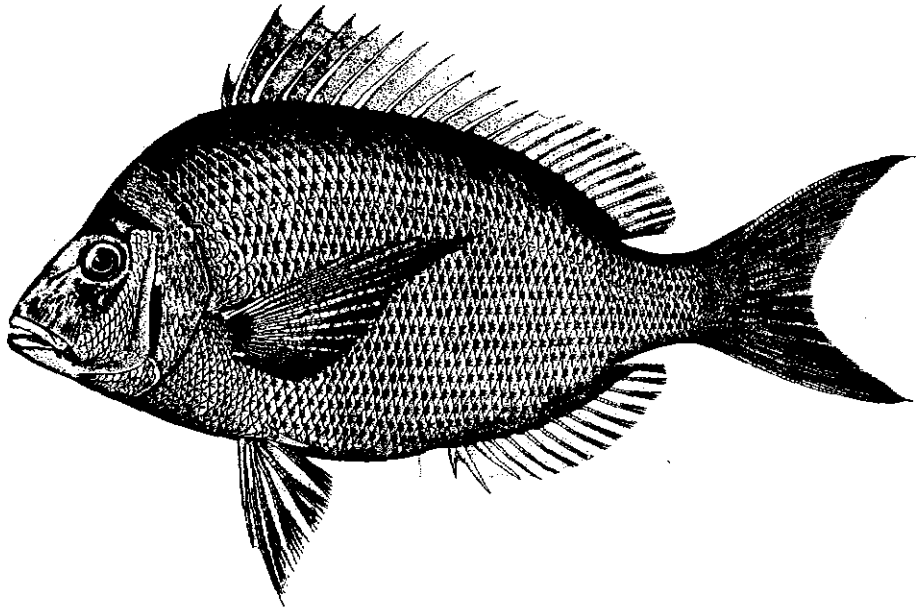

BIOLOGICAL & FISHERIES DATA

ON

SCUP, *Stenotomus chrysops* (Linnaeus)

JANUARY 1978

Biological and Fisheries Data

on

scup, *Stenotomus chrysops* (Linnaeus)

by

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Highlands, N. J.

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FIGURES

TABLES

1. IDENTITY

1.1 Nomenclature

1.1.1 Valid Name

Stenotomus chrysops (Linnaeus) 1766.

1.1.2 Subjective Synonymy

Sparus chrysops L., 1766
Sparus argyrops L., 1766
Sparus zanthurus Lacepede, 1803
Labrus versicolor Mitchell, 1815
Pagrus argyrops Cuv. and Val., 1830
Sargus arenosus DeKay, 1842
Sargus ambassis Gunther, 1859
Stenotomus chrysops Jordan and Gilbert, 1883

1.2 Taxonomy

1.2.1 Affinities

Suprageneric -

Phylum: Vertebrata
Subphylum: Craniata
Superclass: Gnathostomata
Series: Pisces
Class: Osteichthyes
Order: Perciformes
Family: Sparidae

Generic -

Stenotomus Gill, 1865

The generic description given here is that of Jordan and Evermann (1896):

"This genus is close to *Calamus*, having the same quill-like interhaemal bones, the flattened incisors and antrorose dorsal spine mainly distinguishing it; tempora; crest obsolete; frontal bones not gibbous nor porous; antrorose spine attached to the fourth interneural by a downward-projecting spine about thrice as long as the spine; lateral crest nowhere coalescing with the supraoccipital crest; interorbital area flattish, with two low ridges, a small foramen in each of these above front of pupil;

interorbital area much contracted anteriorly; a strongly projecting prefrontal process, which make an acute angle with the supraorbital."

In Latin Stenotomus means narrow (steno) and cutting (tomus).

Specific -

Stenotomus chrysops (Linnaeus)

This specific description is that of Jordan and Evermann (1896):

"Head 3-1/2; depth 2-1/10 D. XII, 12; A. III, 11; scales 8-50-16; snout short, 2-1/2 in head; eye small, narrower than the preorbital, 4 to 4-1/4 in head; fourth dorsal spine 2, third anal spine the longest, 3. Body ovate-eliptical, the depth about the same from the first dorsal spine to the eleventh; anterior profile steep, nape convex, a strong depression above and in front of eye, straightish over snout; pectoral less than head, about 3-1/2 in body, extending to first anal spine; a scaly sheath very conspicuous at base of soft dorsal and anal fins; temporal crest obsolete; supraoccipital crest continuous with the frontal bones; incisor teeth very narrow, almost conical in appearance; molars in 2 rows above; gill rakers small, about 6 + 10; top of head, snout, orbitals, and chin naked; scales on cheek extending from upper margin of eye, the anterior row composed of from 15 to 20 scales; caudal fin forked, the middle ray about 2-1/3 in longest ray. Color brownish, somewhat silvery below, everywhere with bright reflections, but without distinct marking in the adult; soft parts of vertical fins mottled with dark in adult; young faintly barred; axil dusky. Length about a foot."

1.2.2 Taxonomic Status

Morpho-species.

1.2.3 Subspecies

None

1.2.4 Standard Common Names, Vernacular Names

Scup is the common name given by the American Fisheries Society (Bailey et al., 1970). Vernacular names include porgy, porgee, scuppaug, mishcup, maiden, fairmaid and ironside.

1.3 Morphology

1.3.1 External Morphology

The external morphology is described in section 1.2.1 and seen in Figure 1.

Miller and Jorgensen (1973) examined meristic characters from x-rayed specimens. Four specimens were examined with a size range of 107-144 mm (SL). Counts are as follows:

Vertebra			Dorsal Fin	
Precaudal	Caudal	Total	Spines	Rays
10	14	24	12	12

Anal Fin	
Spines	Rays
3	11

Caudal Fin			
Dorsal Secondary Rays	Dorsal Primary Rays	Ventral Primary Rays	Total
9-10	9	8	34-37

In addition, Hamer (1970) made the following meristic counts of fish collected from Quisset, Massachusetts, Sandy Hook, New Jersey, Hudson Canyon, and Cape May, New Jersey:

Lateral line scales.....46-55
Ventral scales below lateral line...12-19
Total gill rakers first arch.....12-20
Dorsal scales above lateral line.....5-10
Pectoral fin rays.....15-17

1.3.2 Cytomorphology

The subjective and objective classification of the acidophilic granulocytes of the red blood cells of scup was made by Kindred (1971) as an auxiliary tool in taxonomic classification. He found scup red blood cells contained acidophilic materials and basophilic matrix and the distribution of the transmission of monochromatic red light by the acidophilic areas of

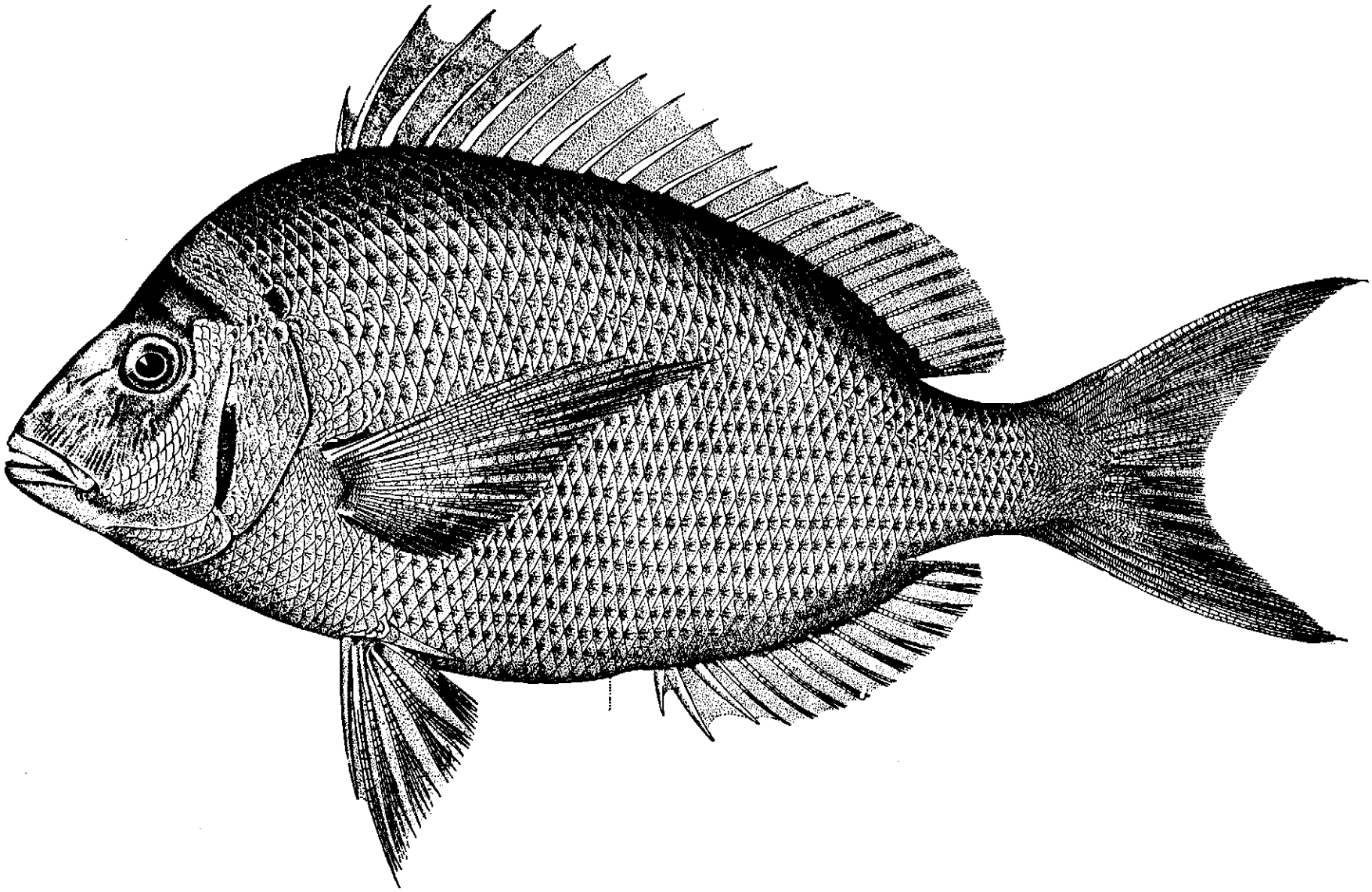

Figure 1. Scup, Stenotomus chrysops (drawing by H. L. Todd, 1884).

photomicrographs in foot candles per 1.0 mm^2 was above and below that of his control, human red blood cells. Transmission values were about 0.03 and 0.32 foot candles per mm^2.

