Gulf States Marine Fisheries Commission

TECHNICAL SUMMARY No. 1

THE SEA TROUT OR WEAKFISHES

(GENUS *CYNOSCION*)

OF THE GULF OF MEXICO

by

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and

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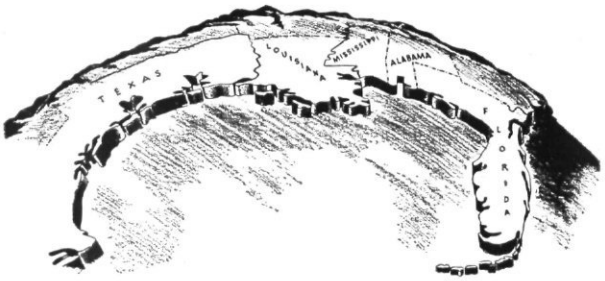
Ocean Springs, Mississippi

OCTOBER, 1958

The Gulf States Marine Fisheries Commission realizing that data on the speckled trout and the two species of white trout appearing in waters of the Gulf states should be summarized, is pleased to present this publication.

Data appearing herein have been gathered from a multiplicity of sources, both published and unpublished, as is evidenced by the accompanying citations. It is believed the basic information contained in this publication can be of considerable assistance to state marine fishery legisiative committees and state fishery agencies in consideration of management measures designed to preserve these species for the commercial and sport fishermen of both the present and the future.

Gulf States Marine Fisheries Commission



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I. Introduction

Fishes of the genus *Cynoscion* have supported an extensive commercial and sport fishery for many years in the five states which border on the Gulf of Mexico. Collectively, Gulf coast fishermen marketed almost five million pounds of sea trout in 1954 with a sales value of over one million dollars. The annual catch by sports fishermen undoubtedly exceeds the yearly commercial catch.

The sea trout, weakfish, or squeteague as they are called on the Atlantic coast, are known for their superior flavor and are among the most sought after food fishes. They are popular as a game fish because they put up a good fight on light fishing tackle. Of the three species of sea trout found in the Gulf of Mexico, the best known and most highly prized is the speckled sea trout, *Cynoscion nebulosus* Cuvier and Valenciennes. The Gulf sand trout, or white trout, *Cynoscion arenarius* Ginsburg, and the silver trout, *Cynoscion nothus* (Holbrook), are of less importance.

The commercial and sport fishery for sea trout is confined to the shallow Gulf waters and to the bays, lagoons, and estuaries where these fish spawn and grow to maturity. Regulation of the fisheries is in the hands of the state governments within whose boundaries the fisheries are conducted. In some cases regulations are based on conditions peculiar to a particular part of the coast; in others the regulations are based on incorrect or inadequate information, and their enforcement is not helpful to the fishermen or the fish.

It was pointed out by Welsh and Breder (1923) that "A fundamental prerequisite for intelligent fisheries legislation—legislation that will serve the true interests of the fisheries and assist toward the increase and perpetuation of the prime sources of supply—is an accurate knowledge of the life histories of the species contributing to that supply. Lacking such knowledge, legislation must be largely a matter of guesswork, based on the varied and often conflicting opinions of interested parties."

A complete picture of the life history of a species of fish is not a simple matter to obtain when the animals have free access to large bodies of water. It is only by painstaking research over a long period of time, which often involves work on problems

that may appear to be unimportant or unconnected with life history studies, that it is possible to get an accurate description of spawning, juvenile habits, growth rates, migratory patterns, and other phases of the life history of the species in question.

The species of sea trout have been the subject of numerous scientific studies in recent years, and a great deal of valuable data are available in publications which are concerned primarily with other subjects. The Gulf States Marine Fisheries Commission, recognizing the need for a compilation of the information on the species of sea trout present in the Gulf of Mexico, presents this publication as a summary of the data accumulated in recent years by fishery scientists.

II. Characteristics of the family Otolithidae

The family is, in many respects, a difficult taxonomic category to define. Whether or not a group is to be ranked at the family level is subjective. Some groups are better known than others, and the anatomical, phylogenetic, and life history data upon which the family concept is based are, for such groups, more adequately described. A tendency to establish new families, to reflect the natural relationships, develops as more becomes known about a group of animals.

Many ichthyologists consider the sea trout and related genera to be closely related to the croaker, drum, and other sciaenids. Jordan and Eigenmann (1889) recognized that the large family of fishes known as the Sciaenidae could be divided readily into two groups based on the differences in the number of vertebrae in the abdominal and caudal portions of the vertebral column. They established two subfamilies; the Otolithinae, which included the old world genus *Otolithus* and the western hemisphere genus *Cynoscion,* where the abdominal portion of the spinal column had 14 or 15 vertebrae and the caudal portion had 10 or 11; and the Sciaeninae, which included the genera *Sciaenops, Pogonias, Micropogon* and others, where the abdominal portion of the spinal column had 9 to 12 vertebrae and the caudal portion had 13 to 20. As is often the case, these subfamilies were later raised to family rank by Jordan (1923). Berg (1940), however, follows Regan (1913) in classifying the percoid fishes and combines the weakfishes and croakers into the family Sciaenidae.

Jordan and Eigenmann *(op. cit.)* and Jordan and Evermann (1898-1900) listed the following characteristics for the sub-

families of the Sciaenidae. These subfamilies will be considered as families here.

> Otolithidae—Vertebrae 14 or 15-10 or 11, the abdominal portion of the spinal column having always more vertebrae than the caudal portion, the anal fin being posterior in its insertion; body more or less elongate, the mouth large, the lower jaw projecting, the preopercle with a crenulate, membranaceous border; snout without distinct pores or slits; preorbital narrow; gill rakers slender, moderate, or rather long; anal fin with one or two very weak spines, the second closely connected with the first soft ray; scales small, smoothish.
>
> Sciaenidae—Dorsal fin contiguous, the soft dorsal being long, much longer than the anal; vertebrae 9 to 12-13 to 20, typically 10-14, the number of vertebrae in the abdominal part of the body being always less than in the caudal part.

While the major distinction between the Otolithidae and the Sciaenidae is the difference in the vertebral column, there are other characteristics that aid in distinguishing the two groups of fishes. Many of the croaker family make a drumming or croaking sound while none of the weakfishes do this. The weakfish commonly have canine teeth in the upper jaw which are missing in the croakers, and the weakfish lack the mandibular barbels which are present on many of the croakers. The differences in the dorsal fins and the anals have already been mentioned. There are also differences in shape and scalation. The sea trouts are more fusiform and round in cross-section, much like a spindle truncated at both ends, and they have larger, terminal mouths. The croakers have a more modified fusiform shape, with a more apparent and more attenuated caudal peduncle; they have differently shaped heads largely due to the subterminal or even ventral position of their mouths. The dermal bones of the croakers are generally rougher in appearance, being ridged, pitted, striated or even spongy. The head of the otolithids is smooth. The croakers have heavy, strongly imbricated scales in contrast to the weaker, deciduous scales of the sea trouts. There are also clear ecological, habitat and behavior differences, which are not known to museum workers. The croakers are generally bottom feeders, and many subsist largely on mollusks. The otolithids are more active predators which live on fast moving prey off the bottom. Like other

active fishes with a high metabolic rate, they die quickly upon capture in contrast to the slower living croakers. The flesh of croakers is firm and maintains itself well after death. The sea trouts have a fine flavor but they deteriorate quickly after death.

Descriptions of the three species of the Otolithidae found in the Gulf of Mexico are given below. The description of *Cynoscion nebulosus* is taken from Hildebrand and Schroeder (1928) while that of *Cynoscion nothus* and *Cynoscion arenarius* is from Ginsburg (1929).

Cynoscion nebulosus Cuvier and Valenciennes

Head 2.95 to 3.25; depth 3.4 to 4.35; C. X (rarely XI)—I, 24 to 26; A. II, 10 or 11; scales 90 to 102. Body elongate, somewhat compressed; back little elevated; head long and low; snout pointed, 3.75 to 4.2 in head; eye 4.45 to 5.35; interorbital 4.5 to 5.9; mouth large, oblique; lower jaw projecting; maxillary reaching nearly or quite opposite posterior margin of eye, 2.2 to 2.3 in head; teeth as in *C. regalis;* gill rakers rather short, 8 on lower limb of first arch; scales, small, thin, ctenoid, extending forward on head, cheeks, and opercles, not present on fins, 11 or 12 between origin of anal and lateral line; dorsal fins contiguous or separate, spines of the first weak, flexible, the longest spines scarcely longer than the longest soft rays; caudal fin pointed in very young, becoming straight to somewhat emarginate in adults; anal fin small, the spines very weak, base of fin ending about an eye's diameter in advance of the end of base of dorsal; ventral fins rather small, inserted a little behind base of pectorals, 1.85 to 2.25 in head.

Color dark gray above, with sky-blue reflections; pale, silvery below; upper part of sides marked with numerous round, black spots, the spots extending on dorsal and caudal fins. Very young with a broad, dark, lateral band; blotches of the same color on the back; base of caudal black. Fins pale to yellowish green; the dorsal and caudal spotted with black in the adult.

Cynoscion nothus (Holbrook)

Vertebrae nearly always 27, rarely 26. Anal soft rays predominantly 9, sometimes 8 and infrequently 10 in speci-

mens from the Atlantic coast. Total number of gill rakers on the first arch in individuals of 30 to 130 mm. have a mode of 13, frequently 12 or 14, rarely 15. Most common number of gill rakers on first arch 3-10.

Snout rather short, shorter than the least depth of caudal peduncle. Caudal peduncle short, the length of the rather short maxillary greater than the distance from posterior end of insertion of dorsal to base of caudal on midline. Eye conspicuously larger than in the other species. Dorsal rather long, the usual number of soft rays 28 or 29, frequently 27, less frequently 30; the number of rays increasing in more northern latitudes, the mode being at 28 in Gulf specimens. Color pale, without conspicuous pigmentation, the upper part usually straw or walnut, the lower part lighter silvery; sometimes an indication of irregular rows of faint spots. Small individuals, up to about 85 mm. standard length, have the upper part more or less faintly clouded, the cloudy areas tending to form transverse bands.

