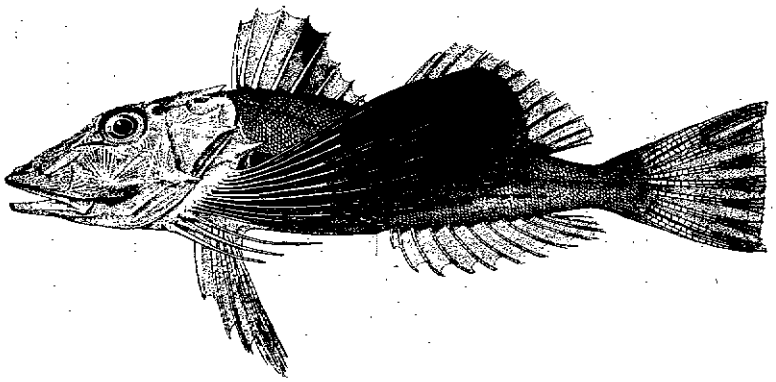

BIOLOGICAL & FISHERIES DATA

ON

STRIPED SEAROBIN, *Prionotus evolans* (Linnaeus)

JANUARY 1981

Biological and Fisheries Data

on

striped searobin, *Prionotus evolans* (Linnaeus)

By

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1. IDENTITY

1.1 Nomenclature

1.1.1 Valid Name

Prionotus evolans Linnaeus, 1766.

Although Trigla was the first genus used in classification of searobins from American waters today it is not a recognized genus for North American searobins but rather the European counterpart to the American genus Prionotus. Trigla was first used by Linnaeus, after Artedi[1], in his tenth edition of Systema Naturae (1758-1759), in which binomial nomenclature has its recognized beginning[2]. Prionotus was first used by Lacépède in his Histoire Naturelle des Poissons (1798-1803)[3].

The following is a history of the valid name:

Trigla evolans

Linnaeus, 1766, Syst. Nat., edit. 12, p. 498.

Gmelin, 1788, ed. (in part) Caroli a Linné. Syst. Nat. 1(3) Pisces, p. 1345.

Goode and Bean, 1885, Proc. U. S. Nat. Mus. 8:204 (redescription of Linnean type).

Prionotus evolans

Lacépède, 1798-1803, Hist. Nat. Poiss., III, p. 37. Also, In Hist. Nat. de Buffon 7:96-98 (both as Le Prionote volant).

Gill, 1873, Cat. Fish. East Coast N. Amer., p. 21 (name only).

Jordan and Gilbert, 1878, Proc. U. S. Nat. Mus. p. 374, (Beaufort, N. C.).

Jordan and Gilbert, 1883, Bull. U. S. Nat. Mus., 16:735.

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[1]Peter Artedi, a naturalist knowledgeable in fish, devised the generic system of ichthyological names used by Linnaeus.

[2]Trigla gurnardus L. described.

[3]Le Prionote volant described. Other species were described under the genus Trigla, including Trigla carolina.

Jordan and Swain, 1885, Proc. U. S. Nat. Mus. 7:541 (foot-note).

Jordan, 1887b, Cat. Fish. N. Amer., p. 903(115).

Jordan and Hughes, 1887, Proc. U. S. Nat. Mus. 9:336 (N. and S. Carolina).

Jordan and Evermann, 1896-1900, Bull. U. S. Nat. Mus. 47(2): 2168, pl. 320, fig. 772 (N. and S. Carolina).
Ginsburg, 1950, Tex. J. Sci. 2(4): 519-522.
Teague, 1951, Comun. Zool. Mus. Hist. Nat. Mont. 3(61): 43-44.

1.1.2 Objective Synonymy

Trigla lineata

Mitchill, 1814, Trans. Amer. Lit. Philos. Soc. 1:430 (homonym of T. lineata Bloch 1793), pl. 4, fig. 4, (New York).

Prionotus strigatus

Cuvier and Valenciennes, 1828-1849, Hist. Nat. Poiss. 4:86 (locality not stated).

Jordan and Hughes, 1887, Proc. U. S. Nat. Mus. 9:335 (Cape Cod to Virginia).

Jordan and Evermann, 1896-1900, Bull. U. S. Nat. Mus. 47(2): 2167 (Cape Cod to Virginia).

Prionotus lineatus

DeKay, 1842, Zool. New York (Fishes). p. 45, pl. 4, fig. 12 (New York).

Gunther, 1859-1870, Cat. Fish. Brit. Mus. 2:192 (Atl. coast of N. Amer.).

Prionotus sarritor

Jordan and Gilbert, 1883b, Proc. U. S. Nat. Mus. 5:615 (Charleston, S. C.).

1.2 Taxonomy

1.2.1 Affinities; including key to northwest Atlantic species.

Suprageneric - several classifications have been suggested which include the following:

Berg, 1947

Class: Teleostomi
Subclass: Actinopterygii
Order: Perciformes
Suborder: Cottoidei
Superfamily: Scorpaenoidae
Family: Triglidae
Subfamilies: Triglini, Peristediini

Greenwood, Rosen, Weitzman and Myers, 1966

Superorder: Acanthopterygii
Order: Scorpaeniformes
Suborder: Scorpaenoidei
Family: Triglidae

American Fisheries Society (Bailey, et al.), 1970

Class: Osteichthyes
Order: Perciformes
Family: Triglidae

Gosline, 1971

Order: Scorpaeniformes
Family: Triglidae

Generic

Twenty-two genera proposed or used for the family Triglidae are listed in Jordan (1923). Only two of these, Prionotus and Bellator and a third, Peristedion (not listed) formerly in the Peristediidae, are used for North American species.

Prionotus - Typically with broad, moderately spiny heads, slender bodies more or less triangular in cross-section, large fan-like pectorals with the lower three rays separate and modified for feeling or "walking" on the bottom, two separate dorsal fins (one spiny and one soft-rayed), and ventral fins located under the pectoral fins. Heads armored with rough bony and spiny plates. D X; 12-13. A 11-12. P(13+3) - (14+3). (Bigelow and Schroeder, 1953).

Bellator - Similar to Prionotus, also has lower three rays of pectoral separate and modified. The first and/or second dorsal spines are often greatly extended depending on sex. Differs from Prionotus chiefly in normally having 11 instead of 10 dorsal spines. D XI; 11-12. A 9-11. P(11+3) - (13+3). (Ginsburg, 1950). Scales large and very rough. Short snout, abruptly descending (Jordan and Evermann, 1896-1900).

Peristedion - Differs from Prionotus in having entire body enclosed in spined bony plates; only two modified pectoral rays; protruding processes on snout; two long barbels on chin (Bigelow and Schroeder, 1953).

Specific

The following fifteen species of Prionotus occur in the western Atlantic (Ginsburg, 1950), however, only nine of these occur off the coast of the United States. The remainder range from the Caribbean to South America.

P. carolinus (Linnaeus), 1771, northern searobin, Massachusetts to Florida.

P. scitulus Jordan and Gilbert, 1883a, leopard searobin, North Carolina to Florida.

P. roseus Jordan and Evermann, 1887, bluespotted searobin, North Carolina to Florida.

P. ophryas Jordan and Swain, 1885, bandtail searobin, South Carolina to Florida.

P. stearnsi Jordan and Swain, 1885, shortwing searobin, west Florida.[4]

P. salmonicolor Fowler, 1903, blackwing searobin, North Carolina to Texas.[5]

P. tribulus Cuvier, 1829, bighead searobin, North Carolina to Florida.

P. evolans (Linnaeus), 1766-1768, striped searobin, Massachusetts to Florida.

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[4] Specimens have been taken off Charleston, South Carolina and Jacksonville, Florida in trawl surveys (1972) by the National Marine Fisheries Service.

[5] P. pectoralis is a synonym of P. salmonicolor (Bailey et al., 1970).

P. alatus Goode and Bean, 1882, spiny searobin, North Carolina to Louisiana.

P. martis Ginsburg, 1950, barred searobin, west Florida.

P. rubio Jordan, 1887a, blackfin searobin, west Florida.

P. paralatus Ginsburg, 1950, Mexican searobin, Texas.

P. punctatus Bloch, 1797, Cuba to South America.

P. beanii Goode, Goode and Bean, 1895, sicklefin searobin, Trinidad, South America.

P. nudigula Ginsburg, 1950, Argentina.

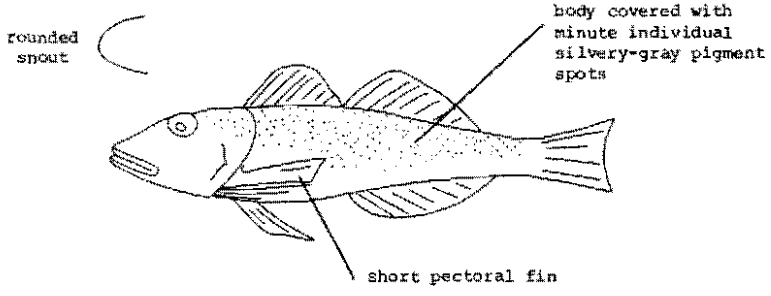
P. evolans differs from other Prionotus species chiefly in two respects: 1) it is one of two species having a distribution in the western Atlantic north of Cape Hatteras, N. C. (the other is P. carolinus) and 2) it is one of two species having two lateral stripes of dark pigment along the body. P. evolans has fairly continuous stripes of uniform width whereas P. tribulus has more mottled appearing stripes. Other distinguishing morphological characters are given in section 1.3.1.

