ANNUAL REPORT

for the fiscal year

September 1, 1949 to August 31, 1950

The Life Histories

of the

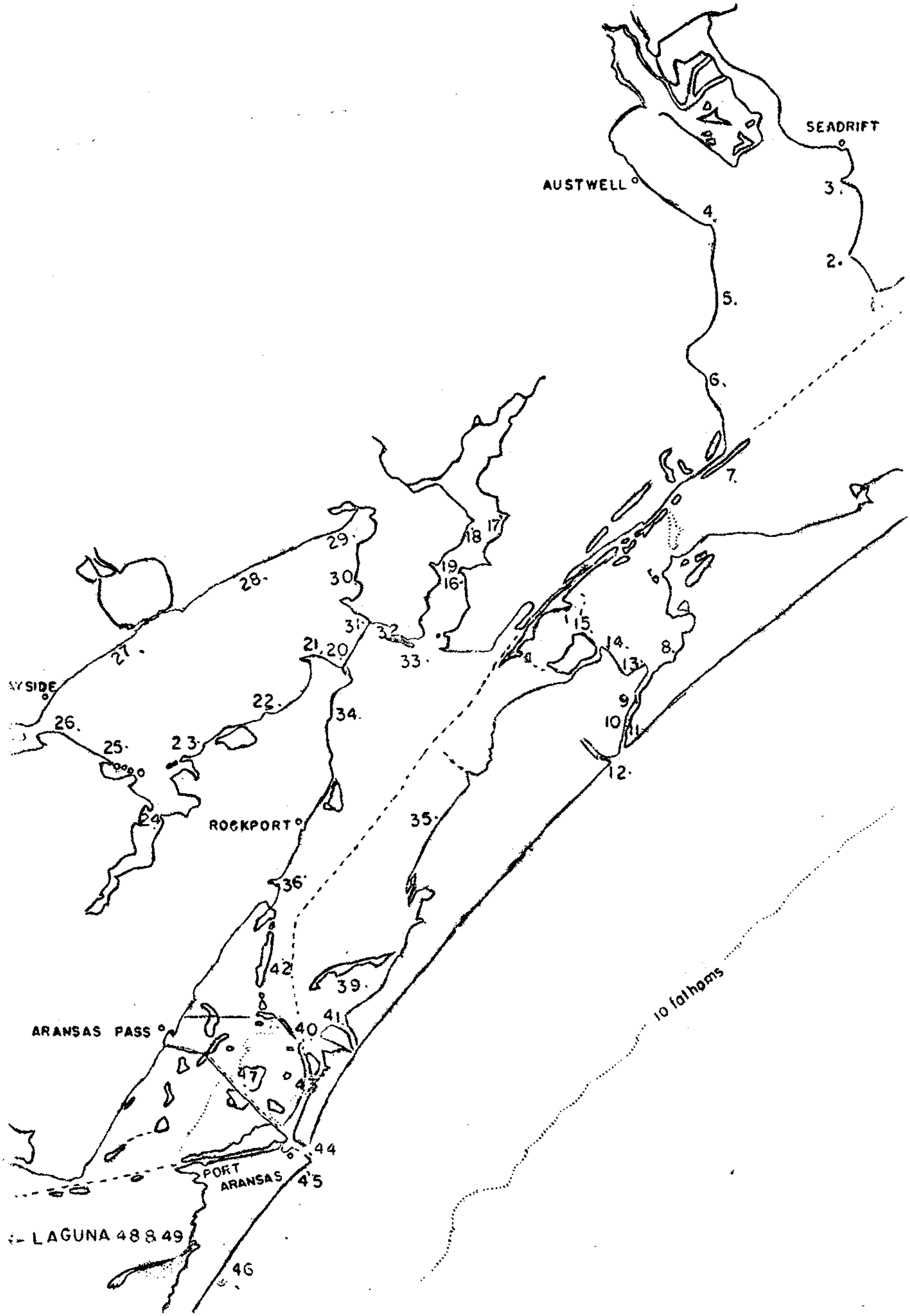
Spotted Sea Trout, *Cynoscion nebulosus*,

and the

Redfish, *Sciaenops ocellatus*.

by

Dewey W. Miles


SEADRIFT
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PORT
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LAGUNA 48 & 49
46
10 fathoms

The Life Histories
of the
Spotted Sea Trout, *Cynoscion nebulosus*,
and the
Redfish, *Sciaenops ocellatus*.

From: September 15, 1949 to August 31, 1950

Biologist: Dewey W. Miles

Boats: Marlin, Barracuda, Skipjack, Sailfish and Manatee

Crew: Santos Pulido, Boat Captain and Assistant

Boat Captain Clarence Munsch also volunteered his services several times throughout the year.

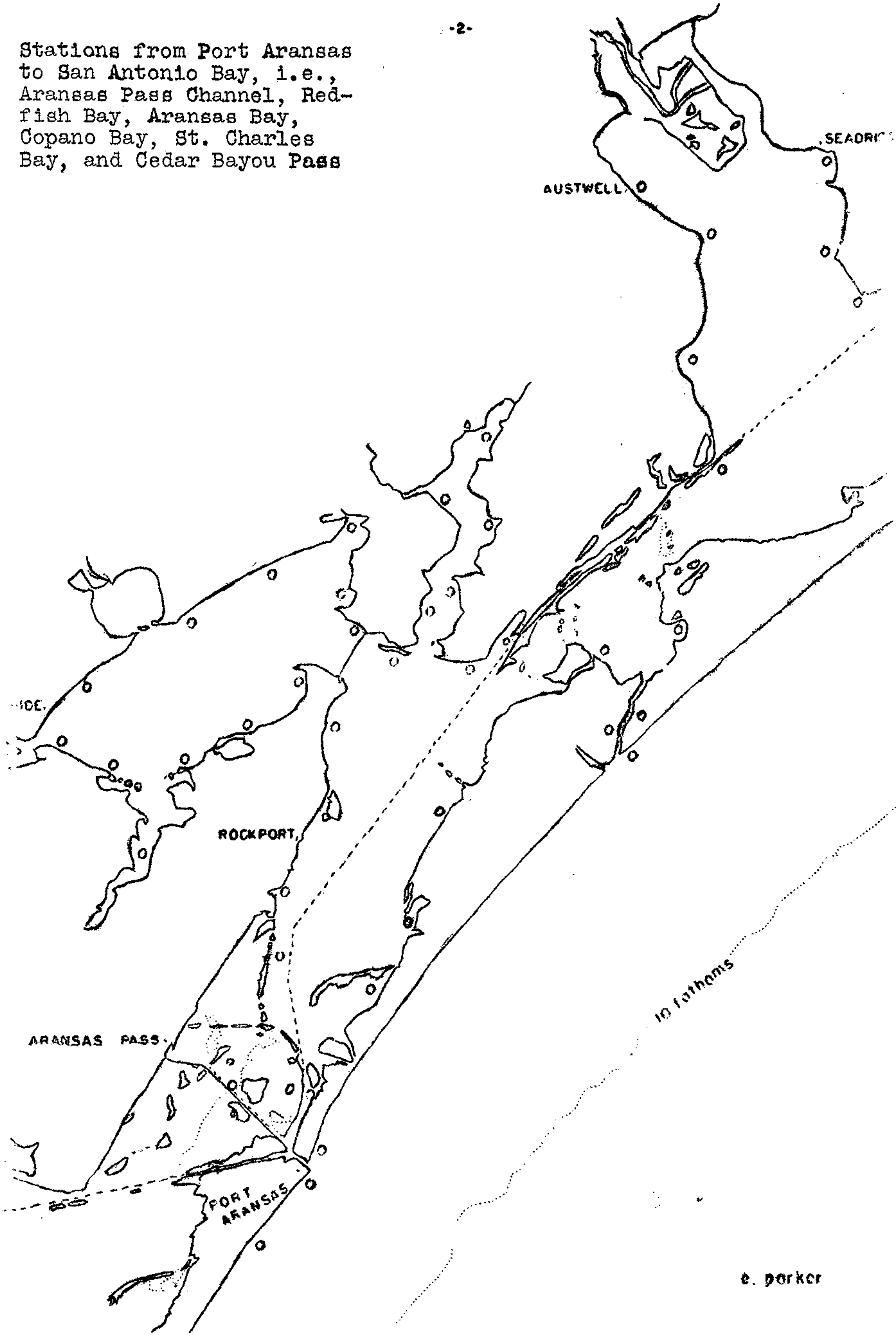
INTRODUCTION AND PURPOSE OF THE STUDY

The study of the life histories of the trout and redfish was initiated after some careful consideration of the original ground work on these fish by John C. Pearson from April, 1926, to June, 1927. The study was proposed by the Copano Research Foundation as a cooperative project between themselves and the Marine Laboratory of the Texas Game, Fish and Oyster Commission. Enough credit cannot be given Mr. Pearson for his splendid work which made possible the basis of the present study.

Some twenty-three years have elapsed since Mr. Pearson's work, which subsequently was responsible for certain conservation measures and revisions of older Texas Game and Fish laws. During this period, many ecological changes have taken place along the Texas coast, where both studies were pursued.

Many questions needed to be answered with scientific data before our existing conservation laws could be changed, or certainly before we could add any new ones. According to residents (or the "old timers" as they are often called) our trout and redfish population has been depleted seriously within the past quarter century. We can assume that this opinion is partly supposition due to changes in the habitat of the fish which has made them more difficult to obtain. Today, we have many port installations, piers, boat yards and divers other types of shore installations which are not conducive to good fishing grounds, if for no other reason than increasing marine traffic. It is not conceivable that we have as many available spawning grounds or protected and unmolested areas as we had twenty-five years ago. To establish any real basis for an

Stations from Port Aransas to San Antonio Bay, i.e., Aransas Pass Channel, Redfish Bay, Aransas Bay, Copano Bay, St. Charles Bay, and Cedar Bayou Pass



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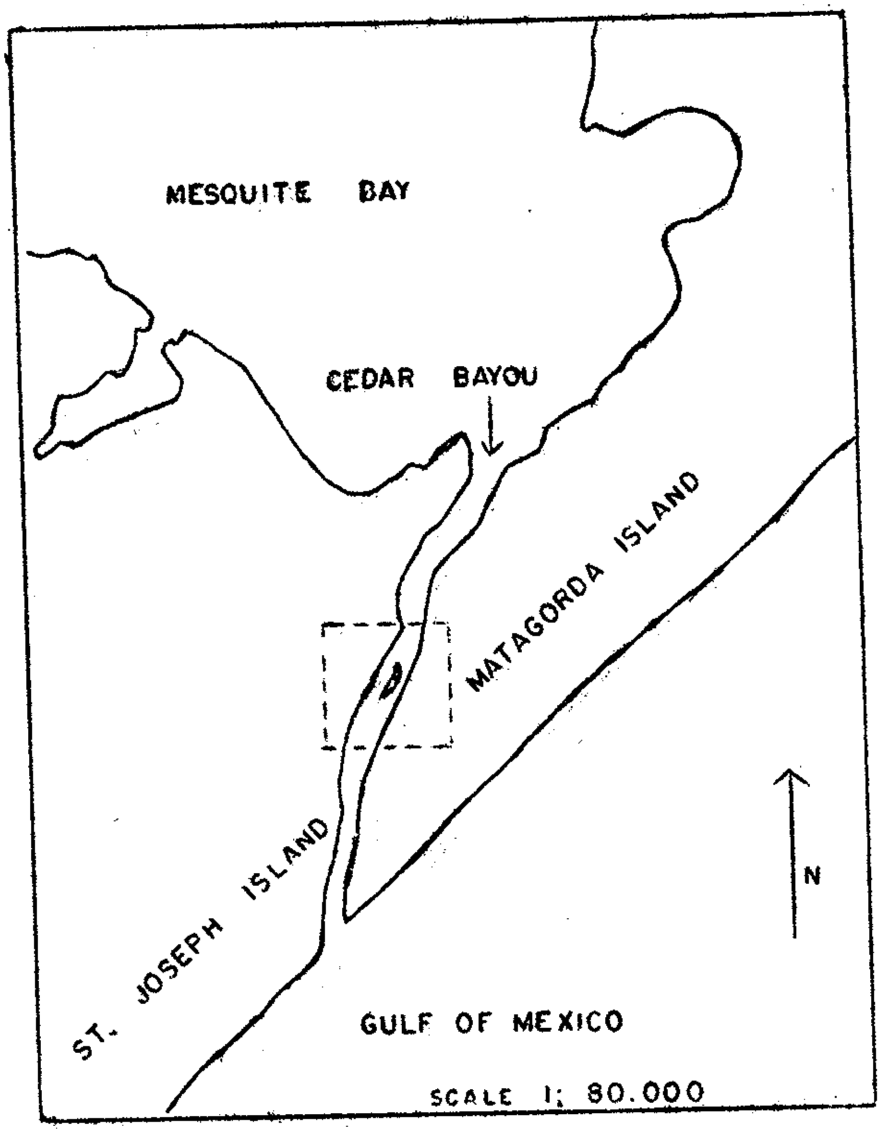
evaluation of our fisheries, we must have scientific data which is sufficiently correlated ecologically to show the possible toll wreaked upon our bay bottoms by certain business enterprises and the two main fisheries on this coast. These two types of operations alone may or may not be partially responsible for the constant disturbance and virtual plowing up of marine vegetation which grows on the bay bottoms. In light of these conditions, it is necessary to establish where these two species of fish select their breeding and nursery grounds and what can be done to stabilize or further their propagation to the utmost economical and physical degree of efficiency. As it was physically impossible to cover the entire Texas coast with the number of men and material available on the 1925-1926 survey, Mr. Pearson chose the central coastal section extending, roughly, from Copano Bay on the north to Baffin Bay on the south, which provided a diverse system of intercoastal and Gulf waters. The present study included the addition of Espiritu Santo and Matagorda Bay on the north and only a portion of Laguna Madre on the south. Corpus Christi Pass, which formerly provided the Gulf opening to Laguna Madre, but has been impassable to fish since Pearson's study, was replaced by Pass Cavallo which provides the Gulf outlet to Matagorda Bay.

