THE FISHES OF TWO GULF COASTAL MARSH AREAS OF FLORIDA

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The low shores of the currently exposed peninsula of Florida slowly emerge from a much larger land mass, the almost flat Floridan Plateau, barely covered by the waters of the Gulf of Mexico on the west and the Atlantic on the east. This plateau is considered one of the earth's most stable areas and is believed to be of great age, having changed only slightly during its many millions of years of existence. At times it has been exposed almost entirely and at others it has been almost submerged. Throughout the Pleistocene the records of these fluctuations in water levels have been preserved with sufficient clarity for geologists to show at least seven old shorelines during that period. The intermittent rises and falls of the water levels, although not great, made conspicuous changes in the amount of land exposed, reducing it at times to only a few small islands and increasing it at others to an area at least double that of the present. In addition to these events, there appears to have been a long-time but gentle tilting of the plateau toward the west, which has gradually and almost imperceptibly drowned a large segment of the Gulf coast of the state and at the same time elevated, with equal gentleness, a major fraction of the Atlantic coast. (*cf.* Campbell 1940; Cook 1945).

Thus, where the shallow seas which cover the submerged portions of the Floridan Plateau meet the almost flat shoreline of the peninsula, a wide intertidal zone results along much of the coast. This zone, between land and sea, is particularly conspicuous in estaurine localities where it often extends many miles inland, at the southern tip of the state where it is covered primarily by mangrove swamps, and along the Gulf side of the northern half of the peninsula where extensive coastal marshes have developed. If we can judge the past by the present, it is not difficult to conclude that intertidal marshes have been long-term features of the Florida coast; and certainly since the Pleistocene they have been much as we see them today, an ecologically distinct habitat fraught with the inhospitalities of unstable water levels, fluctuating temperatures, and rapidly varying salinities.

Although this intertidal (or "coastal" or "salt" or "brackish") marsh reaches its maximum extent on the Gulf coast of the upper peninsula of Florida, it is found in greater or lesser degree all along the more than twelve hundred mile shore of the state, and everywhere it harbors a fauna of fishes conspicuous for its variety of species and its abundance of individual representatives. Questions concerning these fishes are: What is the composition of the brackish marsh fauna? Was it

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derived from fresh waters or the sea? Or, perhaps, is it unique in itself? What are some of the more conspicuous ecological factors of the marshes that mold its fish fauna?

Apparently no intensive ecological or faunistic study has been made of brackish marsh fishes, although there are several studies of the fishes of bays and other inshore waters. In addition, the problem of the relations of fish distribution to water salinities has received no detailed attention in Florida. As Gunter (1938, 1942, 1945) has pointed out, this relationship is known imperfectly for most species of fish which are neither wholly marine nor strictly fresh water inhabitants. Yet the members of this euryhaline group include some of the most important commercial fishes of the world, and in Florida much of the income from fisheries is derived from species which make extensive use of the brackish waters of the state.

The present study was designed to gather data about the fishes of the brackish water marshes as well as of those species which cross that zone by moving back and forth between marine and fresh waters. The principal objectives of the undertaking were to determine which fishes were present and to what extent they inhabited the brackish marshes. A secondary aim was to investigate the influence of salinity on the distribution of marsh fishes. Incidental to the work, some information was obtained relative to the life histories of the species encountered. Certain of these findings are included in the present paper and others have been presented previously by the writer (Kilby, 1949).

Two marshes were selected for the field work. One, at Bayport, receives fresh water from river discharge; the other, at Cedar Key, has a negligible dilution of its water from stream flow. The areas proved to be quite different in both their physical and faunistic features.

Monthly collections of fishes made during 1948 were augmented by many preliminary collections during the preceding six months. Collecting was done in and adjacent to the coastal or salt marshes bordering the Gulf of Mexico. In addition, a number of exploratory collections were made in the shallower waters of the Gulf, the bays, and the fresh waters close to the mainland margins of the salt marshes.

Although no detailed faunal study of intertidal marsh fishes has been attempted in North America, several workers have been concerned with the effects of salinity on fish distribution and the fish populations of bays and other open waters near the shores of the sea. Foremost are Gunter, who studied the temperature and salinity effects and the fish faunas of Texas bay waters; Longley, whose findings of a twenty-five year study of the fishes of the Dry Tortugas were completed and edited by Hildebrand; Hildebrand and Schroeder, who compiled a pioneering work on the fishes of Chesapeake Bay; and, more recently, Reid, who worked on the eulittoral zone fishes of Cedar Key. Without the findings of these and other workers, this study would never have gained much of its substance and, with-

out the challenge presented by Homer Smith's (1943) stimulating lectures on the kidney, it is doubtful that it would have been undertaken.

