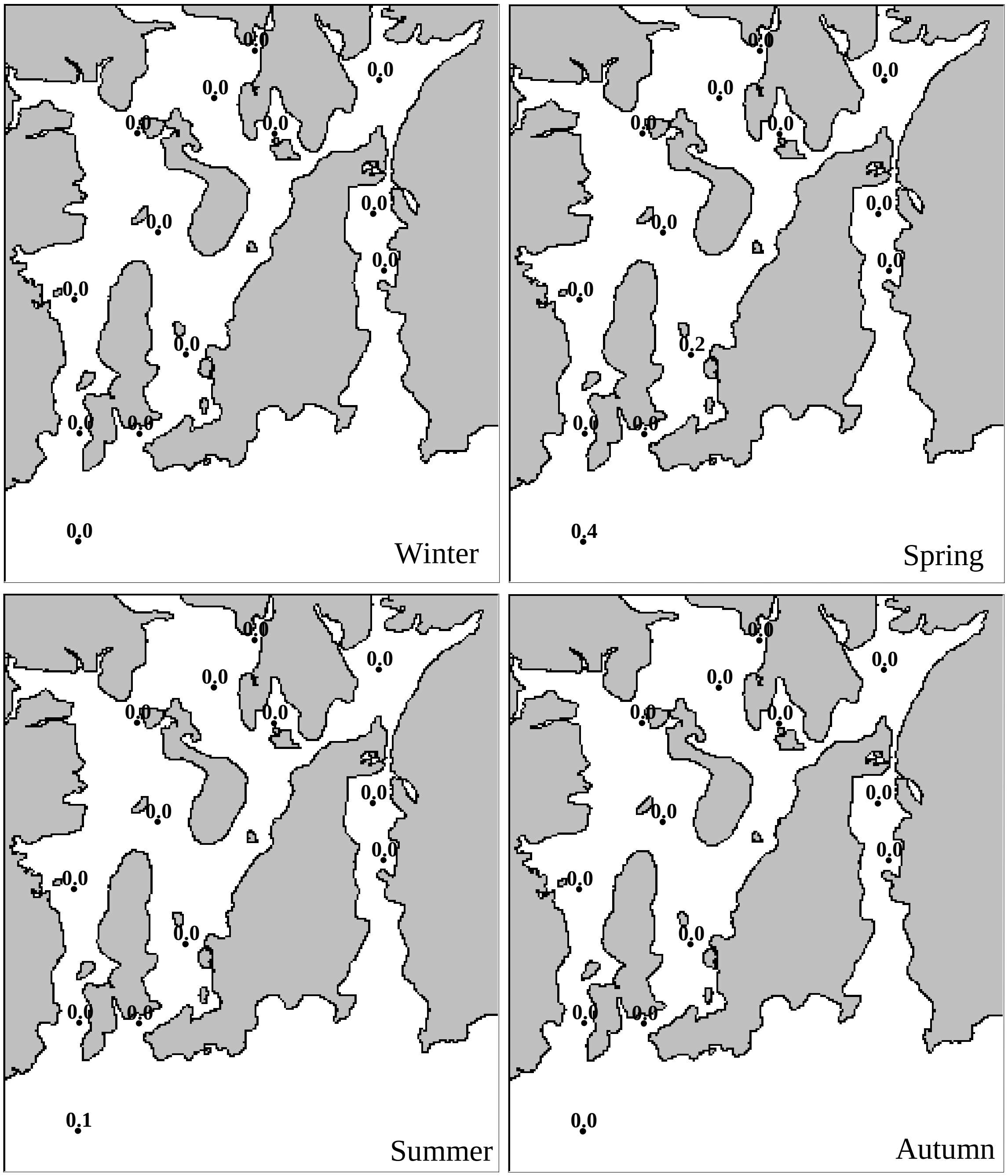


Figure 12b. Distribution and abundance of adult goosefish collected in Narragansett Bay during Rhode Island bottom trawl surveys, 1990-1996. The numbers shown at each station are the average catch per tow rounded to one decimal place [see Reid *et al.* (1999) for details].