METHOD AND SCOPE OF THE YEAR'S STUDY

The first year of the present study was allotted to the study of 0 year class of trout and redfish with special emphasis upon eggs, larval, and post larval young, their preferred nursery grounds, movements during their first months of life, food habits of the 0 year class, their affinity to the micro-organisms of the bay and the tagging of small 0 class and 1 year class fish in order to determine their routes of migration. The tagging program was initiated in January, 1950 and operated in conjunction with the fish trap at Cedar Bayou which furnished a permanent station from which to trap and tag trout and redfish and check their seasonal migrations, as well as movements of all other marine life passing to and from the Gulf of Mexico and the bays. This project is under the supervision of Ernest G. Simmons, biologist for the Texas Game, Fish and Oyster Commission and has furnished valuable information concerning the life history of trout and redfish.

At the same time that fish were being tagged from the fish trap at Cedar Bayou, trout and redfish of generally smaller sizes (due to the types of collecting gear used) were tagged in Copano Bay, Aransas Bay, Redfish Bay, Espiritu Santo Bay, Matagorda Bay, and the Laguna Madre. These supplementary tagging operations were carried out while collecting small fish for age


MESQUITE BAY
CEDAR BAYOU
MATAGORDA ISLAND
ST. JOSEPH ISLAND
N
GULF OF MEXICO
SCALE 1: 80.000

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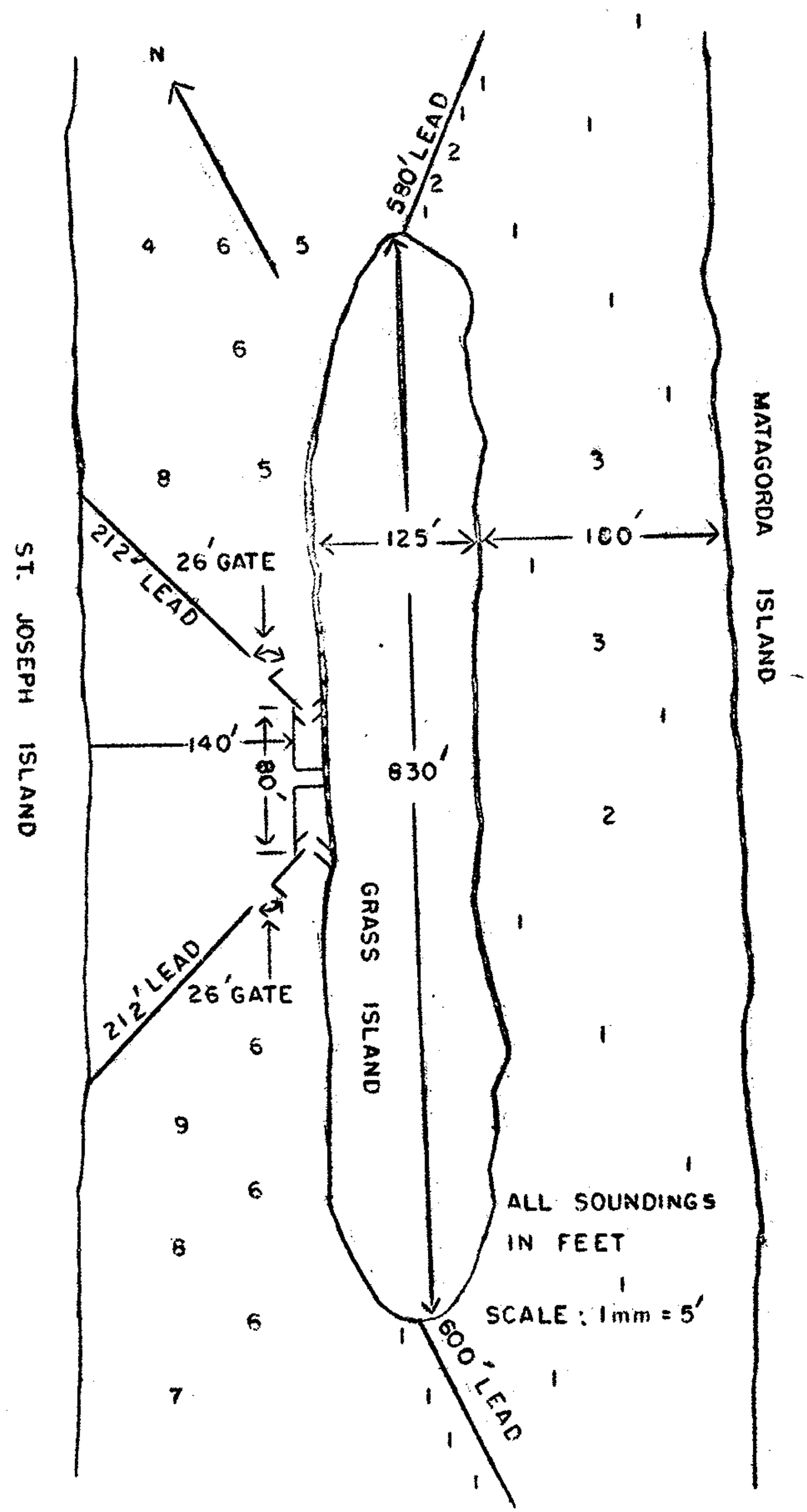
N
580' LEAD
ST. JOSEPH ISLAND
MATAGORDA ISLAND
GRASS ISLAND
125'
180'
212' LEAD
26' GATE
140'
80'
830'
212' LEAD
26' GATE
ALL SOUNDINGS
IN FEET
SCALE : 1mm = 5'
600' LEAD

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and growth determinations and will give us some indication of intro- and inter-bay movements. During the spawning season of sea-trout and the beginning of the spawning season of redfish, the tagging operations were accentuated by a trammel net crew which caught and tagged large sow trout in Cedar Bayou, Aransas Bay, Copano Bay, and the Laguna Madre. Great difficulty was experienced in keeping sea-trout alive long enough to tag if they were to be accurately weighed and properly sexed. This caused us to disperse with weighing and sexing trout during the very hot days in May, June, July, and August of 1950, but records of standard and total lengths, and tagging was carried out to a high degree of satisfaction.

Since the study was not begun until September, 1949, the spawning season was nearly over for the sea-trout as indicated by a modal standard length of 31-35 mm. from September 15 to September 30. The passes to and from the Gulf as well as the primary and secondary bays and estuaries were carefully worked with small 1/4" drag seines from 100 to 200 feet long in order to obtain sufficient numbers of small trout upon which to base a modal age and size. The smallest trout were found in the bays quite removed from the mouths or vicinities of the passes. Some trout as small as 31-35 mm. were found in late November in the bays and larger trout 96-100 mm. were found near the passes in the Matagorda Bay area. Remote bays and bayous such as Boggy Bayou and Powerhorn Lake, and which both lie adjacent to Matagorda Bay yielded large numbers of small trout 11 to 35 mm. as late as November, 1949. A systematic procedure was followed throughout the winter of working all of the areas at certain intervals until enough data had been accumulated to show definite size groups for certain areas and seasons. This routine practice was then abandoned and those areas were worked more frequently which were known to be choice spawning or nursery grounds for small trout and redfish. This practice was especially necessary during the early spring and summer months at which time the small 5-10 mm. sea-trout had to be picked individually out of the thick marine vegetation, Ruppia maritima. By previous sampling of the entire area, the importance of Ruppia maritima as cover and a place of forage for very small trout had been established. This grass not only protected the trout from predators but always held an abundance of small marine shrimp, fish, worms, and other organisms which the small trout utilize as food. A 6 mm. sea-trout laid upon a mass of Ruppia maritima, can only be seen by one specifically looking for the trout due to the nearly perfect color blending.

Table I

Trout Tagged By Net In 1950

Bay Area	Month Tagged	Size Standard Length in mm.	Frequency	Mean Length
Espiritu Santo	May	125-405	45	330
Copano Bay	May	90-205	11	180
Copano Bay	Aug.	290-335	7	310
Aransas Bay	April	325-375	4	325
Aransas Bay	July	270-565	38	330
Aransas Bay	Oct.	285-570	42	325
Mesquite Bay	April	140-375	3	150
Mesquite Bay	Aug.	245-690	50	330
Laguna Madre	April	300-580	2	---
Laguna Madre	Sept.	305-635	32	350

Table II

Redfish Tagged By Net In 1950

Bay Area	Month Tagged	Size Standard Length in mm.	Frequency	Mean Length
Espiritu Santo	June	140-200	3	---
Espiritu Santo	July	200	1	---
Copano Bay	Aug.	210-430	2	---
Aransas Bay	April	385	1	385
Aransas Bay	June	240	1	---
Aransas Bay	July	245-420	8	275
Aransas Bay	Oct.	160-655	52	---
Mesquite Bay	April	155	1	---
Mesquite Bay	July	275	1	---
Mesquite Bay	Aug.	165-500	115	280
Laguna Madre	April	330-490	5	380
Laguna Madre	Sept.	260-565	49	450

Table III

Flounder Tagged By Net In 1950

Bay Area	Month Tagged	Size Standard Length in mm.	Frequency	Mean Length
Espiritu Santo	June	140-225	3	----
Copano Bay	Aug.	300	1	----
Aransas Bay	April	285	1	----
Aransas Bay	July	235-345	8	285
Aransas Bay	Oct.	250-295	2	----
Mesquite Bay	July	265	1	----
Mesquite Bay	Aug.	190-210	2	200
Laguna Madre	Sept.	195-315	4	270

Table IV

Drum Tagged By Net In 1950

Bay Area	Month Tagged	Size Standard Length in mm.	Frequency	Mean Length
Espiritu Santo	May	190	1	----
Copano Bay	Aug.	200	1	----
Aransas Bay	July	170-395	14	185
Aransas Bay	Oct.	165-270	8	185
Mesquite Bay	Aug.	305	1	----
Laguna Madre	April	60-185	4	----
Laguna Madre	Sept.	105-455	83	220

Date and Length Place released	Fish and Tag No.	Date and Length Place received	Sex	Gonads at Release	Gonads at Recovery
May 3, 1950 Crisis Flats- s.e. 330 mm. 1200' trammel net. Released again Aug. 17, 1950 at Cedar Bayou s.e. 338 mm.	Trout #585	Aug. 17, 1950 Cedar Bayou s.e. 338 mm. by rod and reel	Male	Running Milt	Spent
June 7, 1950 Pelican Island Cove s.e. 227 mm. (small drag seine)	Flounder #516	Aug. 17, 1950 Pelican Island Cove s.e. (Not accurately measured). by gig	ND	ND	ND
July 18, 1950 Turtle Bayou s.e. 263 mm. (1200' trammel net)	Redfish #624	Aug. 22, 1950 Turtle Bayou s.e. 265 mm. by rod and reel	ND	ND	ND
April 27, 1950 Trout Bayou s.e. 339 mm. (600' [illegible]	Trout #589	June 6, 1950 Trout Bayou s.e. (not accurately	Male	ND	ND

Class Angiospermae (Seed-pots)
Order Naiaddales
Family Zaunichelliaceae (Pondweeds)

Ruppia maritima is a long, stipitated, ovoid bodied marine grass. Commonly called Ditchgrass or Sea-grass, it occurs in shallow marine waters. It occurs throughout N. A. except the extreme N. (W. I., Mex.) C. A., S. A., O. W.) summer and fall. It occurs in extensive dense masses just beneath the surface of the water.