Methods

An attempt was made to collect random samples of the fish populations. This goal was difficult to maintain and when bias was recognized appropriate note was taken. D-type dip nets, tea strainers, and poison were employed but by far the most frequently used collecting devices were seines of ten and twenty-five foot lengths having a depth of four feet, mesh of a quarter inch, and a four-foot bag located in the center. Whenever possible, the seine hauls were planned so that the body of water being worked was covered by the net from shore to shore and from top to bottom. Seining was continued until it was believed that practically all species of fish present were represented in the collection. The details of these collecting procedures, and those of the methods which follow are available in a manuscript in the University of Florida Library (Kilby, 1950); consequently they are given here with considerable abbreviation.

The fishes were preserved in ten percent formalin and each collection was tagged by a field number identical with that on a field catalog card bearing entries descriptive of the station at the time of the collecting.

McBee Keysort Cards were used for the field catalog, and as the fishes of each collection were identified and examined in the laboratory many of the resulting data were recorded on the card for the proper collection. Subsequent coded punching of the cards permitted rapid recovery of the data.

Unless otherwise stated, all measurements are in millimeters. Lengths are standard lengths and were made with the aid of a fish measuring board.

Salinities were calculated in the laboratory from water temperature and density data collected in the field at the time each collection was made. The equipment and the method varied within permissible limits from the technique employed by the U. S. Coast and Geodetic Survey as described by Schureman (1941: 81-85).

The calculation of interspecific association coefficients, as improved and explained by Cole (1949), was used to answer the following questions: "Are these two species of fish occurring together more (or less) often than is to be expected by chance?" "To what extent do the two species appear to be associated either positively (occurring together), or negatively (occurring separately)?" "How reliable (in terms of its standard error) is the obtained coefficient?"

Calculation of the coefficient produces two figures: the coefficient itself (C) and its standard error (S E). For the species pair *Fundulus c. confluentus* and *Cyprinodon v. variegatus* at Bayport, for example, $C \pm S\ E = 0.81 \pm 0.13$. This means that the two species were found together frequently, and the best measure of the association is 81

percent. (If two species were always together, C = +1.00; if their association was random, C = 0.00; and if they were never together, C = —1.00). The standard error gives an estimate of the reliability of the coefficient in the usual statistical sense and consequently it decreases in magnitude as the number of collections increases.

Other statistical techniques and terms used in the treatment of data are based on those recommended by Simpson and Roe (1939). All errors shown are standard errors.

With the exception of a few specimens deposited elsewhere, all of the fishes taken during this study are available in the University of Florida Collections maintained jointly by the Florida State Museum and the University's Department of Biology.

The Cedar Key Area

The extreme diversity of the coastal physiography at Cedar Key can be appreciated fully only by an aerial view. Complexity of the land and water features of the intertidal zone, which ranges up to three miles in width, is a result of the irregularities in the shore line of the mainland, the presence of numerous islands and oyster bars in the tidal area, the fringing beaches of the Gulf, and the tortuous passageways which facilitate the tidal ebbs and flows. To the eye of a person on the ground the extensiveness of the open water in the intertidal zone is minimized by the presence of emergent vegetation which covers, and also fringes, the shallows around the islands and, to a lesser extent, many of the larger or higher oyster bars. The dominant emergent hydrophyte of the tidal area is oyster grass, *Spartina alterniflora* Linnaeus, but occasional strips and patches of black rush, *Juncus Roemerianus* Scheele, are conspicuous, especially near the mainland and in the vicinities of the larger islands. On top of the oyster bars and skirting the shallows adjacent to the islands, black mangrove, *Avicennia nitida* Linnaeus, frequently forms dense thickets; these, as much as the sweeps of grass, contribute to the impression that the tidal area is much more heavily vegetated than it is shown to be by an aerial observation.

Elevations in the area, although not great, have a marked influence on the vegetation. The mainland near the coast, for instance, is a mere three to five feet above normal high tide level and, from the evidence of the change in tide levels, the gradient across the tidal area is approximately one foot per mile. Thus, an oyster bar which is only twelve inches above the surrounding mud flats may support a dense growth of *Spartina,* or even *Avicennia,* and the slightly more elevated islands and the mainland produce pine woods.