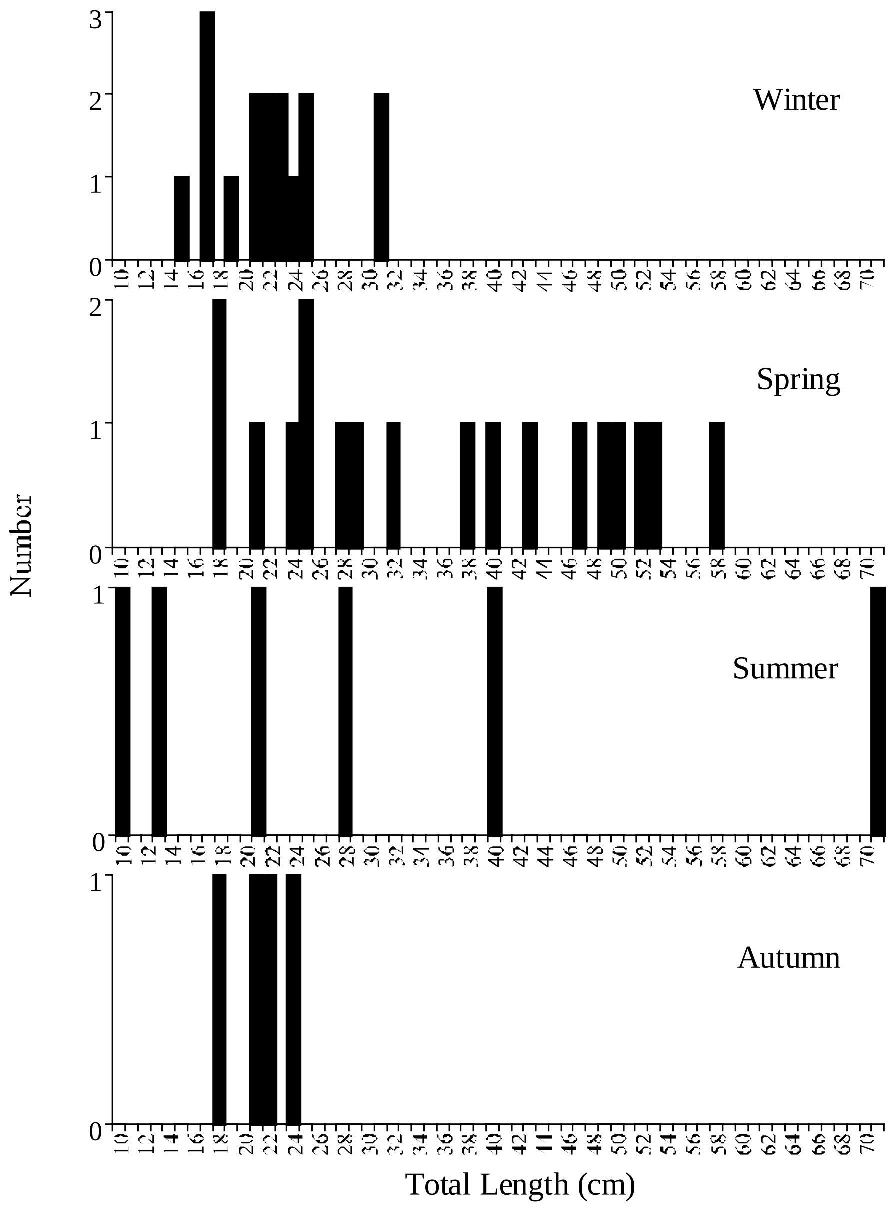


Figure 12c. Size distribution of juvenile and adult goosefish collected in Narragansett Bay during Rhode Island bottom trawl surveys, 1990-1996.