In the extreme southern Coastal Plain the plant may be found during the winter in reduced growths.

We definitely established the close association between small post larval trout and Ruppia maritima which is found in certain locations in some of the bays and in parts of the Laguna Madre. The most efficient collecting net for the small fish seeking cover in this grass was a twelve foot beach seine 6 feet deep made of 1/4" mesh linen twine and lined with 1 mm. aperature cheese cloth which was sewed to the net webbing. This net was pulled slowly over the grassy bottoms of the shallow bays by two men, and yielded good results. After the fish had grown to a size of 25 to 35 mm., a 240, 140, or 100 foot drag seine, with a 10 foot sack in the middle and using 1/4" mesh, was used for collecting. The 100 foot sack drag seine was our most dependable piece of collecting apparatus. Mr. Pearson (1925-1926) experienced our same difficulties in collecting fertilized eggs of the sea-trout. We used a 1 meter circumference silk tow net with 72 threads per inch and one with 125 threads per inch with no success. In as much as the spring spawning period coincides with the great influx of jelly-fish of all species, plankton drags were consistently ruined by the jelly-fish clogging the tow nets. Many hours of plankton towing in spawning areas where sexually mature male and female trout were found proved entirely fruitless. This resulted in a challenge to the supposition that sea-trout eggs were probably pelagic. We can believe now that they instead are demersal and sink to the bottom of the bays into the soft sand and mud where they lie undetected among the shoots of the ever present Ruppia maritima grass.

Several attempts were made to strip very ripe female and male trout and thus artificially hatch the eggs for embryological development studies. This test was carried out four different times and failed completely but we did ascertain that trout sperm would remain viable in unaerated sea-water for 72 hours; this was not true of the eggs which deteriorated within 36 hours in unoxygenated sea-water.

The eggs from a ripe eighteen inch female sea-trout were estimated by ration and proportion count to be 514, 740 eggs. The ripe ovaries weighed 0.25 lbs. and the diameter of the non-fertile trout egg is between .76 and .98 mm. These figures were estimated by counting 113.50 grams of unselected non-fertile eggs from different locations in the ovary which amounted to 1120 eggs ranging between .76 and .98 mm. in diameter. By ration and proportion, the entire ripe ovary contains 514, 740 eggs.

It is obvious that fertilized eggs in all stages of segmentation and the succeeding stages of early larval stages must be obtained before the complete life history of the 0 year class can be known biologically. It is the author's opinion, that this can be achieved successfully only by artificial fertilization or by holding of mature ♂ and ♀ trout in large tanks during the early spawning season until eggs are laid and fertilized.

Length frequency measurements of collected trout indicate that the first spawning occurs in early April or possibly to some extent in late March. The months of May, June, July, and August appear to be the heaviest months for spawning. Spawning continues through September and begins to subside in October and diminishes by the middle of November. May and June are probably the peak months for spawning sea-trout, as evidenced by the large number of mature and ripe sea-trout found in the back bays during this period.

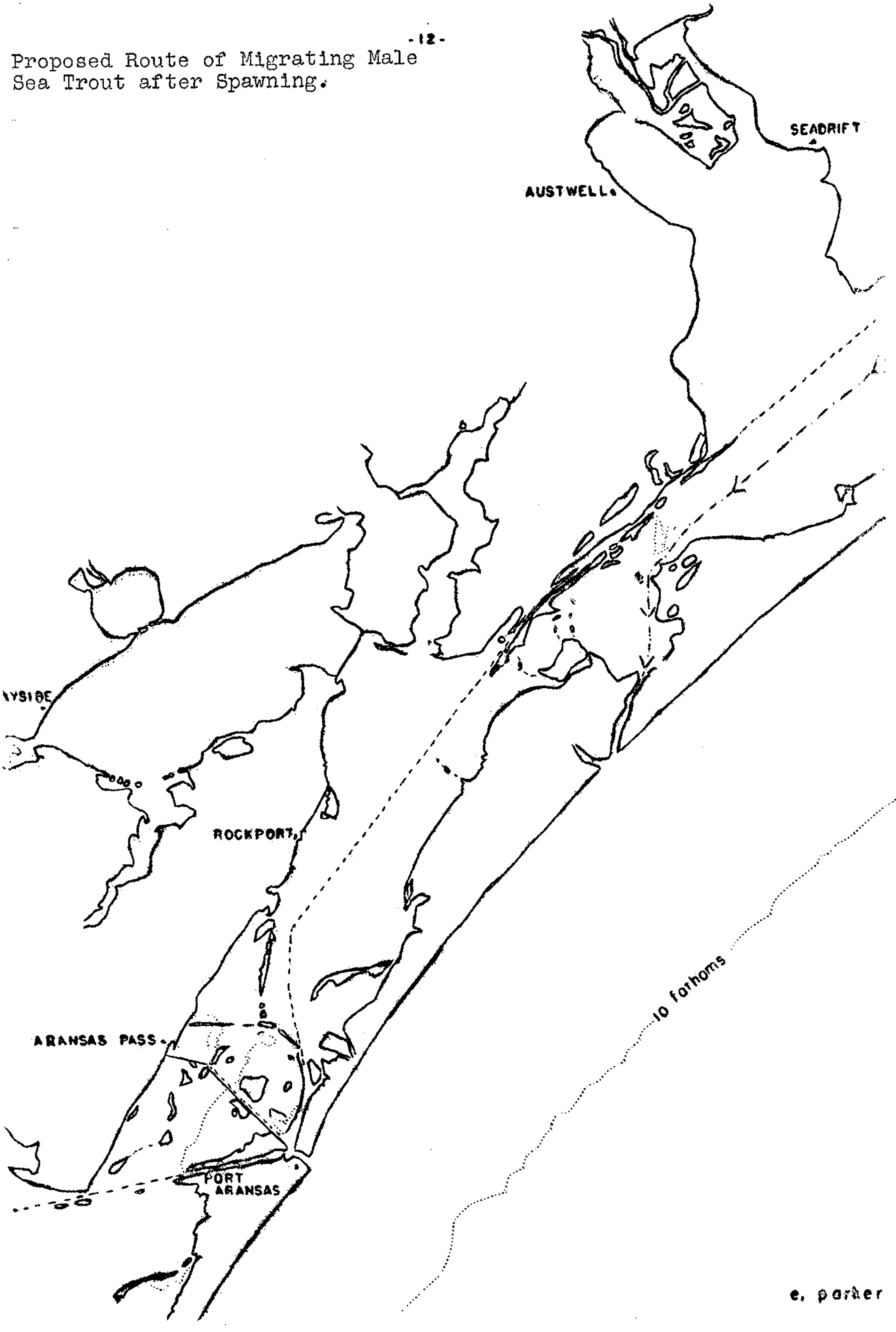
Some of the sexually mature trout which were tagged in April, May, and June, were recaptured by rod and reel sportsmen in July and August and were well spent. One 330 mm. ♂ sea-trout, running milt at the time he was tagged on May 3, 1950, in Esperitu Santo Bay was captured by rod and reel on August 17, 1950, at Cedar Bayou well spent. This fish was travelling toward the Gulf as were many sexually spent sea-trout which ranged from 330 to 380 mm. standard length and averaging between 1.5 and 2 pounds in weight.

The position of these fish in relation to the fish trap in Cedar Bayou is indicative of their migration from the inland waters to the Gulf of Mexico with the cessation of spawning.

A more complete source of information can be found in the Annual report of Ernest G. Simmons' study of The Effects of A Natural Pass Upon Fish Migration. In this report, Simmons shows all returns of the fish tagging program.

Large sow trout were taken for tagging by trammel nets at the mouth of Cedar Bayou between August 15, and August 31, 1950. These trout were going to the Gulf from Mesquite Bay through Cedar Bayou. All of the large females, some of which were 30 inches in total length, were well spent and dissipated from their spawning activities, while large sow trout in a sexually ripe condition could still be found in the remote areas of Copano Bay. Females were also found in the Laguna Madre and Baffin Bay area ready to spawn. During the entire spawning

Proposed Route of Migrating Male Sea Trout after Spawning.



season from April to August, 1950, Simmons found only 2 mature female sow trout going toward the Gulf through Cedar Bayou. This is probably one of those exceptions to the general rule and in my opinion does not indicate that a population of trout spawn outside in the Gulf of Mexico. If this were true, small post-larval trout would have appeared near the mouths of the Gulf passes during the spawning season as well as in the most remote areas of the inland bays and lagoons from April to August, 1950. The tide change is so slight on the Texas coast that small drifting helpless larval forms could not be carried rapidly to the back bay areas. This point can be substantiated later by comparing the areas in which small redfish are found during the redfish's spawning season.

Later checks of stations near the Gulf passes and in the back bay regions in October revealed some spawning taking place in the bays. Small trout 14 to 20 mm. standard length were found in the shallow waters where Ruppia maritima still lay. The large patches of Ruppia maritima at Turtle Pen Flats and Port Bay in Copano Bay were beginning to die. This coincided with the decrease in the number of small trout to be found which, of course, showed spawning activities of the sea-trout to be decreasing. This spawning decrease in the back bays is compared to the sexual condition of spent or immature trout found in the primary bays such as Mesquite, Aransas, and Redfish Bays. Trammel net operations on October 12 and 13, 1950 in Aransas and Redfish Bays revealed that all sea-trout captured were well spent and quite emaciated. The net selects only those trout 13 inches or more in total length. At the time of their capture, these sea-trout were presumed to be travelling toward the waters of the Gulf.

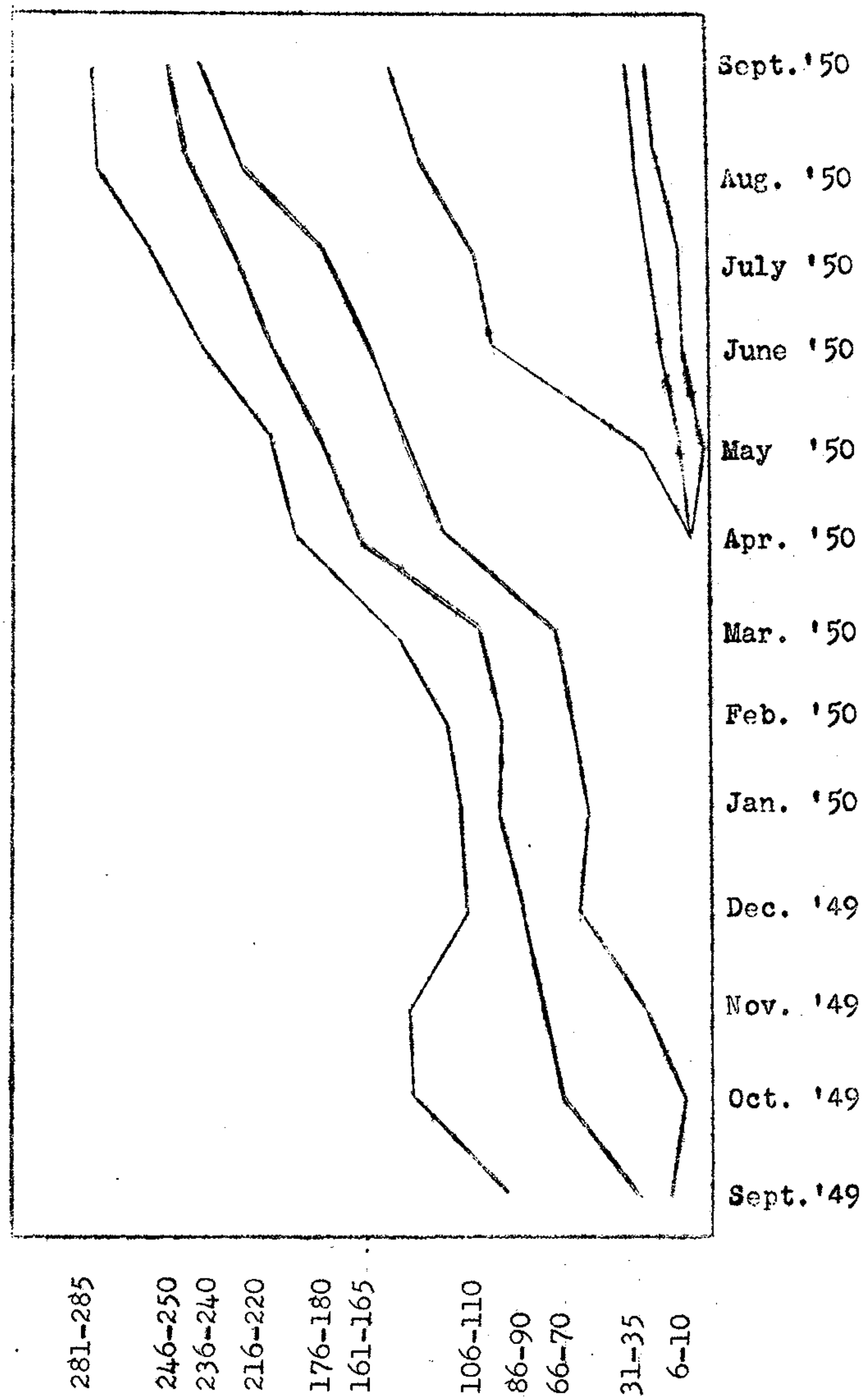
Fig. 1 represents the monthly growth rate in millimeters for a one year period from September 1949 to September 1950. The growth increments are shown on the left hand side of the chart. The growth rate is plotted in increments of four millimeters and the modal line represents the mean average of all the sample specimens collected. The line marked maximum represents the largest sea-trout of the 0 year class collected in any of of the 12 months; the minimum growth line represents the smallest of the collected samples for any given month. The additional chart beginning in April, 1950, represents the beginning of the new 0 year class of 1950, or the new spawning season.

