NBP-91-76

Scup (*Stenotomus chrysops*) Species Profile 38 pp

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Narragansett Bay Estuary Program

SCUP (Stenotomus chrysops) SPECIES PROFILE

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#NBP-91-76

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FOREWORD

The United States Congress created the National Estuary Program in 1984, citing its concern for the "health and ecological integrity" of the nation's estuaries and estuarine resources. Narragansett Bay was selected for inclusion in the National Estuary Program in 1984 , and the Narragansett Bay Project (NBP) was established in 1985. Narragansett Bay was designated an "estuary of national significance" in 1988. Under the joint sponsorship of the U.S. Environmental Protection Agency and the Rhode Island Department of Environmental Management, the NBP's mandate is to direct a program of research and planning focussed on managing Narragansett Bay and its resources for future generations.

The NBP will develop a draft Comprehensive Conservation and Management Plan (CCMP) by December, 1991, which will recommend actions to improve and protect the Bay and its natural resources.

The NBP has established the following seven priority issues for Narragansett Bay:

- management of fisheries
- nutrients and potential for eutrophication
- impacts of toxic contaminants
- health and abundance of living resources
- health risk to consumers of contaminated seafood
- land-based impacts on water quality
- recreational uses

The NBP is taking an ecosystem/watershed approach to address these problems and has funded research that will help to improve our understanding of various aspects of these priority problems. The Project is also working to expand and coordinate existing programs among federal, state and local agencies, as well as with academic researchers, in order to apply research findings to the practical needs of managing the Bay and improving the environmental quality of its watershed.

This report represents the technical results of an investigation performed for the Narragansett Bay Project. Funding was provided by the State of Rhode Island as part of Cooperative Agreement #CX812768 with the United States Environmental Protection Agency with an additional award provided by the National Marine Fisheries Service. It has been subject to the Agency's and the Narragansett Bay Project's peer and administrative review and has been accepted for publication as a technical report by the Management Committee of the Narragansett Bay Project. The results and conclusions contained herein are those of the author(s), and do not necessarily represent the views or recommendations of the NBP. Final recommendations for management actions will be based upon the results of this and other investigations.

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EXECUTIVE SUMMARY

This scup profile is the third document in a series intended to provide background necessary for cooperative management of important finfish species occurring in Rhode Island waters.

This review of the biology of scup, Stenotomus chrysops, includes nomenclature, taxonomy, ecology, stock description, range, abundance in Rhode Island waters, life history, habitat requirements, migration and movements. Also included are information on reproduction, growth and development, food and feeding, predators, disease and parasites. In addition to the commercial and recreational value of the fishery a summary of Rhode Island regulations is also included.

Scup support distinct summer and winter fisheries within the Middle Atlantic Bight. Since the early 1970's the USA nominal catch has steadily increased and reached a peak in 1981 and have continued to decrease considerably. The steady decrease in landings, catch-per-unit-effort and low survey indices suggest that recent exploitation has reduced the stock abundance substantially. Scup is one of the most important sportfish species along the upper east coast. Scup has ranked first through fifth in total numbers of fish landed in Rhode Island waters from 1981-1989 (with the exception of 1985).

Scup is a migratory species that tend to school in groups of like size fish, with larger fish arriving inshore before the smaller fish. Eggs and early larval development occur in saline parts of estuaries. Juvenile scup are found in the greatest numbers inshore. Scup summer in inshore areas where they spawn from May to August. As fall cooling occurs scup then migrate offshore.

The Mid-Atlantic Fishery Management Council (MAFMC) in cooperation with the National Marine Fisheries Service (NMFS), and the Atlantic States Marine Fisheries Commission (ASMFC) are currently drafting a management plan for Scup.

Species Profile: Scup
Stenotomus chrysops

Common Name: Scup
Scientific Name: *Stenotomus chrysops*
Author: Linnaeus 1766

Other Common Names: Porgy (Bigelow and Schroeder 1953; Morse 1978), porgee, scuppaug, mishcup, maiden, fairmaid and ironside (Baird 1873; Morse 1978) and spare doré (Scott and Scott 1988).

Classification:

Phylum:	Chordata
Subphylum:	Vertebrata
Class:	Osteichthyes
Order:	Perciformes
Family:	Sparidae
Genus:	*Stenotomus*
Species:	*chrysops*

VALUE

Commercial:

Distinct summer and winter fisheries for scup occur within the Middle Atlantic Bight, or that part of the Atlantic Ocean within the 100-fathom curve extending from Cape Hatteras to Cape Cod (Neville and Talbot 1964). Scup fisheries in the Middle Atlantic region are conducted primarily by New Jersey and Virginia vessels (Mayo 1982). The New Jersey otter trawl fishery operates throughout the year, with the major portion of the catch taken in the fall and winter from offshore areas between the Hudson and Wilmington Canyons (Mayo 1982). By late winter and early spring, effort shifts to the area between the Baltimore and Norfolk Canyons at depths of 70-180 m (Mayo 1982). In late spring the fleet is fishing south of the Hudson Canyon at depths of 60 m (Mayo 1982), and in the summer months, these vessels move into Long Island Sound and Southern New England (Mayo 1982). This fishery overlaps the Virginia trawl fishery in the winter and the Southern New England trawl and trap fishery in the summer (Mayo 1982). The Virginia winter trawl fishery generated catches in excess of 5,000 metric tons (mt) in the early 1960's, but has averaged less than 350 mt over the past ten years (USDC 1989). The proportion taken by the Virginia trawl fishery has declined from 40% to 60% of the total prior to 1967, to 2% to 16% since 1973 (USDC 1989).

In the Southern New England fixed gear fishery pound nets are used in coastal New York and Massachusetts state waters from April to August (Mayo 1982), while floating traps are fished off Rhode Island from the first of March through the last day of December as prescribed by state regulations (R.I.G.L. 20-5-14). Of the Rhode Island landings, approximately 67% came from floating fish traps with the remaining 33% coming from the otter trawl catch (Sisson 1974). These proportions remain consistent from 1979-1989, with floating fish traps constituting 67%, the otter trawl with 31% and other miscellaneous gear types making up the remaining 2% (Figure 1).

Nominal commercial catches by USA vessels have fluctuated between 18,000 and 22,000 (mt) annually between 1953 and 1963, but have declined to between 4,000 and 5,000 mt during the early 1970's (USDC 1989). Nominal catches by the distant water fleets peaked at 5,900 mt in 1963, then declined to less than 100 mt per year after 1975 (USDC 1989). Since the early 1970's the USA nominal commercial catch steadily increased and reached a peak of 9,800 mt in 1981 (Table 1) and have continued to decrease considerably (USDC 1989). The 1988 catch decreased to 5,800 mt, 25% below the average, yielding the lowest catch over the past eight years (USDC 1989).

Rhode Island commercial landings for scup peaked in 1965, steadily dropped to the lowest value in 1969 and have fluctuated through 1989 (Figure 2). Rhode Island ranks first in commercial landings, with 34% of the total coastwide landings (MAFMC 1990).

Length frequency samples of the commercial catch indicate an increase in the number of young-of-the-year (YOY) scup in 1988. Also, over the past six years commercial length frequencies have shifted to smaller fish (including YOY) (USDC 1989). Mean lengths for both the commercial fishery and NEFC autumn offshore survey exhibit decreases since 1983, and NEFC mean lengths have decreased 44% from 1983 to 1988(USDC 1989). There is a general lack of larger, older scup (>35 cm, >7 yrs.) in both commercial and recreational fisheries (USDC 1989).

The steady decrease in landings, the decrease in catch-per-unit-effort (CPUE) levels, and the near record low survey indices suggest that recent exploitation has reduced stock abundance substantially. The truncated age distributions suggest that exploitation has reduced the population level and is increasingly focusing on young fish. These considerations suggest that the population is over exploited (USDC 1989). For proposed management strategies, see page #13.

Recreational:

Scup is one of the most important sport species along the upper east coast (NOAA 1990). Scup bite very greedily throughout the summer on clams, bits of crab, and sea worms (Nereis). Because scup tend to be concentrated and are easily accessible to sport fishermen during the spring and summer, exploitation by such fishermen is at its peak during

this season (Finkelstein 1971).

Scup has ranked first through fifth in total numbers of sportsfish landed from 1981 to 1989 (with the exception of 1985) for Rhode Island waters (Karlsson 1990). Average length and length/weight relationship are shown in Figure 3 and 4, respectively, for the scup recreational fishery in Rhode Island (Karlsson 1990). Total recreational harvest of scup in Rhode Island is represented in numbers of fish and weight from 1980-1988 in Figure 5.

Estimated recreational catches represent 20% to 50% of the total nominal catches from 1979 to 1987, with the exception of 1987, when it represented 86% (USDC 1989). The 1988 preliminary recreational catch estimate is 28% below the 1987 level (USDC 1989). USA Recreational catch of scup has declined from 7.5 mt in 1960 to 1.4 mt in 1984 (Table 1), and has fluctuated up to 1988 (USDC 1989).

STOCK DESCRIPTION

Tagging studies have suggested the possible existence of two independent population units of scup, one near the southern and the other near the northern end of their range (Neville and Talbot 1964). Tagging studies conducted by Cogswell (1960) and Hamer (1970) confirmed the existence of these units and also indicated a separation on the offshore wintering grounds. However, because of the small number of tag returns from these studies, doubt is cast on the reliability that separate stocks exist (Neville and Talbot 1964). Recent data from NEFC bottom trawl surveys on the distribution and size composition of scup suggest that scup inhabiting the southern New England and Middle Atlantic regions comprise a single population unit (Mayo 1982).

RANGE

Overall:

Scup is a continental shelf species that ranges in the western North Atlantic from Sable Island Bank (Scott and Scott 1988) to Cape Hatteras, North Carolina (Morse 1978). Although infrequent north of Cape Cod (Bigelow and Schroeder 1953), scup reaches the northern limit of its range in Passamaquoddy Bay, New Brunswick (Scott and Scott 1988).

Within Narragansett Bay:

Scup begin to move into Narragansett Bay and Mt. Hope Bay in April (Jefferies et al. 1988; Lynch pers. comm. 1990). Scup remain in Narragansett Bay and coastal waters through November (Jefferies et al. 1988) until the fall migrations have begun (Simpson et al. 1990).

ABUNDANCE IN RHODE ISLAND WATERS

Seasonal abundance and distribution of juvenile scup in Narragansett Bay has been monitored annually at 15 stations since 1986 by the R.I. Division of Fish and Wildlife (Figure 6). From 1986 through 1990, Powell (pers. comm. 1990) found that YOY comprised the entire catch of scup, even though scup infrequently occurred in his collections. Powell

(1989) could offer no explanation for the low numbers of scup collected, although he did venture to say that a possibility exists that the proper shore zone areas are not being sampled or that the population of O-group scup in Narragansett Bay is depressed. However, this conflicts sharply with the 62,929 scup <110 mm collected from 1979-1990 in the Narragansett Bay Trawl Survey. In light of the trawl survey data, the absence of scup in Powell's collection may be taken as an indication that his sampling methods and/or locations are inappropriate for sampling of scup and not as an indication of a depressed population. A 1989-1990 ichthyoplankton survey in Narragansett Bay also revealed very low numbers of scup eggs and larvae, and while the low catch may be cause for concern it may also be within the normal range of variability for this species (Keller 1990; pers. comm.) emphasizing the need for continuous long-term monitoring.