Cynoscion arenarius Ginsburg

Vertebrae 25. Soft anal rays 11, sometimes 10 or 12. Total number of gill rakers usually 14 or 13, frequently 15. The most usual number of gill rakers on the two limbs of the first arch are 4 + 10 or 3 + 10. Caudal not emarginate in individuals over 300 mm., the middle rays being somewhat longer. Least depth of caudal peduncle usually shorter than snout; 1.57 to 1.82 in maxillary. Dorsal soft rays have a modal number of 26, quite commonly 25 or 27. Color pale, without well defined spots, yellowish above, silvery below, the center of the scales above level of gill opening sometimes faint oblique rows of cloudy areas. The back in young cloudy, the cloudy areas tending to form indefinite cross bands.

In the Gulf of Mexico the speckled trout, *Cynoscion nebulosus* is easily identified, but there is some difficulty in distinguishing the sand or white trout, *C. arenarius*, from *C. nothus*. Ginsburg (1929) presented a key to aid in the identification of some of the species. Hildebrand and Cable (1934) give excellent keys for identifying the young of several species, and Jordan and Evermann (1898-1900) have a key for identifying most of the known species of weakfish. The simple key presented here is modified

from Ginsburg *(op. cit.)*. *Cynoscion regalis* is included although it is not known in the Gulf of Mexico.

A Key to the Species of *Cynoscion* found in the Atlantic and Gulf Coasts.

A. Soft rays of dorsal and anal more or less closely scaled. 9 to 12 gill rakers present on lower limb of first arch.

B. Anal rays 9, sometimes 8. 10 gill rakers on first arch. Snout shorter than least depth of caudal peduncle. No conspicuous pigmentation. ..... *Cynoscion nothus*

BB. Anal rays at least 10 in Gulf of Mexico, 11 in Atlantic.

C. Soft anal rays 12, snout usually shorter than least depth of caudal peduncle. Gill rakers 5 + 12. Caudal emarginate in adult. Colored more or less with black spots which frequently form oblique or longitudinal streaks. ..... *C. regalis*

CC. Soft anal rays 11, snout usually longer than least depth of caudal peduncle. Gill rakers 3 + 10 or 4 + 10. Caudal not emarginate in adults. No coloration on body. ..... *C. arenarius*

AA. Soft rays of dorsal and anal not scaled. Soft rays of dorsal 24 to 26; anal 10 or 11. 8 gill rakers on lower limb of first arch. Body covered with numerous round spots extending on dorsal and caudal fins. ..... *C. nebulosus*

In addition to the above characters Gunter (1945) has noted that *C. nothus* has ctenoid scales, which makes it feel rougher to the touch than *arenarius,* and more brittle fin rays, which cause the fins to break off very easily; it also has more yellow on the fins.

III. Distribution of the Weakfishes

Four species of weakfish are found on the west coast of the United States and Mexico. *Seriphus politus* Ayres, the queenfish, *Cynoscion parvipinnis* Ayres, the short-fin sea bass, *C. nobilis* Ayres, the white sea bass, and *C. macdonaldi* Ayres, the totuava, are exclusively Pacific Ocean fishes.

On the Atlantic and Gulf coasts there are four species of the genus *Cynoscion.*

Cynoscion regalis, the weakfish, occurs only on the Atlantic coast, ranging from Cape Cod to eastern Florida. It occasionally occurs as far north as the Gulf of Maine (Ginsburg, 1929). It is a very important commercial fish from Cape Cod to the North Carolina coast. Reports of this species from the Gulf of Mexico are apparently incorrect. The second author has recently found this species in the St. Lucie Estuary, Florida, which is the southernmost record.

Cynoscion nebulosus, the speckled sea trout, occurs from New York to Mexico but is rare north of Delaware Bay (Welsh and Breder, 1923). It is essentially a warm water, coastal fish, with the center of its natural abundance being in Florida and the Gulf States (Pearson, 1929). It is a commercially valuable fish from Chesapeake Bay to Texas.

Cynoscion arenarius, or the white trout, occurs from the west coast of Florida to Texas and Mexico and Hildebrand (1955) recorded this species in trawl catches at Campeche. The white trout is utilized commercially to a small extent in the Gulf of Mexico, but it is not nearly so valued as the speckled trout.

Cynoscion nothus, the silver trout, has been found from Chesapeake Bay to the southwestern coast of Texas (Ginsburg, *op. cit.*). It is common on the Gulf Coast and east coast of Florida and as far north as North Carolina. Hildebrand (1955) reports this species from trawl catches in the Gulf of Campeche where it was not common in 13 to 16 fathoms.

Ginsburg *(op. cit.)* and Gunter (1945) have given some data on the bathymetric distribution of *C. nothus* and *C. arenarius. C. arenarius* is most abundant in the bays and lagoons, and in the shallow open waters of the Gulf while *C. nothus* is most common in slightly deeper waters of the Gulf. Gunter *(op. cit.)* considered *C. arenarius* as primarily estuarine and *C. nothus* as marine, although the distribution overlaps. Hildebrand (1954) noted that *C. nothus* was three times as abundant as *C. arenarius* on the brown shrimp fishing grounds off Texas.

The southern limit of fishes of the genus *Cynoscion* on the west Florida coast is unknown. Not many *C. nebulosus* are reported in the commercial catch south of Tampa Bay. No fishes of this genus have been reported from Tortugas or Key West. Gunter, Williams, Davis and Smith (1948) noted that populations of fishes along the middle part of the west Florida coast were different from those of the northern Gulf. The Sciaenidae and Otolithidae were in decreased numbers to the south. Hildebrand (1955) noted the same thing in comparing the fishes of the offshore northwestern Gulf with those of the Gulf of Campeche. *C. arenarius* and *C. nothus* were reported from Campeche, but in greatly diminished numbers and he called attention to the disappearance of the croakers and weakfishes. It is clear that these two families of fishes are abundant in the bay and shallow waters of the northern Gulf, but they

give way to other families in the southern Gulf.

IV. The Life History of the Speckled Sea Trout, *Cynoscion nebulosus.*

a. Sexual maturity and spawning.

Speckled trout apparently reach sexual maturity when comparatively young. Miles (1949-50) estimated that 10 per cent reach maturity at the end of the first year, at a length of 160 millimeters (6.4 inches). This early sexual maturity was found to be more prevalent among males than among females. At the end of the second year (average length 250 mm. or 10.4 inches) at least 50 per cent were found to be sexually mature with the number of ova in the paired ovaries being around 100,000. The largest spawning classes appear to be the two, three and four year classes; these fish measure from 250 to 450 millimeters (10.4 to 18 inches) in length. The average three year old speckled trout contains some 300,000 eggs while the four year old trout (18 inches) has something like 560,000 eggs. According to Miles (1950-51), histological slides of ovaries of the two and three year old trout indicate that only about one-third of the eggs develop sufficiently to remain viable and to be fertilized at spawning. The five to eight year old trout may contain from 600,000 to 1½ million eggs during the spawning season. These age groups, according to Miles *(op. cit.)* make up a small minority of the total population. Pearson (1929) found the number of eggs in an 18.9 inch trout to be 427,819 and in a 24.4 inch trout 1,118,000.

Pearson *(op. cit.)* reported that the spawning season begins in early spring (not before March) in Texas waters, and continues until as late as October with the height of the spawning season occurring in April and May. Miles (1949-50) found spawning activity until the middle of November and reported the peak of the spawning season to be from May through July. Gunter (1945) found ripe females as late as mid-November in Texas waters. It is possible that fish developing late in the season do not spawn, but resorb their eggs. In the Cedar Key, Florida, area, spawning occurs from late March or early April to October, according to Moody (1950).

Gunter *(op. cit.)* suggested there may be two spawning peaks a season, as claimed by some commercial fishermen. However, biologists have collected no evidence of such double peaks. On the other hand, there is evidence that oysters, fish and shrimp

on the Gulf coast, where the spawning season is long, have a double peak of spawning and it is not unreasonable to expect such a phenomenon in *Cynoscion nebulosus*. Biologists should examine the matter further.

Speckled sea trout, in full roe, are found in inland waters from April to October or November. *Cynoscion regalis* spawns in open water, according to Hildebrand and Cable (1934) and Welsh and Breder (1923). *Cynoscion nebulosus* spawns primarily, if not entirely, within the bays and lagoons along the Texas coast as has been shown by Pearson *(op. cit.)*, Gunter (1945) and Miles (1949-50) and this appears to be true of this species in Florida (Moody, *op. cit.*). Hildebrand and Cable (1934) found that in the Beaufort, North Carolina area these fish may spawn both in the bays and in the open waters, and Joseph and Yerger (1952) took young fish in open waters as well as in tidal streams. Simmons (1957) reported that speckled trout in the Laguna Madre would not spawn where the salinity was greater than 45 *per mille*.

In Texas waters, where both Pearson and Miles worked, the spawning trout were found in the back bays far removed from the passes into the Gulf. Pearson belived that the trout spawned in the deeper waters of the bays and that the eggs floated into the beds of marine vegetation where they hatched. Miles (1949-50) had little success in finding fertilized eggs and presumed that the fish spawned in or near the vegetation and that the eggs were demersal. Welsh and Breder (1923) have reported that the eggs of *C. regalis* are buoyant until the later stages of development.

Miles (1950-51) made some studies of the reproductive structures of the speckled trout. He found that the gonads of the trout went through seven stages of development. These stages appear to be more pronounced in the ovaries than in the testes.