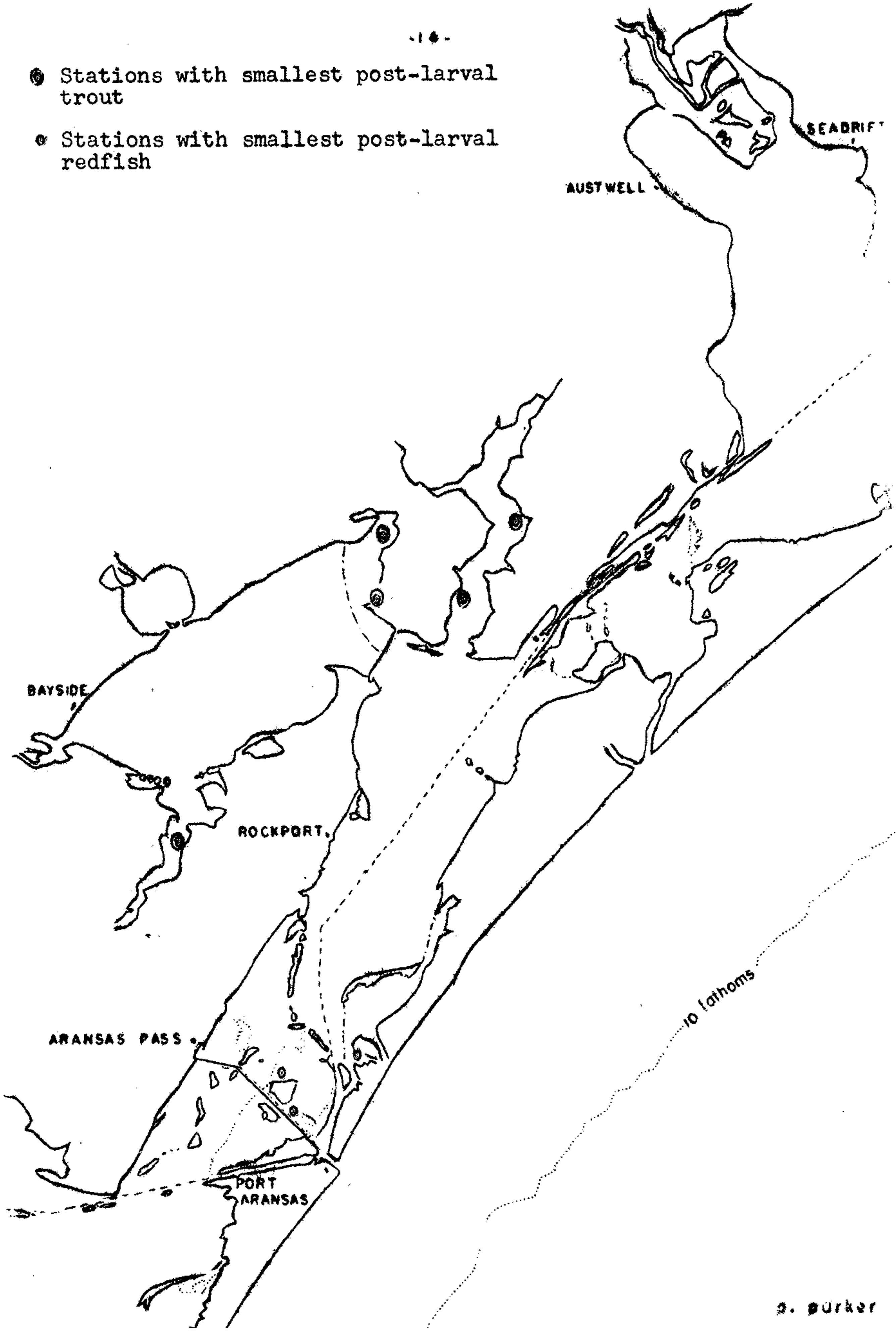
The 0 year class only is represented in this chart.

The food of the small 0 year class sea-trout does not differ radically from that of the mature individual. At the beginning of this study, it was presumed that we would find entirely different food preferences for small trout than we had found for larger and mature sea-trout (Miles 1948-1949).

Fig. 1

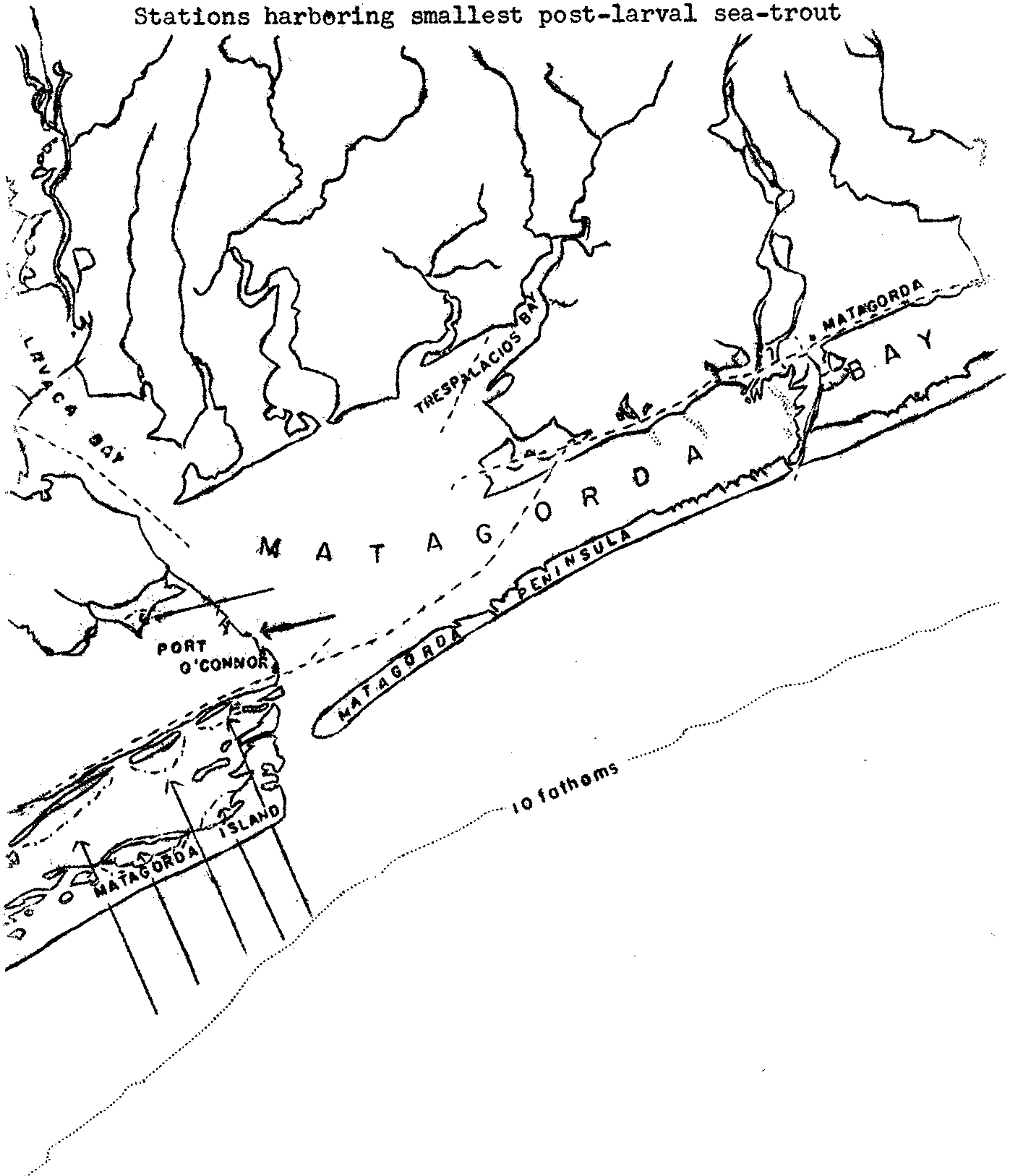
MAXIMUM, MOLAL, AND MINIMUM GROWTH
OF O YEAR CLASS SPOTTEL SEA TROUT, CYNOSCION NEBULOSUS




Stations with smallest post-larval trout
Stations with smallest post-larval redfish
SEADRIF
AUSTWELL
BAYSIDE
ROCKPORT
ARANSAS PASS
PORT ARANSAS
10 fathoms

Matagorda Bay Area

Stations harboring smallest post-larval sea-trout



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Stomachs from 20 mm. to 150 mm. standard length trout were examined both macroscopically and microscopically for food organisms or remains of the same. This operation proved to be more painstaking and tedious than it had been on large sea-trout. The results were gratifying although a great number of specimens could not be examined as had been on the large fish. By microscopic inspection some copepods were found in the stomach remains and pieces of unidentified fish and shrimp could be separated from one another. The small forms of the commercial shrimp P. setiferus and P. aztecus were once again the preferred food staple of small trout. Some small grass shrimp of the Paleamonetes and Tozeuma genera were also very popular. A very small unidentified fish appeared so frequently that the author decided to save some of the bones and tissue for future study. This later proved of considerable value after the same fish was found in less digested stages until whole individuals were finally identified. The small fish was the very common viviporous sheepshead minnow, Cyprinodon varigatus. This small minnow can be found in brackish water or water of high salinity in shallow grassy regions by the hundreds or thousands.

The small shrimp upon which these small trout fed were from 10 to 25 mm. in length and it was especially noticed that the height of the trout spawning season from April to September coincides exactly with the great influx of post larval Peneidae shrimp to the back bay waters during these same months. These small shrimp need the same environmental conditions as do the post larval sea-trout and in so doing furnish a convenient and abundant food staple of the right kind and size for the small trout. Several times during June and July, as much as five pounds of these small shrimp could be seined up with twenty to fifty small trout. Stations 24, 29, and 31 in Copano Bay harbored the largest aggregation of small trout throughout the entire spawning season and were also the richest areas in small shrimp and sheepshead minnows. These three stations were also the ones with the largest and most abundant patches of Ruppia maritima grass.

Fig. 2 shows some of the food items found in small trout stomachs and a partial quantitative study of different sizes of sea-trout of the 0 year class. There appears to be no significant difference in food according to fish size from 35-120 mm. in length.

An analysis of the zoo and phyto plankton forms was begun shortly after the initial study was commenced. This was done to ascertain whether John C. Pearson (1926-27) had left undiscovered anything of vital importance as to the presence of trout and redfish during periods of heavy aggregations of plankton or by the absence of certain species of plankton. A ten to fifteen minute tow was made at each station being tested

Fig. 2

193 trout stomachs
14 contained no food items

Size range of fish--
35-120 mm.