2. DISTRIBUTION

2.1 Total Area

The scup is a continental shelf species of the north-west Atlantic (ANW) occurring regularly from Cape Hatteras, North Carolina to just north of Cape Cod, Massachusetts. Bigelow and Schroeder (1953) report sporadic occurrences north to Cape Ann, Massachusetts since 1835 but never in commercial quantities. Briggs (1958) gives a range for Stenotomus chrysops as Nova Scotia to Florida but does not mention S. aculeatus which replaces scup south of Cape Hatteras, North Carolina (Breder, 1948; Bigelow and Schroeder, 1953; Hildebrand and Schroeder, 1928). During warm months both young and adults are found in tidal bays and sounds and, in the ocean, they are generally found within the 20 fathom contour. Winter distribution is the offshore region from about Cape May, New Jersey to Cape Hatteras to 100 fathoms (Neville and Talbot, 1964; Pearson, 1932).

2.2 Differential Distribution

2.2.1 Spawn, Larvae and Juveniles

Scup spawn in nearshore ocean waters and in Long Island, New York bays from May to August (Kuntz and Radcliffe, 1917; Perlmutter, 1939; Bigelow and Schroeder, 1953; Wheatland, 1956; Herman, 1958). Juveniles and subadults were common in Delaware Bay during 1960 though none were found in the shore zone (deSylva et al., 1962). From a study conducted during 1954 and 1955, Richards (1959) concluded that scup spawn only in the eastern half of Long Island Sound. Pearcy and Richards (1962) collected a few larvae and juveniles at the mouth of the Mystic River, Connecticut during July and August. Merriman and Sclar (1952) found no eggs and only one larva during their survey of Block Island Sound. Juveniles tend to be found in shallower waters within bays and estuaries (Anonymous, 1962) and scup will tend to inhabit the more saline areas of estuaries (Kendall, 1973).

Eggs are buoyant and larvae are pelagic. Scup probably end pelagic stage at about 15 to 30 mm and become bottom dwelling (Lux and Nichy, 1971).

2.2.2 Adults

Extensive seasonal migrations are undertaken from the inshore summer grounds to the offshore winter grounds. They arrive inshore during April off Chesapeake Bay (Hildebrand and Schroeder, 1928) and off southern New England by early May (Baird, 1873; Perlmutter, 1939; Neville and Talbot, 1964; Finkelstein, 1971). There is some evidence that large fish arrive inshore first followed by smaller fish in three waves or runs. Baird (1873) reports three runs: first from April to May and fish of 1-1/2 to 4 pounds, second ten days later of one pound fish, third about ten days later and are yearling fish (4 to 6 inches). Similar reports are made by Hildebrand and Schroeder (1928) for Chesapeake Bay, Neville and Talbot (1964) for the Rhode Island pound net fishery and Sisson (1974) for Narragansett Bay, Rhode Island.

During summer residence fish about four years and older tend to stay in the ocean or near the mouth of larger bays and younger fish enter the shallow areas of bays.

The winter distribution following the southern and eastern autumn migration is usually between 40 and 100 fathoms off southern New Jersey to Cape Hatteras.

Evidence from tagging studies (Hamer, 1970) indicates the winter distribution of scup from southern New England is generally north of the area favored by scup that summer in the New Jersey area. Though some mixing occurs on the winter grounds, differentiation of stocks is still evident. The autumn migration is along shore within the ten fathom isobath followed by an offshore migration (Hamer, 1970).

2.3 Determinants of Distribution Changes

The winter distribution appears to be primarily associated with water temperature. Neville and Talbot (1964) report scup occur in water 45°F (7.3°C) or higher and that density and geographic distribution varies from year to year according to the location of the 45°F (7.3°C) isotherm. Their observations for the years 1931-1935 indicate that 45°F is the lower preferred limit though not the absolute limit of temperature tolerance.

The spring migration and summer residence are closely associated with spawning and increase in feeding activity (for spawning see 2.2.1). Very little growth occurs during the winter (Bigelow and Schroeder, 1953) and it appears feeding is at a minimum during winter.

2.4 Hybridization

No data available.

3. BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality

The scup is heterosexual. Hermaphroditism has not been reported. There is no known sexual dimorphism.

Spawning time of the day - no data available.

Sequence of spawning of individuals in a population - no data available.

Factors influencing spawning time - no data available.

Relation of the time of breeding to that of related and/or associated species - the spawning time of scup coincides with inshore spring spawners such as the weakfish (Cynoscion regalis), tautog (Tautoga onitis) and northern searobin (Prionotus carolinus).

Location and type of spawning ground - for locations see Table 1. Type of spawning ground has not been investigated but it appears spawning occurs over sandy and weed covered grounds.

Variation and causes of variation of spawning grounds - no data available.

Ratio and distribution of sexes on spawning grounds - studies conducted at the National Marine Fisheries Service Sandy Hook Laboratory during the spring of 1974 and 1975 show sex ratios on inshore grounds (<28 m) are approximately 1:1. This indicates no differential distribution by sex probably occurs on the spawning grounds.

Nature of mating act - no data available.

Variation in mating behavior - no data available.

Nesting habits - no nest produced.

Reproductive isolation - Hamer (1970) concluded that scup from New Jersey and southern New England were not completely genetically isolated though isolated enough to produce distinctly different meristic characteristics.

TABLE 1. Reported spawning season, area and authority for scup, Stenotomus chrysops.

Spawning Season	Peak Season	Area	Authority
June	-	Narragansett Bay Vineyard Sound	Goode, 1885
June-August	June	-	Kuntz and Radcliffe, 1918
June-July	June	Woods Hole and Sandy Hook Bay	Nichols and Breder, 1926
May-August	June	Eastern Long Island	Perlmutter, 1939
May-July	June	Long Island Sound	Wheatland, 1956
May-August	June	Southern New England	Bigelow and Schroeder, 1953
May-June	-	Peconic Bays, NY	Finkelstein, 1969
May-July	-	Narragansett Bay, RI	Sisson, 1974

Induction of spawning - no data available.

3.1.2 Maturity

Finkelstein (1969) investigated the maturity of scup in New York waters and determined females and males mature at age 2. Two year scup are between about 110 and 209 mm fork length (Finkelstein, 1969) and weigh between 40 and 200 g (Briggs, 1968; Smith and Norcross, 1968).

3.1.3 Mating

Probably polygamous and promiscuous; no parental care of eggs or larvae known.

3.1.4 Fertilization

External fertilization.

3.1.5 Gonads

No information is available concerning fecundity. However, Finkelstein (1969) determined average monthly ovary weight-body weight ratios from May to September. He found May had the highest ratio (about 2-5%), decreasing in June with July, August and September ratios of approximately 0.3%.

3.1.6 Spawning

Number of spawnings per year - scup spawn once a year. This is indicated by one peak in abundance of eggs and larvae (Perlmutter, 1939; Wheatland, 1956; Bigelow and Schroeder, 1953).

Spawning seasons - see Table 1.

3.1.7 Spawn

Eggs are transparent, spherical and 0.85 to 0.90 mm in diameter; single oil globule usually at the upper pole; egg membrane thin and horny (Kuntz and Radcliffe, 1918).

3.2 Pre-Adult Phase

3.2.1 Embryonic Phase (see Figure 2).

General features of development - Kuntz and Radcliffe (1918) describe the embryological development as, "typical of teleosts with pelagic eggs" and describe

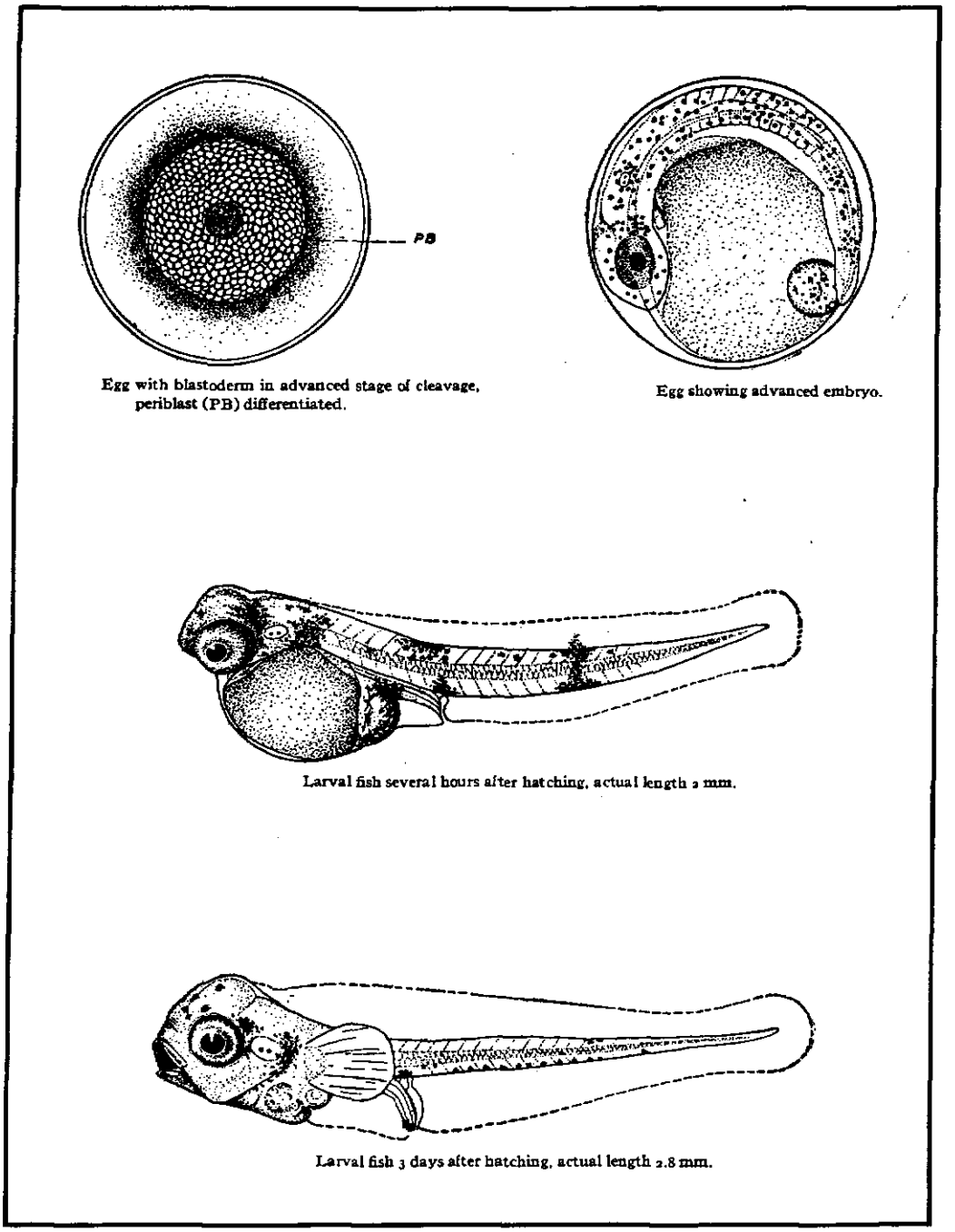

Figure 2. Egg, embryo and larvae of scup, Stenotomus chrysops (from: Kuntz and Radcliffe, 1918).