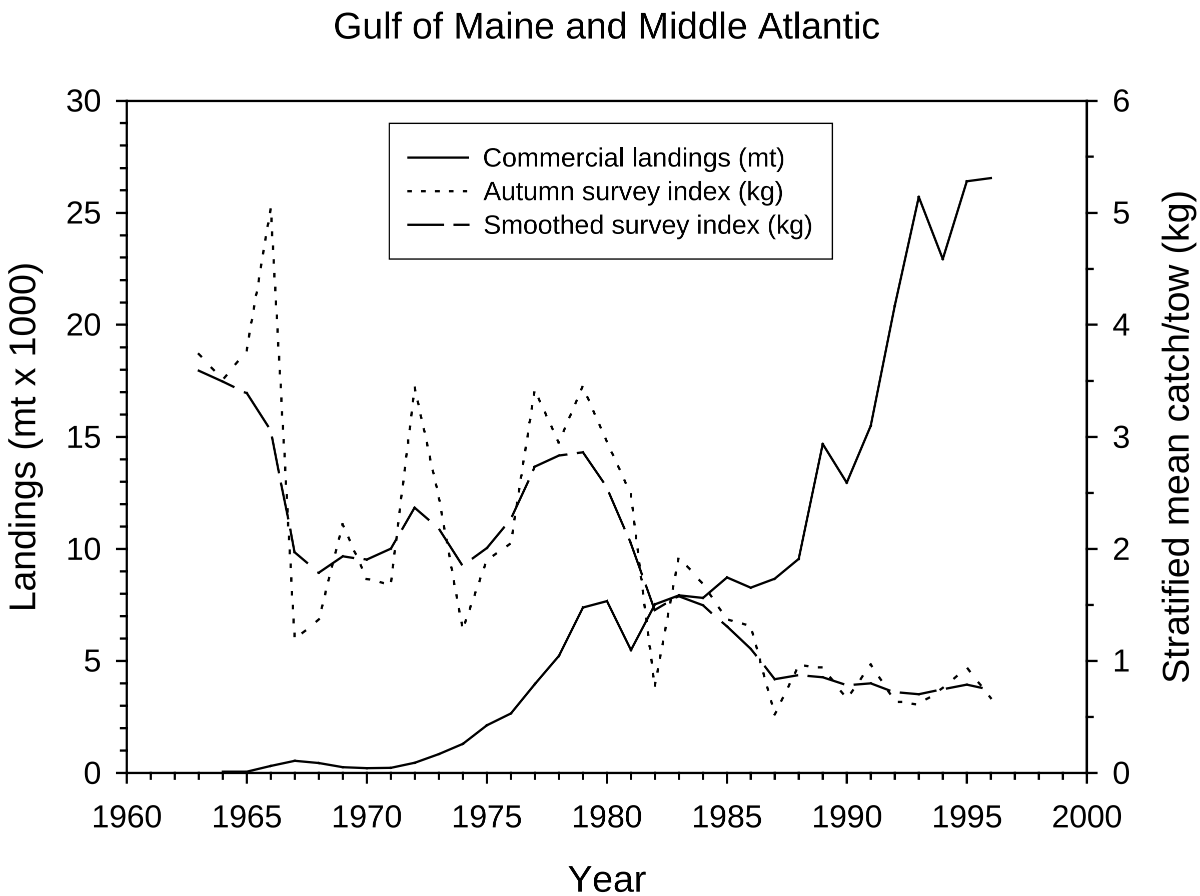


Figure 13. Commercial landings and survey indices of goosefish (from the NEFSC bottom trawl surveys) in the Gulf of Maine and Middle Atlantic.