The first stage is one of immaturity where the gonads are short, small in diameter and nearly colorless. Sex cannot be determined in sea trout until they are six months old, but in fish between six months and one year old the male testis has a characteristic triangular shape while the female ovary is ovoid. The testes as a rule are longer than the ovaries at the same age and length in the young fish, but in older trout these structures are of comparative lengths and girths.

The second or maturation stage may be found in trout as early as February but sexually maturing trout are more prevalent in March and April. During this maturation stage the fish lays down two longitudinal strips of fat just ventral to the gonads. It has been suggested that this acts as a sustainer during the months when little food is taken by the fish during actual spawning activities. The ovaries also develop a yellowish color. Microscopic examinations reveal that the ova are not distinguishable, but the lumen of the ovary appears with connecting canaliculi. The male trout at the same period shows a distinct distension of the testes and the beginning of sperm formation.

The maturation stage is followed by a granular stage, so called because of the appearance of the developing ova which resemble granules or grains within the lumen of the ovary. The ovary, when examined microscopically, is found to contain fully formed, round or ovoid shaped ova in separated groups or lying within small follicular enclosures. During this period the ovary is swollen but firm. The testes increase to three to five times their maturation size and contain a thick milky fluid which contains the spermatozoa.

The next phase of development is the ripe stage. This is recognized by a greatly swollen ovary in a semi-soft condition. Too much handling or pressure on a fish in this stage may rupture the ovarian wall. However, when eggs in this stage are placed in sea water with spermatozoa from a running male trout they will not develop.

The actual spawning phase of gonadal development is known as the running stage. At this time, a light pressure on the abdomen will cause a discharge of eggs or sperm. The yellow color is gone and a slight reddish fluid may be seen mixed with the egg mass, caused probably by the rupture of the ovarian blood vessels during spawning activity. Spawning may occur over a period of several days or as long as three or four weeks, for fish are sometimes caught with one half or less of the egg mass expended.

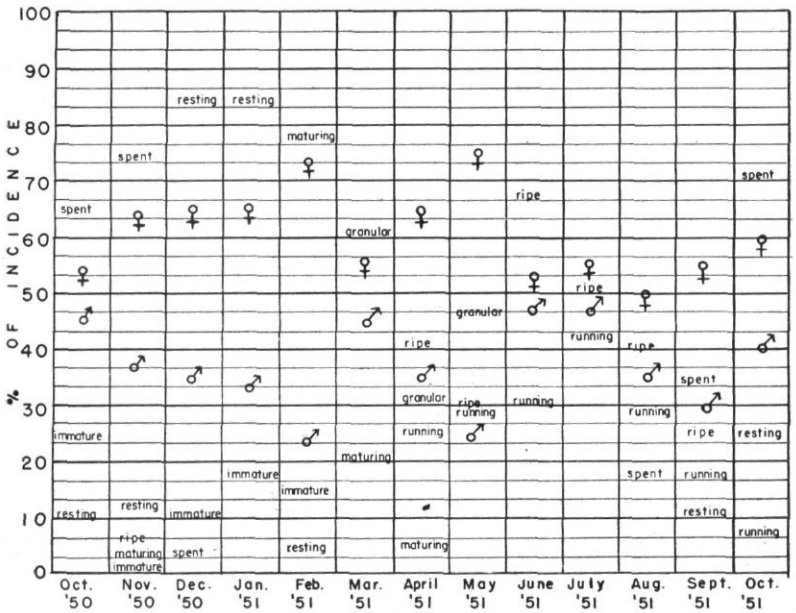
The spent stage is easily recognized by the flaccid ovary and testis. The resting stage for the speckled trout occurs during the coldest months of winter and is of short duration.

Figure 1 is from Miles (1950). It is a diagrammatic presentation of sexual stages of sea trout in Texas.

Spawning may occur in the deeper parts of the bay as suggested by Pearson or in the shallow grass beds as suggested by Miles. Few observations have been made on courtship activities of the speckled trout. Miles (1949-50) saw milling, jumping and violent activity upon the part of several schools of trout in Copano Bay, Texas, which were later captured and examined. The females and some of the males were nearly spent and were rubbed raw around the pelvic fins, lower abdomen and vent.

FIGURE 1

SEXUAL STAGES OF THE SEA TROUT, *Cynoscion nebulosus*



b. Early development, description and habits of the young.

Most workers are agreed that the larval and juvenile development is in the protected beds of vegetation found in many parts of the inland waters. The writers have taken them there many times. According to Miles (1949-50) the spawning and nursery ground vegetation is primarily the ditchgrass, *Ruppia maritima* L., with some evidence of spawning activity and early development in the extensive beds of the green alga, *Acetabularia crenulata* Lamouroux, which is abundant in the upper parts of the Texas Laguna Madre.

Humm (1956) has reported that six species of marine spermatophytes are found along the northern coast of the Gulf of Mexico and indicated that these sea grasses are more or less continuous between Florida and Texas. These grasses are *Ruppia maritima* L., *Diplanthera Wrightii* (Ascherson) Ascherson, *Cymodocea manatorum* Ascherson *(Syringodium filiforme* Kützing), *Thalassia testudium* König, *Halophila englemanni* Ascherson and *H. baillonis* Ascherson. The latter species is confined to 20 to 25 feet of water in the northern part of its range. Of the five species to be found in the shallow bays, *Ruppia maritima* is primarily a brackish water or low salinity inhabitant. *Halophila englemanni* and *Cymodocea manatorum* are seldom found in pure stands. *Diplanthera Wrightii* occurs in patches along the inner beaches of the barrier islands and in Texas bays covers large areas of the shallows. This species apparently will tolerate higher water temperatures and longer exposures to the air than the others. In Texas waters it is found in the hypersaline Laguna Madre and in the estuaries along the upper coast. In recent years bay salinities have been higher than usual because of the drought conditions, and *Ruppia maritima* has not been common. It seems probable that the trout utilize the extensive beds of *Diplanthera* and other grasses as well as *Ruppia.*

The egg and larval stages of *Cynoscion nebulosus* have not been described. Welsh and Breder (1923) described the embryology of *Cynoscion regalis* in Atlantic waters, and it is quite likely that the embryology of the speckled trout is similar to that described for the gray trout. The development of *C. regalis,* and presumably *C. nebulosus,* is typical of most teleostean eggs. The eggs are pelagic, transparent and spherical, from 0.74 to 1.10 millimeters in diameter with from one to four oil globules within the yolk. It seems that during development the specific gravity of the eggs increases sufficiently to cause them to sink in later stages.

The period of incubation at water temperatures of from 68 to 70 degrees Fahrenheit (20 to 21 degrees Centigrade) is 36 to 40 hours, according to Welsh and Breder *(op. cit.).* Smith (1907) stated that in North Carolina the eggs of *C. nebulosus* hatch in 40 hours in water with a temperature of 77°F. The newly hatched larvae are about 1.75 mm. in length with the yolk sac still relatively large. On the newly hatched gray trout, the chromatophores are arranged in groups with yellow chromato-

phores on the sides behind the eye and on the underside of the snout with black chromatophores present on the dorsal surface of the body.

The smallest specimen of *C. nebulosus* described by Hildebrand and Cable (1934) was 1.8 mm. The specimen had developed further than specimens of *C. regalis* of similar size described by Welsh and Breder (1923). At this size the head and trunk are deep and the caudal portion of the body is very slender, an abrupt break in the ventral contour of the body occurring at the vent. The vent in the small specimens is situated in advance of midbody length, the preanal distance being contained in the length to the tip of the vertebral column 2.1 to 2.4 times, and the postanal distance 1.75 to 1.9. The greatest depth of the body is contained in the length 3.1 times, and the depth behind the vent is scarcely greater than the diameter of the eye. The mouth is moderately large and strongly oblique. The vertical finfold is uninterrupted and is without indications of fin rays. The pectoral fin membranes are prominent, but the ventrals are not evident. Dark markings are present on the ventral outline of the chest and abdomen, with a prominent spot immediately in advance of the vent. A series of close-set black spots occupies the anterior half to two-thirds of the ventral outline of the tail.

The specimens 2.5 mm. long have a deep head and trunk, and the caudal portion of the body is slender. The vent is situated almost exactly at midbody length, and the greatest depth is contained about 2.6 times in the length to the tip of the vertebral column. The depth immediately behind the vent is notably greater than the diameter of the eye. The mouth is large and strongly oblique, the gape anteriorly is only slightly below the level of the middle of the eye, and the maxillary reaches nearly to the vertical from the posterior margin of the pupil. The finfold is continuous; however, a thickening of the tissues is evident below the distal part of the vertebral column and also farther forward, constituting the primitive bases of the caudal and anal fins. The pectoral fin membranes are prominent, but the ventrals are not evident. A black lateral stripe begins nearly half the distance to the tip of the tail. Black chromatophores are evident on the ventral outline of the chest and abdomen.

By the time the fish reaches seven millimeters in length the caudal fin is well developed and sharply rounded. The anal and

soft dorsal fin are fully developed but the spinuous dorsal fin remains rudimentary. The pectoral fins also are well developed, but the ventrals are mere tufts of membrane. A black lateral stripe persists, although less distinct than in the smaller fish, and a black band is present on the snout in advance of the eye.

Specimens 16 to 20 millimeters in length are shaped like the adult. The head is long and low, its length being contained 2.7 to 3.0 times in the standard length and the greatest depth of the body 3.9 to 4.15 times. The snout is long and pointed and the mouth has acquired the shape and position of the adult. At a length of 20 mm. the body is almost fully scaled. The black lateral stripe, present in smaller fish, disappears or is hidden by a dark band of numerous minute dark markings extending from the caudal fin to the snout. The dark chromatophores on the head and back form longitudinal bands and in larger specimens there is some pigmentation on the spinuous dorsal.