scup development as follows: As soon as fertilization takes place the protoplasm concentrates at one pole. The first cleavage of the blastodisc occurs in less than one hour and blastoderms in advanced stages of cleavage usually appear radically symmetrical. As segmentation advances a cleavage cavity forms between the blastoderm and periblast. Following this the germ ring becomes fully differentiated as a thickened peripheral zone of the blastoderm. The embryo begins development at this stage and within 18 hours the closure of the blastopore occurs. Pigmentation is observed in embryos with 15 to 20 somites and appear as black and yellow pigment cells sparsely scattered over the embryo and oil globule. As development advances to hatching the yellow chromatophores become aggregated to form heavily pigmented areas.

Parasites and predators - no published information is available but it seems likely the eggs are subject to predation by those invertebrates and vertebrates that feed on the larger components of the plankton.

Rates of development - incubation at 22°C is about 40 hours (Kuntz and Radcliffe, 1918).

3.2.2 Larvae Phase (see Figures 2 and 3)

General features of development - newly hatched larvae are approximately 2 mm in length. In three days larvae are 2.8 to 3 mm long and the yolk is absorbed. At 5 mm the fish is relatively plump and tapers posteriorly. At 10 mm a series of black spots appear near the ventral finfold and along the lateral line. Dorsal and caudal fins are differentiated. By the time they are 25 mm long they show some of the diagnostic characters of the species and irregular transverse bands of pigment appear (Kuntz and Radcliffe, 1918).

3.2.3 Adolescent Phase

General features of development - young assume the basic shape of adults at about 40 to 60 mm in length but retain a number of transverse bars characteristic of the pigmentation of juveniles. Juvenile fish from 50 to 80 mm long are common during September and by November they are 60 to 100 mm. It appears growth is slow during winter because fish 100 to 115 mm are common during the spring (Bigelow and Schroeder, 1953; Finkelstein, 1969). By the next spring they are about 160 mm.

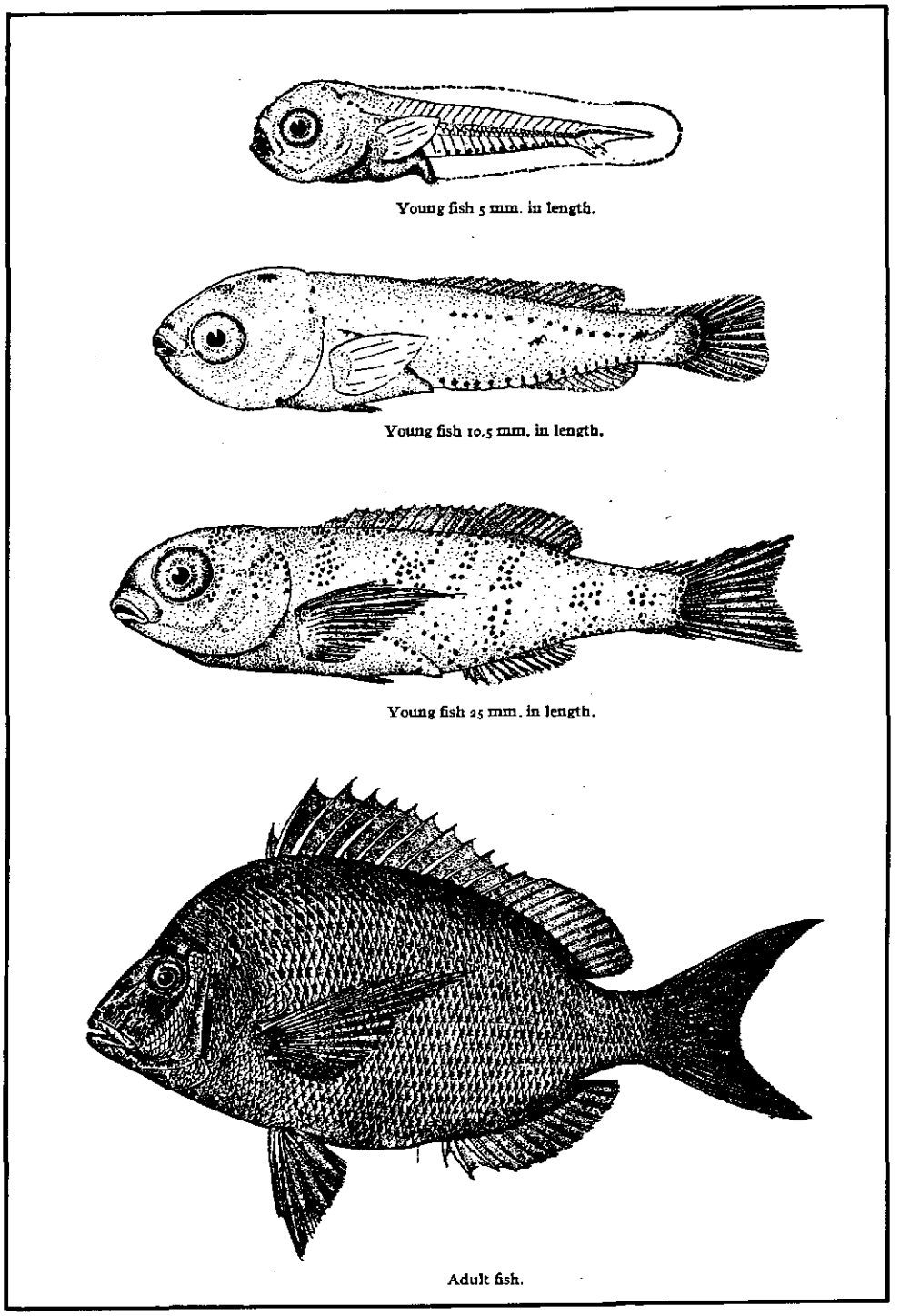

Figure 3. Young and adult scup, Stenotomus chrysops (from: Kuntz and Radcliffe, 1918).

3.3 Adult Phase

3.3.1 Longevity

Average life expectancy - length frequency information collected during National Marine Fisheries Service research vessel cruises indicates the population in the Middle Atlantic Bight is dominated by 2- and 3-year old fish (20-25 cm FL).

Maximum age - 15 years is the maximum age to which scup have been aged (Finkelstein, 1969).

3.3.2 Hardiness

Scup movements are at least partially correlated with temperature; about 7°C is the lower limit of tolerance, though lower temperatures may not be fatal. Baird (1873) refers to mortality of small scup during autumn cold snaps in the Woods Hole, Massachusetts region but gave no mention of water temperature.

Scup have been tagged successfully with spaghetti and Petersen tags (Hamer, 1970). Sisson (1974) investigated the effects upon scup mortality of inserting Floy fingerling and dart tags. He found tagging mortality was between 12.5 and 24.0% in a 9½ week study.

The critical thermal maxima (the temperature at which an organism suffers total loss of equilibrium when experimentally subjected to rapidly rising water temperature) increased from 30.2° to 35.6°C over an acclimation range from 14.8° to 22.2°C (Everich and González, 1977). The critical thermal maxima for scup acclimated to naturally fluctuating temperature regimes are (from Everich and González, 1977):

No. of Individuals	Temperature Range (°C)	Mean Acclimation Temperature (°C)	Mean Critical Thermal Maxima (°C)
26	10-19	14.8	30.2
26	16-22	19.0	31.9
26	15-24	19.9	33.6
21	18-25	22.2	35.6

3.3.3 Competitors

No data available.

3.3.4 Predators

Eaten by piscivorous fishes throughout its range. Fishes known to eat scup are bluefish, weakfish, and striped bass.

3.3.5 Parasites and Diseases

The parasitic Branchiura Argulus intectus has been found on scup (Yamaguti, 1963). Sisson (1974) reported the présence of Vibriosis sp. infection on fins and tails of tank-held fish. As the result of tagging, lesions were identified as ulcerative dermatitis, myosistitis, pancreatitis, and proliferative hepatic lesions.

3.4 Nutrition and Growth

3.4.1 Feeding

Time of day - unknown.

Place - throughout its geographic range.

Manner, etc. - bottom and near-bottom feeders.

Frequency - unknown.

Variation of feeding habits - no data available.

Abstention from feeding - they apparently stop feeding during spawning.

3.4.2 Food

Types eaten - various authors list food items which include: small crustacea, worms, mollusks, squid, vegetable debris, hydroids, sand dollars (Nichols and Breder, 1927; Goode, 1883; Bigelow and Schroeder, 1953). Maurer and Bowman (1975) analyzed 346 stomachs collected between 1969 and 1972 at 26 sampling locations in southern New England and Middle Atlantic (Figure 4). Table 2 lists food items, weight of food items, and the percent weight of the total weight of all food items analyzed. Table 3 lists stomach contents expressed as percent of weight by sampling area (Bowman et al., 1976).