The R.I. Coastal Fishery Resource Assessment program, has annually collected scup, with fall indices contributing more significantly than those of the spring (Lynch and Karlsson 1989). Figure 7 shows the fluctuations in both mean weight per tow (kg) and mean number per tow since 1979, with peaks occurring in 1980, 1984 and 1988 (Lynch and Karlsson in press; 1990). With the exception of biomass indices for Narragansett Bay, both indices of abundance in Rhode Island and Block Island Sounds (as well as mean number per tow in Narragansett Bay) declined in 1989 (Figure 7). Eleven year means of annual abundance by location are found in Table 2. Cursory examination (U.S. Dept. Comm. Tech. Rep. 14. 1978), of length frequency data indicates that 94.2% of the 1988 catch was comprised of 0-1 year old scup with a ten year mean of 89.6% (Lynch and Karlsson 1989). Indices of relative abundance indicate that R.I. coastal waters, especially Narragansett Bay, constitute a nursery area for 0-1 year old scup (≤17 cm). Figure 8 supports this observation. Cursory examination of length frequency data indicate an abundance index for scup ≤17 cm (x/tow) of 112.0 and 133.4 for Narragansett Bay and statewide respectively (Lynch and Karlsson in press; 1990). These indices represent 48.0% and 97.5% (respective of location) of the 1979-1989 annual mean number per tow. Biomass indices (1979-1989 kg/tow) were 3.25 (Narragansett Bay) and 2.76 (statewide) respectively and biomass indices for Narragansett Bay accounted for 67.1% of the mean annual total (1979-1989) (Lynch and Karlsson in press; 1990).

Lynch and Karlsson (1989) found that inshore indices from Massachusetts, Connecticut and Jeffries et al. (1988)(Figure 9) compare favorably for 1987 and 1988. The N.E.F.C. biomass indices from the fall bottom trawl surveys for the Southern New England-Mid- Atlantic area (USDC 1989) and the R.I. fall index both fluctuate over time (Lynch and Karlsson 1989). However, the timing and direction of the fluctuations do not coincide. For example, R.I. fall indices of higher abundance (1980,1984 and 1986-1988) have coincided with years of low abundance reported by N.E.F.C. (Lynch and Karlsson 1989).

LIFE HISTORY

Scup is a migratory species that tend to school in groups of like size fish (Smith and Norcross 1968; Sisson 1974; Morse 1978), with reports of larger fish arriving inshore first followed by smaller fish (Neville and Talbot 1964; Sisson 1974). Most scup spend the summer in bays or within 8-10 km off the coast, where they spawn from May to August (Griswold and McKenney 1984). In the winter, scup are found in offshore waters between Hudson Canyon and Cape Hatteras from 40 to 100 fathoms (Neville and Talbot 1964).

Eggs and early larval development occur in the more saline parts of estuaries (Kendall 1973). In Southern New England, the greatest number of juvenile scup, were caught almost entirely inshore (Bowman et al. 1987). Scup then migrate offshore and south as fall cooling occurs (Kendall 1973).

HABITAT REQUIREMENTS

Type/Substrate:

Eggs and larvae:

Scup spawn buoyant eggs (Johnson 1978; Morse 1978; Griswold and McKenney 1984) and larvae are pelagic (Morse 1978).

Juveniles:

Sisson (1974) found that Narragansett Bay provides an important summer habitat for scup in age classes one through four. Young-of-Year (YOY) scup (Connecticut waters) are most commonly taken in <30 ft strata, particularly in sandy areas with surf clams and in areas where kelp is abundant (Simpson; cited in MAMFC draft 14 MARCH 1990). There appears to be a strong preference for transitional bottom type (5-50% silt and clay) with structures of any kind being important to scup of all sizes (Simpson; cited in MAMFC draft 14 MARCH 1990).

Adults:

Adult scup prefer areas with a smooth to rocky bottom, and are found in the water column anywhere from two to twenty fathoms during the summer(Bigelow and Schroeder 1953) and 40 to 100 fathoms in the winter (Neville and Talbot 1964).

Temperature/Salinity:

Eggs/larvae:

In Narragansett Bay, Herman (1958) found scup eggs in water temperatures and salinities, respectively, that ranged from 12.5°C - 24.4°C (54.5°F - 75.9°F) and 29.02 o/oo - 32.52 o/oo. He also found scup larvae in water temperatures from 20.0°C - 23.5°C (68°F - 74.3°F), but no mention was made of salinity. Laurence (1979) determined that the optimum temperature for laboratory reared scup was 18°C (64.4°F).

Juveniles:

Juvenile scup found in Narragansett Bay occupy water

temperatures in a range of 8°C - 24°C (46.4°F - 75.2°F) (Coastal Fisheries Resource Assessment Trawl Survey 1989). The critical thermal maxima for juvenile scup ranged from 30.2°C - 35.6°C (86.4°F - 96.1°F) depending on acclimation temperatures which varied from 14.8°C - 22.2°C (58.6°F - 72°F) (Everich and Gonsalez 1977).

Adults:

In Narragansett Bay, adult scup can be found in water temperatures that range from 6.0°C - 24.0°C (42.8°F- 75.2°F) (Sisson 1974; Coastal Fisheries Assessment Trawl Survey 1989). In Long Island Sound, scup ranged in water temperatures and salinities of 11°C - 16°C (52°F-61°F) and 29.0 o/oo - 32.4 o/oo (Finkelstein 1969a). Bulger et al. (1990) found adult scup in a salinity range of 17 o/oo - >30 o/oo.

MIGRATION AND MOVEMENTS

The recovery records from tagging studies suggest a north-south and inshore-offshore seasonal migratory pattern (Finkelstein 1969b) consisting of annual migrations made to offshore winter grounds and the inshore summer grounds (Figure 10). In the spring, scup leave the offshore wintering grounds at the 185m isobath and head into coastal waters that extend from New England to New Jersey, during which time spawning occurs (Morse 1978). The fall migration begins in September with most scup arriving at the winter grounds by December (Morse 1978). The winter offshore distribution appears to be affected by the 7.3°C (45°F) isotherm, with changing bottom temperatures affecting year to year abundance of scup (Neville and Talbot 1964).

REPRODUCTION

Mode:

Scup are heterosexual, hermaphroditism has not been reported, and there is no known sexual dimorphism (Morse 1978). Fertilization is external, with no further parental care of eggs or larvae (Morse 1978).

Spawning Factors:

Morse (1978) reported that although the type of spawning ground has not been investigated, it appears that spawning occurs over sandy and weed covered bottoms. It is not likely that egg development can proceed normally in water colder than 10°C (50°F) (Bigelow and Schroeder 1953).

Reproductive Capacity:

Howell and Simpson (1985) found after the examination of 36 female scup (175-230 mm fork length (FL)), an estimated fecundity of 7000 eggs/female (range 700-18900; SD=4860). They also calculated a regression of estimated total egg number on body weight, which resulted in a direct relationship, but a weak predictive value of:

$$R^2=0.11.$$

Also, regression of total egg number on fork length made no improvement:

(R^2=0.086).

Regression of the log of both variables resulted in R values ≤0.05. They felt that a larger sample size would be necessary to show a relationship between body weight or length and fecundity.

Rhode Island Spawning Season/Locations:

Along southern New England scup spawn from May through August, but mainly in June (Bigelow and Schroeder 1953). This is confirmed by Herman (1958) who found eggs in Narragansett Bay from May through August, with a peak in June. Sisson (1974) concluded that the spawning season in Narragansett Bay was in May, June and July, based on the largest number of scup in ripe condition.

GROWTH AND DEVELOPMENT

Egg:

The scup egg is buoyant, transparent and spherical (Bigelow and Schroeder 1953; Herman 1958; Johnson 1978; Griswold and McKenney 1984). The shell is unsculptured, yolk unsegmented with a gold-colored oil globule bearing black pigment, located posterior in the yolk sac (Griswold and McKenney 1984). Herman (1958) found that Narragansett Bay scup eggs ranged from 0.85 - 1.05 mm in diameter, with the oil globule ranging in size from 0.13 - 0.23 mm. These measurements are similar to those found by Bigelow and Schroeder 1953; Johnson 1978; Morse 1978; Griswold and McKenney 1984.

Embryonic Stages:

Kuntz and Radcliffe (1917) describe the embryological development of scup as being typical of teleosts with pelagic eggs. They found that egg incubation is rapid at a water temperature of 22°C (71.6°F), not taking over 40 hours. They continue to describe development as follows: As soon as fertilization occurs, the protoplasm concentrates at one pole. The first cleavage of the blastodisc occurs in <01 hr. and blastoderms are in advanced stages of cleavage, and appear radially symmetrical. As segmentation advances, a cleavage cavity forms between the blastoderm and periblast. Next, the germ ring becomes fully differentiated as a thickened peripheral zone of the blastoderm. At this stage development of embryo begins and within 18 hrs. the blastophore closes. Pigmentation is first observed in embryos showing 15-20 somites. Black and yellow pigment cells appear sparsely scattered over the embryo and oil globule. As development advances, the pigment cells become larger and more numerous. Figure 11 shows the yellow pigment on the embryo as coarse stippling, while the black is shown in solid color. Approaching time of hatching, the yellow chromatophores become aggregated to form heavily pigmented areas. The extra-embryonic blastoderm remains free from pigment.

Larval Development:

This section is based on "Larval development of the scup, Stenotomus chrysops, (Pisces:Sparidae)." (Griswold and McKenney 1984). A more detailed account of postanal length, preanal length, head length, eye diameter, snout length, body depth and prepectoral-pelvic lengths, is presented by Griswold and McKenney (1984). They found that scup eggs hatched in 70-75 hr at 18°C (64.4°F) and in 44-54 hr at 21°C (69.8°F). Newly hatched larvae averaged 2.0 mm standard length(SL), having 24 myomeres. Larvae ranging in size from 2.0 mm to 18.7 mm are shown in Figure 12 and described below.

At **2.0 mm**, finfold extends from the top of the head to the visceral sac, interrupted only by the anus. The gut is a tube with a constriction at its posterior end that extends to the ventral edge of the finfold. There are no fin rays, but an anlagen of the pectoral fins is present. The eyes are not pigmented and mouth unfunctional. The head is bent slightly over the elliptical yolk sac.

Between 48-72 hr after hatching the yolk sac and oil globule are absorbed and hindgut can now be distinguished. During this period the eyes become pigmented, the mouth functional and the larvae begin to feed.

Two dorsal rows of stellate melanophores (one on either side) extend from the snout, over the eyes to beyond myomere 20, appearing to be between the myomeres on the myosepta.

At **2.3 mm** pectoral fin buds appear.

At **2.5 mm** a hiatus appears in a series of melanophores, that extends from mideye level to over the visceral sac. Along the ventral margin of the tail, is a gradual increase in the number of melanophores. Melanophores on the yolk sac and oil globule disappear, with the exception of one or two on the midventral line of the anterior part of yolk sac. The pectoral fins now have bases and blades.

From **2.9-3.0 mm** the pectoral fin rays first appear.

At **3.4 mm** anlagen of caudal base appears.

At **4.0 mm** the stomach is well defined and the hind gut is shorter.

From **4.0-5.0 mm** the pigmentation pattern that will culminate in that of the juvenile begins to appear. The majority of pigment is on the peritoneum dorsal to the viscera and along the midventral line. There are usually no melanophores on the dorsal and lateral parts of the head anterior to the middle of the eyes, although several prominent melanophores are on the midbrain and hindbrain. No pigment appears ventrally on the head region. Development beyond this stage consists of a gradual increase of pigment on the dorsal and dorsolateral parts of the head, mostly occurring above mideye level. Prominent melanophore at articulation of the lower jaw with the quadrate bone.

A gap in the dorsal pigment appears in the occipital region, which becomes part of the barred pattern of the

juvenile. Located anteriorly, there is a melanophore at the cleithral symphysis and posterior to it a large one midventrally on the anterior belly and a smaller one on the posterior belly.

A prominent melanophore appears on the hindgut just anterior to the anus. Melanophores are on most of the anal pterygiophores (this pattern continues externally on ventral myosepta). Several melanophores appear dorsally on the posterior pterygiophores of the dorsal fin, with a few scattered on the finfold.

At **4.2 mm** five pairs of branchiostegals are present.

At **4.3 mm** the principal caudal rays are detectable at the finfold, and are the first rays of any fins to appear.

Notochord flexion begins at **4.7 mm**.

At **4.9 mm** thirteen rays are visible in the pectoral fins.

By **5.2 mm** the cartilaginous skeleton can be easily distinguished.

From **5.4-5.6 mm** cartilaginous hypural plates are present in larvae undergoing notochord flexure.

At **5.7 mm** there are 10 rays visible in pectoral fins. Anlagen of pelvic fins are first seen, with development thereafter occurring from the distal edge medially.