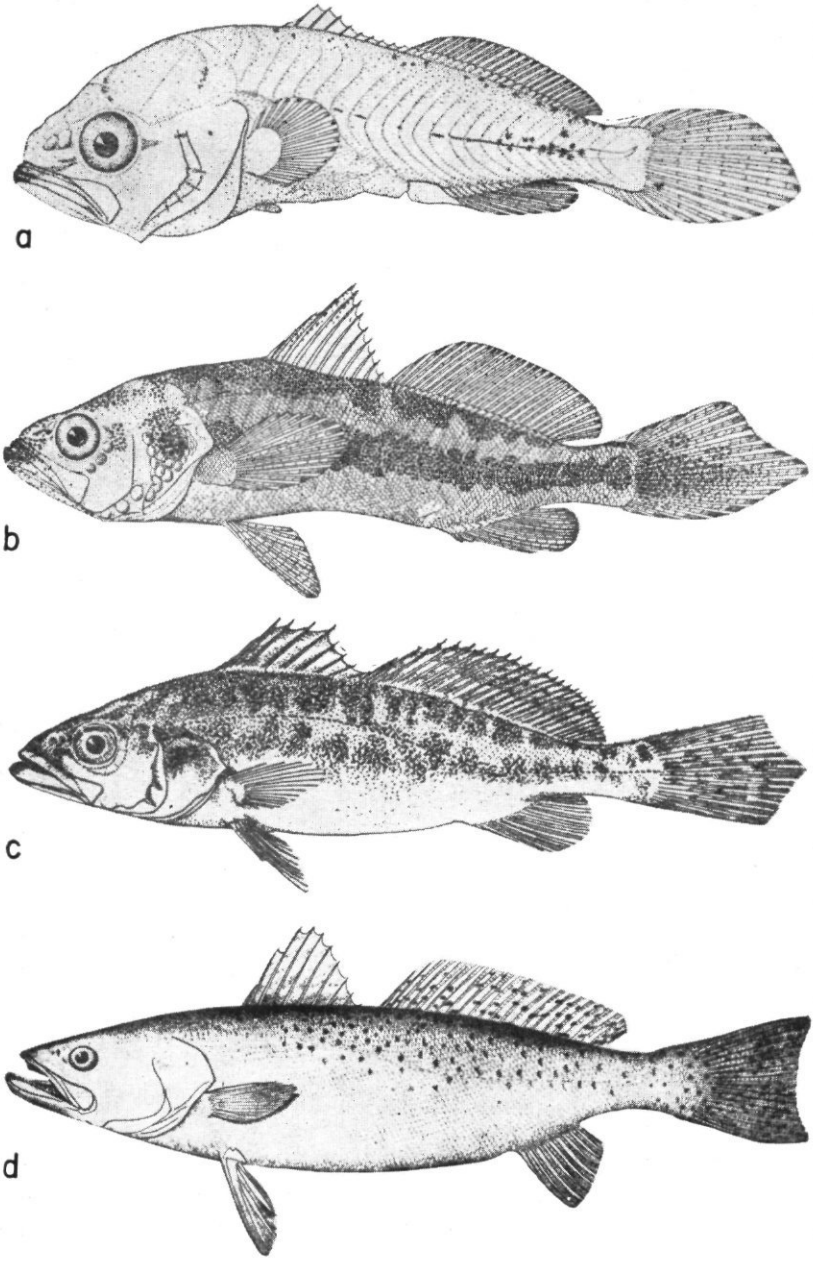
After the trout reaches 16 to 20 mm. in length no important changes in body proportions take place, but as the fish grow there is a change in pigmentation. On a 41 mm. fish there is an interrupted lateral stripe of dark pigment slightly narrower than the eye and a broken stripe of pigment along each side of the median line of the back from the snout to the base of the caudal fin. These bands of pigment become more broken, forming irregular blotches in the 120 mm. fish, and later develop into the round black spots characteristic of the young adult *Cynoscion nebulosus*.

Figure 2 shows four stages in the development of the speckled trout.

The majority of the young fish are found within fifty yards of a shoreline usually in the marine vegetation growing in the bays (Miles, 1949-50). This vegetation affords the small fish protection and the grass beds are alive with multitudes of small crustaceans and fish upon which the juvenile trout feed. The young fish remain in the shallow grassy areas until winter approaches (Moody, 1950), when they move to deeper waters.

Miles (1949-50) studied stomach contents of small trout 20 to 150 mm. in standard length. He found that the food habits of young sea trout are not appreciably different from mature fish. The small forms of the commercial shrimp, *Penaeus setiferus* and *Penaeus aztecus* were the preferred food with the grass shrimp, *Palaemonetes* and *Tozeuma*, ranking high as food.

FIGURE 2
The Speckled Trout, *Cynoscion nebulosus*.
a. 7mm.; b. 27mm.; c. 11 cm.; d. adult



These species of shrimp were found in 70% of the stomachs examined. The sheepshead minnow, *Cyprinodon variegatus,* was frequently found in the larger young fish, with copepods, nereid worms, unidentified vegetation, and some unidentified species of fish making up the rest of the diet of the young trout. Pearson reported numerous gobies in the stomachs of speckled trout. Apparently, this relates mostly to small fish which feed on the gobies abounding in the grass and algal beds. Moody (1950) reported a diet of copepods, mysids, carid shrimp and small marine fish for the young speckled trout. Miles *(op. cit.)* noted that the peak of the trout spawning season coincided with the great influx of post-larval penaeid shrimp into the back bay waters and that these small shrimp required the same type of nursery grounds as do post-larval speckled trout.

c. Growth

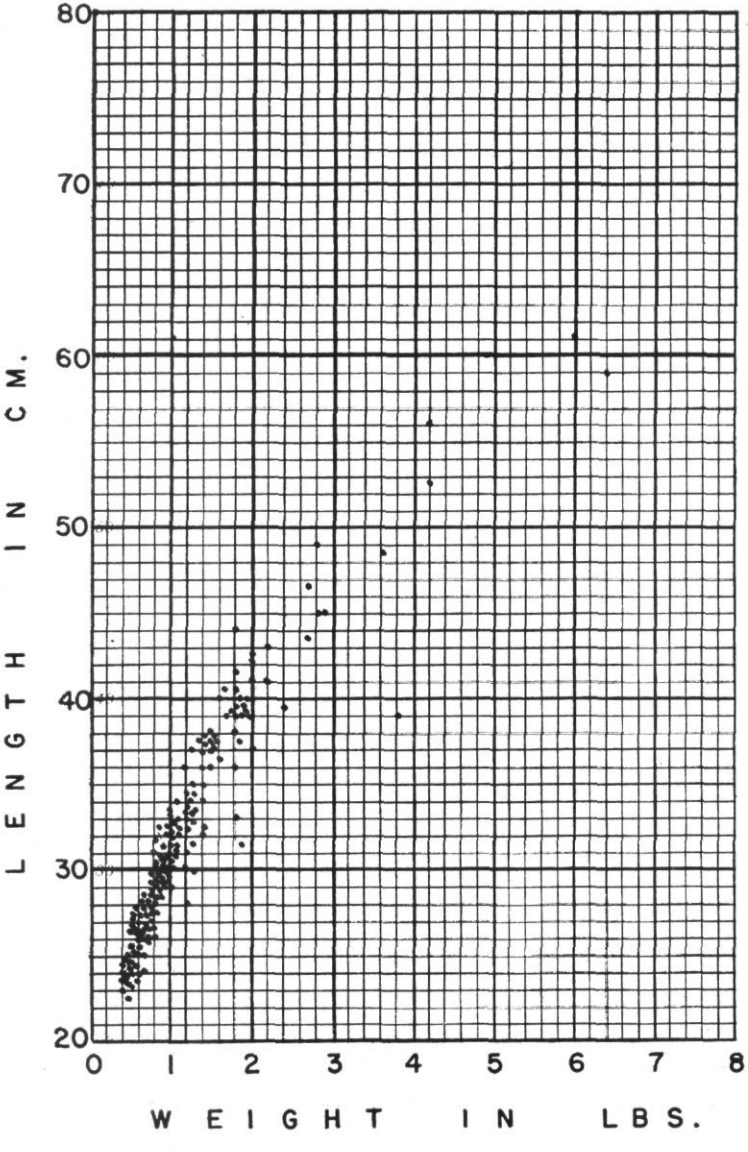
Because of the extended spawning of the sea trout, the various age groups overlap each other to such an extent that it is difficult to calculate growth rates from length-frequency data. According to Pearson (1929) and Welsh and Breder (1923), growth of the young fish is rapid in the summer months and slows down or ceases during cold weather. The most rapid growth, according to these authors, is in July and August. Pearson reported that the 0 year class approaching its first winter had a modal length of 130 millimeters (5.1 inches), the distribution being from 50 to 200 millimeters (1.9 to 7.8 inches). In May of the following year this year class (about one year old) had reached a modal length of 190 to 200 millimeters (7.4 to 7.8 inches). Moody (1950) estimated that a length of 130 millimeters was attained by the first winter.

Young fishes coming into Gunter's (1945) catches in June were from 2.0 to 6.5 cm. long. In January this group was from 6.5 to 19.0 cm. long and in May it merged with larger sizes, the smallest fish being 16.5 cm. long at that time. In June of the following year the 2.0-6.0 cm. group appeared again.

Pearson *(op. cit.)* made some estimates of growth rates of mature sea trout in Texas waters. These estimates were based on scale analyses. The speckled trout is a warm water shore fish. It usually moves into deeper and warmer water with the onset of winter. A cessation of growth probably accompanies the lower temperatures and this is reflected on the scales of the fish by a marked change in pattern and structure. The general

FIGURE 3

WEIGHT-LENGTH RELATIONSHIP
MALE AND FEMALE SEA TROUT
NOV. 1950



character of the annual winter scale growth checks consists in the formation of incomplete bilateral circuli. Because of the intermittent cold weather along the Gulf coast the winter checks, in many cases, may be indistinct.