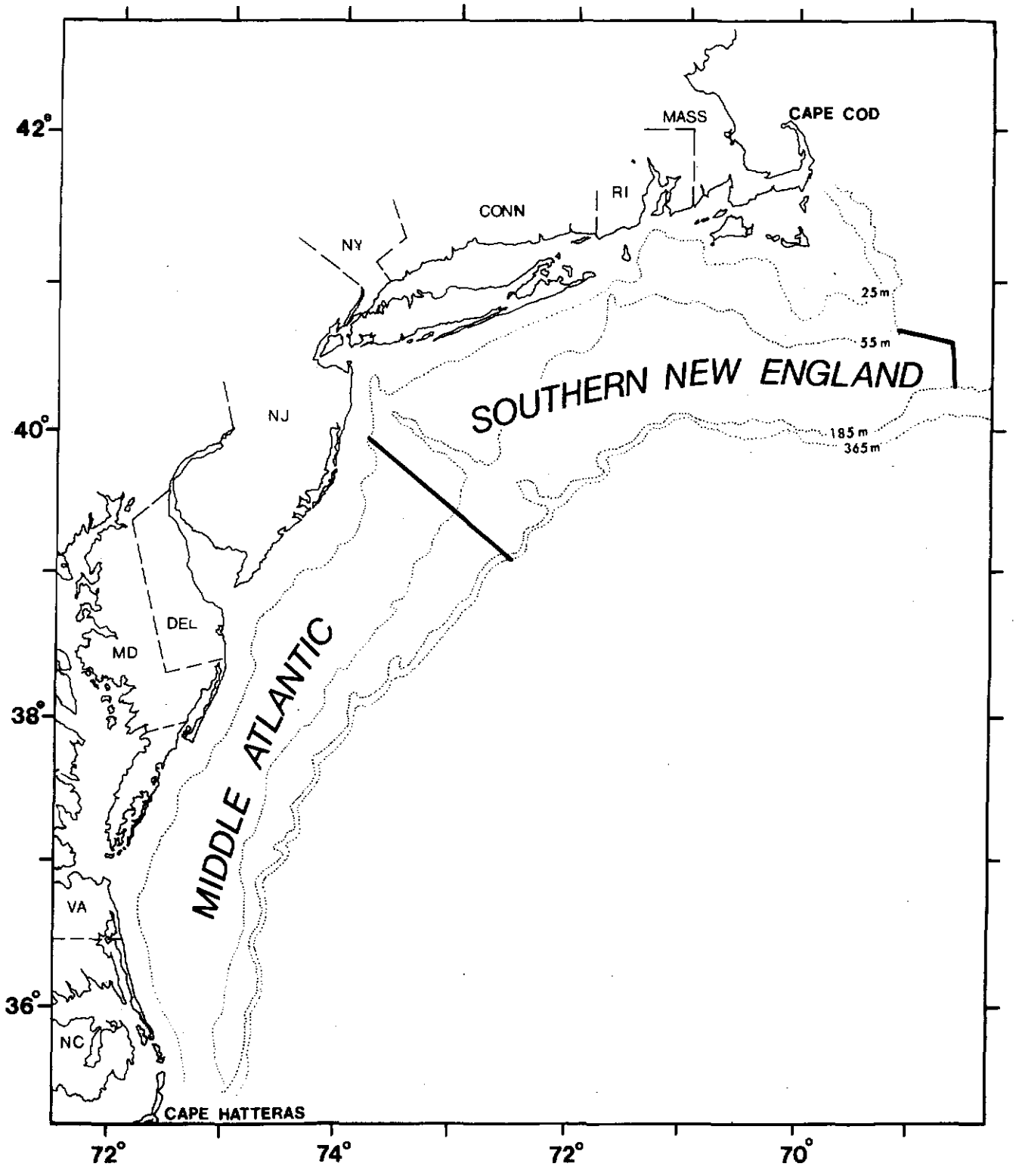

Figure 4. Geographic sampling areas used for collecting and analyzing stomach contents of scup, Stenotomus chrysops (from: Maurer and Bowman, 1975).

TABLE 2. Stomach contents of scup, Stenotomus chrysops, collected between 1969 and 1972 in southern New England and Middle Atlantic (Maurer and Bowman, 1975).

Items	wt(g)	% wt
COELENTERATES	47.24	20.6
Ceriantharia	47.24	20.6
POLYCHAETES	74.45	32.5
Scoleciforms	2.24	1.0
Terebelliforms	4.44	1.9
Sabelliforms	10.73	4.7
Eunicidae	1.21	0.5
Lumbrineridae	5.70	2.5
Nephtyidae	3.76	1.6
Phyllodocidae	0.74	0.3
Polynoidae	4.00	1.7
Other nereidiforms	1.32	0.6
Other polychaetes	40.31	17.7
CRUSTACEANS	21.43	9.3
Ampeliscidae	7.44	3.2
Aoridae	2.01	0.9
Other gammarids	4.21	1.8
Caprellids	0.96	0.4
Other amphipods	3.64	1.6
Decapods	2.73	1.2
Other crustaceans	0.44	0.2
MOLLUSKS	17.78	7.7
Cerastoderma	2.93	1.3
Other pelecyopds	7.21	3.1
Gastropods	7.28	3.1
Other mollusks	0.36	0.2

TABLE 2. (continued)

Items	wt(g)	% wt
ECHINODERMS	3.0	1.4
Echinarachnius parma	1.04	0.5
Ophiopholis	1.96	0.9
ASCIDIANS	0.61	0.3
FISH	2.39	1.0
ANIMAL REMAINS	61.37	27.0
MISCELLANEOUS	0.55	0.2
Total	229.32 g	100.0%

TABLE 3. Stomach contents of Stenotomus chrysops (Linnaeus) expressed as percent of weight by sampling area (Bowman et al., 1976).

Stomach Content Group	Sampling Area: Middle Atlantic	Southern New England	Georges Bank	Gulf of Maine	Western Nova Scotia
CNIDARIA	27.7	-	-	-	-
Anthozoans	27.7	-	-	-	-
ANNELIDA	24.9	54.0	-	-	-
CRUSTACEA	7.7	14.4	-	-	-
Caprellid amphipods	0.5	0.2	-	-	-
Gammaridean amphipods	5.9	6.7	-	-	-
Caridean shrimp	0.1	-	-	-	-
Anomuran crabs	0.1	-	-	-	-
Brachyuran crabs	0.3	-	-	-	-
Isopods	-	0.2	-	-	-
Euphausiids	0.1	-	-	-	-
Mysids	-	0.1	-	-	-
Unidentified	0.7	7.2	-	-	-
MOLLUSCA	10.2	0.8	-	-	-
Gastropods	4.3	-	-	-	-
Pelecypods	5.9	0.3	-	-	-
Unidentified	-	0.5	-	-	-
ECHINODERMATA	0.6	3.3	-	-	-
Ophiuroids	-	3.3	-	-	-
Echinoids	0.6	-	-	-	-
TUNICATA	0.4	-	-	-	-
PISCES	1.4	-	-	-	-

TABLE 3 (continued)

Stomach Content Group	Sampling Area: Middle Atlantic	Southern New England	Georges Bank	Gulf of Maine	Western Nova Scotia	Total
SAND AND ROCK	0.3	-	-	-	-	
Stomachs Analyzed	254	92	-	-	-	346
Number Empty(%)	14.2	7.6	-	-	-	12.4
Mean Weight Per Stomach(g)	0.7	0.6	-	-	-	0.7

3.4.3 Growth

Relative and absolute growth patterns and rates - the growth of scup was investigated by Finkelstein (1969) and the von Bertalanffy growth function by sex is:

$$\text{males} = L_t = 342.5\ [1-\exp\ (-0.2688(t_n + 0.40531))]$$

$$\text{females} = L_t = 374.1\ [1-\exp\ (-0.2247(t_n - 0.3119))]$$

Length is in millimeters fork length.

Smith and Norcross (1968) aged scup by examining scales and found difficulty beyond fish 2 years old. They determined mean fork lengths of 97.5 mm and 153.3 mm at first and second annulus formation.

Sisson (1974) found similar difficulty aging scup by scales beyond four years old collected from traps and otter trawls in Narragansett Bay, Rhode Island. His von Bertalanffy growth equation for both sexes combined from fish aged to four years is:

$$L_t = 323.75\ [1-\exp\ (-0.3365(t_n - 0.3119))]$$

Hamer (1970) determined growth from scales to 13 years old. The mean fork length (cm), von Bertalanffy fitted length (cm) and mean weight (g) from his data are:

Age	Mean Fork Length (cm)	von Bertalanffy Fitted Length (cm)	Mean Weight (g)
0	7.13	7.13	46.8
I	12.84	14.01	60.2
II	19.63	19.13	183.7
III	22.88	22.95	278.7
IV	25.36	25.79	368.7
V	26.74	27.91	425.9
VI	28.16	29.49	490.3
VII	30.14	30.66	589.9
VIII	31.81	31.54	683.2
IX	33.41	32.19	780.8
X	34.64	32.68	861.5
XI	35.50	33.04	920.9
XII	36.33	33.31	980.7
XIII	36.67	33.51	1005.8

Hamer's von Bertalanffy growth equation is:

$$L_t = 34.10\ [1-\exp\ (-0.7964(t_n + 0.294476))]$$

Condition factors - no data available.

Relation of growth to feeding, spawning, etc. - no data available.

Food-growth relations - no data available.

3.4.4 Metabolism

No data available.

3.5 Behavior

3.5.1 Migrations and Local Movements

Extent of movements or migrations - annual migrations are made to the offshore winter grounds and the inshore summer grounds. It appears the inshore migrations during the spring are spawning migrations. The possible existence of two populations with differing migration patterns has been shown through tagging studies. Neville and Talbot (1964) postulated the existence of a southern New England-New York group and a southern New Jersey group. A coordinated tagging study (Hamer, 1970) involving New Jersey Fisheries Laboratory, BCF and New York State Conservation Department have shown there are at least two distinct groups: one summers in the Sandy Hook, New Jersey area and the other summers in southern New England. The New Jersey group migrates within ten fathoms along the coast and winter offshore between Cape May, New Jersey and Cape Hatteras, North Carolina. The southern New England group winters off central and southern New Jersey (Anonymous, 1962; Hamer, 1970).