I am aware of only one published pictorial guide to American searobins, Key to the Estuarine and Marine Fishes of Texas, Parker, 1972. p. 138-140. While it appears to be adequate for Gulf species, the following guide to Prionotus species along the Atlantic coast of the United States includes several not found in Parker's key: P. carolinus, P. evolans and P. alatus.

PROVISIONAL GUIDE TO PRIONOTUS SPECIES ALONG THE ATLANTIC COAST OF THE UNITED STATES FROM MAINE TO FLORIDA

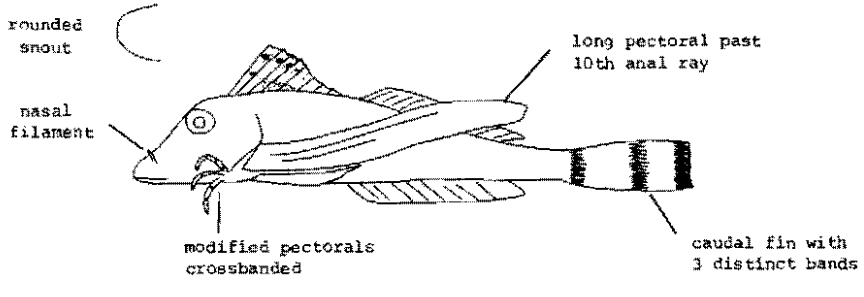
1. P. stearnsi (shortfin searobin)

Pectoral very short - to 1st or 2nd dorsal ray at maximum. Other species with longer pectoral. Occurs SC to FL. DX; 12. All. P(13+3).



2. P. ophryas (bandtail searobin)

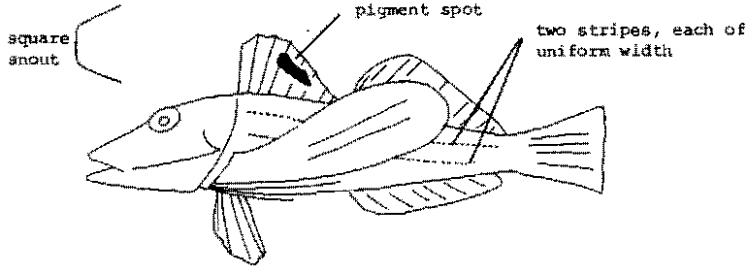
Three distinct bands on caudal fin. Modified pectorals also crossbanded. Diffuse pigment across span of 1st dorsal fin. Filament protruding from anterior nostril. Occurs SC to FL. DX; 12. All. P(14+3).



3. One or two lateral stripes along length of body. Pigment spot between 4th and 6th dorsal spines often spreading. Lachrymal plates extending anteriorly to give a square snout in fish >4" (102 mm).

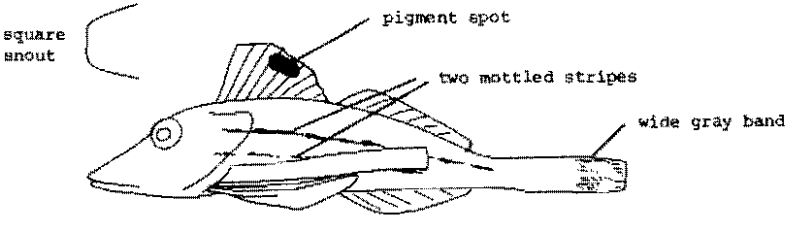
3a. P. evolans (striped searobin)

Two well defined lateral stripes continuous or dashed and of uniform narrow width. Caudal fin of uniform color (no distinct band). Occurs MA to SC. DX; 12-13. All. P(13+3).



3b. P. tribulus (bighead searobin)

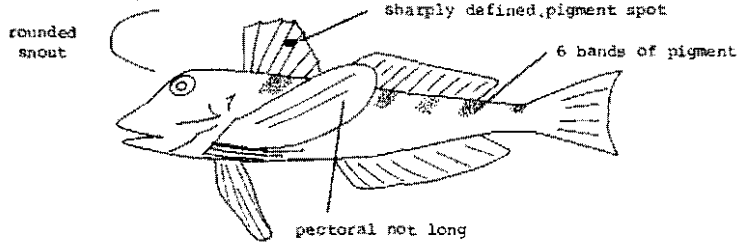
Two mottled or broken lateral stripes of varying width. Caudal fin with distinct wide distal pigment band. Occurs NC to FL. DX; 12. All. P(13+3).



4. Well defined black pigment spot confined between 4th and 5th first dorsal spines.

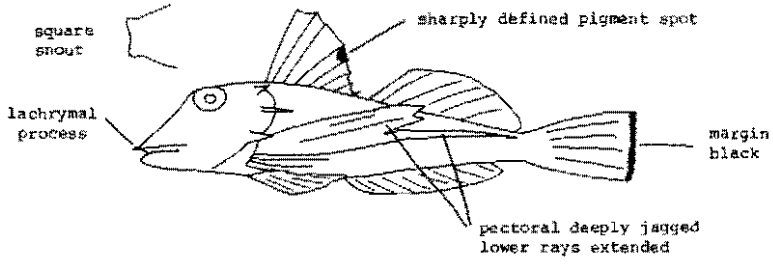
4a. P. carolinus (northern searobin)

Six alternate dark and light bands of pigment dorsally in young specimens - remnants remaining in older specimens. Unique high fin counts. Occurs MA to SC. DX; 13-14. A12. P(14+3).



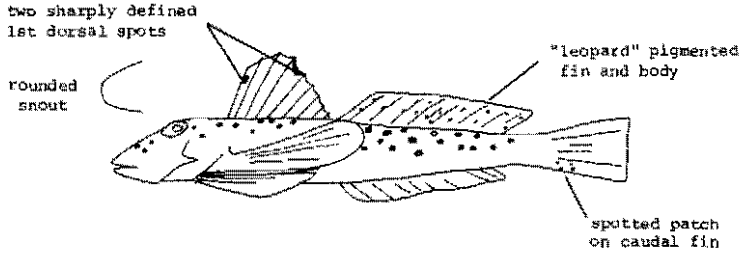
4b. P. alatus (spiny searobin)

Pectoral fin deeply jagged. Caudal fin with black spot or margin distally. Dorsal snout with protruding lachrymal processes. Occurs NC to FL. DX; 12. A11. P(13+3).



4c. P. scitulus (leopard searobin)

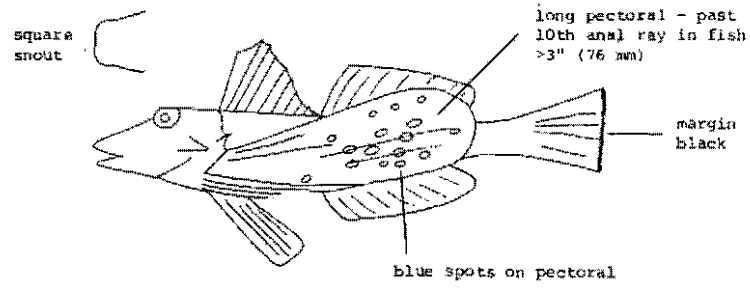
Additional black pigment spot between 1st and 2nd dorsal spines. Upper body and 2nd dorsal fin "leopard" spotted. Slender body. Occurs NC to FL. DX; 13. A12. P(13+3).



5. Pectoral fin long - close to end of anal fin base. Lachrymal plates extending forward to give a square snout.

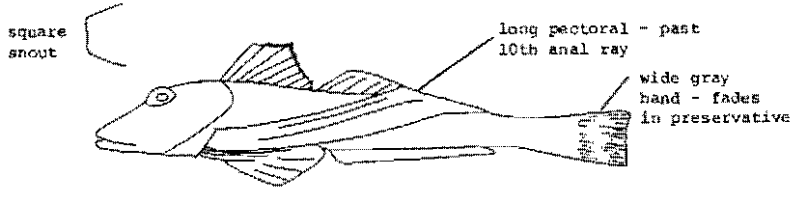
5a. P. roseus (blue spotted searobin)

Blue spots on pectoral. Caudal with black spot on margin distally. Occurs NC to FL. DX; 12. A11. P(13+3).



5b. P. salmonicolor (blackwing searobin)

Uniform or mottled pectoral (not blue spots). Caudal with distinct wide gray distal band. Occurs NC to FL. DX; 12. A11. P(13+3).



1.2.2 Taxonomic Status

The striped searobin was originally classified as Trigla evolans in 1766. The genus has since been changed to Prionotus (Cuvier and Valenciennes, 1828-1849) and various species names have been used. The first review of the genus was published in 1887 by Jordan and Hughes and Prionotus evolans and Prionotus strigatus were described as separate species. In 1950 they were combined as P. evolans by Ginsburg in his revision of western Atlantic Triglidae (see 1.2.3). No genetic information is available.

1.2.3 Subspecies

P. evolans is sometimes referred to as P. evolans evolans (southern subspecies, N. C. and S. C.) or P. evolans strigatus (northern subspecies, MA to VA) (Teague, 1951). Ginsburg (1950) examined the two varieties and found them to be the same with differences due to individual variability, related to age, or continually changing with latitude.

The scale count and the relative length of the pectoral show the greatest divergence with the population on the average. The scale count is lower and the pectoral length greater in southern specimens (Ginsburg, 1950).