In larvae **>6.0 mm** full complements of 11-12 soft rays are present in anal and dorsal fins. The development of the spiny rays in these fins is posterior to anterior and follows soft ray development. Note exception to this is that the posterior most spiny rays in both fins appear first as soft rays.

At **6.1 mm** ossification occurs in the skull, with no ossification posterior to the cleithrum at this time.

By **7.0 mm** ossification occurs notably in pterygoid, metapterygoid, opercular series, supracleithrum and frontal bones. Circumorbitals, parasphenoid and scapula begin ossification. In the first ten vertebrae, the neural spines of the first four vertebrae, the pectoral and caudal fins have begun to ossify.

At **8.0 mm** notochord flexion is complete.

By **8.5 mm** a full array of one spine and five soft rays are present in pelvic fins.

At **9.0 mm** peritoneal pigment has become more dense and prominent, with hindgut nearly covered by large melanophores. Trunk and tail pigment is more extensive. There is pigment along the bases of the dorsal and anal fins that continues posterior to them to the procurrent caudal rays. A line of melanophores runs dorsoventrally at about the juncture of the caudal fin rays and bones. Internally there are melanophores near the bases of the haemal and neural arches. Pigment developed beyond this size is characterized by the development of the barred pattern of the juvenile.

From **9.9-10.8 mm** scales are first seen.

At **10.0 mm** the caudal fin begins to fork.

At **≥10.8 mm** the distal vertebrae (caudal complex) are ossified. Now present as cartilage are the pterygio-

phores. Ossification of the dorsal and anal fin rays and spines is complete. The pelvic fin supports and girdle begin to ossify.

From **12.0-13.0 mm** the larvae are now completely scaled.

At **14.0 mm** a full complement of caudal rays are present with the secondary rays developing in a posterior to anterior direction.

By **14.5 mm** skull development is complete, with ossification of most skull bones. Ossification is complete in the radial, scapula, pelvic fin supports, and girdle. The hypural plates are all present and ossified. A few dorsal plates remain cartilaginous.

At **≥16.5 mm** the sixth and final pair (median one) of branchiostegals appears.

By **16.9 mm** the number of spines on the preopercular margin become serrate.

By the time scup reach **18.0-19.0 mm**, they are now juveniles.

Juvenile Development:

Juvenile scup can range in size from 18.0 - 110 mm TL. At about 40 - 60 mm TL scup assume the basic shape of the adult, but retain the seven transverse bars characteristic of juvenile pigmentation (Morse 1978). In preserved specimens, pigmentation in juvenile scup >23 mm appears pale or light brown; the muzzle, except for tip of snout, is opaque creamy white, which conspicuously contrasts with the rest of the head (Johnson 1978). The iris and most of the opercle is silvery white, including the peritoneum that shows through the thin lower walls of the abdomen (Johnson 1978). A patch composed of dull brown spots appears on each cheek scale (Johnson 1978). The dorsal fins are greyish distally, with all other fins pale to whitish (Johnson 1978).

As a reflection of scale growth, scup apparently gain most of their annual size increment while inshore (June-November), while accruing little growth offshore during the winter (Finkelstein 1969a). It was determined by Finkelstein (1969a) that male and female scup, respectively attained 31.4 % and 28.1 % of their maximum expected length by age I and 47.6 % and 42.5 % by age II. Also, scup (ages 1-2) attained 85-90 % of their annual growth in weight from May-October, while scup (ages 3-6) attained only 60-75 % of their annual growth during the same period (Howell and Simpson 1985). Estimated mean lengths at age for juvenile scup are summarized as follows:

AGE I	INVESTIGATOR
93.3 mm	Howell and Simpson (1985)
97.0 mm	Penttila et al. (1989)
100.0 mm	Sisson (1974)
106.5 mm	Finkelstein (1969a)
110.0 mm	Johnson (1978)

A length-weight relationship was developed by Michelman (1988) for juvenile scup in Narragansett Bay and is as

follows: LOG W=3.23 x LOG L - 1.91 (W=wet weight in grams; L=fork length in cm).

Adult Development:

Scup become sexually mature in their second year at a fork length of approximately 150 mm (Sisson 1974; Johnson 1978; Morse 1978; Penttila et al. 1989). Scup are a relatively slow growing fish, attaining maximum lengths of 39-41 cm and maximum ages of 13-15 years (Hamer 1970; Finkelstein 1969a). Also, McBride and Brown (1980) found scup to reach a maximum length of 43 cm and a maximum age of 19 years.

Growth curves have been developed for scup by various investigators. Finkelstein (1969a) followed the von Bertalannfy growth-in-length function for scup from Peconic Bays in eastern Long Island and fitted this to each sex which resulted in:

$$\text{males: } L_t=342.5\ \{1-e[-0.2688(t_n + 0.40531)]\}$$
$$\text{females: } L_t=374.1\ \{1-e[-0.2247(t_n + 0.47047)]\}.$$
$$(L_t=\text{mm})$$

Sisson (1974) likewise followed the von Bertalannfy formula for scup from Narragansett Bay and combined both sexes and found:

$$L_t=323.75\ \{1-e[-0.3365(t_n - 0.3119\}\ (L_t=\text{mm}).$$

Howell and Simpson (1985) also used the von Bertalannfy formula for scup from Long Island Sound and estimated the parameters at:

$$L_t=389.3\ \{1-e[-0.22(t_n + 0.35\}\ (L_t=\text{mm}).$$

The following length-weight relationships for scup have been measured by the following authors:

AUTHOR	EQUATION
Smith and Norcross (1968)	LOG W=3.0391 x LOG L - 4.7249
Briggs (1968)	LOG W=2.8491 x LOG L - 4.3944
Hammer (1970)	LOG W=2.72 x LOG L - 1.254
Howell and Simpson (1985)	LOG W=3.05 x LOG L -1.69

(W=wet weight in grams; L=fork length in cm).

FOOD AND FEEDING

Michelman (1988) performed field studies in Narragansett Bay, R.I., to determine the feeding periodicity and types of prey consumed by juvenile scup. She found scup to be daytime, therefore visual feeders and that the variation in prey type during a season indicated that this species is an opportunistic feeder. This agrees with the description given by Bigelow and Schroeder (1953) that scup feed on "whatever invertebrates the particular bottom over which they live may afford." Adult scup cease feeding during spawning time (Bigelow and Schroeder 1953; Morse 1978). Feeding and growth activity in scup is apparently at a minimum in the winter and at a maximum during the summer (Bigelow and Schroeder 1953; Morse 1978; Michelman 1988).

The stomach contents from 367 scup were examined (Table 2) for species composition (Bowman et al. 1987). These investigators found that scup 6-10 cm and 11-15 cm fed on substantial quantities of polychaetes (31% and 32%, respectively). Also, scup 6-10 cm fed on an assortment of amphipods (16%) and decapods (10%), along with lesser amounts of mysids (9%) and copepods (4%). Scup 11-15 cm fed on mollusks (18%) such as squid (12%), amphipods (6%) and decopods (2%).

In Narragansett Bay, R.I., Michelman (1988) found that polychaetes and crustacea together made up ≥ 50% of the scup diet by weight, and averaged 72% of the seasonal diet and 88% of the identifiable seasonal diet. Also, crustacea made up 41% and polychaetes accounted for 47% of the identifiable diet in the summer. Michelman (1988) calculated a consumption rate of 0.6-1.7 g dry wt/m^2. She then assumed the diet to consist of 50% polychaetes and 50% crustacea, this being equivalent to a consumption rate of 0.3-0.9 g dry wt/m^2 of each of these prey types in Narragansett Bay. Table 3 shows the stomach contents for juvenile scup, from Narragansett Bay expressed as % dry weight of the diet for each prey type (Michelman 1988). Estimates of the daily food ration for scup were found to be 3.49% dry weight/day using an exponential model and 3.99% dry weight/day using a linear model (Michelman 1988).

PREDATORS

Scup is preyed upon by piscivorous fishes throughout its range. Bluefish, weakfish and striped bass have been known to consume scup (Morse 1978) as were dusky shark, spiny dogfish and john dory (Maurer and Bowman 1975).

COMPETITORS

No information was available to the author at the time of this writing.

DISEASE/PARASITES

In conjunction with the marking studies conducted by Sisson (1974) an evaluation of tag retention and tag induced mortality was also undertaken. He found that fin rot and tail rot were evident on all fish as was infection at the point of tag insertion. It was determined that Vibrio sp. was present and the lesions were identified as ulcerative dermatitis, myosistitis, pancreatitis and proliferative hepatic lesions.

The parasitic Branchiura Argulus intectus has been found on scup by Yamaguti (1963; cited in Morse 1978).

RHODE ISLAND MINIMUM SIZE REGULATION

None

RECREATIONAL SCUP REGULATIONS IN RHODE ISLAND

None

Licenses:

Season:	Fee:
Non-Commercial	
(resident or non-resident)	None
Commercial Fishing	
Fish Traps * (must be out of water 01JAN-28,29FEB)	
License	$100.00
Plus $10.00/trap	$ 10.00
Gill Nets	$100.00
Rod and Reel includes diving	$100.00
Individual (without boat)	$100.00
Commercial Vessels (finfish only)	
Commercial residents vessels *	
Up to 50' LOA	$100.00
50' to 99' LOA	$125.00
over 99' LOA	$ 10.00/ft.
Multiple purpose (good for all above)	$150.00
Plus $10.00 for a gill net license	$10.00
Non-resident otter trawler	$ 5.00/ft.

* **RESIDENTS ONLY**

Expiration of licenses:
Commercial licenses expire annually on December 31. (Rhode Island General Law 20-2-14).

Obtaining licenses:
All marine licenses are issued by the licensing section of the Department of Environmental Management, 22 Hayes St., Providence, R.I. 02908. Tel. No. 401-277-3576.

Rhode Island Game Fish Award Program:
In July of 1988 the state record for scup was set by Frank Dyer of Enfield, CT. The official weight and length of this scup was 3 lbs. at 18-3/4 in.

MANAGEMENT OF THE SCUP FISHERY

Coastwide commercial scup landings have declined steadily since 1981; commercial landings declined 36% from 1988 to 1989. Landings in 1989 of 8.2 million pounds were about one-half the 1980-1989 average of approximately 16.2 million pounds. The recreational catch was also down, at 6.2 million pounds, relative to the ten year average of 6.9 million pounds. The commercial-recreational distribution in 1988 was 57% to 43%. The 1980-89 average was 70% commercial to 30% recreational.

The NEFC autumn offshore survey has been used as an index for scup (USDC 1989). The mean weight(kg) per tow for age 1 + fish has ranged from 0.09 (1970) to 4.64 (1989) over the past 23 years. The 1989 index is nearly 20% larger than the former highest index (3.91 in 1975). The 1989 index is also more than three times as large as the 23 year mean (1.42).

The indices for 1988 and 1987 are the second and third lowest of the time series. The NEFC did not provide variability estimates with the indices, but unquestionably the 1989 number is significantly different from prior estimates. However, the numbers should be interpreted with caution as the estimates are arithmetic means and as a result high catches in only one of the sampling areas could significantly affect the estimates.

FISHING MORTALITY RATE REDUCTION STRATEGIES

The Mid Atlantic Fishery Management Council has agreed that scup are over exploited. The Council has also agreed fishing in excess of the F_{max} level defines overfishing for scup. Best available information indicates that F_{max} is 0.35 for scup (Mayo 1982).

It is, therefore, necessary to adopt a strategy consistent with 602.11(c)(6)(iii), which is the Mid Atlantic Fishery Management Councils definition as overfishing for this species that will reduce mortality to F_{max}. Three alternative strategies have been evaluated.

Several factors should be considered when choosing appropriate mortality reduction strategies. In regard to scup, analyses indicate that the stock has only experienced high fishing mortality rates during the last 10 years. In addition, preliminary Stock Recruitment (S/R) data (Howell pers.comm.) indicate that the stock has a greater compensatory reserve (Spawning Stock Biomass) than summer flounder. Combined, these two facts indicate that the probability of reaching a desired level of spawning biomass in 5 years could be high with strategy 1.

Management measures that would meet the first year fishing mortality rate reduction strategies for scup follow.