At times of extreme high tide the entire tidal area is submerged and takes the appearance of a vast sheet of water being occasionally interrupted by the more prominent islands. Conversely, at extreme low tide, all waters are withdrawn except for those in pools and channels. At such times one would not hesitate to walk through the marshes from the mainland to the town of Cedar Key at the edge

of the Gulf and could do so without getting in water over knee deep. Such a trip, however, would impress upon the venturer that mud is one of the most conspicuous features of the entire area. Mud overlays all of the surfaces of the marshes, except for the outlying strips of beach where white, wave-worked sand may be encountered. The mud is a soft, black, highly organic ooze of considerable depth into which a walker may sink as much as three feet, but usually it is sufficiently compacted to permit fairly easy progress on foot.

In planning the collecting at Cedar Key it was considered logical to follow a transect across the marshes in an attempt to encounter as many different fish habitats as possible, and to work all such stations on an intensive basis for at least a consecutive twelve-month period. It was soon evident, however, that the number of stations had to be limited, although a good means of access to the marshes exists by a road which could be considered a transect line. As a result eleven stations were picked for periodic examination along the road. Five of these were pools situated inside the marshes near the mainland; two were similarly constituted pools near the Gulf margin of the marshes; three were bayous or creeks penetrating the marshes near the mainland; and three were shallows along the shores of the larger bays and of the Gulf. The characteristics of these stations, which are designated by the terms Inner Pools, Outer Pools, Water-courses, and Open Waters, respectively, are outlined in Table 1. The major features of these four categories of habitats are summarized in order to emphasize some of the more pertinent factors of each of them.

Inner Pools

For the purposes of this study a pool is defined as a small, shallow body of water usually devoid of emergent vegetation, which either may retain water during periods of low tide, or become entirely drained at such times. The inner pools at Cedar Key were all surrounded by expanses of oyster grass, *Spartina alterniflora.* They consisted of slight depressions in the surface of the surrounding mud which, in addition to supporting the emergent vegetation, were flooded regularly at high tide. Thus, at extreme low tide some of the pools were drained completely while others, further removed from channels or open waters, might retain up to three and one-half feet of water. At high tide, the influx of water not only raised the levels of the pools, but overflowed into the adjacent marshes in all directions. At such times, fishes could and did leave most of the pools and either fed or took refuge in the surrounding marshes. This flooding also permitted the fishes free access to all parts of the marshes, and therefore facilitated their movements from area to area. The receding waters of the ebb tide forced the fishes to concentrate in the pools, water-courses, and margins of open waters. At such times of concentration they could be netted with facility and consequently nearly all the pool collecting was done at low tide.

The salinity of the pool waters varied through a greater range (1.2 to 35.6 ppt) than that for any other of the groups of habitats, and

TABLE 1.