The age of the fish, in years, according to the scale method of age determination, generally is found by counting the annual winter bands or checks. The length of the fish at the end of each year of life is computed from the series of measurements of a scale from a fish of known length. Knowing the length of the scale included in the annulus of any given year, the total length of the scale, and the length of the fish at the time of capture, the length of the fish at the end of any given year can be determined.

Figure 3 is taken from Miles, Simmons and Breuer (MS). It shows the calculated lengths of speckled sea trout after one to eight winters of growth. Table 1 shows the calculated lengths of the speckled trout upon which Figure 3 is based. Table 2 is a comparison of average calculated lengths of speckled trout in Texas waters (Pearson, *op. cit.)* and in Florida (Welsh and Breder, 1923). The last two workers also determined growth from scale analyses.

Miles, Simmons and Breuer, in an unpublished manuscript on file at the Marine Laboratory of the Texas Game and Fish Commission, estimated growth rates from otolith analyses. The otolith of the speckled trout is large enough to make it comparatively easy to count the annual rings when ground into very thin sections. Figure 4 shows the age and growth as compiled from otolith analyses. These data are partially substantiated by measurements of tagged fish which were returned.

There is a difference in the growth rates of male and female speckled trout. Pearson *(op. cit.)* showed that the younger year classes contained a greater proportion of males than did the older year classes (figure 3). He also showed that the males do not attain the same average mean length as the females and a greater rate of growth might be expected among the females. Such a condition would result in smaller calculated lengths among younger year classes with their higher percentage of males and a lower rate of growth than among the older year classes composed largely of females.

The better informed fishermen have recognized the differences between sizes of male and female *nebulosus,* and the

larger specimens are known in the vernacular as "sow" trout.

FIGURE 4

AGE-LENGTH RELATIONSHIP OF SPECKLED SEA TROUT *(Cynoscion nebulosus)* AS DETERMINED BY OTOLITH EXAMINATION

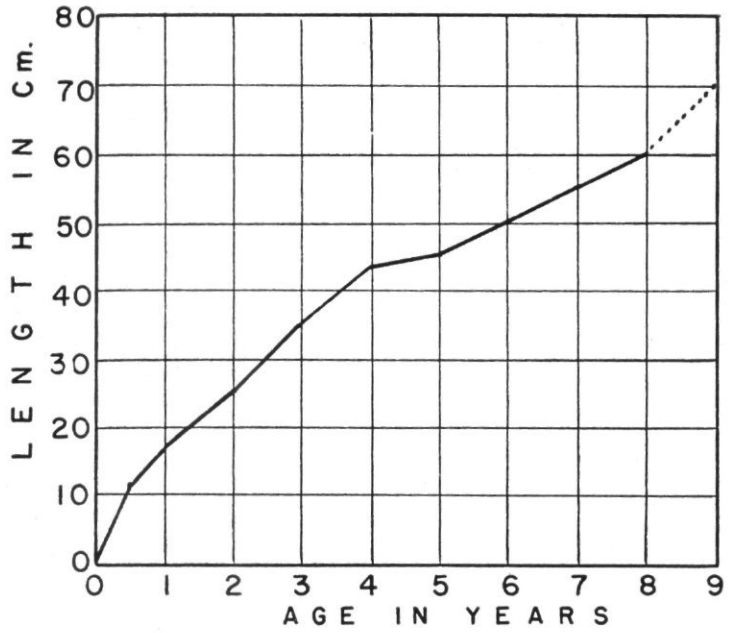


TABLE 1. *Calculated and actual lengths of speckled trout compared.* (After Pearson, 1929)

(Calculated lengths, derived from scale-growth checks generally evident by March, given for fish collected from April, 1926, to February, 1927; actual lengths include only fish taken in March, 1927. The calculated lengths should approximate the actual lengths, but the latter should be slightly larger, since fish taken in March have a newly formed winter scale check plus some additional growth. The calculated lengths for March fish are also presented)

Age in Winters	Averaged calculated length in centimeters, all fish	Total Fish	Averaged actual length in centimeters, March	Number of March Fish	Averaged calculated length in centimeters, March
1—	13.5	71	15.6	14	13.2
2—	22.9	53	23.7	8	22.3
3—	30.6	54	30.4	10	29.8
4—	35.2	42	37.1	16	36.0
5—	40.6	28	42.2	4	40.9
6—	44.2	16	45.0	1	43.1

TABLE 2. *Calculated Average Length*

	Florida fish Cm.	Texas fish Cm.	In.		Florida fish Cm.	Texas fish Cm.	In.
First winter	11-12	15	5.9	Fifth winter	40	40	15.7
Second winter	23	24	9.4	Sixth winter	43	44	17.3
Third winter	31	30	11.8	Seventh winter		49	19.2
Fourth winter	36	35	13.7	Eighth winter		52	20.4

V. HABITS OF ADULT FISH

a. Distribution in relation to salinity, temperature.

While the young trout are confined to shallow grassy areas until the approach of cold weather, the mature fish are to be found throughout a wide range of habitats.

Gunter (1956) lists the speckled trout as being euryhaline. This means, according to his definition, that they have been taken under natural conditions from both fresh water and sea water. The fish that invade fresh water are small, young fish (Cf. Massman, 1954 and Gunter, 1957). Miles found no apparent relationship between salinity and distribution. Gunter (1945) took 456 *C. nebulosus* in 412 hauls with various kinds of nets, at salinities ranging from 2.3 to 34.9 parts per thousand. No special relationship between salinity and size was noted. Eighty-three per cent of the fish were taken at salinities between 5.0 and 20.0, at which ranges 47.6 per cent of the hauls were made. It would appear that *C. nebulosus* is found mostly at medium and low salinities, or that is to say in bay and estuaine waters. However, the sea trout are capable of withstanding the hypersaline waters of the Laguna Madre of Texas up to about 75 parts per thousand (Cf. Hedgpeth, 1947, Simmons, 1957), although Breuer (1957, p. 150) says that in Baffin Bay, "It is conspicuous by its absence when salinities reach 55 parts per thousand." Simmons *(op. cit.)* says young fish are normally collected at salinities up to 60 parts per thousand in the Laguna; larger fish are normally collected up to a salinity of 75 parts per thousand.

During the winter most fishes leave the bay shores and shallows and many of them go to or towards the Gulf. This is a general seasonal movement and it has been extensively described (Gunter, 1938, 1945). The speckled trout is no exception and Pearson (1929) and Simmons (1951) noted that speckled trout move to deeper water with the onset of cool weather. This fish is not commonly taken in trawls, but it becomes rather abundant

in trawl hauls in the bays during the winter, when the young fish leave the shallows. Gunter (1938) found peaks of abundance in trawl hauls in Barataria Bay, Louisiana in January of three consecutive years. He stated, concerning these winter peaks, "Like the croaker the young of this fish were found to be very tolerant of freshwater and low temperatures. Numbers increased from the mouth to the headwaters of the bay, where they attained a maximum and at times predominated in the catches, even exceeding the ubiquitous croaker. Likewise, larger specimens were taken nearer the gulf, but never in as great numbers." A similar winter peak in trawl catches was later found in Texas waters (Gunter, 1945). Fish were taken in trawls in the Gulf only in winter, and all fish taken on the Gulf beach by seines were caught in the fall and winter except one fish taken in August *(op. cit.)*. Marine Products reports of the Texas Game and Fish Commission also show that the catch of *C. nebulosus* in seines on the Gulf beach is larger in the winter months. These figures are given in the section on the commercial fishery. Moody (1950) reported that sea trout move into the rivers and deeper streams along the Florida coast in late winter to escape the occasional low temperatures.

It seems clear that *C. nebulosus* moves into deeper water and towards the Gulf as the temperatures drop in the fall, and a part of the population moves out into the Gulf at this time, largely becoming distributed up and down the beaches. However, most of the fish remain in the bays, as Hildebrand and Cable (1934) previously noted in North Carolina. These workers noted that under such circumstances the trout were frequently numbed and made helpless by the cold.

In spite of the tendency of the speckled trout to migrate to deeper waters during the cold weather, occasional fish kills of major proportions have occurred. Gunter (1941) and Gunter and Hildebrand (1951) reported on the effects of severe "northers" in January when many millions of fish were killed on the lower Texas coast. *C. nebulosus* was among those destroyed, particularly in the shallow bays and lagoons where the fish had no opportunity to move to deeper waters.

b. Food habits of adult fish.

There are considerable data available on the food habits of the speckled trout. Welsh and Breder (1923) found that the menhaden *(Brevoortia tyrannus)* was the most common food item of

Cynoscion regalis and assumed that the food habits of the speckled sea trout were similar. Pearson (1929) noted that 61 per cent of the fish he examined had been feeding on shrimp exclusively, 24 per cent had eaten fish, one per cent crabs, and 14 per cent had eaten mixed organisms, usually shrimp and fish. Gunter (1945) found that the trout feed primarily on fish during winter months with the mullet *(Mugil cephalus)* being the most common food item. There is, according to Gunter, little doubt that shrimp are the preferred food. He found that even in winter when shrimp were scarce that fish were found in trout stomachs only one-third more often than crustaceans, which were mostly shrimp. He also noted that the trout fed almost exclusively on shrimp in January, 1941 until a sharp freeze killed out the shrimp or drove them out of the bays. The trout then turned immediately to fish for their main food, chiefly mullet. Breuer (1957) has noted that the mullet and silversides are the most common food item in the hypersaline Baffin Bay on the lower Texas coast where shrimp are not abundant. The fact that silversides *(Menidia)* and also grass shrimp *(Palaemonetes)* are eaten (Cf. Gunter, *op. cit.*) indicates that the speckled trout sometimes ventures very close to shore for its food, where these two animals are found. Moody (1950) found that various species of shrimp predominate in the diet of speckled trout in Florida.