Scup	Strategy 1		Strategy 2		Strategy 3	
	COMM	REC	COMM	REC	COMM	REC
Quota (M lbs)	7.1	3.0	12.5	5.3	14.8	6.3
Mesh (in)	4.5		4.5		4.5	
Min Size (in)		9.0		9.0		8.0
Possession		30		No		No

It is recommended by the MAFMC that the acceptable strategy for scup management is as follows;

A commercial and recreational quota of 7.1 and 3.01 million pounds respectively, a minimum mesh size of 4.5" and a requirement that commercial fishermen land all of their catch, and a possession limit for recreational fishermen of thirty fish larger than 9" TL.

In addition the following management measures would apply to all strategies.

LIMIT ENTRY INTO THE SCUP FISHERY

Only vessels with documented landings of scup prior to or on 26 January 1990 would qualify for a permit under the limited entry program. Currently, scup are over exploited. The poor condition of other fishery resources in the northwest Atlantic, especially the groundfish stocks, suggest that fishermen will direct their effort to alternative species, including summer flounder, scup, and black sea bass. Limiting participation in the fishery for scup to those who have participated in the fishery in the past, will assure their continued participation in the fishery and increase the possibility that other management measures will improve the condition of the resources. Essentially, fishermen who have stayed in the fishery throughout the rebuilding period would benefit from the stock recovery, rather than having those benefits dissipated to new entrants into the fishery.

It is proposed that this measure apply to all party and charter boats, as well as to commercial vessels. These businessmen have the same dependence on the resources as do the commercial fishermen and should be able to benefit from the results of the rebuilding process.

PERMITS AND FEES

Any owner or operator of a vessel desiring to take any scup within the US EEZ, or transport or deliver for sale, any scup taken within the EEZ must obtain an annual permit for that purpose. This section does not apply to fishermen taking scup for their personal use, but it does apply to the owners of party and charter boats (vessels for hire).

The owner or operator of a US vessel may obtain the appropriate permit by furnishing on the form provided by NMFS information specifying, at least, the names and addresses of the vessel owner, the name of the vessel, official Coast Guard number, directed fishery or fisheries, gear type or types utilized to take summer flounder, gross tonnage of vessel, the permit number of any current or previous fishery permit issued to the vessel, radio call sign, length of the vessel, engine horsepower, year the vessel was built, type of construction, type of propulsion, navigational aids (e.g., Loran C), type of echo sounder, type of computer, crew size including captain, fish hold capacity (to the nearest 100 lbs), quantity of scup landed during the year prior to the one for which the permit is being applied, principal port of landing, the home port of the vessel, and number of passengers (for party and charter boats). The permit shall be subject to inspection by an authorized official upon landing.

Permits expire on 31 December of each year. Permits may be revoked for violations of this Fishery Management Plan (FMP).

SPECIFICATION AND SOURCES OF PERTINENT FISHERY DATA

General

The reporting requirements are intended so that the Council and NMFS may acquire accurate data on the scup catch, disposition of such catch, effort in the fishery, and importance of scup relative to other species. These data are necessary to manage the fishery for the maximum benefit of the United States. It is necessary that reporting be as comprehensive as possible. The following are designed to meet this need. If it is determined that the Secretary does not have the authority to mandate reporting of catches from the territorial sea, alternative methods of securing these data must be developed.

Processors and dealers

Processors shall provide at least the following information to the Regional Director on a weekly basis on forms supplied by the Regional Director: dates of purchases or receipt; name, permit number, and mailing address; pounds purchased or received, by species; name and permit number of the vessel from which scup are landed or received; price per pound, mailing address of dealer or processing plant; and size distribution, by species.

Dealers shall provide at least the following information to the Regional Director on a weekly basis on forms supplied by the Regional Director: dates of purchases or receipt; permit number and address; name and permit number of the vessel from which scup are landed or received; price per pound, by species; date of sale; and disposition of scup, including name and permit number of entity to whom the scup were sold and provide those reports to the Regional Director on the same frequency basis.

The processor shall make the report available for inspection by an authorized officer, or by an employee of the NMFS designated by the Regional Director to make such inspections, at any time.

For one year after the date of the last entry in the report, processors and dealers shall keep each report at the processor's or dealer's principal place of business.

Processors are also required to submit at least the following information to the Regional Director on an annual basis on forms supplied by the Regional Director: number of processing plant employees during each month of the year just ended; number of employees processing scup by month; total payroll for scup processing, by month; plant capacity to process scup; and projected capacity to process scup, for the following year.

If the capacities described in paragraph above change

more than ten percent during any year, the processor shall promptly notify the Regional Director of the change in capacity.

Violations of these requirements shall be subject to the penalties provided for in the MFCMA.

Owners and operators

The owner or operator of any vessel with a permit in the scup fishery shall maintain on a daily basis an accurate log for each fishing trip, on forms supplied by NMFS showing at least: name and permit number of the vessel; total amount in pounds of each species taken; date(s) caught; time at sea; duration of fishing time; locality fished; quantity of scup discarded; crew size; crew share by percentage; landing port; date sold; price per pound; and buyer. The owner or operator shall make the log available for inspection by an authorized official at any time during or after a trip. The owner or operator shall keep each logbook for one year after the date of the last entry in the log. The owner or operator shall submit copies of logbook forms weekly to the Regional Director.

The Regional Director shall revoke, modify or suspend the permit of a vessel whose owner or operator falsifies or fails to submit the records and reports prescribed by this section.

Source: MAFMC-Amendment #1, 20JULY1990.

ACKNOWLEDGEMENTS

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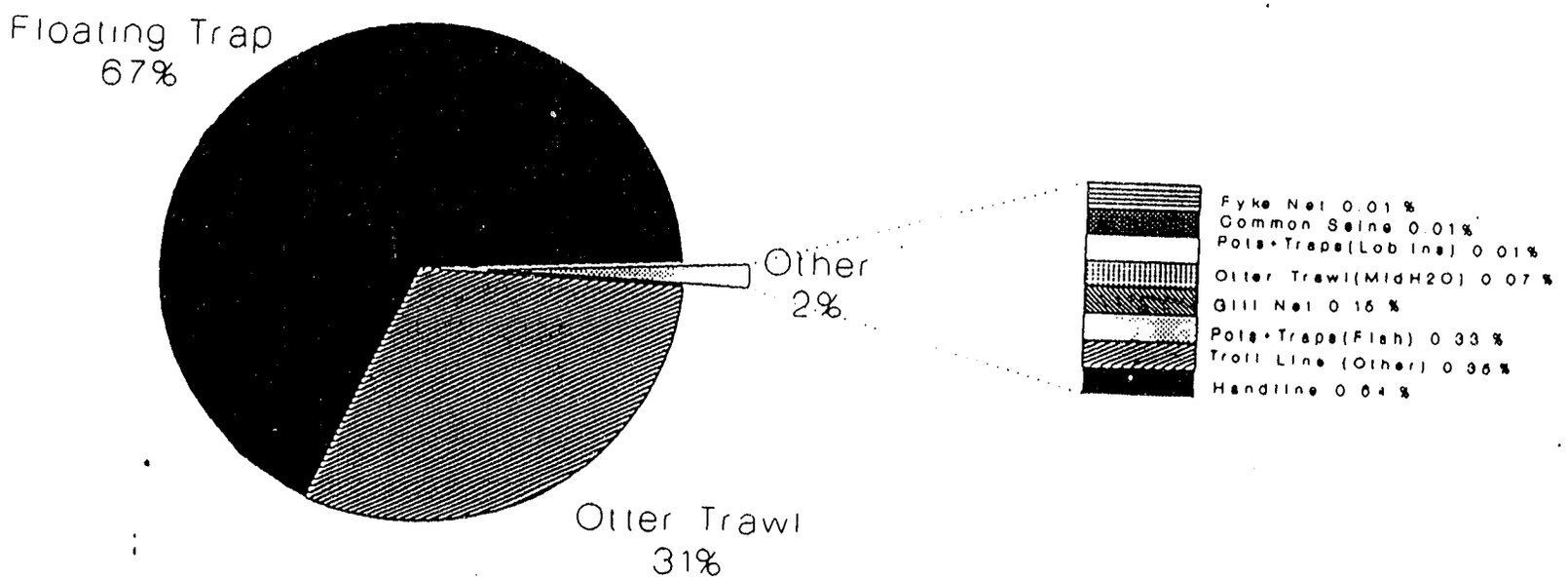
FIGURE 1
R.I. Scup Landings by Gear Type
Zone 1
1979-1989