The fall migration begins during September with most fish arriving at the winter grounds by December. The first arrival inshore occurs during late April or early May.

The winter offshore distribution appears to be affected by the 45°F (7.3°C) isotherm. Changes in bottom temperatures from year to year determine the area of abundance of scup (Neville and Talbot, 1964). Figure 5 shows approximate summer and winter distribution (also see 2.2.2).

3.5.2 Schooling

Extent of schooling habits - scup are a shoaling fish and from evidence from pound net catches, they probably school by size.

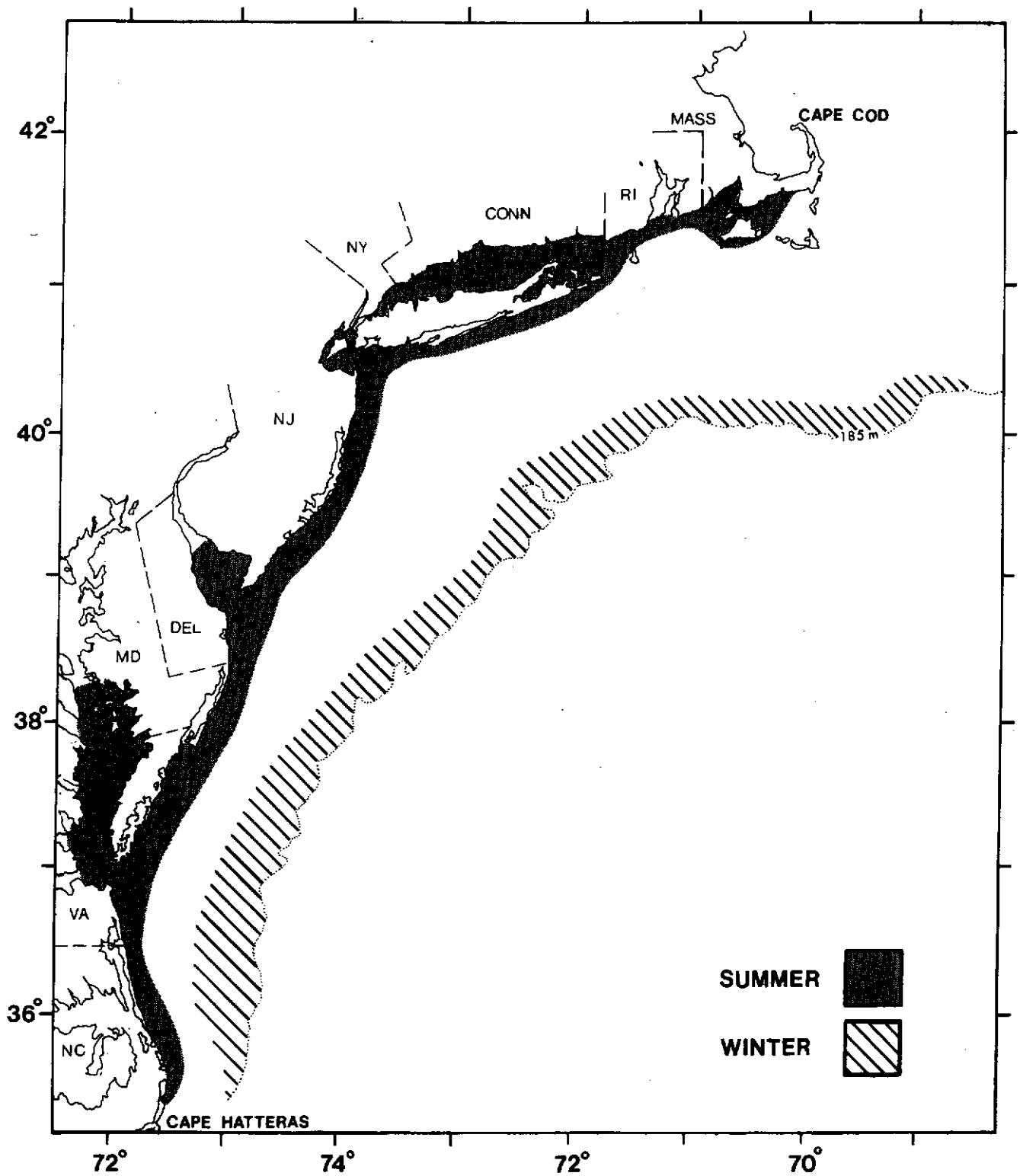

Figure 5. Summer and winter distribution of scup, Stenotomus chrysops, along the Middle Atlantic and New England coasts.

Composition of stocks by size, age and sex - see 4.1.

Mixing of stocks - during offshore winter residence the two populations (southern New England and New Jersey) probably mix and form a common stock (Neville and Talbot, 1964) though Hamer (1970) concluded from tagging studies the New England population winters generally north of the area favored by the New Jersey population.

Mixing of stocks within species of various stages of the life cycle - no data available.

Patterns of schools - no data available.

Vertical movements - scup are known to occasionally occur near the surface (Baird, 1873; Bigelow and Schroeder, 1953).

Size density and behavior of schools in relation to time of day, etc. - Fritz (1965) found research vessel trawl catches were at a minimum at mid-day and increased to a maximum at about mid-night. The percent of catch in numbers by four hour intervals is shown in Figure 6.

Aggregation - no data available.

3.5.3 Responses to Stimuli

Sound production of scup was investigated by Fish (1954) during induced electrical shock. Her findings were "single gutteral thumps or grunts spread between 20 and 1400 cycles, with principle frequencies in the vicinity of 200."

4. POPULATION

4.1 Structure

4.1.1 Sex Ratio

Smith and Norcross (1968) determined a ratio of 1:1 in the winter catch landed in Virginia. Scup collected in the New York Bight from June 1974 to June 1975 by the National Marine Fisheries Service, Sandy Hook Laboratory found a 1:1.26 male to female ratio from trawl samples (see Table 4).

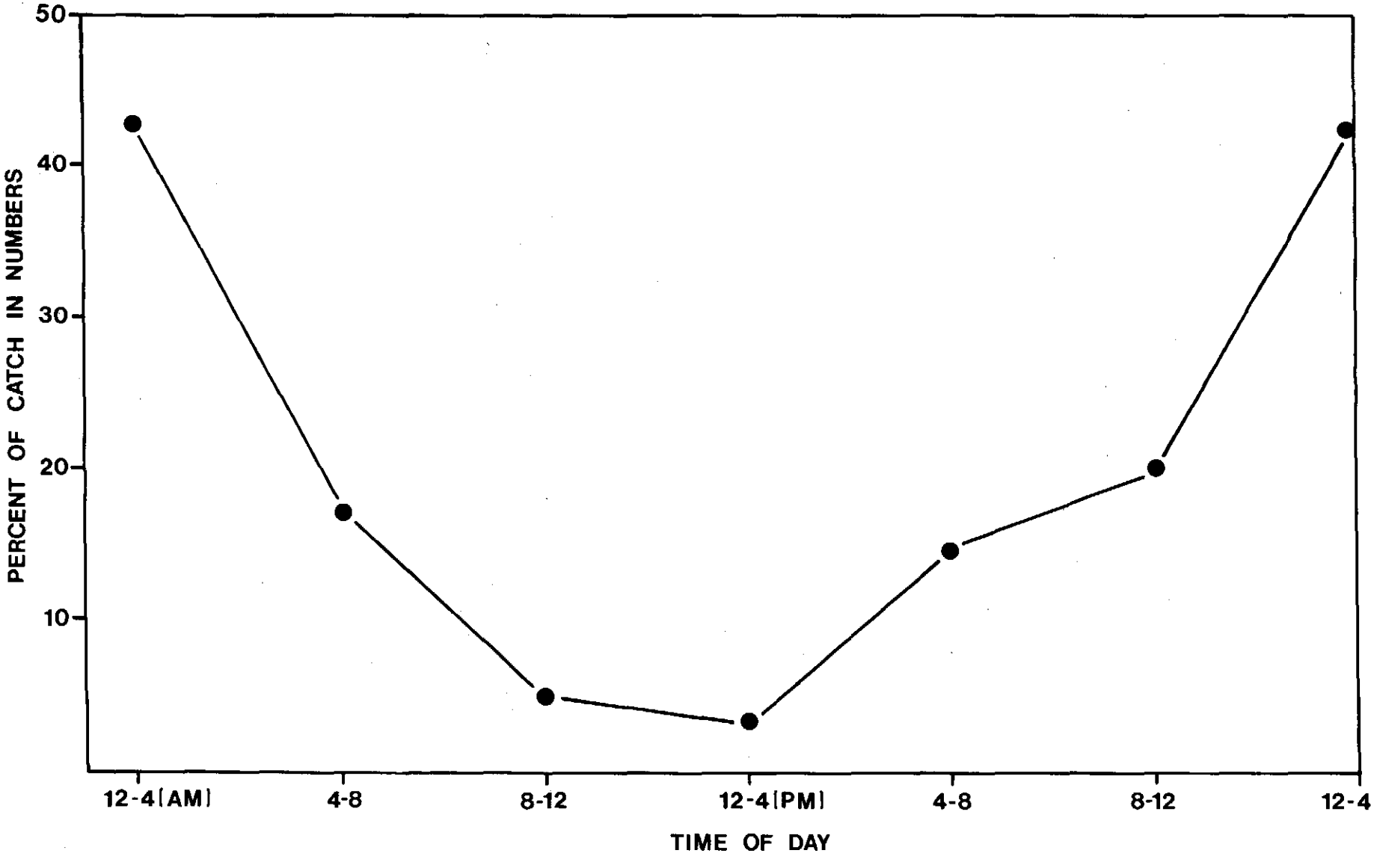

Figure 6. Diurnal variation in trawl catches from autumn research vessel cruises, 1955-1961 (from: Fritz, 1965).

TABLE 4. Monthly sex ratios of scup (Stenotomus chrysops) collected in the New York Bight, June 1974-June 1975.