Gunter noted that only 93 fish out of 153 opened contained food, which he took to be a sign of rapid digestion and voracity. He also stated that 5 of the fish examined had swallowed mullet half their length. One trout 44.5 cm. long had swallowed a mullet 26.0 cm. long. In this connection the words of Breuer *(op. cit.,* p. 150) are worth quoting. "The smaller trout were found to feed mainly on the silversides, while the larger trout feed almost entirely on mullet. The relatively poor catches of trout by the various hook and line methods may be attributed to the peculiar feeding habits of the trout. A large trout will invariably find the largest mullet it can handle and proceed to swallow it. The mullet will generally range from one-half to two-thirds the size of the trout. Many trout taken in the gill nets were found to contain mullet so large that the belly of the trout would be greatly distended, and several inches of the mullet's tail would still protrude from the trout's mouth. Experiments made by keeping these trout for several days before

killing them for stomach analysis showed that the total digestion of the mullet would take from two to three days. Therefore, if a large trout were to feed only 10 to 15 times per month, the chances of taking this trout on a baited hook would be very slim . . . . The majority of trout in Baffin Bay are of the two- to four-year class. These trout feed mostly on silversides, even during the period when shrimp are present."

Simmons (1957, p. 185) reported that trout in the upper Laguna Madre above 500 mm. (19.3 in.) in total length were piscivorous. "Examination was made of 200 stomachs which contained food. Twelve had consumed ten-pounders, six had eaten small trout, and 182 had consumed mullet.—mullet 14 inches long were found partially ingested by trout only 21 inches long. A preferred food item—was *Cyprinodon variegatus.*"

The Texas Game and Fish Commission undertook extensive studies of the food habits of the speckled trout. The Marine Laboratory Annual Reports (Texas Game and Fish Commission) of Miles (1948-49-50), Simmons (1950-51), Robinson (1948), Wilson (1948), Kemp (1948), and Knapp (1948) all show essentially the same data. Kemp (1948) examined 4,302 sea trout. Of these, 2,808 contained food and 73 per cent were found to contain shrimp, usually one of the commercial *(Penaeus)* shrimp. Crabs *(Callinectes sapidus* and *C. danae)* made up 3.5 per cent and fish made up 22.7 per cent of the food. Many of the fish could not be identified (18%), but the menhaden *(Brevoortia),* silversides *(Menidia),* pigfish *(Orthopristes),* and mullet were the most common of those that could be recognized.

c. Movements of sea trout.

Fish trap studies at Cedar Bayou, on the central Texas coast, were conducted to determine to what extent fish utilize the passes between Gulf and bay waters. Simmons (1951) reported that sea trout, sexually mature and in spawning condition, began moving through the pass into the bay areas in late March and continued until late June. Simmons noted that sea trout did not migrate to spawn until water temperatures were approximately 70° F. It also was evident that in July and August movement of sea trout was governed by the presence or absence of penaeid shrimp.

There was a fairly large outward migration of sea trout in September and October and, according to Simmons, this may have been caused by changes in water temperature.

Miles, Simmons and Breuer (no date) reported that tag returns indicate that the trout coming in from the Gulf tend to mill around the bay side of the passes for a week or more after entering, before gradually working their way into spawning areas farther in.

Tag returns from Texas waters indicate that the speckled trout population in bay areas is fairly static, although some tagged trout traveled as much as 65 miles before recapture. The tag returns also indicate that there is little inter-bay movement.

VI. Parasitism

The helminths of marine fishes of the Gulf are not well known. Chandler (1954) lists only one species of digenetic trematode from sea trout and only one cestode.

Many fishermen become alarmed at seeing their prize catch badly infested with worms in the flesh. The worms are common in many of the croakers as well as in the sea trout and apparently are more common in the larger fish. Parker (1951) has given some information on the "spaghetti worms" found in sea trout. According to this account the worms are the pleurocercoid stage of a tapeworm. The initial stages are spent in copepods and are transmitted to the trout when these little crustaceans are eaten by young trout. The adult stage of this cestode occurs in sharks. This tapeworm will not develop in man and is in no way harmful to humans. Chandler *(op. cit.)* says this parasite is *Poecilancistrium robustum* or a related species. Fishery biologists on the Gulf coast have noted the great increase in the number of inquiries concerning these worms in speckled trout during the past five years. There seems to be little doubt that the percentage of infestation has increased considerably in recent years, possibly with the increase in salinity in Gulf waters which accompanied the long drought that was broken in 1957. Various fishermen, especially sports fishermen, sometimes bury their whole catch or throw it away. The American people are not in the habit of knowingly eating worms even if well cooked. However, if they would remember that all animals are parasitized and that these worms in no way destroy the palatability of the trout and in no way are harmful or infectious to human beings, the fish could be eaten with good conscience.

Ectoparasites seem to be uncommon on speckled trout. No monogenetic trematodes have been reported from this fish.

Pearse (1952) recorded one caligoid copepod, *Caligus sciaenops,* from the roof of the mouth of a fish at Port Aransas. Bere (1936) and Causey (1953 and 1955) recorded four specimens of *Lernanthropus gisleri* on the gills of trout from Florida, Louisiana, Texas and Tuxpan, Mexico. This species seems to have more of an affinity for *Cynoscion nebulosus* than any other parasitic copepod. Pearse *(op. cit.)* took 45 specimens from 29 fish at Port Aransas, Texas.

VII. The Commercial Fishery

a. Statistics

In an early survey of the commercial fishery of the Gulf states (Collins, 1892) the catch of speckled trout in 1888 was estimated at 2,412,514 pounds, with a value of approximately $98,000. The data for 1955 (Anderson and Power, 1957) show a total of 3,586,000 pounds of speckled trout landed by commercial fishermen with a value estimated at $888,000. The speckled trout fishery ranks behind the menhaden, mullet, and red snapper both in number of pounds landed and in total value.

Table 3 is a summary of the available commercial fishery statistics for the five Gulf states. This summary is taken from

Table 3. *Commercial Landings of Speckled Trout in the Gulf States in thousands of pounds, as reported by U. S. Fish and Wildlife Service and its predecessors.*

Year	Florida West coast	Alabama	Mississippi	Louisiana	Texas	Total
1887			258	524	941	
1888	511	228	280	522	872	2,413
1889	615	205	370	619	1,077	2,886
1890	602	209	372	656	1,120	2,959
1897	767	296	453	567	1,012	3,095
1902	1,913	259	473	1,078	1,119	4,842
1908	1,207	208	517	1,103	1,055	4,090
1918	1,694	139	356	1,190	1,613	4,992
1923	1,591	49	410	783	1,524	4,357
1932	(1,867)	103	124	412	976	3,482
1936	(2,927)	106	180	765	1,836	5,814
1937	(2,335)	146	211	788	2,090	5,570
1938	(2,389)	119	249	490	1,978	5,225
1940	(2,734)	165	47	212	752	3,910
1945	(3,464)	370	102	639	1,680	6,255
1948		235	62	338	588	
1949	4,279	143	102	693	614	5,831
1950	3,033	63	62	673	582	4,413
1951	2,935	69	142	543	410	4,099
1952	3,266	102	245	572	479	4,664
1953	2,486	98	203	500	585	3,872
1954	2,224	58	140	406	638	3,466
1955	2,006	81	166	490	843	3,586
1956	2,023	79	214	592	553	3,461

the data presented in various statistical reports cited at the end of this paper. The statistics through 1923 include some landings of other species of *Cynoscion*. The figures in parentheses for the Florida production are estimates, based on the fact that in the years thereafter the west coast production was about 70 per cent of the total for the state; and these figures are 70 per cent of the Florida total production, as given in the federal statistical reports.

Table 3 shows that trout production has varied from year to year, and this is not surprising. The period covered is seventy years. During this time the population of the country has increased enormously, and it has been through two world wars and one major depression. Prices have varied considerably. At times there was a glut of fishermen and at times they were scarce. About forty years ago sailboats gave way rapidly to power boats. At the same time the more lucrative shrimp fishery developed and fishermen turned away from fish. Since 1920 pressure from sport fishermen has brought about an increasing curtailment of fishing areas, especially in Texas waters. The catch of sports fishermen has also increased enormously. During this period Florida has suffered from four major and several minor outbreaks of the Red Tide, while Texas waters were decimated of fish by at least seven hard cold spells, (which may kill up to 100 million pounds of fishes), several fish kills by oversalinity in the Laguna Madre and two outbreaks of the Red Tide (Cf. Gunter, 1952).

When the commercial production of sea trout on the Gulf coast is considered in connection with all these factors, and numerous smaller ones not mentioned here, it is seen to have been amazingly stable. This is shown in Table 4. This table is derived from table 2 and gives (as well as the reported statistics allow) the average annual production decade by decade for the past seventy years. These figures show that the annual average production per ten year period has not fluctuated more than 10.3 per cent under or 14.0 per cent over 4,562,000 pounds for the past fifty years. The figures also show that Florida production has more than doubled in the past fifty years, while Louisiana, Mississippi and Alabama catches declined more than 50 per cent. Texas production has declined over 63 per cent in the last decade. This is obviously due to the curtailment of fishing areas by laws passed at the behest of sports fishermen.

At present less than 25 per cent of Texas bay waters remain open to net fishermen. Since Texas (with Florida) is one of the states with greatest commercial production, the decline in total production for the Gulf, which was over 20 per cent for the last ten years, will probably continue. Texas production held up during the war years when restrictions were somewhat relaxed because of the need to produce food, and declined sharply thereafter. This is shown clearly in tables 3 and 4.