Food eaten	# of stomachs containing same.	Total number of Organisms found.	Size range of food in millimeters	% of total # stomachs
Unid. shrimp	91	171	3-25	47.5
Palaeomonetes Shrimp	14	24	10-30	7.6
Peneidae Shrimp	28	49	11-30	14.7
Copepods	4	12	2-8	2.1
Crabs (Portunidae)	1	1	8	.01
Unid. fish	22	23	10-30	11.5
Mojarro	1	1	17	.01
Sheepshead minnow C. varigatus	6	6	10-15	3.2
Sciaenidae Unid.	1	1	20	.01
Lizzard Fish	1	1	18	.01
Gobie	1	1	12	.01
Isopods (Unid.)	3	7	2-5	1.5
Nereid worms	4	4	4-11	2.1
Squid	1	1	15	.01
Jingle shell	1	1	2	.01
Vegetation Unid.	14	18	1-3	7.6
	193	321		100%

Stomachs With Shrimp Only	Stomachs With Fish Only	Stomachs With Mixed Food Organisms
81	12	23
42.5%	5.9%	12.1%

There is no significant difference in food according to fish size from 35-120 mm.

for eggs or larvae and a general plankton breakdown made. All attempts to correlate the presence of planktonic forms with that of 0 year class trout and reds have failed. We do know that the smallest fish will eat the large macroscopic copepods but they do not depend upon them as a direct food item. These copepods and diatoms eventually come to non-plankton eating fish as food through other regular plankton feeders.

Fig. 3 shows the predominate species of phyto plankton for each month of the year in each major area. The copepod Calanus finmarchinnius was usually present in the back bays in at least moderate aggregations most of the entire year.

Scale studies were made on trout and redfish of the 0 year class as well as scales of large trout and redfish whenever available. A means was sought to correlate the number of radii with the length-frequency method of age determination on trout and redfish which had not yet attained one annulus or winter growth check. The results were found to be only about 50% accurate and therefore this method was discontinued.

The age in winters can be determined from trout and redfish scales by the number of annuli or winter growth checks formed during those winter months when normal growth subsides. This practice is fairly reliable in northern waters where a distinct annulus is formed instead of a mere overlapping at usually one point on the circulii on the scales of trout and redfish in the warmer Texas Gulf Coast waters. Many redfish scales from fish thirty to thirty-seven centimeters in length did not show the customary winter growth check due to the past two very mild winters. Some scales were found which could be read and agreed very well with the length-frequency method of age determination. A permanent library of scales from all types of fish has been established for the purpose of cross checking ages of fishes against length measurements. This cross-check will be of more value through the year 1951, at which time larger fish will be the focus of study.

The pertinent points of the first year's study on the Life History of the Trout and Redfish, of the Texas gulf coast have been explained in this report from an analysis of the data collected in the field. The incidents and observations told to me by commercial and sports fishermen, and guidance from John C. Pearson who made the study in 1925 and 1926, have been carefully considered along with the field data accumulated.

The following evidence has been found from this study and reinforces some of the early groundwork (Pearson 1925-1926).

1. The sea-trout seek remote parts of the back bays in which to spawn from early April until the middle of November.

	Copano Bay	Aransas Bay	Cedar Bayou	Lydia Ann Channel	Port Aransas
Aug. 1949	Coscinodiscus granii	Rhizosolenia alata Rhizosolenia calcar avis	Biddulphia granulata	B. granulata	B. granulata
Sept. 1949	Chaetoceres affinis	B. longicruris	R. shrubsolei	R. shrubsolei	R. shrubsolei
Oct. 1949	(None)	(None)	C. affinis	B. mobiliensis	C. affinis
Nov. 1949	Biddulphia mobiliensis	(None)	B. mobiliensis	S. costatum	S. costatum
Dec. 1949	C. granii Thalassiothrix frauenfaldii	B. mobiliensis	S. costatum	C. affinis	C. granii
Jan. 1950	Coscinodiscus asteromphalus	C. asteromphalus	S. costatum	C. granii	S. costatum
Feb. 1950	Ditylum brightwellii Skeletonema costatum	S. costatum	S. costatum C. asteromphalus	S. costatum	C. asteromphalus C. costatum
Mar. 1950	Gyrosigma balticum	C. asteromphalus	C. asteromphalus D. brightwellii	C. asteromphalus	C. asteromphalus D. brightwellii
Apr. 1950	C. asteromphalus Nitzschia sigma var. rigida	C. asteromphalus	C. asteromphalus	C. asteromphalus	C. asteromphalus
May 1950	C. asteromphalus	C. asteromphalus C. granii	Thalassiothrix med. var. pacifica	C. asteromphalus	Thalassiothrix med. var. pacifica
June 1950	Epithemia spp.	C. asteromphalus	Thalassiothrix med. var. pacifica	R. alata R. calcar avis	C. asteromphalus C. wailesii
July 1950	C. granii	C. asteromphalus Hemidiscus hardmaniana	C. asteromphalus R. alata	R. alata	R. alata C. concinnus

Dominant Species of Plankton Samples

Fig. 3

2. The height of the spawning season takes place from May to July inclusive.

3. Small post-larval sea-trout need the protection of Ruppia maritima grass for cover and a place for food forage during their first four months of life. They are found in water depths of 2 1/2 to 5 1/2 feet. They favor cool areas having maximum temperatures of 29° C. The eggs of the sea-trout are probably demersal and adhere to bottom vegetation in quiet waters.

4. The basic food of sea-trout for the first six months of life consists of larval, post larval, and young commercial species and grass shrimp (Peneidae and Paleamonetidae). The sheepshead minnow, C. varigatus is a forage fish for young trout of the 0 year class but is second to small shrimp as a staple food.

5. Most post larval trout are found in quiet waters with a salinity range from 22.0 to 28.0 parts per thousand. This has not been definitely established as a critical factor.

6. The greatest distance traveled by a tagged trout has been approximately fifty miles.

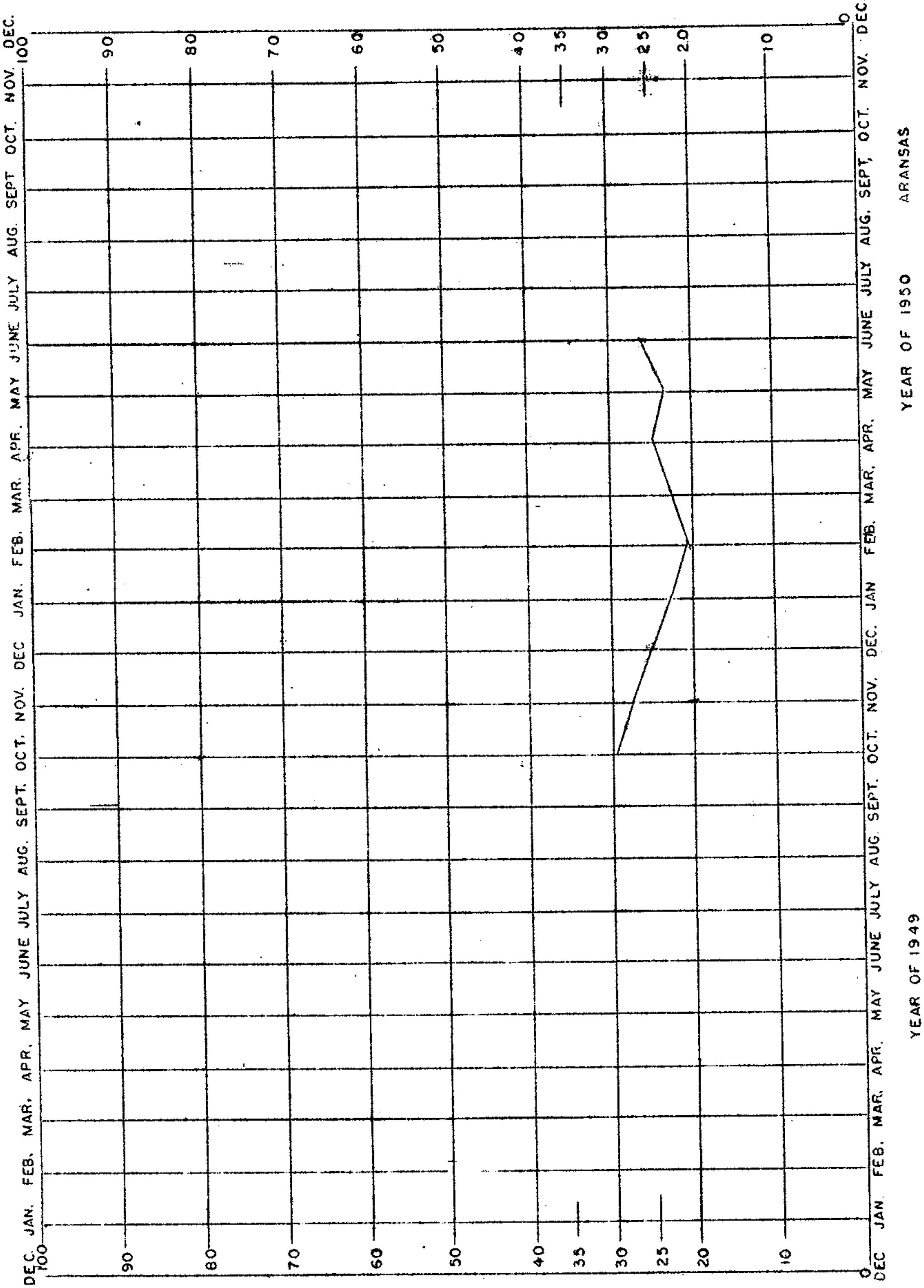
The Redfish, Sciaenops ocellatus

The study of the redfish, Sciaenops, was begun in September, 1949 along with that of the sea-trout, Cynoscion nebulosus. The same information about this fish was sought such as the eggs, larval, and post larval forms and their spawning season and places of spawning. The same groundwork has been done on the life histories (Pearson 1926-1927) of this fish as had been done on the sea-trout. No fertilized ova had ever been collected and described and not many small post larval forms had been collected.

Pearson's evidence from collections of his smallest post larval redfish indicated that sexually mature redfish spawn in the Gulf of Mexico close to the mouths of the passes or around the mouths of the passes themselves. This evidence is substantiated by the findings of the second fall season in October, 1950. The first small redfish were taken in October, 1949, at Pelican Island, which lies between Matagorda Island and Matagorda Peninsula in Matagorda Bay. This small island lies only about one and one-half miles from the gulf waters of Pass Cavallo. The redfish were in a small cove on the bay side of the island and so were protected from the gulf current which carried them