Month	Sample Size	Males		Females		Unsexed[1]	
		Number	Percent	Number	Percent	Number	Percent
June	162	3	1.9	1	0.6	158	97.5
July	50	4	8.0	10	20.0	36	72.0
August	90	3	3.3	2	2.2	85	94.5
September	385	23	6.0	9	2.3	353	91.7
October	467	59	12.6	71	15.2	337	72.2
November	309	37	12.0	104	33.6	168	54.4
February	3	1	33.3	-	-	2	66.7
March	-	-	-	-	-	-	-
April	24	11	45.83	11	45.83	2	8.33
May	397	159	40.1	180	45.3	58	14.6
June	367	16	4.4	10	2.7	341	92.9
Total	2254	316	14.0	398	17.7	1540	68.3

[1]Unsexed includes immature and mature specimens that were not sexed.

Size at maturity - see 3.1.2.

Maximum size - 450 mm and 1.5 kg (Bigelow and Schroeder, 1953).

Density of size groups - no data available.

Length and weight relationships - length-weight relationships were calculated by Smith and Norcross (1968) and Briggs (1968). The regression equations are:

Log W = -4.7249 + 3.0391 (Log L) Smith & Norcross (1968)

Log W = -4.3944 + 2.8941 (Log L) Briggs (1968)

The length-weight relationships were determined from males and females from National Marine Fisheries Service research vessel trawl catches during June 1974-June 1975. The least squares regression equations are:

males: Log W = -5.0173 + 3.1739 (Log L)

females: Log W = -4.8289 + 3.0926 (Log L)

Total: Log W = -5.0222 + 3.1693 (Log L)

Analysis of covariance showed no significant difference between males and females. Figure 7 shows the length-weight relationship of scup collected in the New York Bight from June 1974 to June 1975.

4.1.2 Age Composition

Age composition of the population as a whole was inferred from length-frequency distributions tabulated from catches made during National Marine Fisheries Service research vessel cruises of the Middle Atlantic Bight. Ages 1 and 2 (10-20 cm FL) predominate the catches off New York and New Jersey. Fish age 4 and older (>25 cm) accounted for about 10% of research vessel catches.

Age distribution of the catch - Smith and Norcross (1968) investigated the scup catches in the winter trawl fishery based in Virginia from length frequency information. The commercial catch was dominated by fish 150-225 mm long. This coincides with calculated sizes for 2 and 3 year old fish.

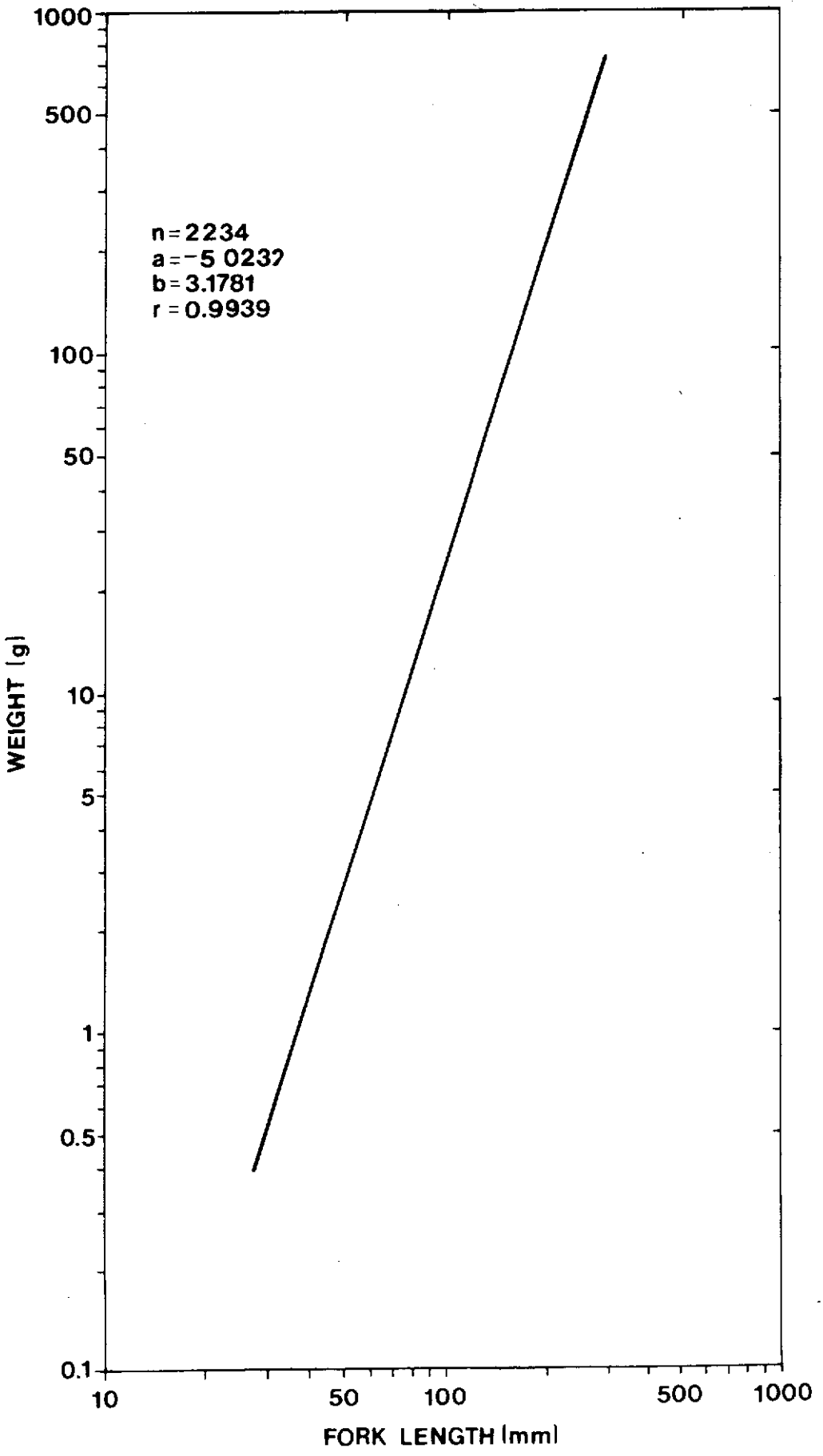

Figure 7. Length-weight relationship of scup, Stenotomus chrysops, collected in the New York Bight, June 1974 to June 1975.

Variation with depth, season, etc. - no data available.

Age at first capture - probably predominately two and three years old as estimated from length data presented by Smith and Norcross (1968).

Age at maturity - see 3.1.2.

Maximum age - see 3.3.1.

Density of age groups - no data available.

4.1.3 Size Composition

Length composition of the population as a whole - monthly length frequencies for scup captured in the New York Bight during National Marine Fisheries Service research vessel cruises are shown in Figure 8.

Size at first capture - the size will vary somewhat with gear used but the majority of the catches have a minimum of 140-150 mm. Smith and Norcross (1968) sampled the winter trawl fishery and found 150 mm to be the average minimum. Pound net catches are selected and sorted by size with undersized fish being discarded.

4.2 Abundance and Density

4.2.1 Average Abundance

Estimation of population size - Edwards (1968) estimated a standing crop of 65.71 x 10^6 lbs for southern New England and Georges Bank from catch/tow data of trawl surveys. This estimate does not include the entire population.

4.2.2 Changes in Abundance

Changes in abundance are reflected somewhat in the landings (see 5.4.3). Neville and Talbot (1964) determined changes in abundance reflects changes in success of reproduction and not changes in availability.

4.2.3 Average Density

Annual mean density - no data available.

Density of adult females - no data available.

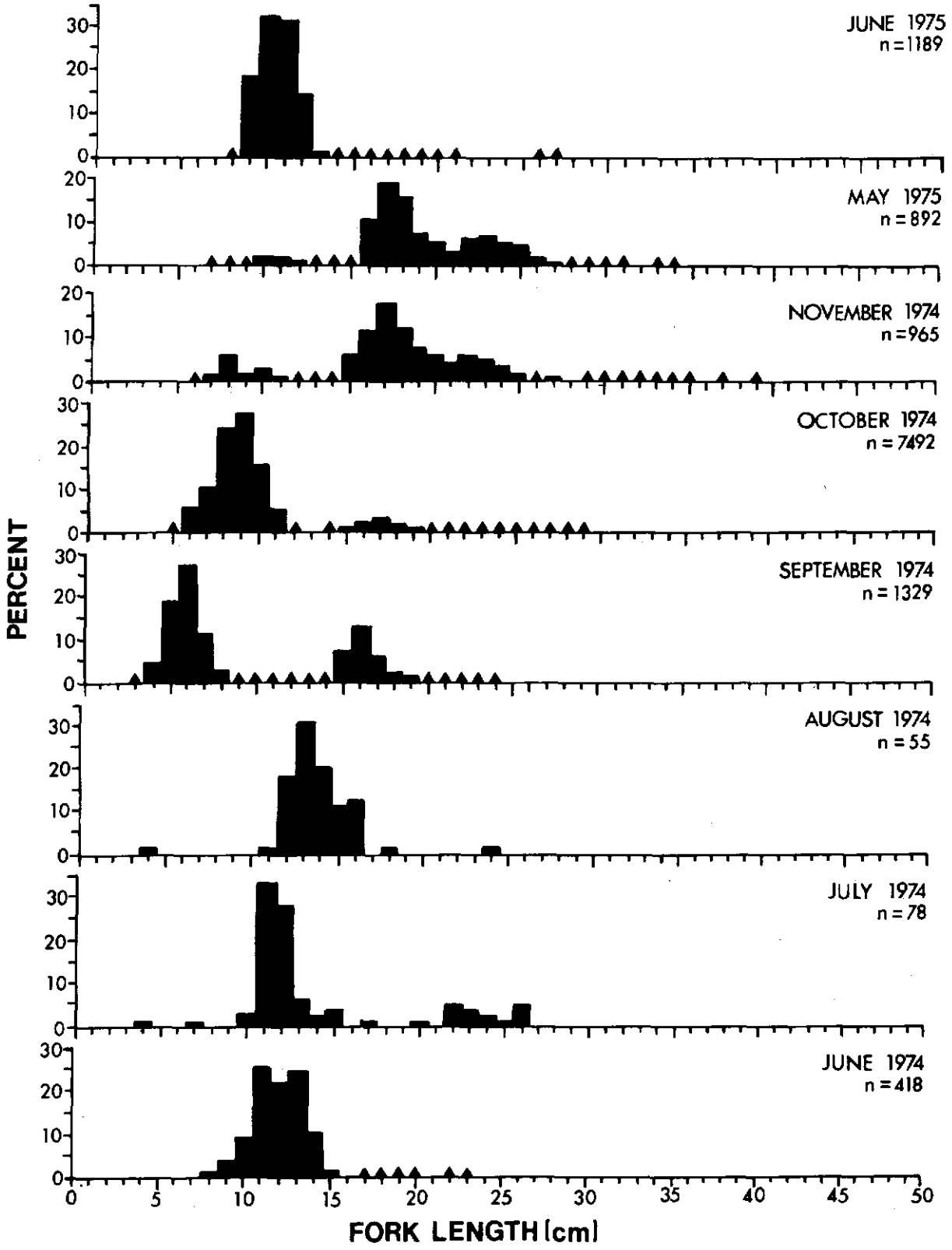

Figure 8. Monthly length-frequency of distributions of scup, Stenotomus chrysops, collected in the New York Bight, June 1974 to June 1975 (< indicates less than 0.5%).