1.2.4 Standard Common Names, Vernacular Names

The standard common name adopted by the American Fisheries Society is striped searobin (Bailey et al., 1970). Vernacular names include: sea robin, flying fish (Hildebrand and Schroeder, 1928); northern striped sea robin, red sea robin, cock or male robin (on the erroneous assumption that P. evolans is the male and P. carolinus is the female of the same species) (Marshall, 1946).

Members of the family Triglidae are often referred to as "gurnards" (akin to the French "grogner" - to grunt, growl, grumble) because of the sound they emit. They should not be confused with the "flying gurnard" (family Dactylopteridae, genus Dactylopterus). The only other fish sometimes referred to as a gurnard is Callionymus draco. According to Bigelow and Schroeder (1953), "gurnard" is the European terminology and "searobin" American.

1.3 Morphology

1.3.1 External Adult Morphology

Searobins typically have broad, moderately spiny heads, slender bodies triangular in cross-section, large fan-like pectorals with the lower three rays separate and modified for feeling or "walking" on the bottom, two separate dorsal fins (one spiny and one soft-rayed), and ventral fins located under the pectoral fins (Bigelow and Schroeder, 1953).

Two detailed descriptions of P. evolans have been published; those of Ginsburg (1950) and Teague (1951). The Ginsburg description follows:

"D IX-XI; 11-13. A 10-12. P 12-14. GR 14-20. Sc 82-103. Dorsal spines normally 10 (variants having 9 or 11 appear with a slightly greater frequency than in other species). Dorsal rays usually 12, varying 11-13: anal ray usually 11, varying 10-12 (frequency of occurrence of variants from the usual apparently differing somewhat with the population, see below). Attached pectoral rays usually 13, sometimes 12 or 14. Gill rakers on upper limb of outer gill arch usually 3 or 4, sometimes 5; lower limb with 14-20 gill rakers: combined number on both limbs 17-24; tubercles 1-4 on upper limb, 1-8 on lower... Spines on head rather well developed in small specimens; buccal, rostral and supplemental preopercular spines disappearing with growth in the order named, size at disappearance varying greatly with the individual (possibly also differing somewhat with the population), approximate length at disappearance as follows: buccal at 150 mm, rostral at 200, a slight trace of supplemental preopercular present up to 3.0 mm, absent in 3 specimens 335-470 mm; lachrymal plate moderately rounded and projecting, fairly serrate in front. Occipital groove slightly indicated in the young, disappearing early in life. Chest scaled, except a small, subtriangular naked area in front (chest naked in 2 specimens 23-25 mm: in 2 of 27 mm chest partly scaled in one, fully scaled in other; fully scaled in 2 specimens 29-30 mm). First three dorsal spines graduated, the third longest, the fourth a little shorter or subequal to third. First dorsal spine and first ray moderately or slightly serrate; first dorsal ray unbranched, second ray usually branched, often unbranched. Pectoral not having its posterior edge emarginate, slightly rounded or nearly truncate, when truncate, the edge nearly transverse or slightly oblique; the fin reaching to over base of sixth anal ray varying to some distance beyond anal base (differing to some extent with the population, see below). Caudal moderately to slightly emarginate.

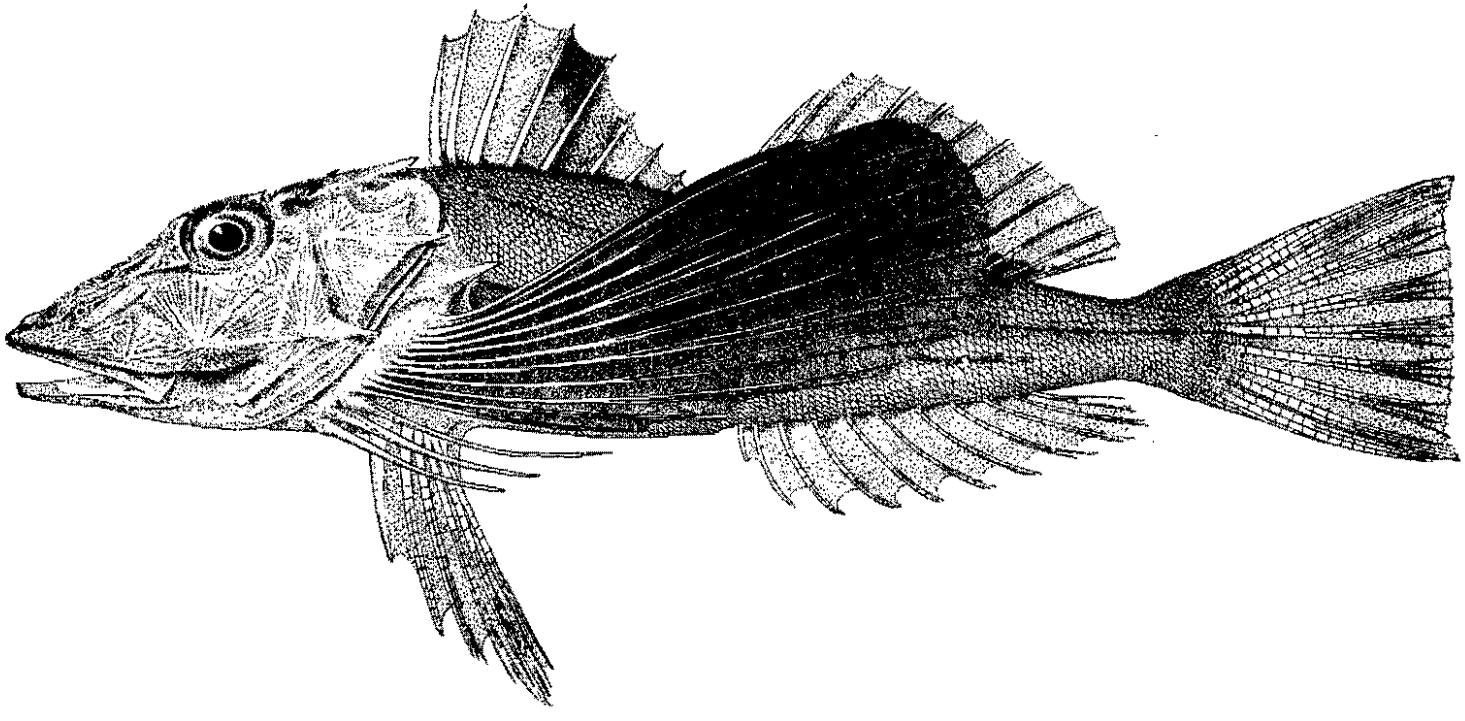


FIGURE 1. Adult striped searobin, Prionotus evolans, from Goode (1884). Drawing by H. L. Todd.

"A black streak along course of lateral line; a black or brown line or streak below lateral line from humeral spine backward, usually ending not far from end of anal often continued backward as a row of small spots; often a group of small spots below anterior part of lower line in a narrow lengthwise area; the two lines developing approximately between 45-60 mm, often very faint or interrupted in considerably larger specimens, rather sharply marked in large fish. The small specimens with oblique rather faint dark crossbands on upper part of body, two under soft dorsal, one each a short distance behind its beginning and before its end, respectively; a similar, still fainter band sometimes perceptible under spinous dorsal; a rather faint blotch at caudal base: the above dark markings disappearing with growth, and absent in the larger specimens. Body often with few or many pearly white dots. Pectoral very dark to black, the larger specimens often with fine, transverse, cross-streaks, closely crowded, nearly continuous or more or less interrupted, the streaks present or absent depending on individual variability. Dorsal spot large, extending to margin of fin and usually between fourth and sixth spines, sometimes part of spot between fifth and sixth spine rather faint.

"This species is very close to tribulus and differs from it chiefly in 4 characters: in having more numerous gill rakers and scales, in having the spines on the head not as well developed and in color. Not one of these characters will absolutely separate the two species. They intergrade moderately in the number of scales and gill rakers.... The differences in spine development becomes evident on direct comparison. (Because the spines diminish in size with growth in both species, as they do in other species, the comparison must be made size for size.) The differences between the two species in spine development is usually rather pronounced except in very large specimens, and is of considerable help in separating the species; but occasional variants are not definitely separable by this character alone. The difference in color is also not absolute. Variants of evolans, in the small and medium size groups have one or both lengthwise lines interrupted and faint; while some specimens of tribulus show a trace of these lines.

"A minor character which is of some value in separating the two species refers to the color of the pectoral. In evolans, the cross streaks on the pectoral, when present, are more crowded, and also finer, than in most specimens of tribulus."

Fresh coloration, according to Bigelow and Schroeder (1953), is a reddish to olive-brown ground color, with a dusky or bronze-brown lateral striped, dusky to black first dorsal fin blotch, orange to brown pectoral with pale edges, pale brown or orange modified pectorals marked with narrow brown bars.

For description of eggs, larvae and juveniles see 3.1.7, 3.2.1, 3.2.2, 3.2.3.

1.3.2 Cytomorphology

No information available.

1.3.3 Protein specificity

No information available.

2. DISTRIBUTION

2.1 Total Area

Striped searobins occur from Cape Cod, Massachusetts to South Carolina (Bigelow and Schroeder, 1953), rarely straying north to the Bay of Fundy (Leim and Day, 1959) and south to Florida (Bullis and Thompson, 1965). They can be found from the estuaries to the edge of the continental shelf and they prefer a sandy bottom.