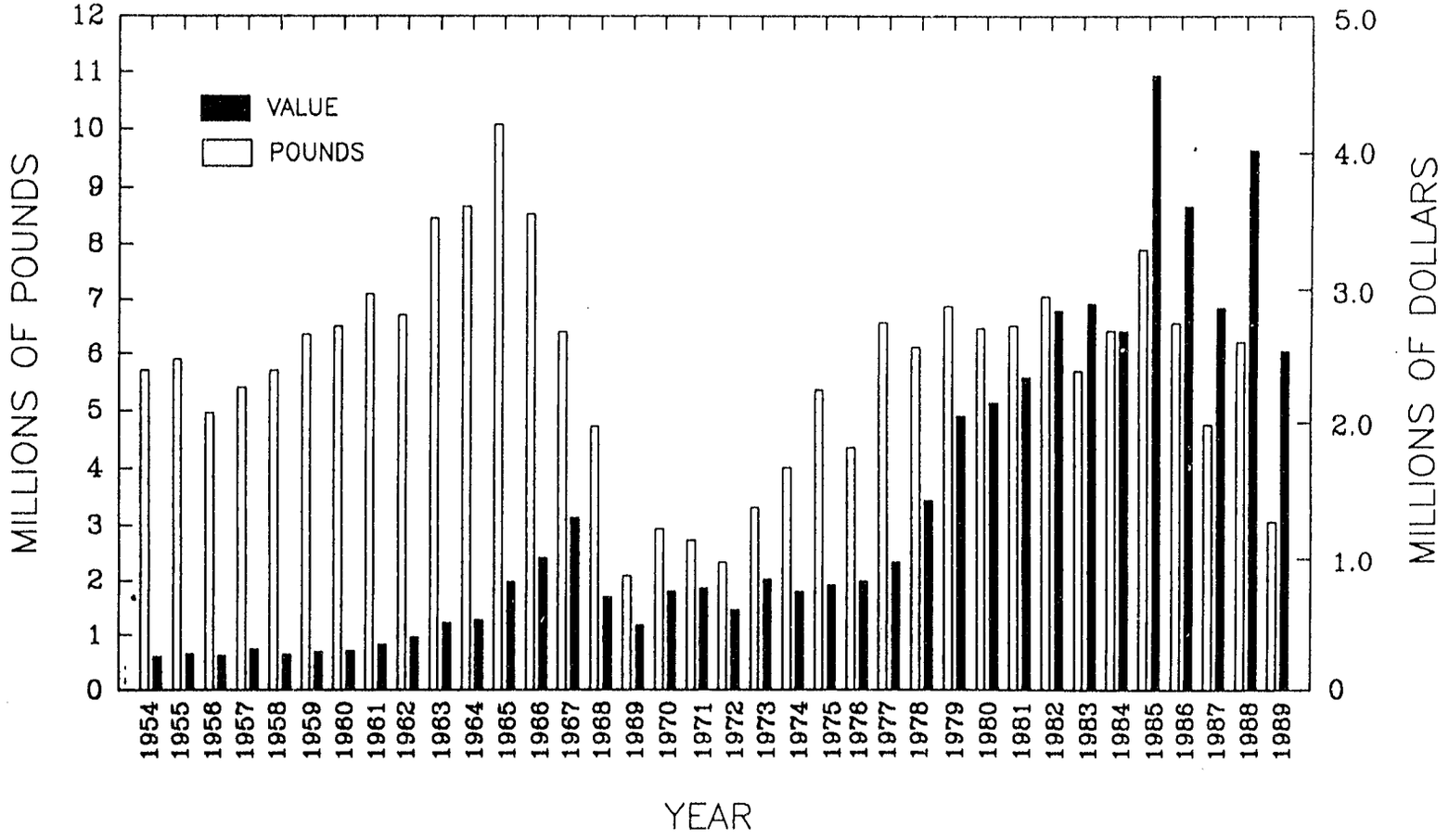


Data Source: NMFS Statistics Section

FIGURE 2

RHODE ISLAND COMMERCIAL LANDINGS

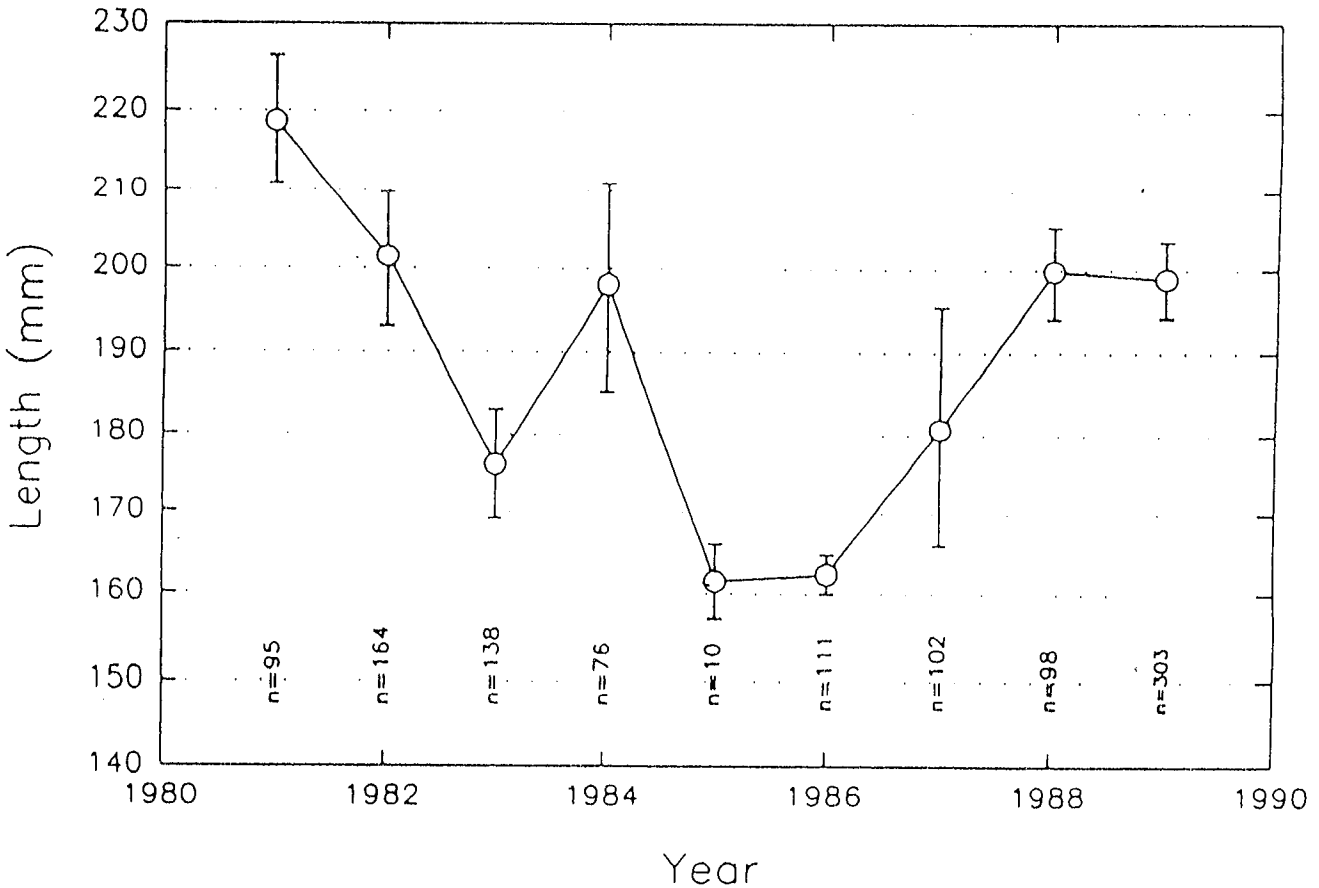
SCUP



Data Source: National Marine Fisheries Service

FIGURE 3
SCUP AVERAGE LENGTH

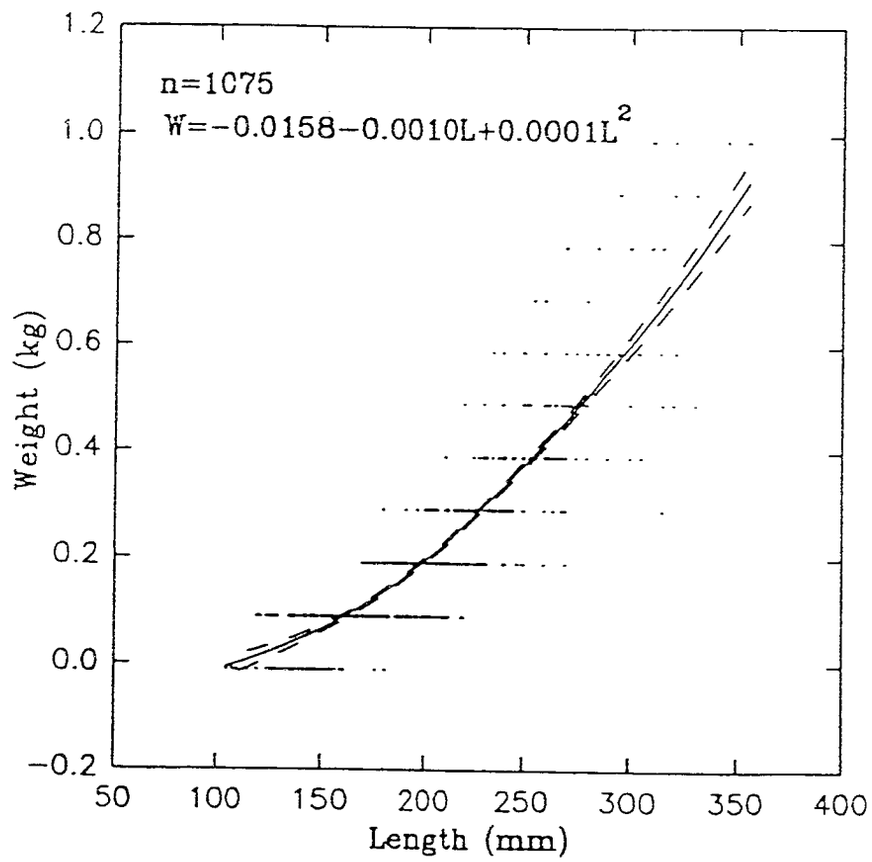
RHODE ISLAND RECREATIONAL FISHERY



Yearly average length for scup from data obtained by Rhode Island Marine Recreational Fishery Statistics Survey, 1981-1989. Error bars indicate 95% confidence intervals.

FIGURE 4

LENGTH/WEIGHT RELATIONSHIP
RHODE ISLAND RECREATIONAL FISHERY
SCUP, 1981–1989

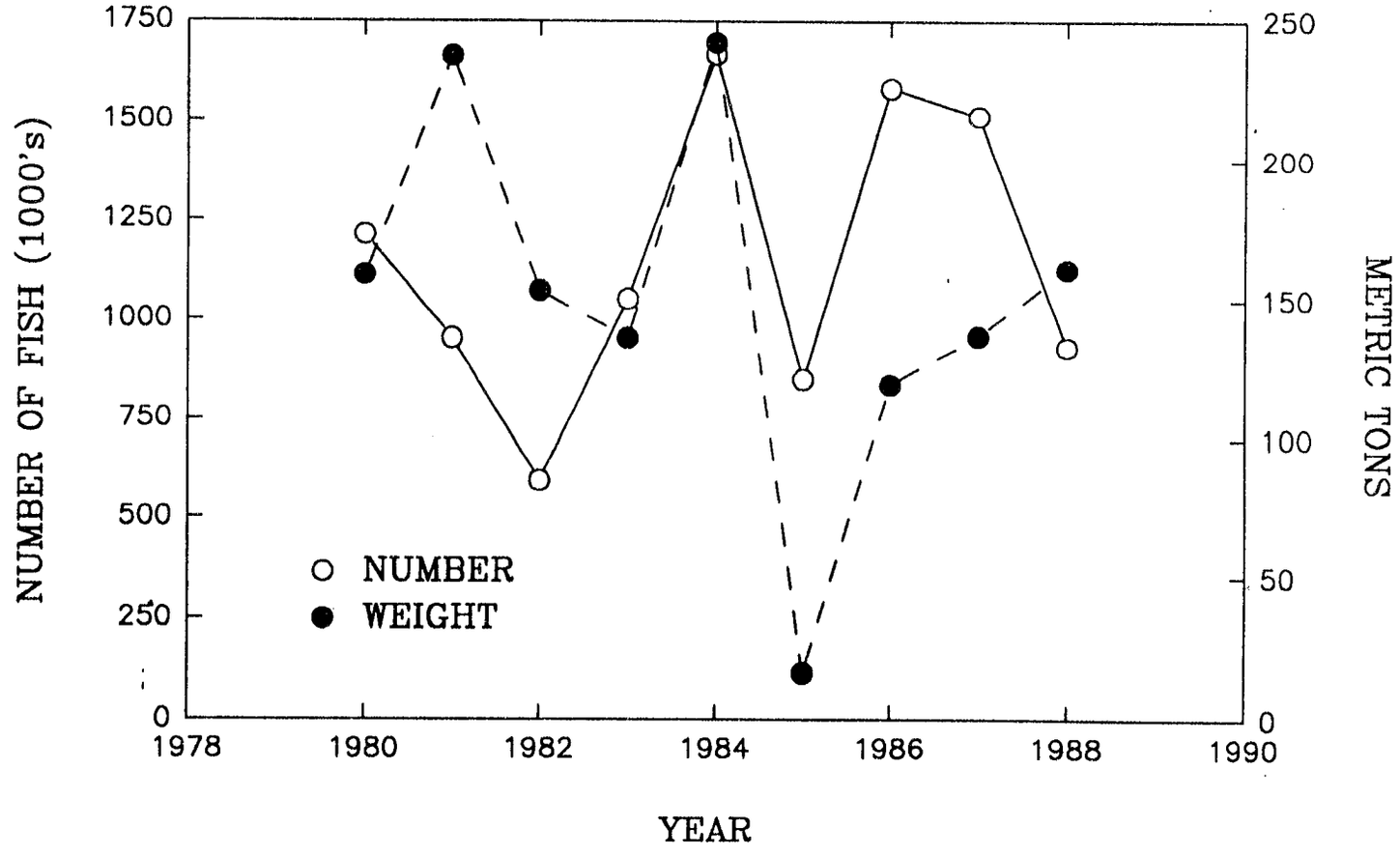


Length/weight relationship for scup from data obtained by Rhode Island Marine Recreational Fishery Statistics Survey, 1981-1989. Second order regression (solid line) calculated as $W=-0.0158-0.0010L+0.00001L^2$ (R=0.88) with 95% confidence interval (dashed lines).