4.2.4 Changes in Density

No data available.

4.3 Natality and Recruitment

See section 4.2.2, Changes in Abundance.

4.4 Mortality and Morbidity

4.4.1 Mortality Rates

Finkelstein (1969) calculated from tagging studies a 15% exploitation annually and 80% natural mortality.

4.5 Dynamics of Population

No data available.

4.6 The Population in the Community and the Ecosystem

No data available.

5. EXPLOITATION

5.1 Fishing Equipment

5.1.1 Gears

Present gear - scup are caught by otter trawl, floating trap, pound net, purse seine, gill net and hand lines. A typical otter trawl used by small to medium American draggers consists of 8 x 4 feet doors, head rope 62 feet with 48 floats, foot rope 88 feet long, the mesh size tapers from 5 inches stretch to 2¼ inches at the cod end (Smith and Norcross, 1968). Pound net is stationary and limited to a depth of about 60 feet or less. The net is held in place by poles set in the bottom. Floating traps are similar to pound nets but are buoyed and anchored instead of staked. Purse seines consist of a net weighted on the bottom with floats on the top which is used to encircle the fish and pursing the net to collect the fish in a small area.

Changes in types of gear during the development of the fishery - the changes in trawl gear reflect advances made since its introduction. The principal changes were made about 1929 when the offshore winter trawl fishery began. Before this time, trawl catches constituted a small portion of the total landing but during the 1930's an increased effort by draggers made trawl catches the most important sources of scup.

5.1.2 Boats

Type - otter trawlers, seine-netters and pound boats constitute the primary types of boats.

Size and power - the domestic fleet is generally the small Atlantic dragger, 30 to 74 feet, with a crew of 2 to 6 men. Foreign vessels are usually larger -- up to 250 feet.

5.2 Fishing Areas

5.2.1 General Geographic Distribution

Scup are caught throughout its range but the distribution of fishing areas changes seasonally following the migrations of the fish (see 2.1 and 2.2). Figures 9 and 10 illustrate the general distribution of the summer and winter trawl fisheries.

5.2.2 Geographic Ranges

Distance from coast - caught in bays, sounds and estuaries in summer and offshore about 50-70 miles in winter.

Areas of greatest abundance - during summer the greatest abundance is from central New Jersey to Nantucket and during the winter from Maryland to Cape Hatteras, North Carolina.

5.2.3 Depth Ranges

Bathymetric contour - from 1-100 fms - rarely deeper.

Variations of density with depth - no data available.

5.2.4 Conditions of the Grounds

No data available.

5.3 Fishing Seasons

5.3.1 General Pattern of Seasons

Fished all months of the year.

5.3.2 Dates of Beginning, Peak and End of Seasons

Scup arrive inshore about the beginning of May and are caught in pound nets, floating nets and by draggers until about October when they begin the offshore migration.

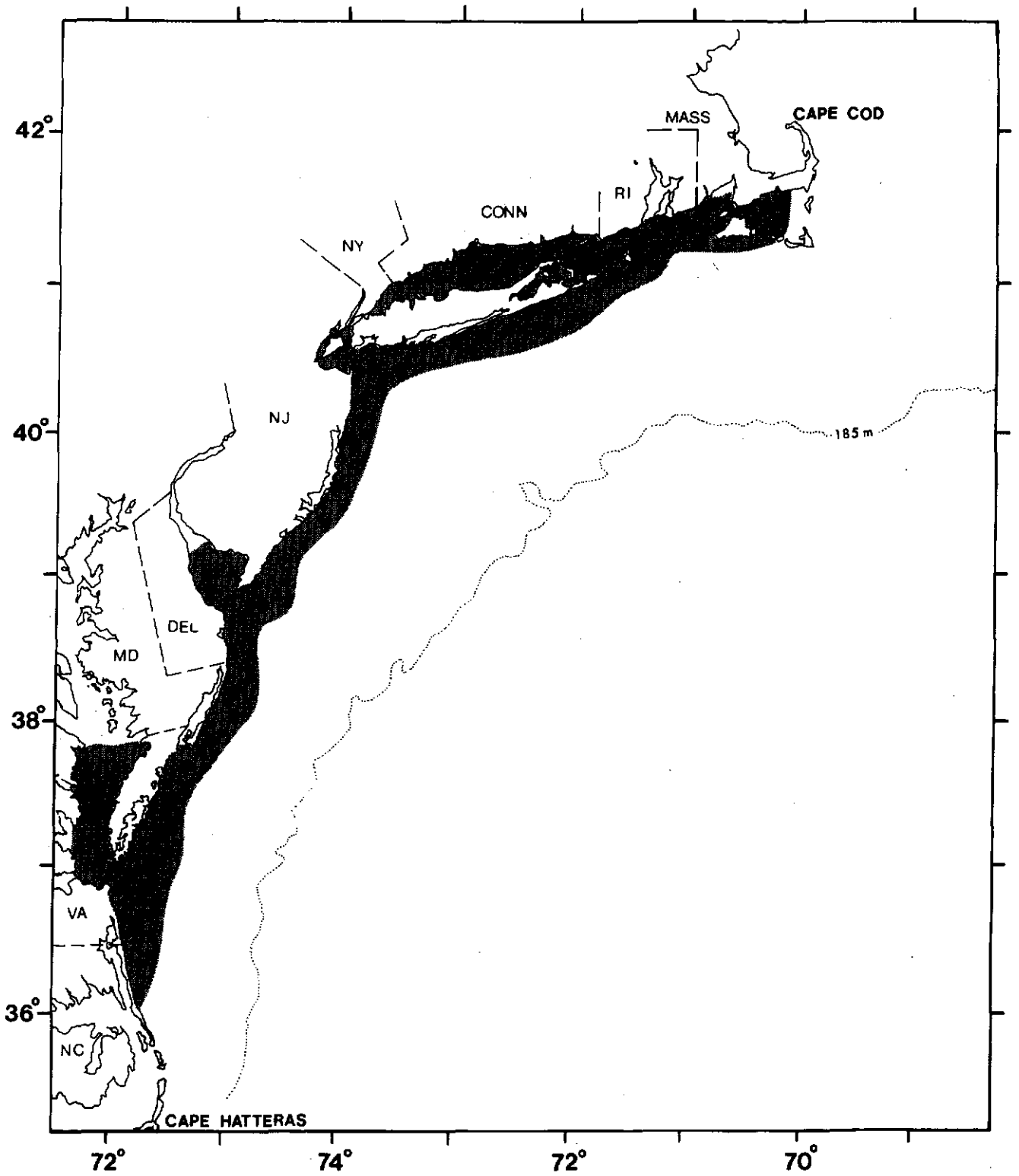

Figure 9. The general distribution of the summer trawl fishery.