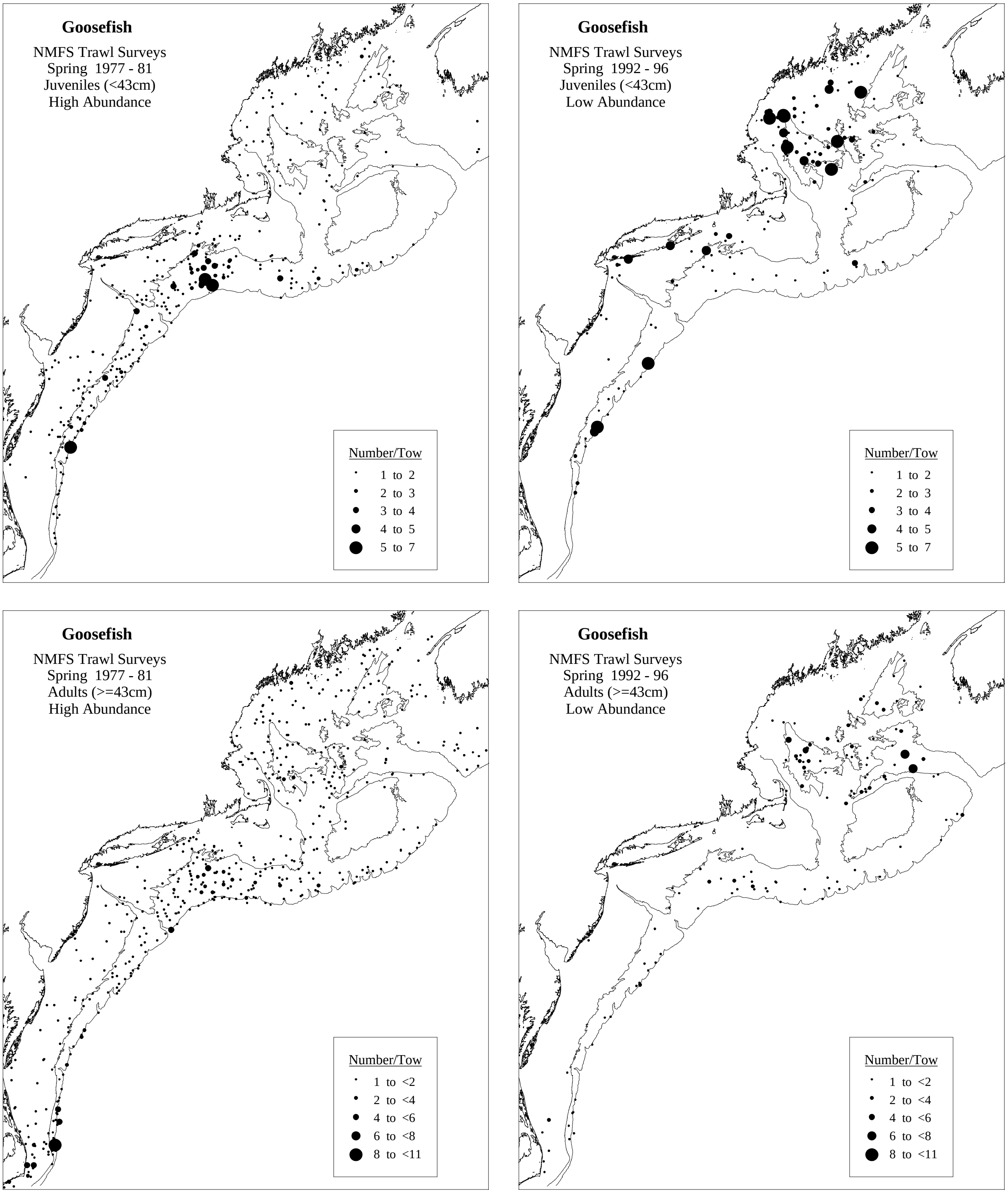


Figure 14. Distribution and abundance of juvenile and adult goosefish during periods of high (1977-1981) and low (1992-1996) population abundance (see also Fig. 13), from NEFSC spring bottom trawl surveys.

Publishing in *NOAA Technical Memorandum NMFS-NE*

Manuscript Qualification

This series represents a secondary level of scientific publishing in the National Marine Fisheries Service (NMFS). For all issues, the series employs thorough internal scientific review, but not necessarily external scientific review. For most issues, the series employs rigorous technical and copy editing. Manuscripts that may warrant a primary level of scientific publishing should be initially submitted to one of NMFS's primary series (*i.e., Fishery Bulletin, NOAA Technical Report NMFS,* or *Marine Fisheries Review*).

Identical, or fundamentally identical, manuscripts should not be concurrently submitted to this and any other publication series. Manuscripts which have been rejected by any primary series strictly because of geographic or temporal limitations may be submitted to this series.

Manuscripts by Northeast Fisheries Science Center (NEFSC) authors will be published in this series upon approval by the NEFSC's Deputy Science & Research Director. Manuscripts by non-NEFSC authors may be published in this series if: 1) the manuscript serves the NEFSC's mission; 2) the manuscript meets the Deputy Science & Research Director's approval; and 3) the author arranges for the printing and binding funds to be transferred to the NEFSC's Research Communications Unit account from another federal account. For all manuscripts submitted by non-NEFSC authors and published in this series, the NEFSC will disavow all responsibility for the manuscripts' contents; authors must accept such responsibility.

The ethics of scientific research and scientific publishing are a serious matter. All manuscripts submitted to this series are expected to adhere -- at a minimum -- to the ethical guidelines contained in Chapter 1 ("Ethical Conduct in Authorship and Publication") of the *CBE Style Manual*, fifth edition (Chicago, IL: Council of Biology Editors). Copies of the manual are available at virtually all scientific libraries.

Manuscript Preparation

Organization: Manuscripts must have an abstract, table of contents, and -- if applicable -- lists of tables, figures, and acronyms. As much as possible, use traditional scientific manuscript organization for sections: "Introduction," "Study Area," "Methods & Materials," "Results," "Discussion" and/or "Conclusions," "Acknowledgments," and "References Cited."

Style: All NEFSC publication and report series are obligated to conform to the style contained in the most recent edition of the *United States Government Printing Office Style Manual*. That style manual is silent on many aspects of scientific manuscripts. NEFSC publication and report series rely more on the *CBE Style Manual,* fifth edition.

For in-text citations, use the name-date system. A special effort should be made to ensure that the list of cited works contains all necessary bibliographic information. For abbreviating serial titles in such lists, use the most recent edition of the *Serial Sources for the BIOSIS Previews Database* (Philadelphia, PA: Biosciences Information Service). Personal communications must include date of contact and full name and mailing address of source.

For spelling of scientific and common names of fishes, mollusks, and decapod crustaceans from the United States and Canada, use *Special Publications* No. 20 (fishes), 26 (mollusks), and 17 (decapod crustaceans) of the American Fisheries Society (Bethesda, MD). For spelling of scientific and common names of marine mammals, use *Special Publication* No. 4 of the Society for Marine Mammalogy (Lawrence, KS). For spelling in general, use the most recent edition of *Webster's Third New International Dictionary of the English Language Unabridged* (Springfield, MA: G.&C. Merriam).