Average Salinity in p.p.t. and Air and Water Temperatures

Bay or Area	Air Temp. C°	Water Temp. C°	Salinity p.p.t.	Months Tested
Copano	26.82	25.75	25.4	10-11-1-2-4-6-7-8-9-10
Espiritu Santo	22.79	22.57	25.9	9-10-11-12-2-3-4-6
Matagorda	24.28	23.03	25.2	9-10-11-12-2-3-5-6
St. Charles Bay	23.83	23.42	21.7	9-11-1-2-3
Aransas Bay	25.55	24.88	23.5	9-10-1-5-6-7
Mesquite Bay	20.56	20.81	27.6	10-11-1-2-4-5-6-7-8-9
San Antonio Bay	23.59	22.83	16.1	9-11-1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YEAR OF 1949
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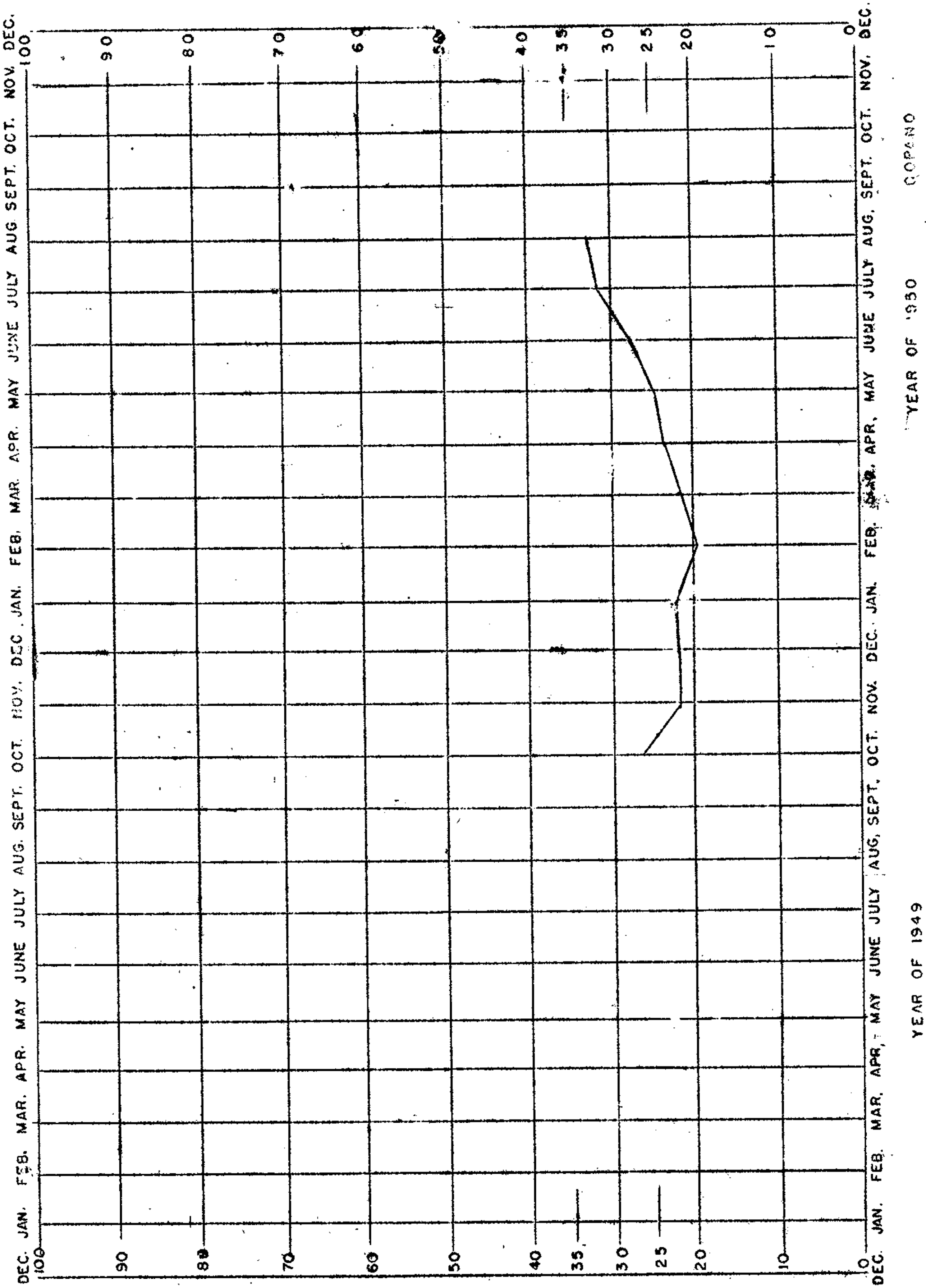
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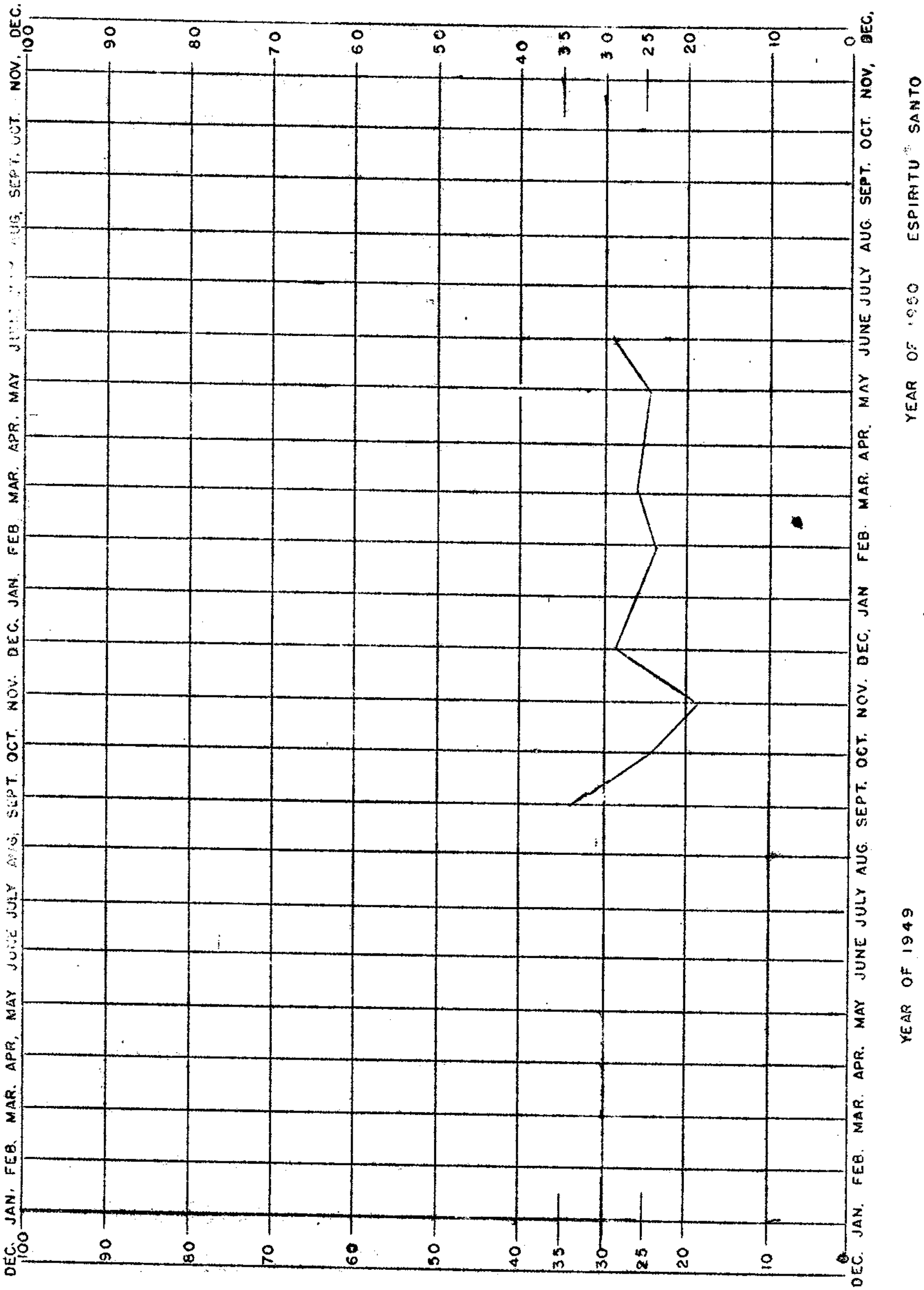

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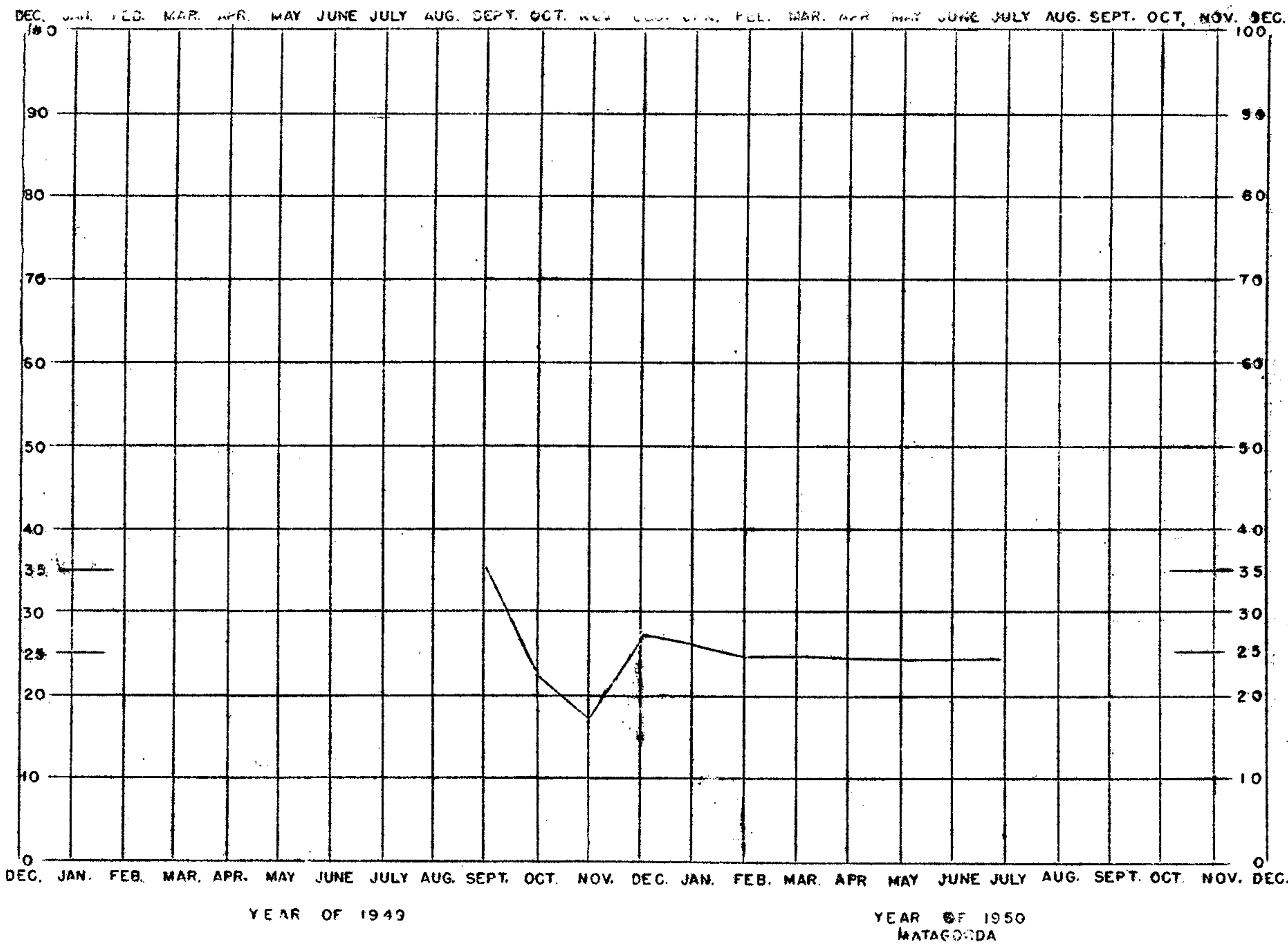
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YEAR OF 1950
MATAGORDA

a. parker

inside of Pass Cavallo. Most of the spawning season of 1949 was spent in the secondary bays and produced no small redfish indicating the absence of mature redfish within these areas. At this same time many small post larval trout could still be collected in Powderhorn Lake, Barroom Bay, Espiritu Santo Bay and the bayous running into Matagorda Bay. Not one redfish was found in these waters above named until November, at which time the first small redfish had reached a standard length of twenty-one to twenty-five millimeters. Redfish of this size could be found in Espiritu Santo Bay throughout November, December and January. Redfish of the 15-18 mm. size were collected at Pelican Island as late as December 18, 1949. The protected cove inside Pelican Island could easily shelter small larval fish from any tide changes for long periods of time. The bottom vegetation inside Pelican Cove consisted of a red algae and sparce patches of marine grass. Several attempts were made to obtain sexually mature bull redfish but all of the redfish captured at that time were inside the bays and were sexually immature. The largest redfish caught for examination was a male measuring twenty-seven inches standard length but he was not in a sexually mature condition.

A check of the scales from this fish indicated that he had passed his fourth winter of life. According to Pearson's report (Pearson 1926-1927) the winter checks on the scales of large fish are not reliable after the third winter growth check has been formed.