2.2 Differential Distribution (size)

2.2.1 Spawn, Larvae and Juveniles

Eggs and larvae - Striped searobin eggs have been reported in Narragansett Bay and Long Island Sound (Appendix I) however, species identification is questionable as the only published reference to the description of striped searobin eggs (Perlmutter, 1939) was refuted by Wong (1968).

Juveniles - Juveniles are taken with adults in ocean surveys but their distribution has not been analyzed separately. Juveniles are reported in Long Island estuaries fairly regularly in the late summer and fall (Appendix I).

2.2.2 Adults

Results of surveys conducted by the National Marine Fisheries Service from Cape Canaveral, Florida to Nova Scotia, Canada (Table 1) indicate that adult and juvenile striped searobin north of Cape Hatteras are nearly all taken inshore (<15 fm) from May to November and nearly all offshore (60-200 fm) in March and early April. Migration appears to occur inshore in late April and offshore in late November.

TABLE 1. Distribution of striped searobins (juveniles and adults) along the Atlantic coast of the United States as reported in three shelf survey programs. A checkmark (✓) indicates presence; X indicates absence.

		North of Cape Hatteras, North Carolina		
		Inshore 0-15 fm	Mid-Shelf 15-60 fm	Far-Shelf 60-200 fm
Winter	1971 March		X (a)	✓ Little Egg Inlet, NJ to Oregon Inlet, NC (a)
	1972 March		X (a)	✓ Great Egg Harbor Inlet, NJ to Chesapeake Bay, VA (a)
	1973 March	X (a) Cape Cod, MA to NJ surveyed.	X (a)	✓ Chesapeake Bay to Cape Hatteras, NC (a)
	1974 Mar.-Apr.		X (a)	✓ Off Chesapeake Bay (a)
	1975 March	X (a)	X (a)	Off Delaware and MD (Block Is. NY to Chesapeake Bay surveyed) (a)
Spring	1973 May-June	✓ Block Is., RI to Cape Hatteras, NC (a)		
	1974 April	✓ Off NJ (a)		
Summer	1970 August	✓ Long Is., NY to Ocean City, MD (b)		
	1971 July-Aug.	Long Is., NY to Cape Hatteras, NC	X (b)	
	1975 September	✓ Long Is., NY to Del. (a)	X (a)	X (a)
Fall	1971 October		X (a)	X (a)
	1972 Nov.-Dec.	✓ Long Is., NY to Cape Hatteras, NC (a)		
	1973 Sept.-Oct.		X (a)	X (a)
	1973 Oct.-Nov.	✓ Block Is., RI to Cape Hatteras, NC (a)		
	1975 Oct.-Nov.	✓ Block Is., RI to Cape Hatteras, NC (a)	✓ Few off Chesapeake Bay (a)	X (a)
	1975 December	✓ MD to Cape Hatteras, NC and off N. tip of Long Is. (a)	✓ NY-NJ area (a)	✓ Chesapeake Bay to Cape Hatteras, NC (a)

		South of Cape Hatteras, North Carolina		
		Inshore 0-15 fm	Mid-Shelf 15-60 fm	Far-Shelf 60-200 fm
Winter	1960 Dec.-Jan.		X (c)	X (c)
Spring	1972 May	X (b)	✓ Cape Hatteras, NC to Sapelo Sound, GA (b)	X (b)
Fall	1971 November	✓ Cape Lookout, NC to Cape Fear, NC-one at St. Augustine Inlet, FL (b)	✓ Off Beaufort, SC (b)	X (b)
	1972 Oct.-Nov.	✓ Cape Hatteras, NC to Cape Fear, NC and off Charleston, SC (a)	✓ Cape Fear, NC to Charleston, SC (a)	X (a)
	1973 Oct.-Nov.	✓ Cape Hatteras, NC to Cape Fear, NC (a)		

Description of surveys and data: (a) Grosslein, 1969 (data available through the Northeast Fisheries Center, Resource Surveys Investigation, Woods Hole, Mass.)
(b) Wilk and Silverman, 1976
(c) Bullis and Thompson, 1965

South of Cape Hatteras present data indicates a limited inshore - offshore migration restricted to inshore and mid-shelf waters (<60 fm) with no searobins being recorded in far-shelf waters (Table 1).

Few adult striped searobin have been reported in estuarine trawl surveys (Appendix I) however, salt-water angling surveys (Table 2) report large numbers in estuaries.

2.3 Determinants of Distribution

Temperature and time of year - Marshall (1946) found searobin species entered New England waters at temperatures slightly above 4.4°C and left before the temperature fell below 15.5°C. Mann (1974) found the first searobins at inshore Long Island Sound stations off Shoreham, N.Y. at temperatures of 10°C in May and the last ones at 8°C in December (See 3.5.3 Response to Stimuli - Temperature). Abbe (1967) found that striped searobin in the Delaware River migrated with the northern searobin before the temperature fell below 18°C and before the end of September.

Salinity - Abbe (1967) found striped searobin in the Delaware River in lower salinities than northern searobin, being taken in salinities of 18-31.7°/oo, whereas northern searobin were taken mainly above 27°/oo. He states that: "The fish is one of the very few that showed any size segregation on the basis of salinity. Those fish caught at salinities above 27°/oo were usually more than 20 cm long. However, in the salinity range of 18 to 24°/oo the average length was only 12 to 16 cm. Larger fish were also caught in the higher numbered sectors, but this was probably because of the higher salinities."

2.4 Hybridization

No information available.

3. BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality

Heterosexual. Hermaphroditism not reported.

TABLE 2. Estimated number of searobins caught by anglers in the estuaries and ocean north of Cape Hatteras, North Carolina in 1965 and 1970 (Deuel and Clark, 1968; Deuel, 1973).

	Number caught (in thousands)			
	Cape Hatteras-New Jersey		New York-Maine	
	Estuaries	Ocean	Estuaries	Ocean
1965	1,004	720	1,783	508
1970	1,433	4,398	1,810	1,010

3.1.2 Maturity

Both sexes of striped searobin reach maturity at 2-3 years and a length of 208-301 mm in the Chesapeake Bight. They begin to develop in the spring or summer one year before spawning (McEachran and Davis, 1970). Marshall (1946,) found one-year olds (18 cm) from New England waters capable of producing ripe eggs although the ovaries were small and eggs few in number. McEachran and Davis (1970) note that Marshall's fish were probably two year olds rather than one.

3.1.3 Mating

Moulton (1958) has indirect evidence that searobins produce a staccato call thought to characterize the breeding season as opposed to a grunting sound they usually emit (See 3.5.3, Auditory).

3.1.4 Fertilization

External.

3.1.5 Gonads

Stages of development are summarized as follows:

Immature - transparent tubules about 1 mm in diameter (McEachran and Davis, 1970).

Developing - opaque tubules >1 mm diameter; testes white, ovaries yellow-orange, small eggs visible at 14X shortly after start of gonadal enlargement (McEachran and Davis, 1970).

Ripe - ripe testes from a 345 mm, 503 g striped searobin taken July 28, 1974 were opaque white, of fine texture, 60-80 mm long, ranged from 20-30 mm wide and weighed 17.28 g (pers. observ.).

Marshall (1946) reports: "Variability of egg size and development is conspicuous throughout. The largest eggs, whether ripe or partially so, are not grouped but are scattered amongst less developed eggs of diverse sizes. Correlated with this is the fact that few eggs are ripe at any one time and the breeding season is somewhat prolonged."

3.1.6 Spawning

McEachran and Davis (1970, p. 351) found yearlings from Chesapeake Bay and Bight started maturation in April and all had enlarged gonads by November. Those two years or older were running ripe from May through early July with the highest incidence in mid-June. By August they were spent or recovering. They found more gravid and ripe striped searobins in the estuaries in April 1966 and May 1967 than in the ocean. Mann (1974) also reports striped searobin in "running ripe" condition in Long Island Sound from early May through mid-July.

No information is available describing the act of spawning.

3.1.7 Spawn

No information available. See 2.2.1.

3.2 Preadult Phase (to sexual maturity)

3.2.1 Embryonic phase

No information available.

3.2.2 Larval phase

No information available.

3.2.3 Adolescent phase

No information available.

3.3 Adult Phase

3.3.1 Longevity

From a study of otoliths, McEachran and Davis (1970) determined the oldest fish in their Chesapeake Bight samples to be 7 years (415 mm). They did not report relative abundance of each age group. Mann (1974) collected a 9 year old striped searobin from Long Island Sound.

3.3.2 Hardiness

No information available.

3.3.3 Competitors

No information available.

3.3.4 Predators

Dusky shark, sandbar shark (Casey, 1964), man.

3.3.5 Parasites, Diseases, Injuries and Abnormalities

Parasites of striped searobin listed by Linton (1901) from Woods Hole specimens are:

> Echinorhynchus acus Rudolphi: (Linton, 1892)
> Rhynochobothrium - cysts in peritoneum (Linton, 1897)

No information is available as to diseases, injuries and abnormalities.

3.4 Nutrition and Growth

3.4.1 Feeding

The digging and "feeling" movement exhibited by the modified pectorals of searobins has been connected with the search for food. In 1884, Goode observed searobins using their modified pectorals to stir up the weeds and sand to rout out the small animals on which they fed. Bardach and Case (1965) supported the observation with their findings that blinded anosmic searobins responded by digging when food extracts were placed in the water proximal to their modified pectorals (See 3.5.3, Chemical).