Descriptions of Collecting Stations in the Cedar Key Area

Station No. & Name	Location	Maximum Diameters	Min. & Max. Depths	Bottom Slope	Bottom Composition	Submerged Aquatics	Tide Influence	No. of Colls.	Salinity in PPT. Range	Salinity in PPT. Mean	Temperature in °C. Range	Temperature in °C. Mean	No. of Spec.	No. of Species	Most Abundant Species (% of total catch at station shown for each species)
INNER POOLS															
1 Roadside Pool	Close to mainland	40′x60′	3.3′-3.5′	Gently shelving	Sand and mud	None	Occasional	13	5.4-35.6	17.6	12.0-33.0	24.5	3465	11	*M. latipinna* 48.9, C. *variegatus* 31.5, *A. xenica* 6.6, *F similis* 5.4, *Gambusia* 4.3.
2 Upper Pool	Close to mainland	18′x35′	1.5′-2.0′	Precipitous	Black organic mud	None	Regular	8	18.6-26.1	21.8	22.0-32.0	29.4	6255	11	*M. latipinna* 61.1, *A. xenica* 14.0, *Gambusia* 12.2, *C. variegatus* 8.8. *F. c. confluentus* 2.8.
3 Middle Pool	Close to mainland	25′x40′	1.8′-2.0′	Precipitous	Black organic mud	None	Regular	8	2.5-23.9	18.6	15.5-32.5	26.8	3177	16	*M. latipinna* 43.9, *A. xenica* 26.3, *C. variegatus* 11.8, *F. c. confluentus* 9.5, *Gambusia* 3.9, *M. cephalus* 1.3, *F. similis* 1.3.
4 Lower Pool	Close to mainland	15′x50′	0.0′-2.0′	Precipitous	Black organic mud	None	Regular	7	1.2-25.2	18.7	15.5-34.0	26.3	1594	13	*A. xenica* 46.1, *M. latipinna* 24.4, *C. variegatus* 15.7, *F. c. confluentus* 7.0.
5 Culvert Pool	Close to mainland	8′x10′	1.5′-2.5′	Sharply sloping	Sand	None	Regular	15	14.5-27.4	20.9	12.5-37.5	25.3	2155	14	*M. latipinna* 33.3, *C. variegatus* 20.8, *F. g. grandis* 18.7, *A. xenica* 12.7, *F. similis* 9.0.
OUTER POOLS															
6 Airport Pool	Gulf edge of marsh	20′x60′	0.2′-2.5′	Gently shelving	Black organic mud	None	Regular	15	19.1-30.2	24.1	17.0-35.5	26.8	5876	28	*M. latipinna* 22.3, *M cephalus* 21.7, *A. xenica* 16.6, *C. variegatus* 15.5, *F. grandis* 10.9, *F. similis* 4.7.
7 Borrow Pool	Gulf edge of marsh	45′x400′	4.5′-5.0′	Gently shelving	Mud and sand	None	High tide only	16	15.4-27.8	23.2	16.0-36.0	27.2	6126	29	*M. beryllina* 21.2, M. *latipinna* 21.0, *A. xenica* 13.0, *L. xanthurus* 10.8, *C. variegatus* 9.6, *F. similis* 7.2.

WATER COURSES															
8 Bayous	Mainland edge of marsh	20′x—	0.1′-4.5′	Flat; sides often steep	Sand and mud	None	Regular	8	0.8-17.5	8.9	12.0-27.0	19.2	976	15	*C. variegatus* 34.9, *F. grandis* 17.7, *F. similis* 14.3, *A. xenica* 13.1, *M. latipinna* 5.6, *E. argenteus* 3.9.
OPEN WATERS															
9 Airport Bay	Gulf margin shallows	500′x500′	0.0′-4.5′	Gently shelving	Mud and oyster bars	None	Regular	5	25.9-37.6	30.5	19.0-31.0	24.3	474	30	*E. argenteus* 16.2, *A. xenica* 10.8, *A. m. diaphana* 10.1, *S. ocellatus* 10.1, *F. similis* 7.4, *F. carpio* 6.3, *F. grandis* 5.5.
10 Causeway Bay	Bay margin shallows	Indefinite	0.0′-4.0′	Gently shelving	Mud and oyster bars	None	Regular	6	16.3-26.5	20.1	22.0-26.0	25.9	636	16	*C. variegatus* 21.9, *M. cephalus* 17.8, *F. similis* 16.4, *A. m. diaphana* 12.4, *L. xanthurus* 9.9, *M. berryllina* 4.0, *A. xenica* 4.1.
11 Gulf Beach	Beach shallows of Gulf	Indefinite	0.0′-4.5′	Gently shelving	Hard sand and sandy mud	None	Regular	16	20.0-31.1	25.9	17.0-31.0	25.8	2507	40	*A. m. diaphana* 40.8, *M. berryllina* 16.0, *F. similis* 9.2, *E. gula* 8.1, *M. cephalus* 6.2, *M. vagrans* 4.4.

the same is true for temperature, which showed a range of 12 to 37.5°C. This observed variation is not unexpected when it is considered that the tide waters are spread over the muds of the marshes in a thin sheet, usually to a depth of only a few inches, and that under these conditions the effects of precipitation, evaporation, radiation, and dilution by seepage waters are quickly discernible.

In these areas the characteristic combination of species is *Mollienesia latipinna, Cyprinodon v. variegatus* and *Adinia xenica* (Table 1).

Outer Pools

The outer pools at Cedar Key are substantially like those nearer the mainland except that they are closer to the high salinity waters of the Gulf and their areas of surrounding marsh are less extensive. These factors probably account for the higher mean salinity encountered, its smaller range (15.4 to 30.2 ppt), and possibly the more moderate temperature range (16° to 36°C) in comparison with the inner pools.