Many "old timers" who have fished the Texas gulf coast for thirty to fifty years say they have never caught a "bull redfish" with roe during the spawning season from early October to December. Since these fishermen did most of their fishing in the back bays such as Copano, St. Charles, and Redfish Bays, this seems to support the theory of Pearson that redfish spawn in the Gulf of Mexico. One Rockport fisherman did catch two 35 inch redfish on Turtle Pen Flats in Copano Bay about seven years ago. He said the roe was the size of a man's arm and weighed four to six pounds. A Copano Bay fisherman also reported catching a bull redfish at the Copano causeway in the fall of 1948; the roe weighed four pounds and the bull red was over thirty inches in length. The gulf beach fishermen at Port Aransas, however, tell of catching many mature bull redfish during October and November of each year. The largest single haul of some 400 small redfish 15-18 mm. in length were found at North Pass in Aransas Bay in a shallow protected bayou. The incoming tides from Lydia Ann Channel tend to deposit small sized marine animals in this pocket where they remain undisturbedby ebbtide. Plankton tows in the gulf around and inside of the passes failed to reveal a catch of eggs or early larval stages. By January of 1950, fifty millimeter redfish were found most abundantly in the primary and secondary bays of the area under study. These fish of four months of age had worked back into the remote protected areas such as Turtle Pen Flats in Copano, Light House Pocket in Espiritu Santo and Big Devil Bayou in St. Charles Bay. All of the localities above described are grassy regions in rather quiet shallow water. Salinity readings for these three areas were all close to 23 p.p.t. At this stage of development the small redfish has the characteristic black spot of the adult redfish on the caudal fin and additional spots the same size on the dorsal part of his body and along the lateral line. The number of spots appearing on the small red will range from ten to twenty four on each side of his trunk. These body chromatophores begin to disappear first from the lateral line and then the dorsal trunk region as it reaches the 100 to 140 mm. age or from 6 to 7 months old. Sometimes this multi-spotted condition persists throughout adulthood. The redfish begins to leave the shallow waters of the back bays as he reaches a length of 85 to 100 mm. at which time he seeks deeper waters in the primary bays and may even be found in deep bayous close to the gulf passes. A few reds from five to six inches in length were found in the open gulf surf during the month of May, 1950. This is probably an exception as the usual gulf migration begins when the fish approaches his first year of life around 300 to 325 mm. Many one year old redfish can be found in the surf around the passes and in the passes during late August and September as he reaches the end of his first year. Trammel net operations for the purpose of tagging redfish revealed a large population of 250 to 350 mm. redfish near the gulf waters in August. In September 420 to 570 mm. redfish were found in the Laguna Madre near North and South Bird Islands moving toward Corpus Christi Bay or Aransas Pass. These fish were presumably moving out to the gulf to spawn. In September, J. L. Baughman, Chief Marine Biologist of the Texas Game, Fish and Oyster Commission observed what appeared to be large schools of adult redfish in the open gulf about three quarters to one mile offshore. Mr. Baughman observed these fish from an airplane and estimated the schools to cover up to an acre in area. These first schools were sighted milling around in circles between Port Isabel, Texas and Eighth Pass on the Mexican coast. The first post larval redfish of 1950 were picked up on October 9th in a small bayou off Aransas Pass Channel near Cummings Cut. The distance from the Pass at Port Aransas to the spot where they were found is about one to one and one-half miles. These first post larval forms were from 3.5 to 6 mm. in length and had just absorbed the last of their yolk sac. The red at this stage is easily identified under the microscope by the soft dorsal and anal ray count and the presence of small chromatophores near the caudal fin, anal rays, and on the dorsal part of the head. The mouth is well formed and characteristically redfish. At this time, the larval croakers had not begun to come into the bays from the gulf and so separation of the two fish was not necessary, although it can be done easily by the soft dorsal ray count alone.

Two days later a small group of fish 5 to 7 mm. was seined up in North Pass where they were found among the Ruppia maritima grass patches. All of these small forms were collected by a small seine lined with cheesecloth and a push-net lined with cheesecloth. In all cases, the small reds were found among the patches of marine grass where they were not carried back out to the gulf by ebbing-tidal currents. These two groups of larval forms are thought to be indicative of the beginning of the redfish spawning season in this area. This presumption was made after seining the gulf beach six days out of every week since September 15th.

After finding these 3.5 mm. fish near the Gulf Pass, a trip was made to Copano Bay and several spots were seined with a fine net to catch small post larval fish.

No small redfish of any kind were found in Copano Bay which is situated 12 miles from the Port Aransas entrance and 9 miles from the Cedar Bayou Pass entrance into the Gulf of Mexico.

A trammel net operation for the purpose of tagging fish was made at Allyn's Byte in Aransas Bay on October 11th. Many 250 to 300 mm. redfish were caught along with sea-trout ranging from 300 to 560 mm. One strike with 1200 feet of net captured ten large redfish 530, 545, 560, 565, 595, 645, and 665 mm. standard length. Some of these fish were bull reds which were spent and very emaciated from the previous spawning activities.

These fish were not separated as to males and females due to the necessity of tagging them for possible return information on their future movements. One return from a tagged redfish which was received after this report was written shows a 65 mile migration in 13 days. The 24.8 inch bull redfish was tagged at Allyn's Byte in Aransas Bay on October 12, 1950 along with several other large bull redfish. They all appeared to be in an emaciated condition and the larger ones appeared to have just finished spawning. Seining of this location the following day produced only one of the previously tagged bulls, which was again released, indicating they had moved on. The 24.8 inch red was caught October 25, 1950 in the cut-off at the canal near the town of Matagorda. This 65 mile movement in a period of 13 days appears to be the record thus far for migrating redfish.

It is possible that they had spawned in the gulf and had returned through Aransas Pass where they were working their way up the west shore of St. Joseph Island.

All of the mature trout captured in this operation were also well spent indicating a cessation to their spawning season. The bull redfish were feeding near a shallow reef with patches of grass growing on the bottom. The water depth was 3 to 6 feet and the surrounding area was alive with golden croaker, Micropogon undulatus and flat or spot croakers, Leiostomus xanthurus.

Fig. 4

130 Redfish
40-127 mm.

7 stomachs with
no food items.

Food Eaten	#Stomachs containing organisms	Total Number of Organisms Found	Size Range of Food in Millimeter	% of Total Stomachs
Unid. Shrimp	51	120		39.2
Paleamonetes	15	38		11.5
Peneidae	32	90		10.1
Copepods	0			
Crabs (Unid.)	10	15	6-8	7.7
Crabs (Portunidae)	6	10	6-15	4.7
Fish (Unid.)	15	23	10-20	11.6
Fish (Scianidae)	3	5	15-20	2.3
Fish (mullet & minnows)	5	11	10-20	3.8
Gobie (Emerald)	2	2	25	1.5
Squilla Shrimp	1	1	30	.8
Worms (Unid.)	10	25	5-15	8.0
Squid (Unid.)	3	3	15	2.3
Grass (Unid.)	12	?	?	9.3
Digested material	19	?	?	14.6

Shrimp Only	Crabs Only	Fish Only	Mixed Organisms
66 Stomachs	5 Stomachs	9 Stomachs	20 Stomachs
51%	3.8%	6.9%	15.4%
			Shrimp, crabs and fish Shrimp & crabs Shrimp & fish Fish & crabs

The golden croakers were developing roe and milt and the average standard length of those taken was 150 to 200 mm. These croakers were unquestionably headed towards the gulf to spawn in late October or early November; the sexes were split about equally and many were fully ripe. For further information concerning different year classes of redfish, refer to Simmons report on "The Effect of a Natural Pass Upon Fish Migration" and "The Fish Tagging Program".

Food

A study was made on the food preferences of small redfish 35-120 mm. as was made on the trout. The results were approximately the same except for percentage differences in shrimp, fish and crab occurrence per stomach. Fig. 4 shows the tabulated results from examining 130 redfish stomachs from 35-120 mm. Once again shrimp appears to be the preferred staple of food and the increase in the number of fish and crabs eaten as compared to the sea-trout may be due to the season when small shrimp is scarce. There seemed to be no significance difference between the food of 35 mm. redfish and 120 mm. redfish. The types, frequencies of occurrence, and percentages of overall organism eaten by small redfish of the 0 year class differ only slightly from those of the older year classes of redfish (Miles, 1948-1949).

By the end of September the modal length of 0 year class redfish had reached 316 mm. Three sizes of redfish in the 0 year class were 366, 320, 310 mm. and showed the maximum, modal, and minimum sizes reached from October, 1949 to September 30, 1950.

Fig. 5 shows the growth rate of 0 year class redfish for a one year period. The lower part of the graph shows the spawning season to begin in September or October and extend through the month of December.

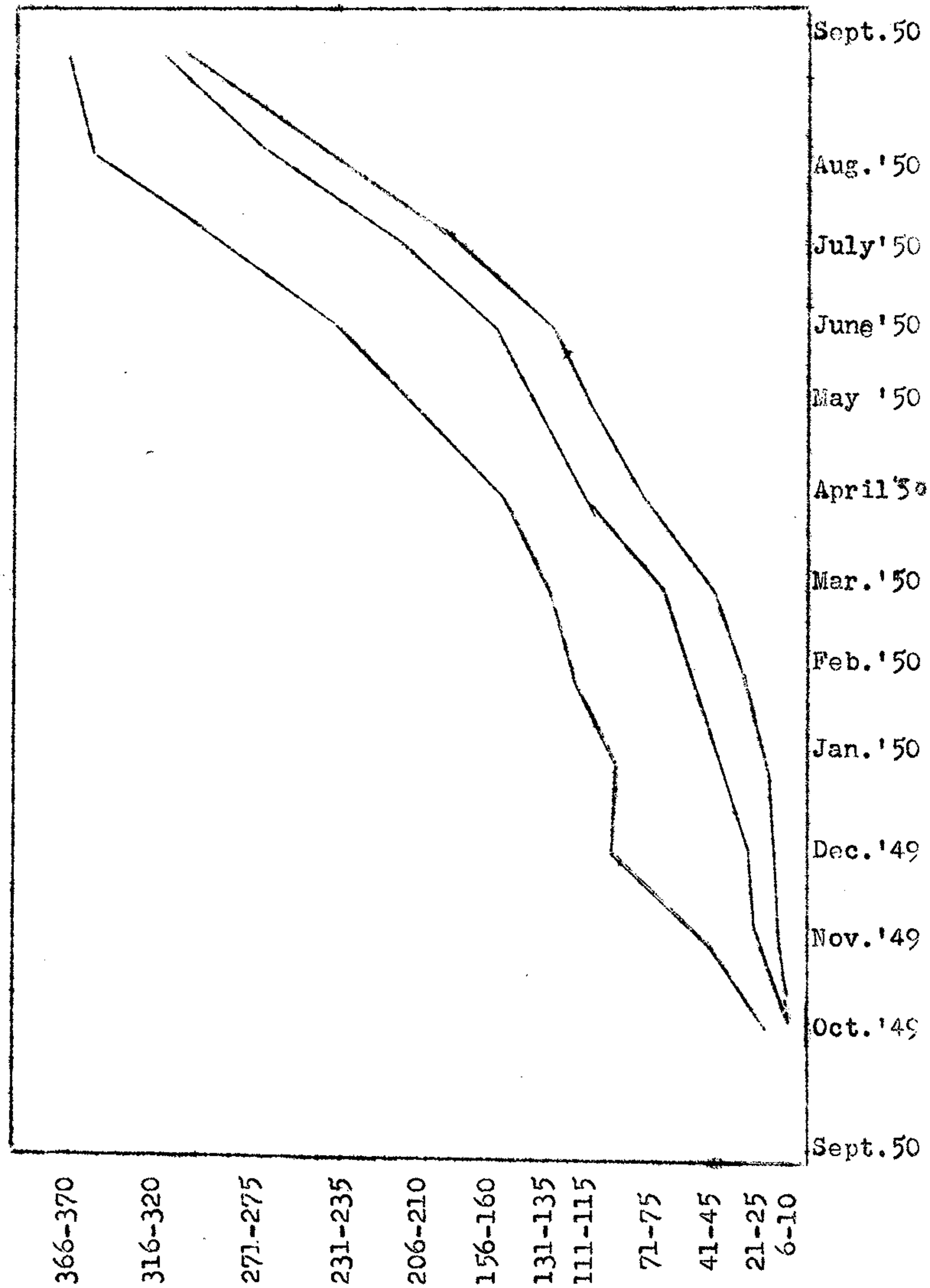
Severe irregularities in the plotted lines may be due to differences in food availability or sex differences.

The modal line plotted for the 0 year class shows that some of the reds will reach a market size of 14 inches by the end of their first year of life. The average or modal size, however; will only be 12.8 to 13.0 inches and so must be over one year old before they are of any commercial importance.