Although research indicates that the modified pectorals are involved with the detection of food, the findings of Marshall (1946) indicate that searobins most likely feed on organisms on or just above the bottom rather than burrowed in the bottom. This conclusion was reached when he compared the stomach contents of searobins with the most abundant organisms listed by Lee (1944) in his bottom samples of the same area and found little correlation.

3.4.2 Food

The following are listed by Bigelow and Schroeder (1953): shrimps, crabs, amphipods, squids, bivalve mollusks, annelid worms, small fish (herring, menhaden, winter flounder), seaweed, any bait.

A more detailed analysis of stomach content is given by Marshall (1946). He found young-of-the-year striped searobin consumed copepods in the greatest quantity (>100 organisms/stomach) with the decapod shrimp, Crangon septemspinosa and cumacean Diastylis sp. taken in small quantities (<5 organisms/stomach). Larger striped searobins (18-1/2 - 30 cmSL) at Menemsha Bight, Vineyard Sound, MA., consumed the mysid, Mysis americana, amphipod, Gammarus locusta and decapod, Crangon septemspinosa in large numbers (>60 organisms/stomach). Small numbers of northern searobin, amphipods, undetermined Pleuronectidae and Teleostomi were also found. The only organism not found in the striped searobin but found in the northern searobin from the same area was the pelecypod Tellina tenera.

Mann (1974) analyzed the stomach content of striped searobin from Long Island Sound off Shoreham, N.Y. Young-of-the-year fish were found to consume the decapod shrimp Neomysis spp. and Crangon septemspinosa almost exclusively. The diet of larger fish was composed of at least 60% crustacea with crabs found in the highest percentages and the decapod shrimp Crangon septemspinosa second highest at all times of the year. Small fish were the only other food item consumed in all seasons. Mysids, bivalves, gastropods, polychaetes, nemerteans, fish eggs, plant seeds, copepods, plastic balls, sand, squid and algae were found in small amounts.

3.4.3 Growth Rate

The following statistics from McEachran and Davis (1970) are based on otolith readings taken from 803 striped searobin in the Chesapeake Bight.

Age	Mean fork length (mm)	
	1966	1967
I	151	173
II	221	237
III	249	261
IV	272	278
V	288	315
VI	341	323
VII	415	

Age-class statistics from Mann (1974) based on either otolith or scale readings of 514 striped searobin taken in Long Island Sound off Shoreham, N.Y.

Age	Standard Length (mm)	Average Standard Length (mm)	No. of Specimens
0	40-110	88	87
I	110-220	173	15
II	120-270	227	60
III	200-300	240	178
IV	210-330	267	114
V	230-370	292	40
VI	260-350	300	17
VII	320-360	337	2
IX	384		1

The striped searobin is potentially a larger fish than the northern searobin, reaching a maximum length of about 457 mm (18 in.) (Bigelow and Schroeder, 1953).

Wilk, et al. (1978) found a statistically significant difference in the weight of male and female striped searobin of the same length from the New York Bight. Length-weight slopes for the two sexes did not differ significantly ($P>0.05$), however, the intercepts did ($P<0.01$). Calculated weights of females 200 mm long were found to be 7% heavier than males of the same length.

Length-weight equations and sample size (n) for striped searobin from trawl surveys in the NY Bight from June 1974 to June 1975 were:

$$\log_{10} W = -4.3727 + 2.7943 (\log_{10} L), \quad n = 151 \text{ males}$$

$$\log_{10} W = -4.8289 + 2.9928 (\log_{10} L), \quad n = 140 \text{ females}$$

W = weight (g)
L = fork length (mm)

3.4.4 Metabolism

No information available.

3.5 Behavior

3.5.1 Migration

A seasonal migration occurs north of Cape Hatteras; inshore during spring months and offshore in early winter. North-south migration is not known. (See 2.2.2, Adult Distribution).

3.5.2 Schooling

There is no direct evidence of schooling although an occasionally large catch of several hundred striped searobin per tow is reported in the results of the National Marine Fisheries Service spring and fall groundfish surveys. This pattern of catch suggests a discontinuous distribution occurs over the bottom.

3.5.3 Response to Stimuli

Optical - Lee (1942) found the red-winged searobin Prionotus strigatus (Cuvier) (a synonym of P. evolans) "responds to a white background by concentrating the melanophore pigment and dispersing the pigment of the erythrophores; and to a black background by dispersing the melanophore pigment, and the partial concentration of the erythrophore pigment in the majority of instances."

He found that the eyes of the searobin are necessary for the color changes in responses to various backgrounds with the conception of the appearance of a white patch on the dorsal head region in response to bright light. He also found "With the light-adapted animal at rest, a slight disturbing stimulus such as tapping on the tank or waving the hand between the fish and the light source will produce a complete pallor of the pectoral erythrophores within 2-4 seconds.... At the removal of the exciting stimulus, the entire innervated region of the fin regained its previous coloration within 10-15 seconds...."

Auditory - Moulton (1955, 1958) discusses the possibility of eliciting a staccato call from searobins which is thought to characterize the breeding season, by playing imitations and recordings of the call into the water. Fish and Mowbray (1970) compared Moulton's tapes of field recorded sounds with those of their own from searobins held in bay enclosures and laboratory aquaria and concluded that the sounds recorded by Moulton were probably of sciaenid origin.

Parker (1912) found that in a controlled study of response to sound made by an iron ball hitting the side of a wooden tank that the northern and striped searobins "exhibited unmistakable tendencies to gather near the sound center".

Chemical - Lee (1942) found "Injections of adrenalin cause a concentration of the pigment in all melanophores and erythrophores, regardless of whether they are innervated or denervated," while denervation alone causes a dispersion of all chromatophore pigments. Bardach and Case (1965) found blinded, anosmic searobins strongly reacted by digging to extracts of rotted clams, worms or squid applied to the water proximal to their modified pectorals. The responses to fresh extracts were weaker. They had a positive response to milk. The digging response was elicited by application of several amino acids. When the lips or mouth were stimulated the animals responded by swallowing or gulping instead of digging.

Thermal - Schwartz (1964) found in a study of response of the striped searobin to low water temperature all seven searobins studied survived water temperatures of 3.3 - 3.9°C for 81-86 days. All were normal in behavior to that point when several began to glide slowly throughout the aquarium with pectorals held near the body. Within a month all were gliding with the pectorals or all fins held erect. Later all specimens died.

4. POPULATION

4.1 Structure

4.1.1 Sex Ratio

Approximately 1:1 in fish sampled from the New York Bight (Wilk, et al., 1976).

4.1.2 and 4.1.3 Size and Age Composition

Length frequency histograms (McEachran and Davis, 1970) from Chesapeake Bight samples taken seasonally during 1966 and 1967 are generally bimodal. One mode occurs in the 125-225 mm range and consists of yearlings while the second is in the 200-325 mm range and probably comprises several older age groups.

4.2 Abundance and Density

4.2.1 Relative Abundance

Marshall (1946) reports the ratio of northern and striped searobins to be 2.5:1 from June to September in Buzzards Bay and Vineyard Sound, MA. A similar ratio (2.6:1) was obtained in the New York Bight (Wilk, et al., 1977).

Results of NMFS sport fishing surveys off the northeastern U.S.A. from June 1973 to June 1974 rank searobins tenth in weight of "other finfish" following bluefish, striped bass, weakfish, tautog, scup, dogfish, other (miscellaneous species), spot and black sea bass in descending order. They ranked higher than croakers, cunner, cusk, black drum, red drum, kingfishes, Spanish mackerel, puffers, shad, skates, smelt, tilefish and toadfish (U. S. Dept. Comm., NMFS, 1976).

Of the 21 groups of "other fish"[6] mentioned above, ICNAF commerical landings record searobins varying usually from 9th to 18th in weight over a 12 year period with a single high rank of third in 1968. They were generally greater than the angler, tilefish, wolffishes, bluefish, croaker, black sea bass, spot and squeteague (U. S. Dept. Comm., NMFS, 1976).

A summary of mean catch per tow data from fall bottom trawl surveys of the NMFS, 1963-74 (Table 3) gives an idea of fluctuations in abundance. Searobins in the southern New England area (ICNAF 6A and 5Zw) (Figure 2) remained at a fairly constant low level, increasing slightly in 1972. In the middle Atlantic area (ICNAF 6B and 6C) searobins were far more abundant in 1967. In 1968 they decreased abruptly, continuing downward to a low level in 1974.

4.2.2 Actual Abundance

No information available.

4.3 Natality and Recruitment

No information available.

4.4 Mortality and Morbidity

No information available.

4.5 Dynamics of Population (as a whole)

No information available.

4.6 The Population in the Community and the Ecosystem

See 3.5.2.

5. EXPLOITATION

Sport fishery - searobins are good fighters and they are comparable in quality to a kingfish or whiting as food (Goode, 1884). Despite this, they are generally considered a nuisance to most fishermen as they are spiny to handle and there is relatively a small amount of flesh that can be eaten.

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[6] "other finfish" - defined by the International Conference for the Northwest Atlantic Fisheries (ICNAF) as all species except cod, haddock, redfish, silver hake, red hake, pollock, sea herring, mackerel, flounders, large pelagic fish (like tuna, swordfish and sharks other than dogfish), billfishes and menhaden.