FIGURE 5

RHODE ISLAND MRFSS

TOTAL HARVEST OF SCUP BY RECREATIONAL FISHERY
1980–1988



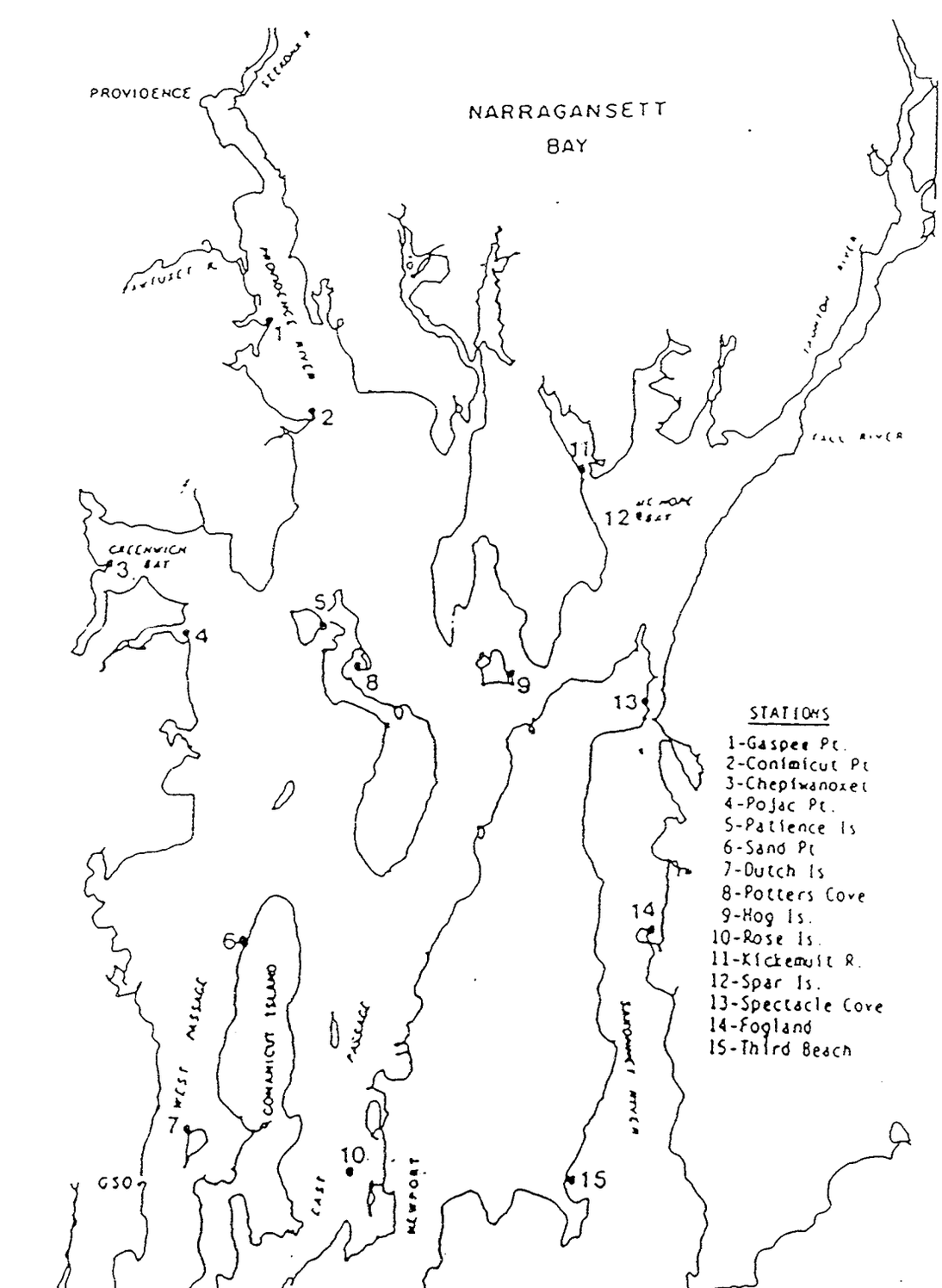
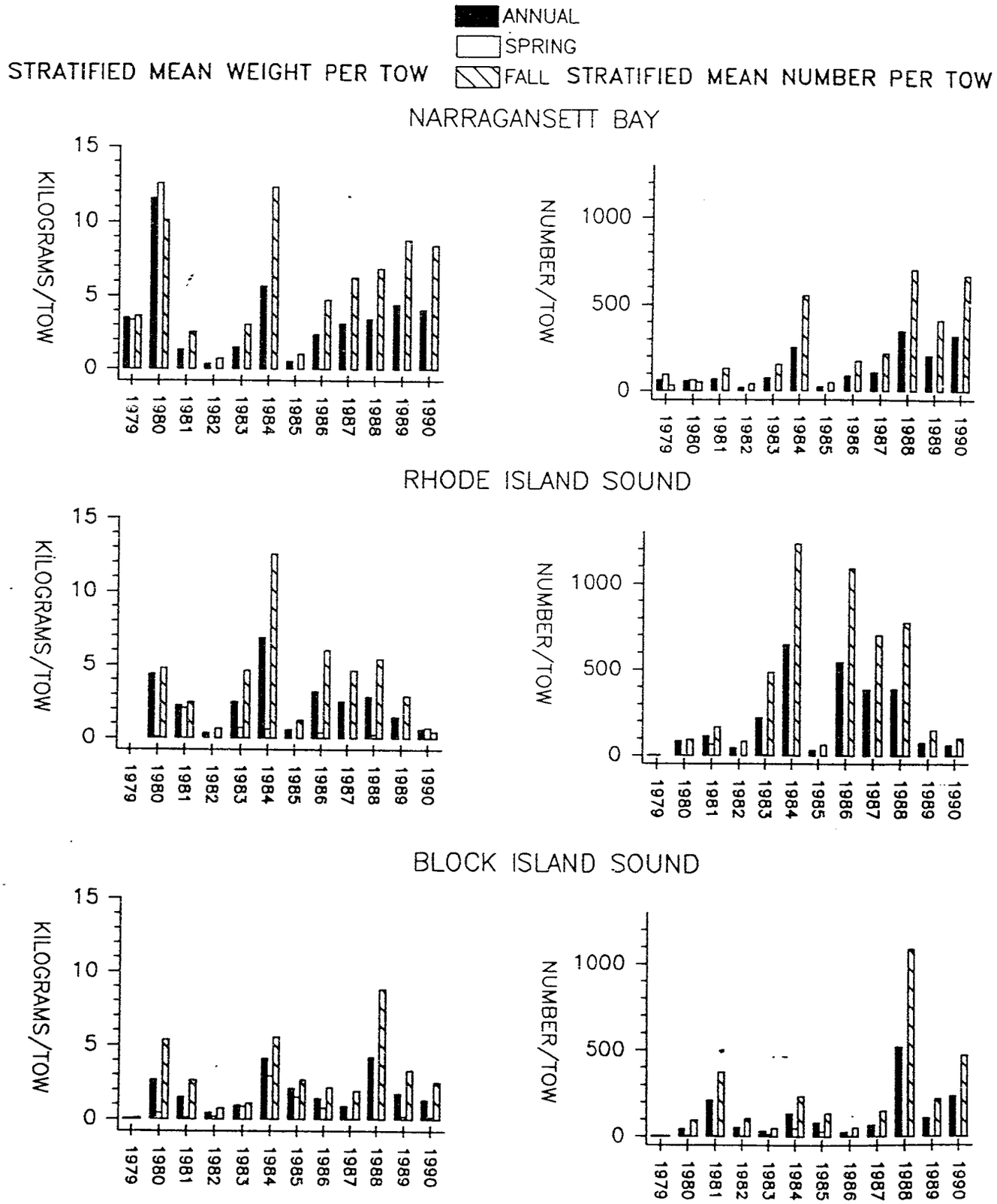


FIGURE 6. Juvenile finfish survey stations.

Source Powell 1986

FIGURE 7

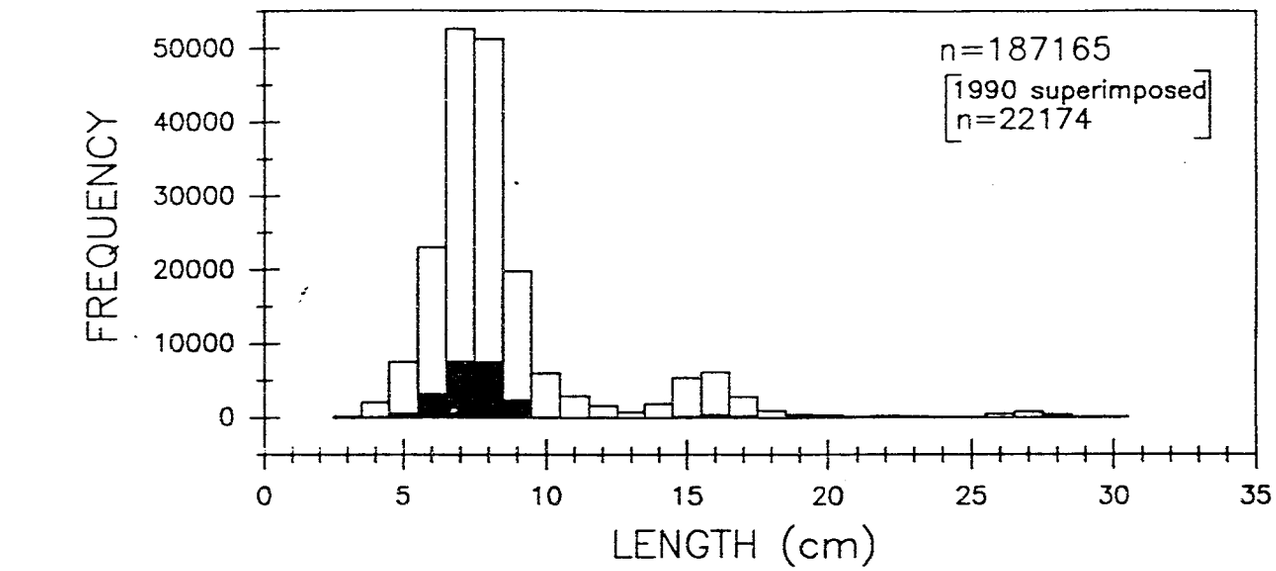
SCUP MEAN NUMBER AND WEIGHT PER TOW

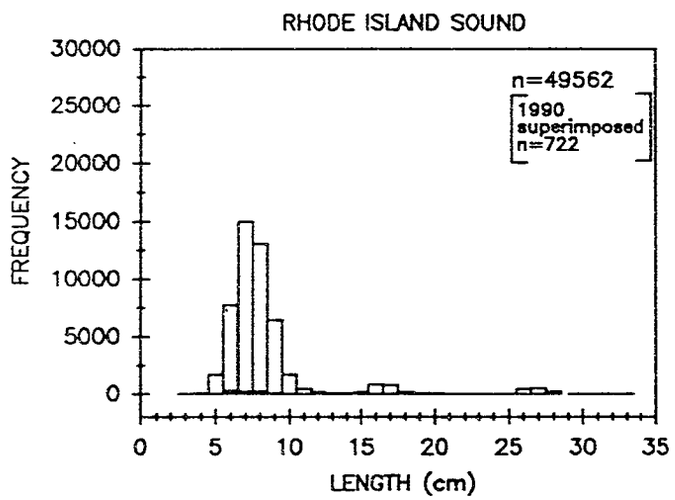


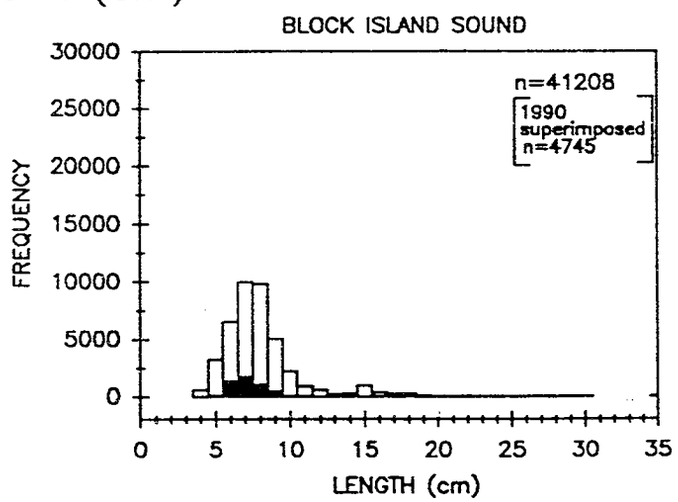
(Data Source: Rhode Island Coastal Fishery Assessment (Trawl Survey))