Typing text, tables, and figure captions: Text, including tables and figure captions, must be converted to, or able to be coverted to, WordPerfect. In general, keep text simple (*e.g.*, don't switch fonts, don't use hard returns within paragraphs, don't indent except to begin paragraphs). Especially, don't use WordPerfect graphics for embedding tables and figures in text. If the automatic footnoting function is used, also save a list of footnotes as a separate WordPerfect file. When the final draft is ready for review, save the text, tables, figure captions, footnotes, and front matter as separate document files.

Tables should be prepared using all tabs or all spaces between columnar data, but not a combination of the two. Figures must be original (even if oversized) and on paper; they cannot be photocopies (*e.g.,* Xerox) unless that is all that is available, nor be on disk. Except under extraordinary circumstances, color will not be used in illustrations.

Manuscript Submission

Authors must submit one paper copy of the double-spaced manuscript, one magnetic copy on a disk, and original figures (if applicable). NEFSC authors must include a completely signed-off "NEFSC Manuscript/Abstract/Webpage Review Form." Non-NEFSC authors who are not federal employees will be required to sign a "Release of Copyright" form.

Send all materials and address all correspondence to:

Jon A. Gibson, Biological Sciences Editor
Northeast Fisheries Science Center
National Marine Fisheries Service
166 Water Street
Woods Hole, MA 02543-1026 USA

Research Communications Unit
Northeast Fisheries Science Center
National Marine Fisheries Service, NOAA
166 Water St.
Woods Hole, MA 02543-1026

STANDARD
MAIL A

Publications and Reports of the Northeast Fisheries Science Center

The mission of NOAA's National Marine Fisheries Service (NMFS) is "stewardship of living marine resources for the benefit of the nation through their science-based conservation and management and promotion of the health of their environment." As the research arm of the NMFS's Northeast Region, the Northeast Fisheries Science Center (NEFSC) supports the NMFS mission by "planning, developing, and managing multidisciplinary programs of basic and applied research to: 1) better understand the living marine resources (including marine mammals) of the Northwest Atlantic, and the environmental quality essential for their existence and continued productivity; and 2) describe and provide to management, industry, and the public, options for the utilization and conservation of living marine resources and maintenance of environmental quality which are consistent with national and regional goals and needs, and with international commitments." Results of NEFSC research are largely reported in primary scientific media (*e.g.*, anonymously-peer-reviewed scientific journals). However, to assist itself in providing data, information, and advice to its constituents, the NEFSC occasionally releases its results in its own media. Those media are in three categories:

NOAA Technical Memorandum NMFS-NE -- This series is issued irregularly. The series includes: data reports of long-term or large area studies; synthesis reports for major resources or habitats; annual reports of assessment or monitoring programs; documentary reports of oceanographic conditions or phenomena; manuals describing field and lab techniques; literature surveys of major resource or habitat topics; findings of task forces or working groups; summary reports of scientific or technical workshops; and indexed and/or annotated bibliographies. All issues receive internal scientific review and most issues receive technical and copy editing. Limited free copies are available from authors or the NEFSC. Issues are also available from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161.

Northeast Fisheries Science Center Reference Document -- This series is issued irregularly. The series includes: data reports on field and lab observations or experiments; progress reports on continuing experiments, monitoring, and assessments; background papers for scientific or technical workshops; and simple bibliographies. Issues receive internal scientific review but no technical or copy editing. No subscriptions. Free distribution of single copies.

Fishermen's Report* and *The Shark Tagger -- The ***Fishermen's Report*** (FR) is a quick-turnaround report on the distribution and relative abundance of commercial fisheries resources as derived from each of the NEFSC's periodic research vessel surveys of the Northeast's continental shelf. There is no scientific review, nor any technical or copy editing, of the FR; copies are available through free subscription. ***The Shark Tagger*** (TST) is an annual summary of tagging and recapture data on large pelagic sharks as derived from the NMFS's Cooperative Shark Tagging Program; it also presents information on the biology (movement, growth, reproduction, etc.) of these sharks as subsequently derived from the tagging and recapture data. There is internal scientific review, but no technical or copy editing, of the TST; copies are available only to participants in the tagging program.

To obtain a copy of a technical memorandum or a reference document, or to subscribe to the fishermen's report, write: Research Communications Unit, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543-1026. An annual list of NEFSC publications and reports is available upon request at the above address. Any use of trade names in any NEFSC publication or report does not imply endorsement.