TABLE 3. Mean catch per tow (kilograms) of searobins in NMFS strata, with approximately corresponding ICNAF Divisions (Figure 2), from Albatross IV autumn bottom trawl survey data, 1967-74 (Clark and Brown, 1977).

NMFS Strata	ICNAF Division or Subdivision	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
61-76	6B, 6C					130.1	13.8	5.4	6.9	3.1	1.7	1.9	1.9
1-12	6A, SZw	1.0	0.8	0.5	0.7	0.8	0.3	0.5	0.2	0.3	4.7	0.3	0.1

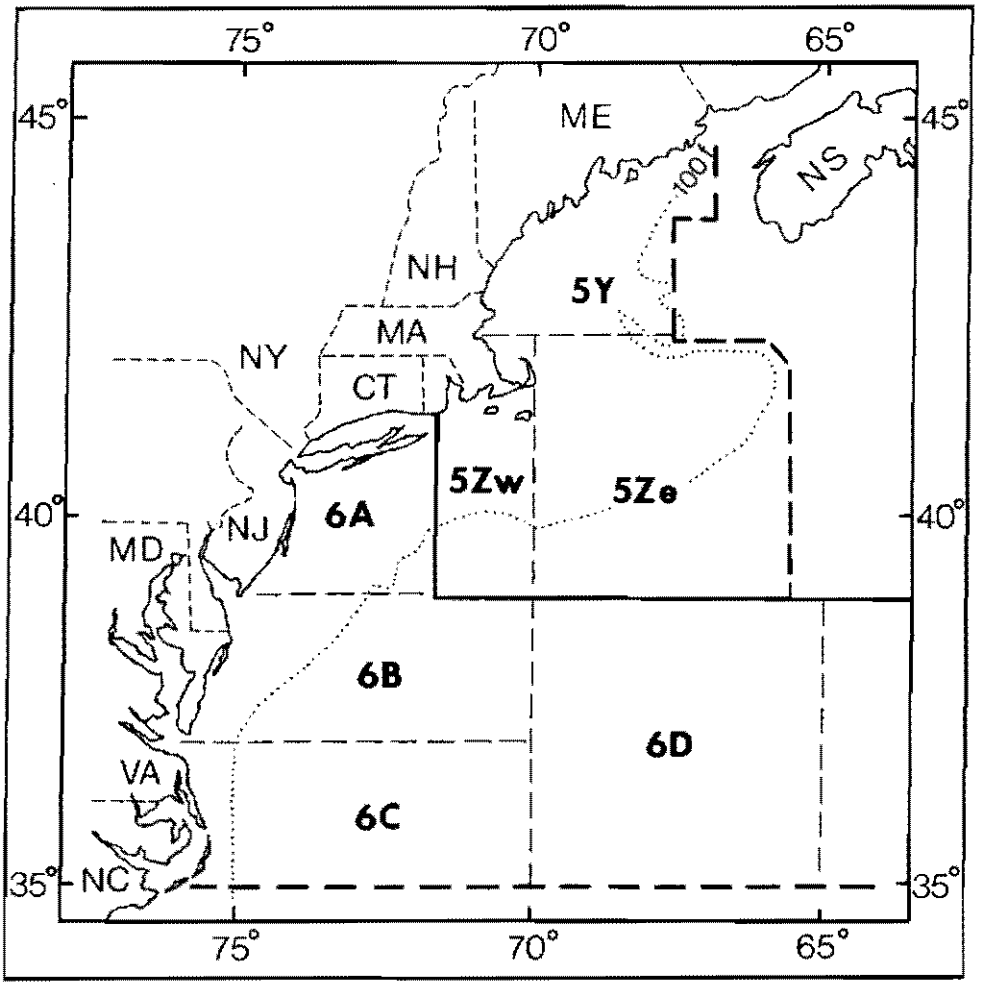

FIGURE 2. Portion of the Atlantic Coast showing locations of ICNAF Subarea 5 and Statistical Area 6.

Commercial fishery - searobins are considered trash fish and are taken incidently with the food fish catch or with the trash fish catch. I know of no special fishery for searobins.

5.1 Fishing Equipment

Sport - searobins bite at any type of fresh bait. Results of salt water angling surveys (Table 4) indicate that the majority of searobins are caught from stationary boats and many are taken from shore with still bait. Off New England, searobins are principally caught around bridges, piers and jettys, whereas south of New York Harbor, more are caught from beaches and banks.

Commercial - Snow (1950) reported that the boats used by the trash fishery at New Bedford, Massachusetts were small draggers with an average length of 51 ft. and an average of 26 tons. The gear was the same used for otter trawling operations except that a liner of 1-1/2 or 2 in. mesh was inserted in the cod end of the net to support the heavy weight of a haul of trash fish.

Most ports taking searobins do not have a specific trash fishery but take searobins incidently with their regular food fish catch. Searobins are mostly taken with the otter trawl, pound net and floating traps (Table 5). A few are reported in fyke net, hoop net, haul seine and purse seine catches.

5.2 Fishing Areas

The greatest numbers of striped searobins are found from Cape Fear, N. C. to Montauk Point, N. Y. with very few taken north of Cape Cod, Mass. They are usually found on sandy bottoms. They tend to keep to the bottom but swim actively and are sometimes caught close to the surface.

5.3 Fishing Seasons

Inshore - May through October

5.4 Fishing Operations and Results

Sport - see Table 6.

Commercial - commercial catch records are influenced by the fact that 1) many states do not have trash fisheries and thus many fish are thrown overboard; 2) some states (Delaware and North Carolina) have not reported searobins; and 3) fishing areas for individual states overlap and may vary from year to year. Therefore, reported numbers (Table 7) are of limited value for searobins except for evaluating general trends.

TABLE 4. Number of searobins reported in 1960, 1965 and 1970 salt-water angling surveys by region and method of fishing (Clark, 1963; Deuel and Clark, 1968; Deuel, 1973).

Year	Region	No. of Anglers (thousands)	No. of Searobins Reported (thousands)				
			Boat		Shore		
			Still	Moving	Still	Moving	Total
1960	North Atlantic	24	287	3	-	3	293
	Middle Atlantic	44	2,747	-	236	-	2,983
	South Atlantic	3	-	-	3	-	3

Year	Region	No. of Anglers (thousands)	Boat	Bridge Pier Jetty	Beach Bank	Total
1965	North Atlantic	134	2,079	149	63	2,391
	Middle Atlantic	95	1,327	8	389	1,724
	South Atlantic	-	-	-	-	-

Year	Region	No. of Anglers (thousands)	Boat	Bridge Pier Jetty	Beach Bank	Total
1970	North Atlantic	263	2,556	177	87	2,820
	Middle Atlantic	367	5,194	188	449	5,831
	South Atlantic	4	-	-	4	4

TABLE 5. Commercial landings of searobins, by gear. Numbers in pounds. (U. S. Dept. Commer. B. F. 1930-1940; U. S. Dept. Int. F.W.S. 1942-1969; U. S. Dept. Commerc. NMFS 1971-1976)

	Massachusetts		Rhode Island			Connecticut				New York					New Jersey			Maryland		Virginia		
	Pound Net	Otter Trawl	Floating Trap	Otter Trawl	Pound Net	Otter Trawl	Hand Line	Gill Net	Pound Net	Otter Trawl	Pound Net	Pyke: Hoop Net	Floating Trap	Gill Net	Otter Trawl	Pound Net	Purse Seine	Otter Trawl	Pound Net	Otter Trawl	Pound Net	Haul Seine
1930	87,450	-	101,978	4,500	-	40,556	-	-	500	-	11,139	-	3,115	400	-	117,747	-	600	-	-	-	-
1935	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600	-	-
1940	700	19,500	112,400	2,400	400	6,500	100	200	-	23,700	34,300	-	-	-	7,100	97,000	-	-	-	8,200	2,000	-
1945	-	2,500	9,700	-	-	18,500	300	-	-	3,400	3,400	-	-	-	3,600	300	-	-	-	10,200	-	-
1950	-	-	68,100	2,800	-	-	-	-	-	36,900	-	-	-	-	2,300	52,100	-	-	-	30,800	-	-
1955	-	16,500	6,200	5,200	-	14,500	-	-	-	11,500	-	-	-	-	400	1,500	-	-	-	2,400	-	-
1960	-	-	205,200	4,200	-	5,000	-	-	-	2,700	3,500	-	-	-	-	17,800	-	-	-	500	-	-
1961	-	-	187,800	3,000	-	22,100	-	-	-	100	5,500	-	-	-	-	2,600	-	-	-	-	-	-
1962	-	-	98,700	-	-	11,600	-	-	-	-	-	-	-	-	1,000	-	-	-	-	3,000	-	-
1963	-	-	130,000	1,400	-	3,400	-	-	-	1,100	9,800	-	-	-	-	19,700	-	72,100	-	3,100	-	-
1964	-	-	88,200	-	-	7,400	-	-	-	-	25,000	-	-	-	-	43,500	-	525,400	-	6,300	-	-
1965	-	-	252,000	-	-	10,500	100	-	-	6,500	66,300	-	-	-	174,000	-	-	-	-	7,800	-	-
1966	200	-	207,100	-	-	30,800	200	-	-	1,900	38,700	-	-	-	-	198,100	-	455,500	-	-	13,000	-
1967	-	-	125,700	100	-	28,500	300	-	-	17,600	46,800	-	-	-	-	-	-	321,000	-	2,700	14,200	-
1968	-	-	224,400	-	-	100,000	-	-	-	50,400	5,600	-	-	-	300	5,800	-	26,800	-	-	67,200	7,000
1969	600	-	71,700	-	-	600	200	-	-	29,400	35,800	-	-	-	-	2,500	-	95,900	-	-	1,000	-
1970	-	-	128,500	-	-	9,400	-	-	-	39,400	35,800	-	-	-	-	-	-	39,900	-	-	-	-
1971	-	-	70,100	-	-	90,100	-	-	-	111,600	30,400	-	-	-	13,500	600	-	-	-	-	-	-
1972	-	-	139,700	-	-	31,100	-	-	-	42,100	2,200	300	-	-	-	600	700	-	-	-	-	-
1973	-	-	151,500	-	-	600	-	-	-	-	11,700	40,500	-	-	6,800	400	-	-	-	-	800	-

- no record

TABLE 6. Number of searobins caught per angler in 1960, 1965 and 1970 (Clark, 1963; Deuel and Clark, 1968; Deuel, 1973).