FIGURE 8

SCUP LENGTH FREQUENCY
R. I. COASTAL FISHERY ASSESSMENT (TRAWL SURVEY)
1979–1990







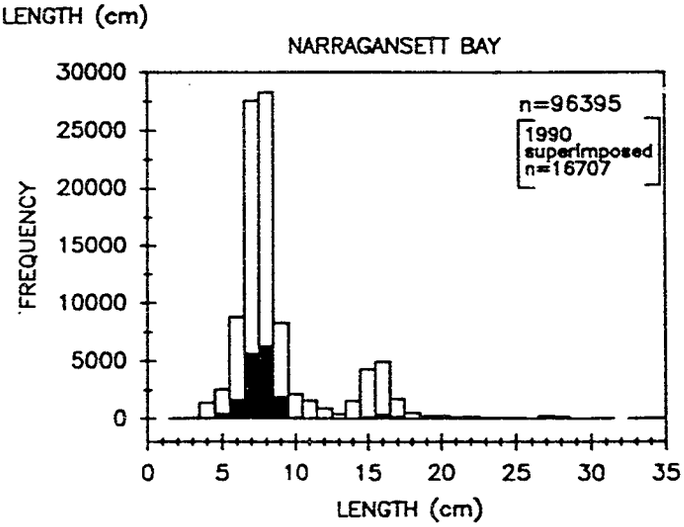
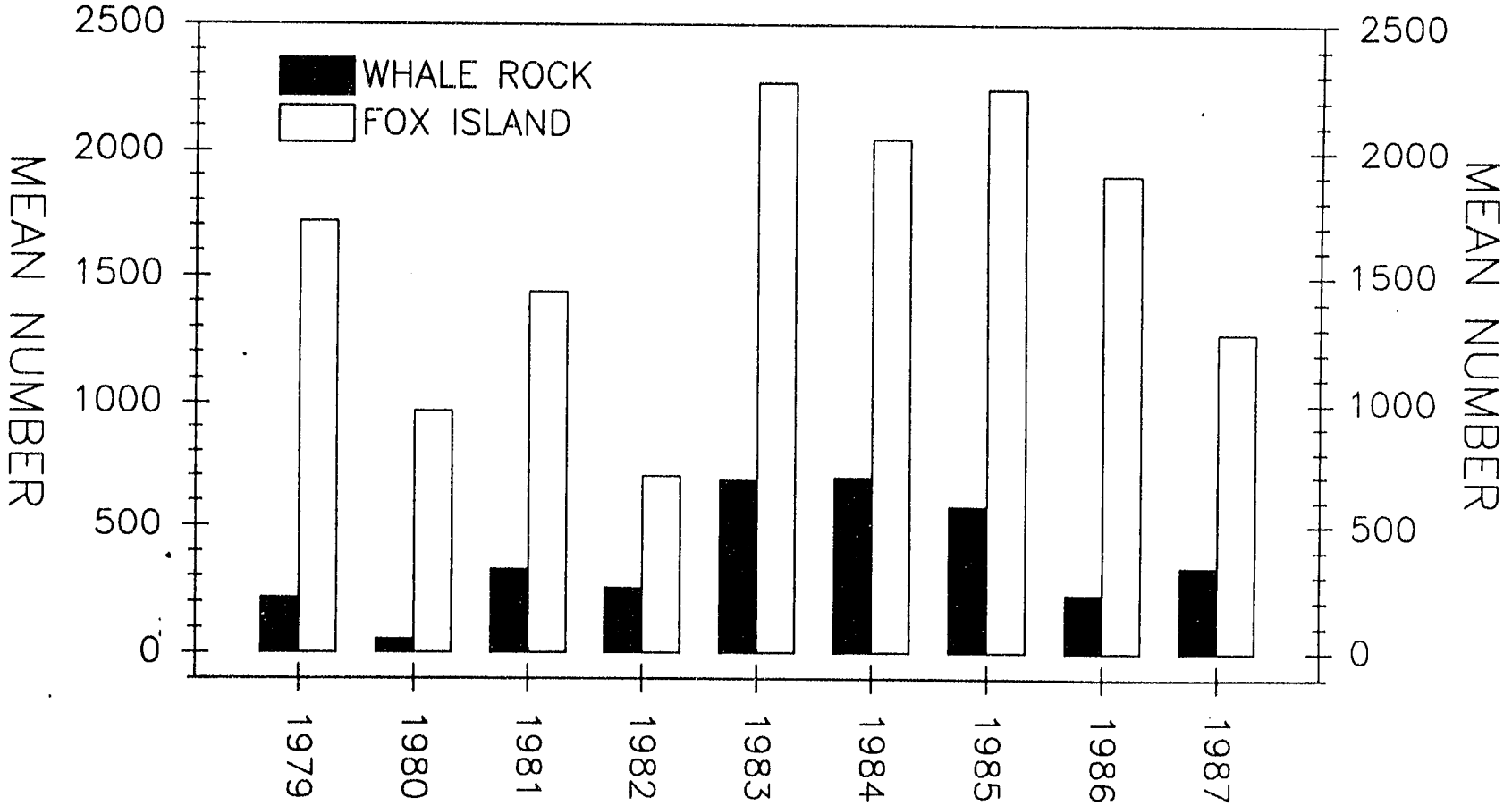


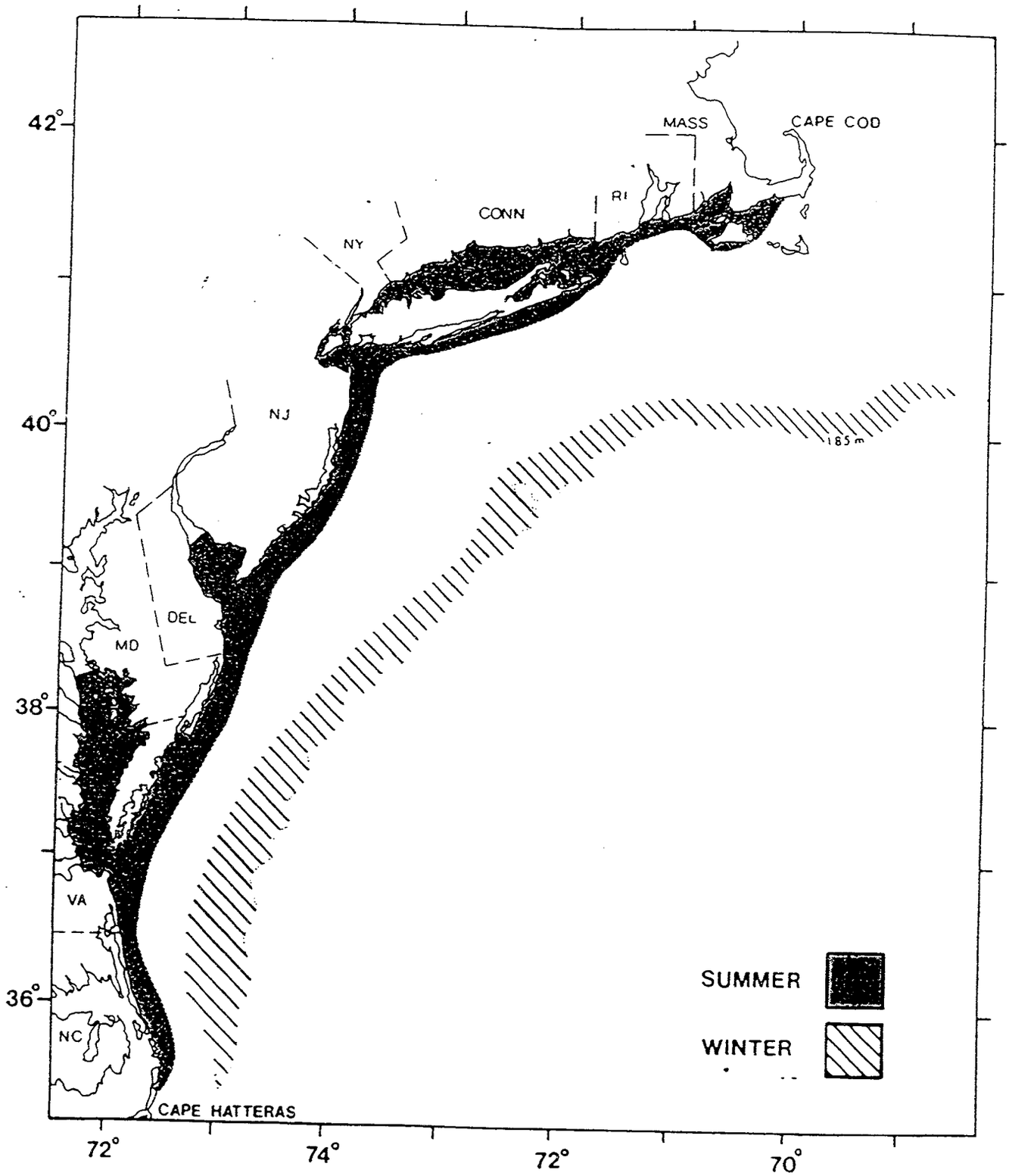
FIGURE 9

WHALE ROCK, RIS AND FOX ISLAND, NARR. BAY
SCUP ANNUAL SUM MEAN MONTHLY CATCH
1979–1987



(Data Source: Jeffries et al. 1988)

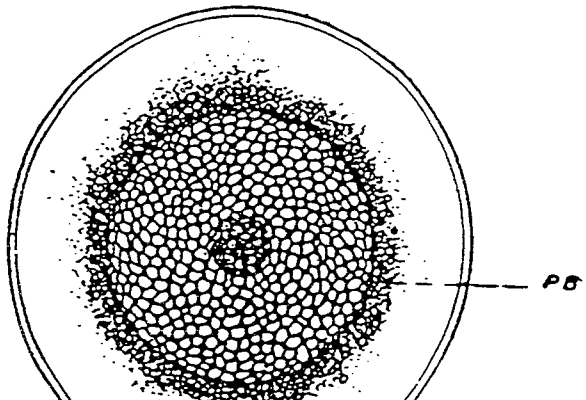
FIGURE 10



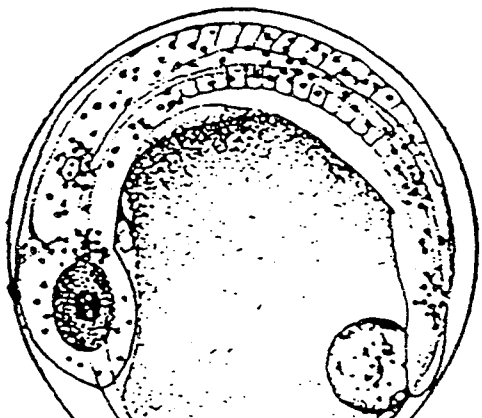
Summer and winter distribution of scup, Stenotomus chrysops, along the Middle Atlantic and New England coasts.

Source: Morse 1978.