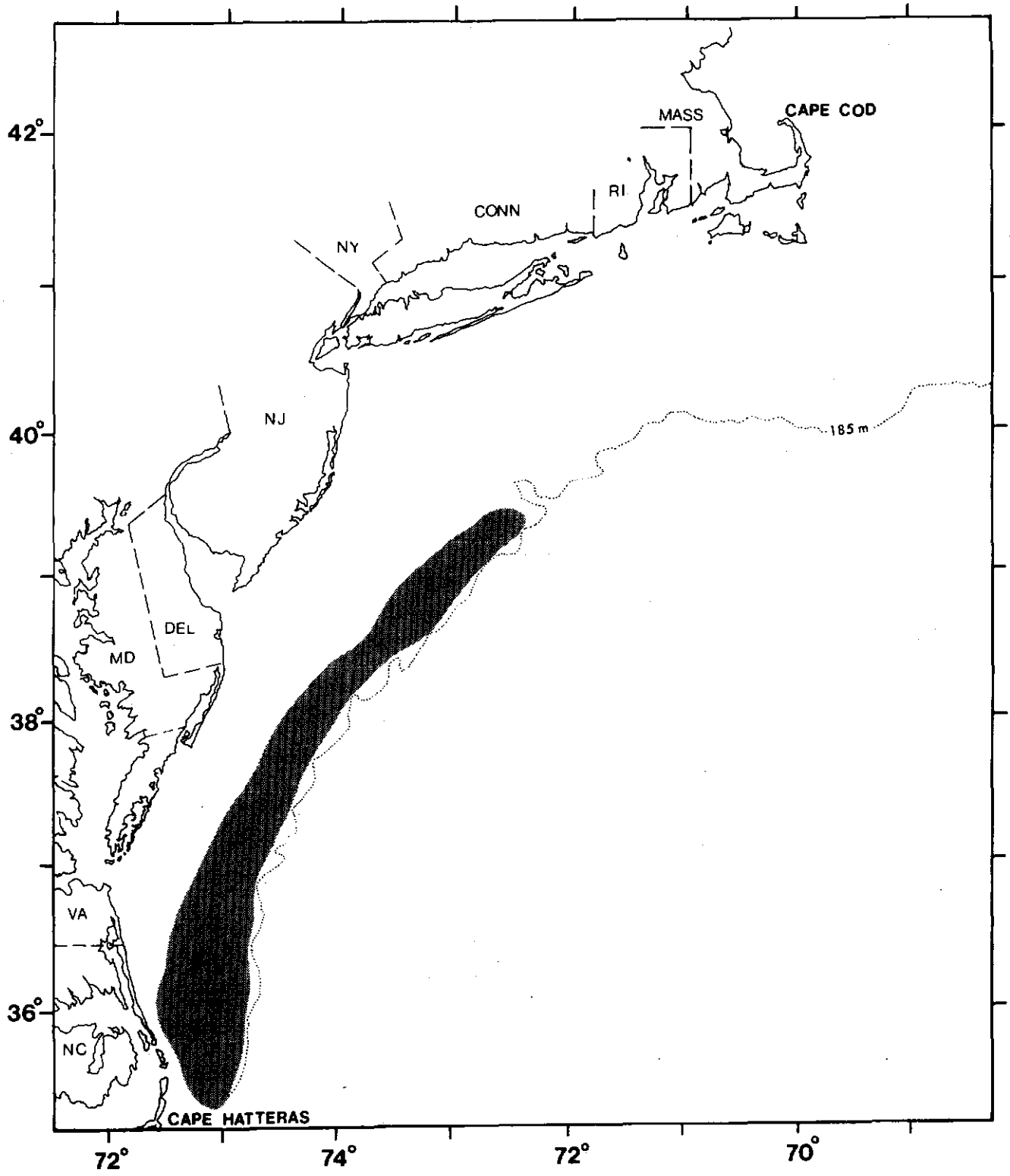

Figure 10. The general distribution of the winter trawl fishery.

The winter trawl fishery follows the migrating fish and peak catches usually occurring in February and March.

5.3.3 Variation in Date and Duration of Season

It appears the arrival and departure as well as distribution is correlated with weather and water temperatures.

5.4 Fishing Operations and Results

5.4.1 Effort and Intensity

No current information available but Pearson (1932) and Neville and Talbot (1964) give catch-effort information for the early 1930's. Between 300,000 and 500,000 lbs/trip and between 1000 and 6000 lbs/day are given as catch/effort data.

5.4.2 Selectivity

No data available.

5.4.3 Catches

Tables 5, 6 and 7 give United States landings by year and state, gear type and state and the sport catch. Catches by recreational fishermen reported by Deuel and Clark (1968) and Deuel (1973) for the years 1965 and 1970 showed a drop from 14 million fish to 4 million respectively in the area north of Cape Hatteras, North Carolina. Total recreational landings in weight (thousand metric tons) decreased from 6.5 to 2.0 during the five year period. Commercial landings during the same five year period showed a drop from 1.3 to 0.3 thousand metric tons.

6. PROTECTION AND MANAGEMENT

6.1 Regulatory (Legislative) Measures

Under Preliminary Management Plans established for 1977 under PL 480 by the National Marine Fisheries Service, foreign vessels were restricted to taking scup only as a by-catch in limited areas and times (called "windows") established for mackerel, hakes and squids. Furthermore, the mackerel fishery was limited to mid-water trawling only.

The states of New York and New Jersey have imposed a minimum size of 7 inches below which it is illegal to capture, offer for sale or purchase scup.

TABLE 5. Landings of scup, Stenotomus chrysops, by state in thousands of pounds, 1879-1976

Year	MA	RI	CT	NY	NJ	MD	VA	Total
1879	1,022	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1880	(1)	6,691	930	(1)	(1)	(1)	(1)	(1)
1887	2,322	3,030	2	(1)	(1)	-	-	(1)
1888	1,786	4,208	2	(1)	(1)	-	-	(1)
1889	2,501	6,064	7	348	12	(1)	(1)	(1)
1890	(1)	(1)	(1)	369	16	-	-	(1)
1891	(1)	(1)	(1)	351	26	-	-	(1)
1897	(1)	(1)	(1)	745	758	-	4	(1)
1898	1,044	6,390	101	(1)	(1)	(1)	(1)	(1)
1901	(1)	(1)	(1)	804	607	33	(1)	(1)
1902	589	6,834	396	(1)	(1)	(1)	(1)	(1)
1904	(1)	(1)	(1)	1,494	1,055	32	49	(1)
1905	1,019	5,540	28	(1)	(1)	(1)	(1)	(1)
1908	1,136	4,616	95	1,294	1,196	(1)	65	(1)
1919	79	8,261	2	(1)	(1)	(1)	(1)	(1)
1920	(1)	(1)	(1)	(1)	(1)	102	35	(1)
1921	(1)	(1)	(1)	1,297	4,116	(1)	(1)	(1)
1924	158	1,192	2	(1)	(1)	(1)	(1)	(1)
1925	(1)	(1)	(1)	(1)	(1)	45	402	(1)
1926	(1)	(1)	(1)	928	2,452	(1)	(1)	(1)
1928	855	2,004	(2)	(1)	(1)	(1)	(1)	(1)
1929	908	1,624	386	1,223	7,854	55	177	12,227
1930	792	1,646	285	1,218	7,564	60	404	11,969
1931	1,953	1,177	66	1,337	7,249	50	404	12,236
1932	2,427	1,958	63	1,074	6,436	36	1,712	13,706
1933	2,133	2,020	42	1,478	4,882	83	1,506	12,144
1934	(1)	(1)	(1)	(1)	(1)	39	692	(1)
1935	4,786	1,852	113	1,899	5,185	122	1,935	15,892
1936	(1)	(1)	(1)	(1)	(1)	45	1,434	(1)
1937	8,234	1,678	150	1,707	5,045	26	1,931	18,771
1938	9,817	1,146	121	2,492	4,950	22	2,344	20,892
1939	5,787	1,419	574	3,873	4,355	143	2,574	18,725
1940	8,958	1,399	486	2,462	3,314	324	3,655	(1)
1941	(1)	(1)	(1)	(1)	(1)	120	2,513	(1)
1942	157	1,830	649	4,289	5,879	135	2,712	15,651
1943	272	2,098	2,240	4,824	5,394	(1)	(1)	(1)
1944	385	1,179	1,129	5,631	4,491	309	6,253	19,377
1945	3,642	1,103	1,387	4,265	5,995	495	4,960	21,847
1946	818	1,488	946	3,712	(1)	631	6,460	(1)
1947	343	2,896	1,500	3,302	5,400	374	4,826	18,647
1948	1,548	3,799	2,207	6,152	8,348	1,669	7,055	30,778
1949	466	2,417	1,762	7,285	9.354	1,524	5,985	28,793
1950	608	4,467	1,574	10,022	10.436	612	7,610	35,329
1951	1,033	4,081	1,814	9,597	8,800	1,018	10,078	36,421
1952	825	4,393	1,589	9,212	9.664	220	7,608	33,511
1953	818	5,386	2,305	10,410	15,608	85	8,385	42,997
1954	343	5,724	2,052	12,818	13,594	64	11,562	46,157
1955	1,020	5.903	3,395	13,050	7.624	124	13,172	44,288
1956	1,164	4,959	1,609	10,892	6,066	128	11,289	36,107
1957	1,443	5,403	1,068	11,761	7,872	179	6,326	34,052
1958	1,258	5,716	1,312	14,319	8.941	107	6,815	38,468
1959	1,428	6,361	1,347	13,490	12,653	278	11,526	47,083
1960	1,223	6,516	1,132	12,969	13,669	104	13,407	49,020
1961	1,089	7,105	992	12,055	13,687	99	11,256	46,283
1962	1,388	6,717	982	10,695	14,879	102	11,161	45,924
1963	747	8,469	759	9,308	12,729	68	9,551	41,631
1964	490	8,673	722	8,344	8,551	218	10,929	37,927
1965	422	10,086	959	7,537	9,098	422	6,277	34,801
1966	426	8,543	519	4,077	4,338	240	8,224	26,367
1967	669	6,416	231	3,288	4,019	202	4,462	19,287
1968	686	4,722	507	2,800	3,420	50	2,432	14,617
1969	274	2,081	135	1,637	3,618	49	2,858	10,652
1970	408	2,937	100	1,215	3,116	5	2,076	9,857
1971	564	2,736	108	1,321	2,068	27	1,912	8,736
1972	539	2,338	57	1,321	3,647	(2)	1,299	9,201
1973	652	3,322	191	2,903	2,970	1	825	10,864
1974	892	4,010	(1)	3,634	6,040	1	474	(1)
1975	363	5,357	(1)	3,831	(1)	171	408	(1)
1976	1,719	4,357	(1)	2,468	(1)	35	270	(1)

(1) No data available
(2) Less than 500 pounds

TABLE 6. Landings of scup, *Stenotomus chrysops*, by state, by gear in thousands of pounds for 1973.

State	Otter Trawl	Pound Nets	Hand Lines	Gill Nets	Floating Traps	Fish Traps	Haul Seines
Massachusetts	452	187	13	-	-	-	-
Rhode Island	1557	-	5	-	1760	-	-
Connecticut	191	-	0.5	-	-	-	-
New York	1350	776	239	-	-	-	540
New Jersey	2967	1	-	0.6	-	1	-
Maryland	0.7	-	-	-	-	0.3	-
Virginia	821	3	-	1	-	-	0.4

TABLE 7. Sportfish catch statistics for scup taken from Clark (1962), Deuel and Clark (1968) and Deuel (1973).

Year	Area	Number of Fish Caught	Number of Anglers	Weight of Catch	Principal Areas and Method of Fishing (number of fish caught)					
					Ocean	Sounds, Rivers, Bays	Private or Rented Boats	Party or Charter Boats	Bridge, Pier or Jetty	Beach or Bank
1960	Maine-New Jersey	14,409	256	13,420	(11,864 caught from boats - 3,045 caught from shore)					
	New York-North Carolina	3,177	148	3,180	(3,051 caught from boats - 126 caught from shore)					
1965	Maine-New Jersey	10,819	280	10,150	4,095	6,724	6,883	2,249	1,584	103
	New York-North Carolina	3,047	167	4,244	2,608	439	1,143	1,702	56	146
1970	Maine-New Jersey	2,850	202	2,296	661	2,189	2,204	412	199	35
	New York-North Carolina	1,188	117	2,127	803	385	191	557	358	82

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