TABLE 4. *The average commercial production of speckled trout by the Gulf states, for each decade of the past seventy years. The table is derived from table 2. Figures are in thousands of pounds.*

	Florida West coast	Alabama	Mississippi	Louisiana	Texas	Totals
1887-96	576	211	320	580	1,003	2,690
1897-1906	1,340	278	463	823	1,066	3,970
1907-16	1,207	208	517	1,103	1,055	4,090
1917-26	1,643	94	383	987	1,569	4,676
1927-36	2,397	105	152	589	1,406	4,649
1937-46	2,731	200	152	532	1,625	5,240
1947-56	2,782	103	148	534	588	4,155

TABLE 5. *Commercial Landings of Speckled Trout from Florida.*

Year	Pounds
1949	4,705,923
1951	4,161,337
1952	4,707,946
1953	3,669,887
1954	3,458,786
1955	2,921,714

In Florida a part of the trout production is incidental to the mullet fishery, according to the 12th Biennial Report of the Florida State Board of Conservation (1956). The decline in landings of speckled trout accompanied a decline in the mullet fishery with fishermen turning to other market fish for a livelihood. This decline in trout production is also evident in the production records for the entire state as shown in Table 5. The statistics presented in Table 5 have been taken from the Biennial Reports of the Florida State Board of Conservation (1950 to 1956 inclusive).

In summary, Alabama, Mississippi and Louisiana commercial production of speckled trout for the past thirty years has been stable at low levels, compared to the previous thirty or forty

years; Florida production has been stable at a high level on the same basis of comparison. Texas production has declined sharply in the past ten years and will probably continue to do so, because of restrictions on the fishery, leading to a total decline for the Gulf states.

With regard to the reliability of the statistics some comment is in order. The collection of statistics in the past ten years has been greatly improved both by the states and the federal government. There were skips of years in the earlier statistics. It is particularly regrettable that during the war years the Fish and Wildlife Service, partly for lack of money, collected no statistics in the South Atlantic and Gulf, except in 1945. The 1940 statistics were repeated in the annual reports until 1945 and the latter figures were repeated until 1948 when regular reports were resumed.

In addition the earlier catches were often reported by men who had many reasons for underestimating their catches. However, these matters were taken into consideration by the statistics collectors. The statistics collected by the federal government have been adequate to show major changes in the oyster, shrimp and menhaden fisheries, and we believe they are similarly reliable for the speckled trout fishery in which no large scale variation is shown, except in recent years. The annual totals may be inaccurate by several thousand or even a few hundred thousand pounds, but such errors do not change the general picture.

Aside from the total production statistics certain information is available on the way speckled trout are caught. The information is derived from the Fish and Wildlife Service statistics from 1932 to 1954, inclusive. There were no reports for 1933, 1934, 1935, 1939, 1941, 1942, 1943, 1944, 1946 and 1947. Thus the figures are concerned with thirteen years over a twenty-two year period from 1932 to 1954. A summary of the results is shown in table 6.

TABLE 6. *Pounds of* Cynoscion nebulosus *caught by different gear in thirteen years over the period from 1932 to 1954, as reported in commercial statistics from the five Gulf States.*

Castnets	1,100	Trotlines	1,292,000
Spears	11,700	Haul Seines	8,703,521
Pound Nets	37,400	Trammel Nets	14,191,000
Trawls	96,400	Pole and Line	18,254,000
Stopnets	264,000	Gill Nets	20,721,000
Trolls	357,000	Totals	63,928,000

There is some information on the seasonal catch of speckled trout available from Texas and West Florida waters. The largest bay catches in Texas come during the winter months as a general rule, but there is a great deal of fluctuation due in part to demand and to selling price. Table 7 shows the average catches on the Gulf beach by months for a seven year period 1950 to 1956, inclusive. Greatest catches were made in the fall and winter months. In general the spring and summer are periods of low production.

Table 8 gives the speckled trout landings on the west coast of Florida by months for the years 1952 to 1956, inclusive. It might be stated parenthetically that the chief production is from Brevard (east coast) and Lee (west coast) counties, which contain back bays and lagoons. We are indebted to Mr. Durbin Tabb and the Florida State Board of Conservation for these figures. Mr. Tabb is of the opinion that the sports and commercial fishermen take about equal quantities of speckled trout on the Florida west coast. Thus the total Florida production is probably about double that shown in the table.

It is quite clear from Table 8 that the greatest commercial production on the Florida west coast is during the fall and winter months, with the summer monthly production dropping to approximately half of the winter production. This table coincides with information from the other parts of the Gulf.

b. Depletion or Overfishing

Depletion can be defined in either biological terms or in terms of economics. Biological depletion results when the fishery takes more fish, in terms of weight, than the stock is capable of replacing each year, while economic depletion takes place when

TABLE 7. *Average catches of speckled trout on the Texas Gulf beach in pounds per month for a seven year period 1950-1956.*

	Totals for period	Average pounds per month
January	33,625	4,803
February	66,256	9,465
March	24,080	3,440
April	25,168	3,595
May	27,809	3,973
June	42,326	6,046
July	34,100	4,871
August	27,561	3,937
September	13,763	1,966
October	21,901	3,128
November	55,791	7,970
December	37,954	5,422

TABLE 8. *Speckled Trout Landings, West Coast of Florida, 1952-1956, inclusive, by Year and Month in pounds.*

	1952	1953	1954	1955	1956	Totals
Annual Landings	3,266,245	2,431,124	2,222,182	2,000,910	2,023,069	
Monthly Landings						
January	410,754	292,509	353,433	149,742	167,006	1,373,444
February	270,093	243,485	224,399	181,531	190,006	1,109,514
March	184,424	206,578	204,964	154,994	194,466	945,426
April	307,369	147,585	238,027	145,650	142,447	981,078
May	350,732	195,549	114,455	126,936	143,326	930,998
June	295,199	111,176	91,051	108,699	98,124	704,219
July	192,046	141,623	123,269	129,985	110,480	697,403
August	157,987	158,204	111,845	145,541	127,922	701,499
September	245,387	141,945	143,847	137,648	128,873	797,700
October	219,409	264,852	181,562	228,638	196,597	1,091,058
November	349,785	302,143	197,370	250,490	235,380	1,335,168
December	283,060	225,475	237,960	241,086	288,442	1,276,023

it is no longer profitable to fish (Cf. Idyll, 1952). The most reliable index of depletion is the yield in relation to the effort involved. Unfortunately, there are no data of this sort available for the speckled trout fishery.

The fluctuations in Florida landings (Table 3 and Table 4) may be explained in part by the fluctuations in the mullet fishery; the landings in the other Gulf states show some variation with the trend toward decreasing production in the last decade. This is particularly true of Texas. Statistics taken from the Texas Game and Fish Commission Annual Reports (1937-1956) inclusive are presented in Table 10. The production records from Higgins and Lord (1927) are found in Table 9. While these statistics are tabulated for different periods of time, they will be of value in giving a fairly complete picture of the commercial fishery for trout in Texas since 1890.

There are a number of factors that may have contributed to the decline in the speckled trout commercial catch in Texas. The severe freeze in the spring of 1940 may explain the fall in landings in 1939-40. The "northers" have been known to destroy millions of pounds of fish along the Texas coast as has been reported by Gunter (1952) and by Gunter and Hildebrand (1951). In addition to mortality due to the unusually cold weather, many trout undoubtedly leave the shallow bays where the fishermen work, and do not return until water temperatures increase considerably. In times of severe cold, fish may be unavailable to the fishermen for long periods.

Baughman (1948) pointed out that the upper Texas coast supported most of the commercial fishery in 1890 with Galveston Bay alone accounting for about 38 per cent of the total bay catch while the Laguna Madre produced only two per cent. In 1947-48 Galveston Bay produced less than two per cent of the total bay catch while the Laguna Madre accounted for 64 per cent or better. The decline in the fisheries of the upper coast and the increased importance of the very productive Laguna Madre does not show in the total statistics. The catch of trout in the Laguna Madre as compared with that taken in other bays is shown in Table 10. The declines in trout production in the Laguna are due to the periods of severe cold and to regulations which, in recent years, have prevented many parts of the Laguna from being used by the commercial net fishermen.

TABLE 9. *Commercial Landings of Speckled Trout in Texas, 1890-1923.*

Year	Pounds
1890	1,120,450
1897	1,011,620
1902	1,119,300
1908	1,055,000
1918	1,613,370
1923	1,523,965

TABLE 10. *Commercial Landings of Speckled Trout in Texas, 1936-1956.*

Year	Laguna Madre	Bays of Upper Texas Coast	Gulf Beaches	Total
1936-37	1,040,074	594,962	28,593	1,563,629
1937-38	963,212	829,102	46,883	1,839,197
1938-39	742,534	540,576	43,154	1,326,264
1939-40	462,910	274,860	24,728	762,498
1940-41	471,337	322,036	58,636	851,909
1941-42	577,953	470,737	33,961	1,082,651
1942-43	597,782	591,174	76,186	1,265,056
1943-44	888,294	677,753	68,103	1,633,750
1944-45	843,892	694,855	42,933	1,581,680
1945-46	654,303	484,400	63,701	1,202,404
1946-47	269,548	278,742	34,092	582,382
1947-48	210,037	265,742	15,609	491,388
1948-49	258,039	186,953	20,266	465,258
1949-50	96,396	320,936	13,436	430,768
1950-51	105,105	196,383	64,298	365,786
1951-52	133,475	238,678	76,655	372,153
1952-53	213,319	242,420	76,067	531,806
1953-54	229,892	199,983	60,317	490,192
1954-55	415,855	246,815	64,165	726,933
1955-56	357,347	167,540	51,183	576,070

Higgins and Lord (1927) were concerned with a reported decline in the commercial fisheries in Texas. They found considerable variation in the catch resulting from restrictive legis-

lation. During the war years when closed areas were opened to commercial fishing, production increased sharply. This is also true of the years during World War II as is shown in Table 10. These authors pointed out that available statistics were not sufficient to show depletion. They indicated that the supply of fish had not kept pace with the increased demand brought about by an increasing population.