FIGURE 11



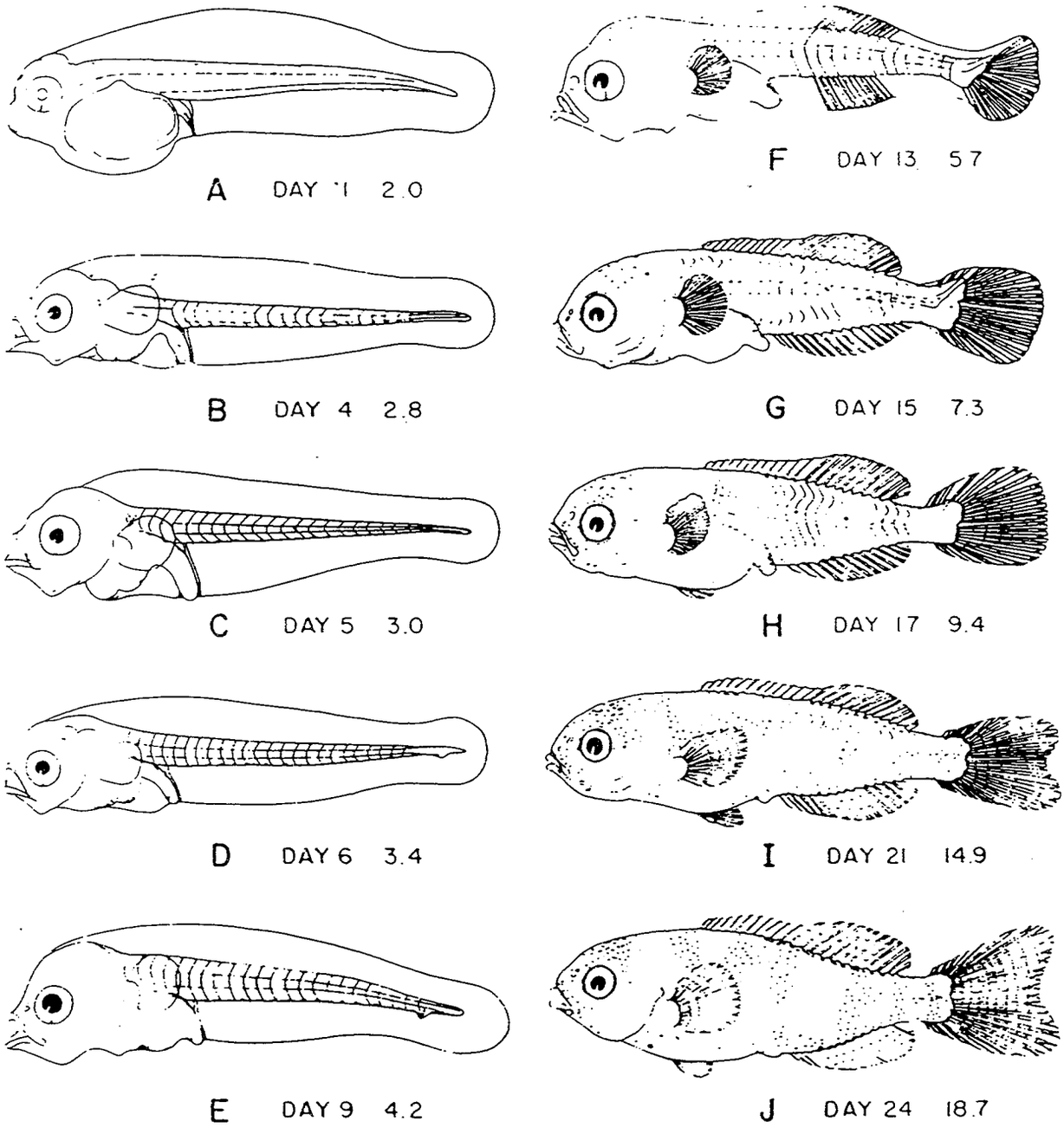
Egg with blastoderm in advanced stage of cleavage, periblast (PB) differentiated.



Egg showing advanced embryo.

Source: Kuntz and Radcliffe 1917.

FIGURE 12



-Development of *Stenotomus chrysops*. Lengths (SL) are in millimeters.

Source: Griswold and McKenney 1984.

Scup

Southern New England - Mid-Atlantic

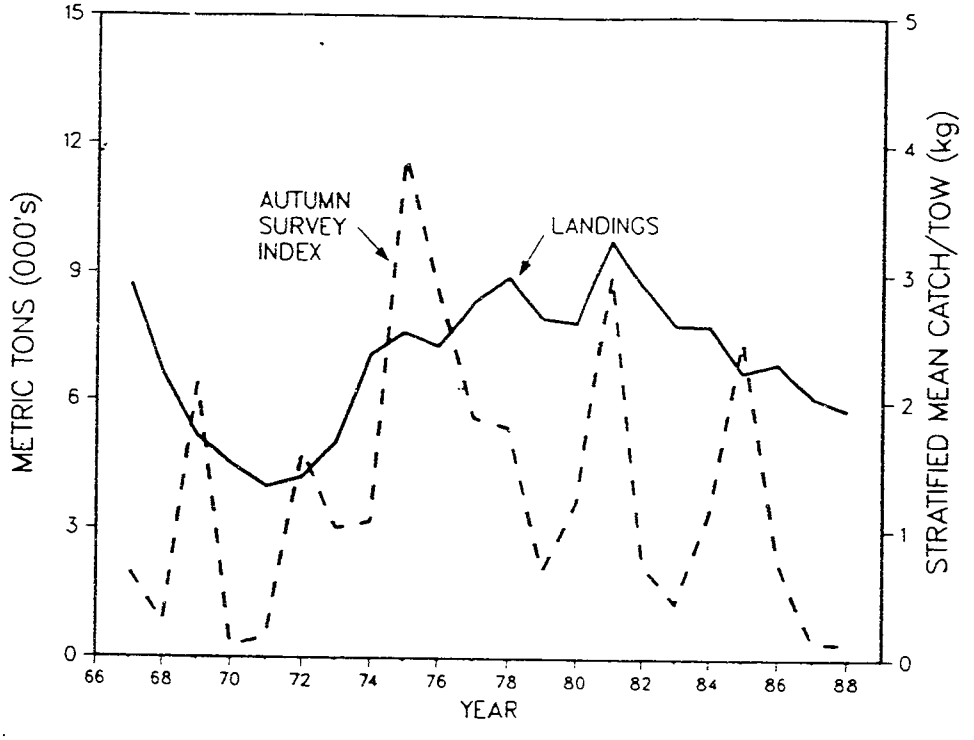


TABLE 1. Recreational catches and commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	3.9	2.0	3.1	3.4	1.4	3.3	5.9	3.2	2.3[1]
Commercial									
USA	7.9	9.8	8.7	7.8	7.8	6.7	6.9	6.1	5.8
Canada	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	-	-
Total nominal catch	11.8	11.8	11.8	11.2	9.2	10.0	12.8	9.3	8.1[1]

[1] **Preliminary**

(USDC 1989)

TABLE 2. Annual means of number per tow and weight per tow (kg) by location for scup 1979-1989.

	x/T	kg/T
Narragansett Bay	115.5	3.24
Rhode Island Sound	256.8	2.56
Block Island Sound	108.3	1.85
State	136.8	2.76

Source: Lynch and Karlsson in press; 1989.

TABLE 3. Composition of the stomach contents of juvenile scup, *S. notomus chrysops*, expressed as a percentage of the total stomach contents weight versus fish length for samples collected in the northwest Atlantic for the year 1973-1976.

STOMACH CONTENTS	LENGTH CATEGORY (cm) 6-10	11-15
NEMERTEA	[0.5]	[0.1]
NEMATODA	[-]	[0.3]
POLYCHAETA	[31.1]	[32.0]
Spiophanes bombyx	0.7	-
Spionidae	0.4	-
Cirratulidae	-	0.6
Flabelligeridae	-	0.6
Maldanidae	1.2	2.0
Ammotrypane sp.	0.8	0.1
Travisia sp.	1.7	-
Ophelliidae	-	<0.1
Oweniidae	3.2	-
Ampharetidae	1.2	2.3
Terebellidae	-	<0.1
Sabellidae	4.8	-
Glyceridae	1.2	0.4
Lumbrineridae	1.6	4.1
Nephtyidae	5.7	0.7
Onuphidae	-	0.7
Phyllodocidae	3.9	<0.1
Polynoidae	0.3	0.5
Sigalionidae	3.5	6.6
Polychaeta tubes	0.4	0.3
Other Polychaeta	9.5	13.1
SIPUNCULIDA	[0.5]	[-]
CRUSTACEA	[44.4]	[11.7]
Amphipoda	(15.6)	(6.4)
Ampelisca agassizi	-	0.2
Byblis serrata	0.4	1.0
Ampeliscidae	0.6	0.3
Caprellidae	1.2	1.3
Ericthonius rubricornis	0.2	0.1
Ericthonius sp.	0.2	-
Unciola irrorata	3.6	1.2
Gammarus sp.	2.2	-
Gammaridae	3.6	1.0
Hyperiidae	0.2	<0.1
Leptocheirus pinguis	3.4	1.3
Other Amphipoda	<0.1	-
Decapoda	(9.8)	(2.1)
Cancer irroratus	6.8	-
Crangon septemspinosa	0.8	0.3
Pagurus acadianus	-	0.1
Pagurus sp.	1.1	1.4
Paguridae	0.2	0.1
Unidentified crabs	0.6	0.2
Unidentified shrimps	0.3	-
Isopoda	(0.1)	(0.3)
Cirolana sp.	0.1	0.3
Cumacea	(<0.1)	(-)
Euphausiacea	(0.6)	(-)
Meganyctiphanes norvegica	0.6	-
Mysidacea	(9.4)	(0.3)
Neomysis americana	8.0	0.2
Other Mysidacea	1.4	0.1
Copepoda	(3.8)	(<0.1)
Calanoid Copepoda	0.7	-
Other Copepoda	3.1	<0.1
Other Crustacea	(5.1)	(2.6)
MOLLUSCA	[0.1]	[17.9]
Bivalvia	(0.1)	(0.4)
Acoela	(-)	(2.9)
Cephalopoda	(-)	(12.4)
Decapoda squid	-	0.9
Other Cephalopoda	-	11.5
Other Mollusca	(-)	(2.2)
CHAETOGNATHA	[-]	[0.1]
ECHINODERMATA	[-]	[0.9]
Echinoidea	(-)	(<0.1)
Aceste sp.	-	<0.1
Other Echinodermata	(-)	(0.9)
PISCES	[-]	[0.3]
Osteichthyes	(-)	(<0.1)
Osteichthyes eggs	-	<0.1
Other Pisces	(-)	(0.3)
ANIMAL REMAINS	[23.4]	[36.6]
SAND	[-]	[0.1]
Number of fish examined	154	213
Number of empty stomachs	52	84
Mean stomach content weight (g)	0.043	0.131
Mean fish FL (cm)	8	12
Mean fish weight (g)	10.2	36.9
% BW of stomach contents	0.42	0.36

Source Bowman et al. 1987.

TABLE 4. Stomach contents of juvenile scup, *Stenotomus chrysops*, from Narragansett Bay, RI. Results are expressed as % dry weight of the diet for each prey type. (*) indicates that this prey was present, but that the dry weight was less than the detection limit of 0.01 g.

DATE	6/23/87	6/30/87	7/15/87	7/28/87	8/12/87	8/25/87
N	31	5	5	10	5	10
N EMPTY	2	0	0	0	0	0
	% DRY WT	% DRY WT	% DRY WT	% DRY WT	% DRY WT	% DRY WT
POLYCHAETES	45.8	49.9	14.3	42.9	50.1	19.2
Maldanidae	2.8	8.3	14.3	14.3	31.3	7.7
Pherusa affinis	5.7	8.3	0.0	0.0	6.3	11.5
Nereis sp	5.7	0.0	0.0	14.3	0.0	0.0
Nepthys sp	23.0	33.3	0.0	0.0	0.0	0.0
Unidentified remains	8.6	*	*	14.3	12.5	*
CRUSTACEA	28.4	33.4	71.5	42.9	18.9	34.6
Leptochirus sp	2.8	0.0	0.0	*	0.0	0.0
Neomysis americana	2.8	16.7	28.6	*	6.3	7.7
Hermit crab	0.0	0.0	0.0	0.0	0.0	17.4
Brachyuran crab	*	0.0	14.3	14.3	0.0	0.0
Amphipods	2.8	*	*	0.0	6.3	*
Unidentified remains	20.0	16.7	28.6	28.6	6.3	11.5
MOLLUSKS	2.8	0.0	0.0	7.1	*	3.8
COELENTERATES	0.0	0.0	0.0	0.0	0.0	7.7
Cerianthiopsis sp	0.0	0.0	0.0	0.0	0.0	7.7
FISH	0.0	0.0	0.0	0.0	6.3	19.2
eggs	*	*	0.0	0.0	0.0	0.0
larvae	0.0	0.0	0.0	0.0	6.3	19.2
UNIDENTIFIED	21.0	16.7	14.3	7.1	25.0	15.4

	N	66
	N EMPTY	2
	SEASON TOTAL WT (G)	SEASON TOTAL % DRY WT
POLYCHAETES	0.42	38.2
Maldanidae	0.12	10.9
Pherusa affinis	0.07	6.4
Nereis sp	0.04	3.6
Nepthys sp	0.12	10.9
Unidentified remains	0.07	6.4
CRUSTACEA	0.37	33.6
Leptochirus sp	0.01	0.9
Neomysis americana	0.08	7.3
Hermit crab	0.04	3.6
Brachyuran crab	0.03	2.7
Amphipods	0.02	1.8
Unidentified remains	0.19	17.3
MOLLUSKS	0.03	2.7
COELENTERATES	0.02	1.8
Cerianthiopsis sp	0.02	1.8
FISH	0.06	5.5
eggs	0.00	0.0
larvae	0.06	5.5
UNIDENTIFIED	0.20	18.2

Source: Michelman 1988.