	North Atlantic	Middle Atlantic	South Atlantic
1960	12.2	67.8	1
1965	17.1	18.1	0
1970	10.7	15.9	0

TABLE 7. Commercial fisheries statistics for searobins (in thousands of pounds).

Year	MA	RI	CT	NY	NJ	MD	VA
1928	<1	468	14	30	23	-	50
1929	-	255	30	23	40	1	-
1930	<1	194	41	15	118	1	-
1931	<1	101	29	33	70	1	-
1932	5	81	30	15	17	<1	-
1933	<1	74	3	19	11	1	-
1934	<1	74	3	19	11	-	1
1935	18	219	40	47	45	-	-
1936	18	219	40	47	45	-	1
1937	56	103	22	16	55	-	3
1938	81	289	4	12	73	-	3
1939	52	203	13	37	58	-	38
1940	20	115	7	58	104	-	10
1941	20	115	7	58	104	-	-
1942	-	100	1	63	94	-	3
1943	-	51	29	45	25	-	3
1944	-	32	63	43	4	-	32
1945	3	10	19	7	4	-	10
1946	-	8	43	9	4	-	12
1947	-	15	56	5	5	-	21
1948	-	14	144	5	9	-	30
1949	-	9	120	17	24	-	15
1950	-	71	37	37	54	-	31
1951	-	72	245	5	6	-	103
1952	1	9	68	3	14	-	116
1953	15	68	5	20	12	-	1
1954	-	144	4	22	14	-	4
1955	16	11	14	12	2	-	2
1956	1	7	5	20	263	-	8
1957	-	226	29	83	127	-	14
1958	-	476	5	-	48	-	10
1959	-	220	7	3	273	-	-
1960	-	205	5	6	18	-	1
1961	-	188	22	6	3	-	-
1962	-	99	12	-	1	-	3
1963	-	130	3	11	20	72	3
1964	-	88	7	25	44	525	6
1965	-	252	11	72	174	-	8
1966	1	207	31	40	190	456	13
1967	-	126	29	64	-	321	17
1968	-	224	100	56	6	27	74
1969	1	72	1	65	3	86	1
1970	-	129	9	75	-	40	-
1971	-	70	91	142	14	-	-
1972	-	140	31	45	1	-	-
1973	-	151	1	52	7	-	628
1974	656	230	-	42	1	-	-
1975	-	116	-	45	667	-	-
1976	125	70	-	38	1,210	-	-

- No record

Nominal catches of Atlantic shelf searobins by ICNAF countries from 1964-1973 are given in Table 8. ICNAF fishing areas are illustrated in Figure 2.

6. PROTECTION AND MANAGEMENT

6.1 Regulatory Measures

At present searobins fall within the category "other finfish".[7] A total allowable catch (TAC) is set by ICNAF for these fish collectively. The TAC recommended by the NMFS for 1977 was 150,000 tons. On attainment of the quota all fisheries are terminated and subsequently only incidental catches (1% of the total weight of all other fish on board) are allowed (U. S. Dept. Comm., NMFS, 1976).

6.2 Control or Alteration of Physical Features of the Environment

No information available.

6.3 Control or Alteration of Chemical Features of the Environment

No information available.

6.4 Control or Alteration of Biological Features of the Environment

No information available.

6.5 Artificial Stocking

No information available.

7. AQUACULTURE

No information available.

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[7] Defined by the International Conference for the Northwest Atlantic Fisheries (ICNAF) as all species except cod, haddock, redfish, silver hake, red hake, pollock, sea herring, mackerel, flounders, large pelagic fish (like tuna, swordfish, and sharks other than dogfish), billfishes and menhaden.

TABLE 8. ICNAF nominal catches of searobins by country in subarea 5, Georges Bank and the Gulf of Maine, and statistical area 6, Middle Atlantic Bight, 1964-73 (metric tons).

Area	GDR		JAP		POL		ROM		USSR		USA		TOTAL	
	5	6	5	6	5	6	5	6	5	6	5	6	5	6
1964	-	-	-	-	-	-	-	-	-	147	14	-	14	147
1965	-	-	-	-	-	-	-	-	-	-	300	-	300	-
1966	-	-	-	-	-	-	-	-	98	1,279	94	-	192	1,279
1967	-	-	-	-	-	-	-	-	124	370	94	196	218	566
1968	-	-	-	-	-	-	-	-	1,130	7,872	102	239	1,232	8,111
1969	-	-	-	-	-	-	-	-	1,758	145	156	1,590	1,914	1,735
1970	-	-	-	41	-	-	-	-	-	258	148	141	148	440
1971	-	-	4	20	-	-	-	-	46	792	50	110	100	922
1972	15	31	-	-	-	-	29	-	283	3,489	47	26	374	3,546
1973	-	1	-	-	962	90	-	-	604	1,172	37	37	1,603	1,300

APPENDIX I. Summary of estuarine surveys to 1975 along the Atlantic coast of the United States with number of searobins taken.

Estuary	Reference	Frequency and Dates of Survey	Method of Catch	Eggs and Larvae (# caught and dates)	Juveniles and Adults (# caught and dates)
Maine - none					
New Hampshire - none					
Massachusetts					
Merrimack River (9 stations)	Jerome, Chesmore, Anderson and Grice 1965	monthly Jan.-Dec. 1964	minnow seine haul seine trawl		no searobins taken
Parker-River-Plum Island Sound (9 stations)	Jerome, Chesmore and Anderson 1968	monthly Jan.-Dec. 1965	minnow seine haul seine trawl		no searobins taken
Essex Bay (9 stations)	Chesmore, Brown and Anderson 1973	monthly May-Dec. 1969	seine trawl		no searobins taken
Annisquam River-Gloucester Harbor Coastal System (8 stations)	Jerome, Chesmore and Anderson 1969	monthly Apr. 1966-Mar. 1967	minnow seine haul seine shrimp trawl		no searobins taken
Beverly-Salem Harbor (9 stations)	Jerome, Chesmore and Anderson 1967	monthly Jan.-Dec. 1965	minnow seine haul seine trawl		no searobins taken
Lynn-Saugus Harbor (9 stations)	Chesmore, Brown and Anderson 1972	monthly June 1968-June 1969	minnow seine haul seine trawl		no searobins taken
Dorchester Bay (9 stations)	Chesmore, Testaverde and Richards 1971	monthly June 1967-May 1968	haul seine shrimp trawl		no searobins taken
Quincy Bay (9 stations)	Jerome, Chesmore and Anderson 1966	monthly Jan.-Dec. 1964	minnow seine haul seine trawl		no searobins taken
Hingham Bay (13 stations)	Iwanowicz, Anderson and Ketschke 1973	monthly	beach seine haul seine shrimp trawl otter trawl		no searobins taken
North River (6 stations)	Fiske, Watson and Coates 1966	monthly June 1964-June 1965	minnow seine haul seine shrimp trawl		no searobins taken
Wellfleet Harbor (9 stations)	Curley, Lawton, Whittaker and Hickey 1972	monthly Sept. 1968-Aug. 1969 (except Dec.)	beach seine otter trawl		P. carolinus(1) adult, Oct. P. ovolans(2) adults, Sept.
Pleasant Bay (6 stations)	Fiske, Watson and Coates 1967	monthly Jan.-Dec. 1965	beach seine haul seine otter trawl		no searobins taken
Waquoit Bay-Eel Pond (7 stations)	Curley, Lawton, Hickey and Fiske 1970	monthly June 1967-May 1968 (except Jan. and Feb.)	shrimp trawl beach seine		P. carolinus(4) adults, Aug.-Sept. P. ovolans(1) adult, Aug.
Wewentic River	Lobida 1969	monthly, bimonthly and weekly Jan.-Dec. 1966	plankton nets seine otter trawl fyke nets gill nets		P. carolinus(1-5) present but rare
Westport River (6 stations)	Fiske, Curley and Lawton 1968	monthly May 1965-1966	haul seine shrimp trawl		P. carolinus(5) adults, Sept.-Oct.
Rhode Island					
Narragansett Bay (4 stations)	Herman 1963	weekly Mar. 1957-Mar. 1958	meter net Clarke-Bumpus sampler	P. carolinus(1,395) eggs, June-Aug. P. ovolans(1,488) eggs, June-Aug. P. spp.(285) larvae July-Sept.	
Pettaquamscutt River and Pt. Judith Pond (4 stations)	Mulkana 1966	summer and early fall 1962	shore seine		P. ovolans(4) juveniles in river