Simmons (1951) and Miles (1949) stated that trout three to four years of age were more prevalent in bay areas than were the older or younger age groups. They felt that the bay populations were older than was to be desired, indicating that spawning was insufficient. The size of the younger year classes could be limited by overfishing the spawning population or by overfishing the small fish. Destruction of spawning and nursery grounds by such man-made disturbances as dredging channels, industrial pollution, and siltation from rivers and streams has not been studied but may be of some importance.

There is no clear indication that depletion of the speckled trout population has taken place on the Gulf coast. Restriction of commercial fishing has certainly taken place in Texas, but it is possible that increased sports fishing, on which there are no figures, has tended to equalize the situation and to maintain the fishing pressure on the trout population.

On the other hand, Simmons (1957, p. 185) has shown that many large trout exist in the Laguna Madre. "Trout of eight to nine pounds were abundant and individuals of twelve pounds were not rare. Three individuals which weighed 15 pounds were collected at Station 37 in March, 1952." Sixteen pounds is the maximum known weight of the speckled trout. The presence of a large number of older, slow growing fish is indicative of an unexploited population. A younger, faster growing population will produce more pounds of fish in a given time in the proper environment. Apparently the Laguna Madre population could stand more fishing.

VIII. The Sports Fishery

There is no estimate available of the number of sea trout taken annually by sport fishermen, but the catch is probably at least as great as the commercial catch.

The speckled trout is the most popular of the bay fishes for the tourist. The trout fishermen buys most of the live bait now available all along the coast.

Trout are caught the year round but the best trout fishing is in the spring of the year when the fish are moving into the shallow bays, and in the fall. Sport fishermen find that trout are more common on the oyster reefs during fall months. Party boat fishing is usually on the oyster reefs the year round or on bottom where oyster shell is abundant. Early morning hours are best for fishing. The water is usually calm and clear and the fish apparently are feeding during the early daylight hours.

Night fishing has become very popular in Texas and Louisiana. The Arroyo Colorado in South Texas is well known for the excellent fishing under lights. Lighted piers are to be found all along the bay shores and many fishermen feel that the fish bite more readily at night than during daylight hours. The lighted oil well rigs in many of the Texas and Louisiana bays are also popular fishing spots. Fish attracted by the light (or by the food organisms attracted by the light) strike at live bait, plugs or spoons.

Trout bait varies, but live shrimp is by far the most widely used. Trout can be taken on dead shrimp, on cut mullet and at times on crabs and cyprinodonts. The large trout feed on mullet and small mullet are used on trot line hooks.

Surf fishing is a popular sport along the Gulf beaches and, as a rule, the larger trout are taken in the surf. Sportsmen look forward to a "run" of "sow" trout along the beaches in early summer. These sow trout usually are taken near the passes or inside the bays in the grass close inshore.

Most party boat operators, bait dealers, and fishermen with long experience on the coast are very definite in their feeling about a decline in abundance of speckled trout in Texas and in a decline in the average size of trout caught. The usual case is to place the blame on the commercial fishermen.

The following is a brief summary of an article by W. McFadden Duffy in the Louisiana Conservationist, Volume 6, pp 2-4, 8, July-August, 1954. The article is entitled Speckles in the Sand.

> Spring to late fall schools of spotted sea trout cruise the lower Atlantic and Gulf of Mexico prowling shallow inside waters. Big ones seldom are found in schools. They prefer weed covered shoals along the shores. In early fall they move shoreward and lay in the grassy bottoms, preying on shrimp, small fry and crustaceans.

Big southern sea trout are ready to smash a bucktail or surface plug with unusual aggressiveness.

A mature sea trout averages around four pounds but many run as high as 7 or 8 pounds and a rare few go as high as 12. The world's record sea trout was taken in Florida waters and tipped the scale at 14 pounds.

Small crabs make excellent bait for sea trout. Grass shrimp and sea shrimp make ideal top water baits. Live squid are particularly good at night. Sea trout also feed on sand eels, clams, menhaden, and small mullet.

Sea trout go readily for plugs and spoons, spinners, metal squids, streamer flies and bucktails.

In the fall, instead of taking them in the grassy shallows, you will find that they are hanging out in the deeper holes, those pot holes along the shore.

IX. The Life Histories and Utilization of the White and Sand Trouts

The white trout, *Cynoscion arenarius,* and the sand trout, *Cynoscion nothus,* are of minor economic importance, and they have not been the subject of any detailed life history study. Some data have been collected on these species in the course of other studies.

Cynoscion arenarius does not attain the size of the speckled trout. Ginsburg (1931) reported that examples of *arenarius* about a foot in length were frequently encountered. The largest fishes taken in trawl catches in Louisiana by Gunter was 377 mm. (15.4 in.) in length.

C. arenarius was the second most abundant of the commercial fishes taken in trawl catches in Louisiana by Gunter (1936). The greatest numbers of white trout were taken at salinities above 15.0 parts per thousand by Gunter (1945), although many fish were caught at lower salinities. Most of the small fish were caught between salinities of 15.0 and 25.0 parts per thousand, but there was some correlation between size and salinity of the water where they were caught. The average length of fish taken in 0.0 - 4.9 parts per thousand salinity was 75.2 mm., in 10.0 - 14.9 parts per thousand, 127.8 mm. and 30.0 parts per thousand and over, 150.5 mm. Simmons (1957) reported *C. arenarius* as not common in the Laguna Madre, especially at salinities above 45 *per mille.* They were encountered most often in December and January.

Gunter (1945) took small *Cynoscion arenarius* 18 to 38 millimeters in length from April to September in Texas bays indicating that this species has a prolonged spawning season. Simmons (1950-51) reported that mature white trout moved through Cedar Bayou, Texas, on the way to the Gulf beginning in May. This migration continued through August. Very small white trout were found entering the bays in June and through the summer along with spent adults. Simmons concluded that the white trout spawned in the Gulf, probably near the passes. Reid (1954) found sexually mature adults in the spring in Florida.

There is a migration of the white trout into the Gulf at the onset of cool weather in Texas (Gunter, *op. cit.*). Gunter (1938) had previously shown that there was a decline of numbers of *C. arenarius* in the bays of Louisiana in the fall and winter.

Reid (1954) reported that *C. arenarius* fed mostly on fishes and crustacea in Florida. An examination of 99 stomachs by Reid (1955) showed 74 to contain food. Of those containing food, approximately 84 per cent had eaten fishes with *Brevoortia patronus* the most common. About 18 per cent of the fish had eaten shrimp.

Hildebrand (1954) took over 7300 *C. arenarius* in commercial shrimp trawls off Southwest Pass, Louisiana, Sabine Pass, Texas, the 24 - 10 grounds off South Texas and Off Obregon, Mexico. The depths ranged from 7 to 37 fathoms, but few were caught in water deeper than 30 fathoms. Nearly all offshore fish were large but few were over 300 mm. (11.8 in.) long. He reported fish with ripe gonads in August, 1951. He found shrimp, a triglid, *Prionotus stearnsi,* and a small serranid, *Paracentropistes pomospilus,* in the stomachs.

Cynoscion nothus is not a common inhabitant of the bays. It undoubtedly spawns offshore, probably in deep water. Welsh and Breder (1923) state that spawning appears to occur in the autumn. The young, 6.0 centimeters and over, are quite similar in appearance to the young of *Cynoscion regalis.* Gunter (1945) found small fish only in October and November.

Hildebrand and Cable (1934) state that the largest specimen seen in the Beaufort, N. C. area was 288 millimeters (9¼ inches) long while Ginsburg (1931) states that specimens over ten inches in total length are not common. It is possible that large specimens may be found in deep water. The largest fish taken by Gunter was 238 millimeters.

It has been noted previously that this species is more common in the Gulf than in the bays. Gunter (1938, 1945) has pointed out that this species enters the bays only during cooler months, indicating that water temperature is also a factor in excluding this fish from the bays.

Hildebrand (1954) found, on the trawling areas mentioned above, 18,500 *C. nothus,* or roughly three times more than *arenarius.* This species was much more abundant than *arenarius* in 31-37 fathoms of water. Fish caught in the winter and spring ranged from 160-219 mm. in length. A number of small ones, 60-90 mm. long, were taken in May. A fish with nearly ripe ovaries was taken off Obregon, Mexico in August.

Breuer (1957) and Simmons (1957) neither one reported *C. nothus* from the Laguna Madre. Although this species is ordinarily found in offshore and higher salinity waters than either *nebulosus* or *arenarius,* it seems not to prefer bay water even when it is of high salinity.

Little data are available on landings of the white trout. Early records on trout landings probably included some white trout as well as sand trout. Stevenson (1892) reported that 129,150 pounds of bay sand trout and 10,000 pounds of surf sand trout were marketed in Texas in 1890. There is no indication of which species he had reference to, but the white trout is commonly called sand trout in Texas, and most likely the species was *Cynoscion arenarius.* The white trout has never been a valuable market fish, but with reported declines in speckled trout production this fish may become more important. Table II is a summary of the white trout landings from Anderson and Petersen (1953, 1954) and Anderson and Power (1955, 1956a, b).

TABLE 11. *Commercial Landings of White Trout in the Gulf States*

Year	Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Total
1940	78,500	2,000	84,000	51,000	2,600	218,100
1945	395,000	212,000	198,500	278,000	40,000	1,123,500
1950	181,000	24,000	54,000	208,500	2,000	470,000
1951	397,000	35,000	40,000	59,000	23,000	555,000
1952	205,000	44,000	294,000	30,000		574,000
1953	128,000	35,000	697,000	35,000		895,000
1954	74,000	48,000	1,340,000	31,000	32,000	1,525,000

There are no figures from the Gulf states on the catch of *nothus* and the catch is evidently reported with *C. arenarius.* The total is doubtless quite small in the regular fish houses due

to the smaller size of the fish. However, both *C. arenarius* and *C. nothus* are abundant in the catches of trash fish used for protein meal and for cat food. Thus, their commercial importance has increased considerably in recent years, although the total take is unknown because there are no figures on the species composition of the trash fish catches.

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