It is interesting to note that the small reds grew a length of only 4.2 inches from October, 1949 to the last of March, 1950, while 8.6 inches were added from the first of April to the last of September. The mildness or severity of the winter season

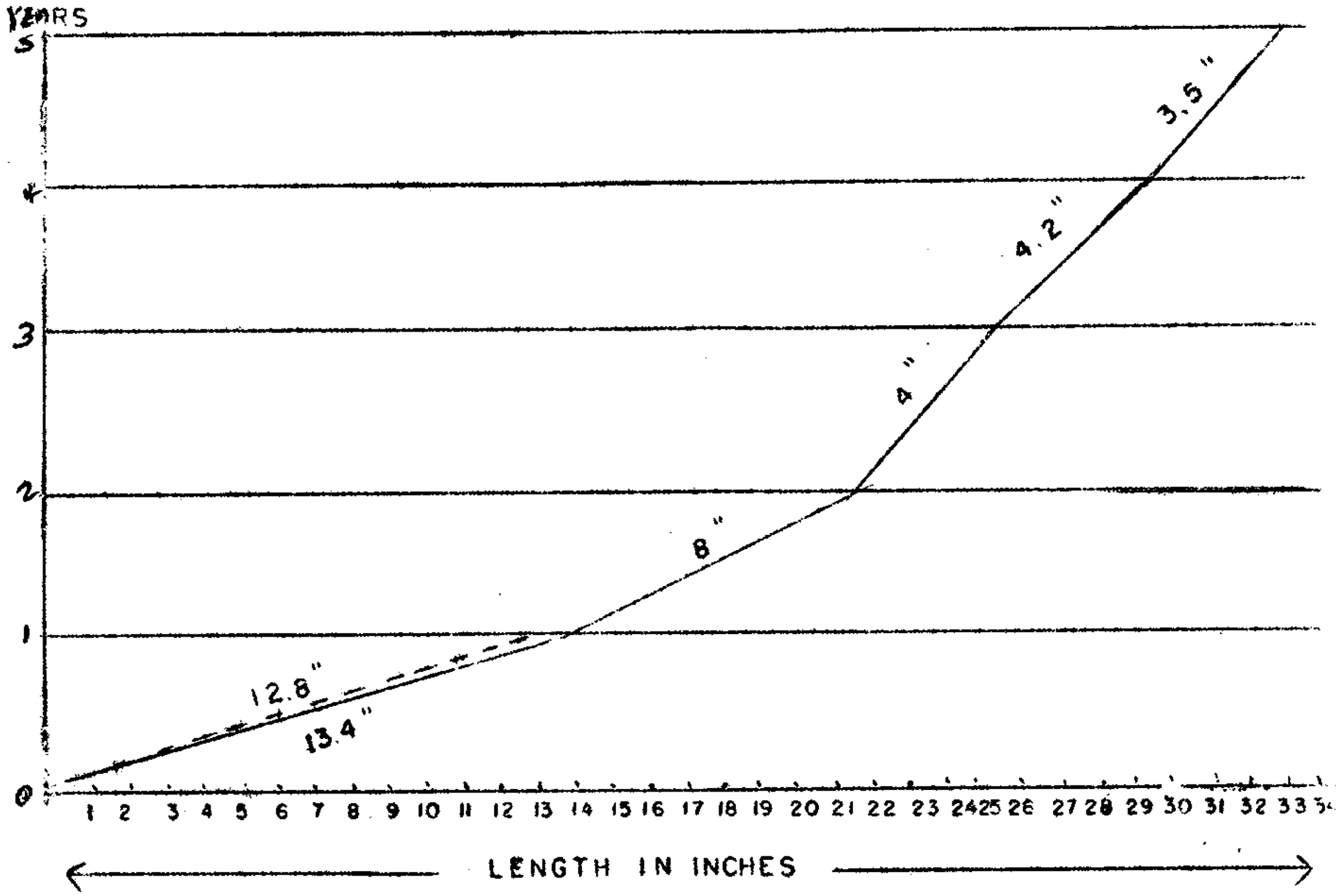
Fig. 5

MAXIMUM, MODAL, AND MINIMUM GROWTH OF O YEAR CLASS REDFISH, <u>SCIAENOPS OCELLATUS</u>



The growth rate for 0 to 5 year old redfish is shown below

(Pearson 1926-1927)



The unbroken line represents Pearson's 1926-1927 approximation; the broken line represents Miles 1949-1950 0 year class approximation.

first year of life, a general migration is made to the passes and bayous near or leading into the gulf.

6. Bull redfish 25 inches in standard length have been found to have spawned and returned to the bays. The maximum marketable size for redfish should be lowered from 35 to 28 inches or even smaller.

7. The average length of a one year old redfish is 12.8 inches with some redfish going as high as 14.4 inches; this puts a small portion of the 0 year class range within the minimum market size.

8. The percentage of capture of large reds 420 to 680 mm. is small compared to that from 250 to 350 mm.; the largest reds taken by seine were in the Laguna Madre, Aransas Bay, and Matagorda Bay.

9. Returns on tagged redfish show the greatest distances which have been traveled by redfish to have been 10 miles.

Artificial Fertilization of Copano Lake

The essential food chain of any given species of fish usually commences many animals or organisms removed from the last eaten items of food. We know that the most simple food chain associated with any of our popular eating fish consists of at least 3 to 5 organisms before it is finally eaten. Suppose, for example, that a large copepod is eaten by a small herring-like fish and he in turn is eaten by a piggy fish or pin perch. A larger fish may eat either of them and then perhaps a large trout or redfish eats the fish which has eaten all four of them. This realization, which has been known for years, lead to the idea of enriching the water with an abundance of nutrient material which would act as food for the smallest organisms such as the desmids, diatoms, and copepoda. The copepods eat most species of the first two mentioned above.

The diatoms, being able to synthesize their own food from H_2O and CO_2 must then be enriched by chemical means.

Experiments have proved the need of phosophates to animal life and in the case of some invertebrates it is believed they need an abundant supply of the same. Waters which appear to be low in content on the microorganisms usually have a deficiency in phosophates and nitrates.

The artificial fertilization of fresh water lakes, for the purpose of building up the plankton or microorganisms, has been popular for some time. An experiment was made in fertilizing a small salt water pond in Scotland several years ago and the results were encouraging.

It was decided to try an experiment on a small salt water lake of approximately five acres which lies northwest of the head of Copano Bay. Copano Lake and Copano Creek are joined together forming a small lake with a narrow, shallow, and winding creek.

Fig. 6 shows the enlarged representation of the lake with soundings at mean high tide.

Plankton samples were taken 2 months before fertilization and all were very sparce in the number and quantity of species found. A representative sample of the animal population was taken by a 10' trawl and is shown in the following table.

Table I

Organism	Size Range	Quantity
Red shrimp, *P. aztecus*	65-70 mm.	18
Red shrimp, *P. aztecus*	45-50 mm.	17
Crabs, *C. sapidus*	40-50 mm.	3
Perch, *L. rhomboides*	32-50 mm.	8
Glut herring, *P. aestivalis*	22 mm.	1
Croaker, *M. undulatus*	50-65 mm.	6

This test was made on April 3, 1950 at 0800 at which time the water was 1-2' average depth and the air and water temperatures were 24.7°C and 22.8°C respectively; the salinity was 24.4 p.p.t.

Several successive tests were made for the next two months and plankton results were approximately the same.

Table II shows the plankton sample analysis which was made before the first application of fertilizer.

Fig. 6

Rough Map and Soundings of Copano Lake

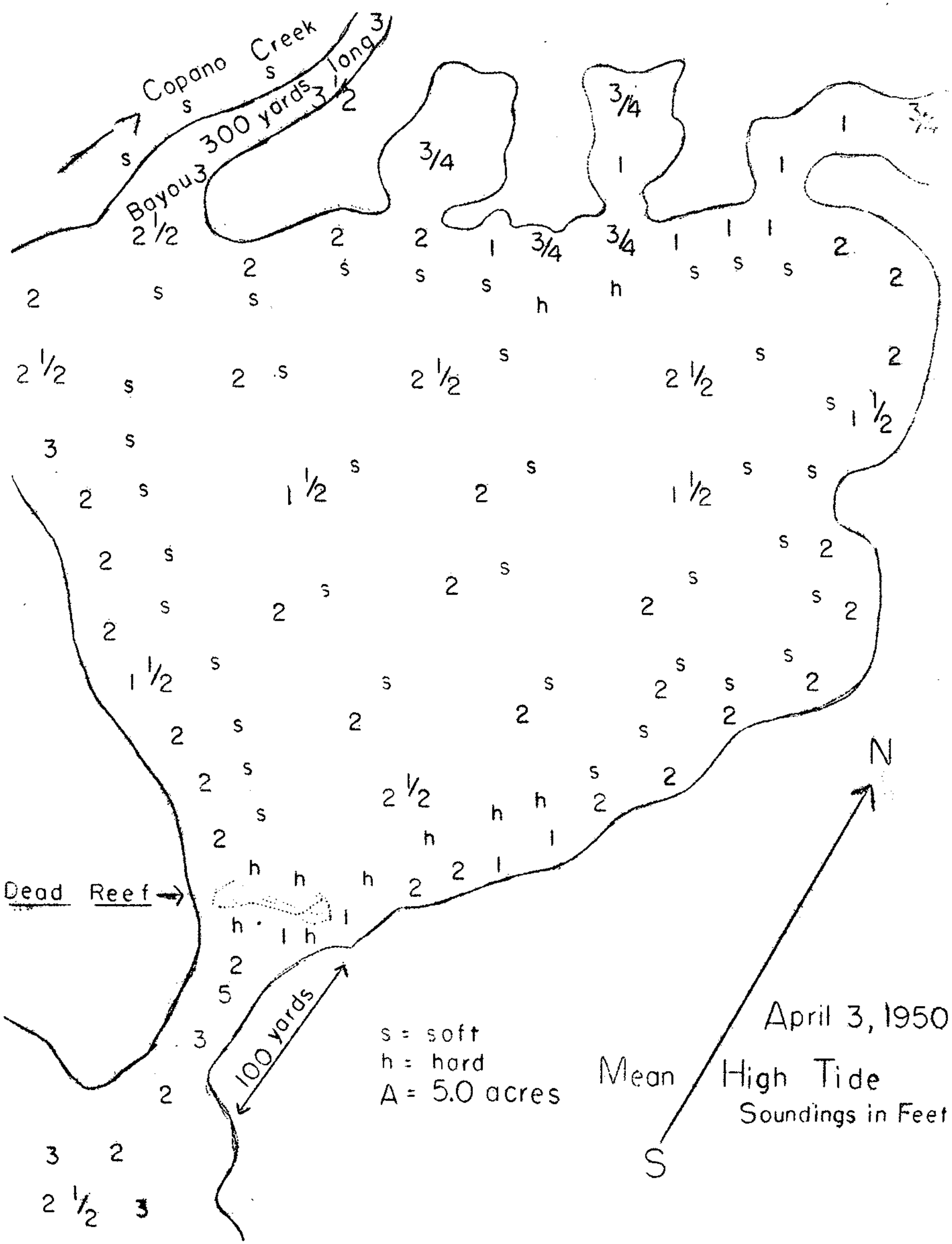


Table II

Species	Quantity Per Sample	Distribution in Lake
Green algae	Minute Patches	S.W. shore of Lake
Thallasiothrix spp.	Very sparce	S. shore to entrance
Detritos	Heavy aggregation	" " " "
C. finmarchilis	3/ 10 cc sample	West shore to Lake
Navicula spp.	1/ 10 cc sample	" " " "
Unid. algal growth	Minute clumps	Entire Lake

The first application of fertilizer compound consisting of cottonseed meal and superphosophates in a 2:1 ration was made July 10, 1950. Air temperature was 29.3° C and water temperature was 29.8° C, the salinity was 27.2 p.p.t. Due to the low water depth of 12 inches and the fairly high water temperature, the concentration was reduced to 800 lbs. for the lake area and Copano Creek. The compound was mixed with the lake water into a super natant fluid and spread over the entire surface of the lake by boat.

At this time the following forms were picked up in the plankton tows around the lake. Most of these are bottom forms and not truly planktonic.

Copepods--sparce
Diatoms--Navicule-light
Epithemia gibba-sparce
N. closteruim-sparce
Blue green spp.-
3 forms of Oscillatoria
N. sigma. var. rigida-light
Amphora spp.-sparce
Lichmophora spp.-sparce
Gyrosigma balticim-sparce
Pleurosigma spp.-sparce

On July 14, a plankton check revealed a slight increase in copepod aggregation and an abundant aggregation of several species of the diatom Rhizosolema. At this time, the water depth had increased 6 inches, air and water temperatures were 31.0° C and 28.6° C respectively and the salinity had increased to 28.0 p.p.t. The dissolved oxygen content in the middle of the lake was 11.2 p.p.m. and in Copano Creek it was 14.4 p.p.m. This range was high enough for all marine forms.

On August 2, 1950, a plankton check revealed the following.

Species or Form	Aggregation
Meris mopedia	Moderate to thick
Coscinodiscus granii	Light
Pleurosigma	Sparce
Navicula spp.	Light
Amphiprora gigantia	Sparce
Epithemia	Sparce
Nitschia closterium	Light
Copepoda	Moderately heavy

Air and water temperatures were 31.26° and 33.5° C and the salinity was 29.5 p.p.t. Many shrimp, *P. aztecus*, and rat redfish were seen in the lake. One very large redfish and one large gar (species not determined) was also noted. Mullet were very thick throughout the lake and Copano Creek.

An additional twelve hundred pounds of fertilizer was added at this time and a plankton check on August 8, 1950 showed a slightly higher aggregation of copepods and diatom forms. No new species were found.

In conclusion, the results were satisfactory insofar as the fertilizer compound did raise the general planktonic abundance. It cannot be stated authoritatively whether or not the increase in microorganisms was responsible for the apparent increase in shrimp, mullet, and redfish. This may have been due to the season alone at which time many redfish are found on the flats in the back bays of Copano. A fertilization project of this nature should be carried on over a one year period at least in order to determine its effectiveness.