APPENDIX I (continued)

Estuary	Reference	Frequency and Dates of Survey	Method of Catch	Eggs and Larvae (# caught and dates)	Juveniles and Adults (# caught and dates)
Connecticut					
Block Island Sound	Merriman and Solar 1952	monthly Aug. 1943-July 1946	trawl plankton net	no searobins reported	no searobins reported
Mystic River	Pearcy and Richards 1962	weekly, biweekly and monthly Feb. 1959-Feb. 1960 eggs and larvae July 1958-Feb. 1960 juveniles and adults	hook and line plankton net small beam trawl otter trawl beach seine trapnet, dipnet	P. carolinus(6) eggs, July-Aug., (2) larvae, June-Aug.	P. carolinus(5) juveniles and adults, Aug.-Oct.
New Haven Harbor	Warfel and Merriman 1944	biweekly July 1942-June 1943	haul seine		P. carolinus(1) juvenile, summer P. evolans(92) juveniles, Aug.-Sept.
Long Island Salt Waters (large # localities)	Greeley 1939	July-Aug.	fine-mesh seine		P. carolinus(1) young adult, Aug., P. tribulus(11) juveniles, July-Aug.
Long Island Salt Waters (56 stations)	Perlmutter 1939	monthly May-Oct. 1938	plankton nets Crisk trawl shrimp trawl otter trawl	P. carolinus(205) eggs, May-Aug., (14) larvae, June-Sept. P. evolans(several) eggs, May-July	P. carolinus(19) juveniles P. evolans(21) juveniles, Oct.
Long Island Sound (4-20 stations)	Wheatland 1956	biweekly Mar. 1952-Mar. 1954	Clarke-Bumpus plankton sampler	P. carolinus(22) eggs, June-Aug. P. evolans(25) eggs, June P. spp.(2) larvae, July-Aug.	
Long Island Sound	Richards 1959	35 cruises Apr. 1954-Nov. 1955	Clarke-Bumpus sampler	P. carolinus(35) eggs, June-Aug. P. evolans(11) eggs, June-Aug. P. spp.(7) larvae, July-Aug.	
Long Island Sound (2 stations)	Richards 1963	nearly every two weeks July 1956-July 1957	modified shrimp trawl		P. carolinus(143) juveniles and adults, May-Nov. P. evolans(3) adults, May-Aug.
Long Island Sound	Williams 1968	19 days Apr. 1964-May 1966	Clarke-Bumpus sampler	P. spp.(>100) eggs	
Long Island Sound (9 stations)	Mann 1974	monthly and biweekly Jan. 1973-Jan. 1974	trawl seine gill net plankton nets	P. spp. eggs and larvae	P. carolinus(577) juveniles and adults May-Dec. P. evolans(533) juveniles and adults May-Dec.
New York					
Lake Montauk (2 stations)	Austin 1973	monthly July 1971-Dec. 1972	plankton nets	P. spp.(11) larvae, July 1972, (1,738) eggs, July 1971, (8,256) eggs, June-Sept. 1972	
Great South Bay (3 stations)	Briggs and O'Connor 1971	random dates May-Oct. 1967 May-Nov. 1968 (no seining June of either year)	seine		P. carolinus(1) juvenile, Sept.
Hudson River (9-12 stations)	Perlmutter, Schmidt and Laff 1967	1-4 times/mo. each sta. June-Aug. 1964 and 1965	seine		all species not reported
Hudson River (9-12 stations)	Perlmutter, Schmidt Keller, Ford and Siniasky 1968	1-4 times/mo. each sta. June-Aug. 1964 and 1965	seine		all species not reported
New Jersey					
Sandy Hook Bay (6 stations)	Croaker 1965	monthly, weekly Oct. 1960-1961	plankton nets	P. spp.(281) eggs, May-June	
Carson and Manasquan Inlets	Murawski 1970	"continuous monitoring" Apr. 1967-Mar. 1969	plankton nets	P. spp.(4,143) eggs, June-Sept., (64) larvae, July-Oct.	

APPENDIX I (continued)

Estuary	Reference	Frequency and Dates of Survey	Method of Catch	Eggs and Larvae (# caught and dates)	Juveniles and Adults (# caught and dates)
Delaware					
Delaware River	Amos 1954				
Delaware River	Shuster 1959				
Delaware River	deSylva and Kalber 1960	monthly Sept.-Nov. 1958	otter trawl		P. carolinus(150) adults, Sept. P. evolans(13) adults, Sept.-Nov.
Delaware River (20 shore sites)	deSylva and Kalber and Shuster 1962	alternate months and biweekly Aug. 1958-Feb. 1960	haul seine		P. carolinus(1) juvenile, Aug., adults common summer and fall. P. evolans, adults common summer and fall.
Delaware River (12 zones)	Abbe 1967	monthly Aug.-Oct. once Nov.-Jan. Aug. 1966-Jan. 1967	otter trawl		P. carolinus(794) adults, most Aug.-Sept. P. evolans(95) adults, most Aug.-Sept.
Rehoboth and Indian River Bays (18 stations)	Derickson 1970 and Derickson and Price 1973	monthly June 1968-May 1969	seine otter trawl		P. carolinus(5) juveniles, July P. evolans(1) juvenile
Maryland					
Isle of Wight and Assawoman Bays (66 stations)	Schwartz 1964	various dates Mar.-Oct. 1959-63	otter trawl trap nets beach seine oyster trays hook and line		P. carolinus juvenile and adults common May-Sept. P. evolans adults, Aug.-Sept
Chincoteague and Sinepuxent Bays	Schwartz 1961	monthly trawl Mar.-Dec. 1959	beach seine crab potting hook and line oyster tong trays otter trawl		P. carolinus adults present May-Sept.
Chincoteague Bay (oyster beds)	Arve 1960	3 times a week Aug.-Nov. 1958 and 59	wire traps		no searobins taken
Patuxent River (96 stations)	Mansueti 1950	1-3 times a year spring, fall and winter	minnow seine bag seine box traps hoop net dipnet		no searobins taken
Virginia					
Chesapeake Bay (22-24 stations)	Massmann and Mansueti 1963)	4 cruises Sept. 1957; Jan., Apr., and July 1958	otter trawl		P. carolinus(4) young adults July, Sept. and Jan.
Rappahannock River (16 stations)	Massmann, Ladd and McCutcheon 1952	22 cruises Mar.28-Nov. 6, 1951	trawl		no searobins taken
Chesapeake Bay, York and Pamunkey Rivers (16 stations)	Massmann 1962	monthly in 1958 most months 1956, 1957, 1959	semi-balloon shrimp trawl		P. carolinus(345) Mar.-Dec. P. evolans(21) May-Nov.
Pamunkey River (9 stations)	Raney and Massmann 1953	weekly seining June 28-Sept. 29, 1949	minnow seine surface trawl roten one bottom trawl plankton net	no searobins taken	no searobins taken
North Carolina					
Beaufort area and Neuse River	Taylor and Dudley 1961	monthly and biweekly Mar. 1957-Feb. 1960	haul seine	P. carolinus(17) larvae, Sept.	P. carolinus(1) juvenile, Apr. (2) adults, Aug.
Beaufort Inlet area (7 stations)	Pearse, Humm and Wharton 1942	weekly in summer 1939 and 1941; irregularly rest of year	seine otter trawl		P. carolinus common on sandy bottoms P. acuticus present

APPENDIX I (continued)

Estuary	Reference	Frequency and Dates of Survey	Method of Catch	Eggs and Larvae (# caught and dates)	Juveniles and Adults (# caught and dates)
South Carolina					
South Carolina Estuaries (33 stations)	Sheely, Miglarese and Joseph 1974	central estuaries monthly, others quarterly Feb. 1973-Jan. 1974	bottom trawl		P. carolinus(3) P. evolans(1) P. tribulus(24) juveniles
Georgia					
Sapelo and St. Catherine Sounds (14 stations)	Dahlberg and Odum 1970	3-week intervals Jan. 1967-Feb. 1968	otter trawl		P. pectoralis(1) Jan. P. evolans(147) most months P. scitulus(87) most months
Ossabaw and Wassaw Sounds	Mahood, Harris, Music and Palmer 1974	monthly Oct. 1972-Sept. 1973	otter or shrimp trawl gill net seine		Triglidae 21.4 lb. trawled all year; none seined
Doby and Sapelo Sounds	Mahood, Harris, Music and Palmer 1974	monthly Oct. 1971-Sept. 1972	otter or shrimp trawl gill net seine		Triglidae 34.3 lb. trawled all year; none seined
St. Andrews and St. Simons Sounds	Mahood, Harris, Music and Palmer 1974	monthly Oct. 1970-Sept. 1971	otter or shrimp trawl gill net seine		Triglidae 77.7 lb. trawled all months; none seined
Florida					
St. Johns River (12 stations)	Tagatz 1968	several to many times yearly Apr. 1961-Nov. 1963	seine trawl		P. scitulus(25) juveniles, June-Oct. P. tribulus(28) juveniles, most months
St. Lucie River (13 stations)	Gunter 1963	5 scattered months each year Jan. 1957-Jan. 1959	seine otter trawl		P. tribulus(4) juveniles, Jan.
St. Lucie and Indian Rivers	Springer 1960	3 surveys Sept. 1957, Mar. 1958, and Mar. 1959	trawl		no searobins taken

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