Species were more numerous, but not necessarily more abundant in individuals, in the outer pools than in any other habitat except the Gulf shore waters. The variety is due to the presence of the marsh species plus additions from the nearby Gulf.

In addition to *Mollienesia latipinna, Adinia xenica,* and *Cyprinodon v. variegatus,* which were also found abundantly in the inner pools, appreciable numbers of *Fundulus similis* always were present in the outer pools.

Water-courses

The bayous, creeks, tide guts, and channels were grouped together under this title, and all collections from such habitats were considered together after a separate study showed that the similarities between stations warranted such a procedure.

At Cedar Key the water-courses studied were in the mainland edge of the marsh and proved particularly difficult as collecting stations. Seining during high tide was unproductive and at low tide was not much better. Apparently no species is well adapted to the swift waters and the rapidly changing levels of the bayous.

Salinities in the water-courses near the mainland are low to medium (0.8 to 17.5 ppt). This condition is due almost entirely to dilution by underground seepage water from the mainland, and this fresh water is supplied in sufficient quantities to offset the rise in salinity of the marsh waters due to evaporation. At dead low tide the bayou water does not taste salty and can be seen seeping into the channel from the sands along the banks.

The species which are characteristic of the water-courses include *Fundulus g. grandis* and *Fundulus similis* when taken with *Cyprinodon v. variegatus, Adinia xenica,* and *Mollienesia latipinna.* Also characteristic, however, is the size of the specimens found. The pool fishes usually are of all sizes, with an emphasis in numbers on the smaller individuals, whereas the fishes of the water-courses are almost

always adults or at least half-grown individuals.

Open Waters

This category was assigned to include those stations where the collecting was accomplished in the shallows along the margins of the bays and the Gulf. These habitats were examined principally in order to determine, in part, the availability of species for populating the marshes. Collecting was done by seining the shallows both parallel and perpendicular to the shore, and the exploring was kept within two hundred feet of the land.

Salinities of these open waters showed a short range varying from 16.3 to 31.1 ppt for all locations. The range, however, was much less for individual stations. Temperatures were neither quite so low nor quite so high as at other stations, and it is likely that if the data had been collected further from shore, the range of both salinity and temperature would have been lessened.

Fundulus similis and *Menidia beryllina* were present in most of the catches, but other species were caught with less regularity.

The pools, water-courses, and inshore waters at Cedar Key are under the influence of the nearby offshore waters from both a physical and a faunistic standpoint. The offshore region presents a variety of fish habitats and the fish fauna is rich in both species and numbers of individuals. One of the more obvious causes for the abundance of fish found in the offshore region lies in the luxuriant and extensive bottom vegetation. Such is not the case in the intertidal zone where submerged aquatic plants are so poorly represented that they could not be of real importance in either the food or the cover relationships of the marsh fishes.

The causes for this paucity of submerged vegetation may rest partly in salinity. Although the salinity range is extensive at Cedar Key (0.8 to 37.6 ppt), the mean salinity is high (21.1 ppt) (fig. 1). Such a high mean salinity appears to prevent the development of the dense stands of aquatic spermatophytes so often found in the fresh and the mildly brackish waters of Florida.

Water temperature data are shown in figure 2. The range was from 12°C to 37.5°C; the mean was 25.9°C. The Bayport temperatures appear to be less variable than those for Cedar Key (fig. 2). The Coefficient of Variation for temperatures taken at Cedar Key is 25.4% and the equivalent for Bayport is 17.4%. These coefficients support the above statement that the Bayport temperatures are less variable than those at Cedar Key. (The difference between the coefficients contains its error 4.2 times. This indicates that the difference is real insofar as these data give a true picture of the situation.)

THE BAYPORT AREA

The Bayport area has much in common with that at Cedar Key, but an aerial view emphasizes the differences. From a physiographic viewpoint the Bayport tidal area appears much less diverse than the

one at Cedar Key; although the mainland has an irregular outline, the tidal area is dotted with islands, and the Gulf margin of the land is tortuous. The most obvious simplifying factor is the absence of expanses of open water within the tidal zone. At Bayport the mud flats are vegetated principally with dense stands of black rush, *Juncus Roemerianus,* which is intermixed with small patches of oyster grass, *Spartina alterniflora.* Thus the oyster bars are eliminated, as well as the mud-bottomed embayments of open water which are so con-

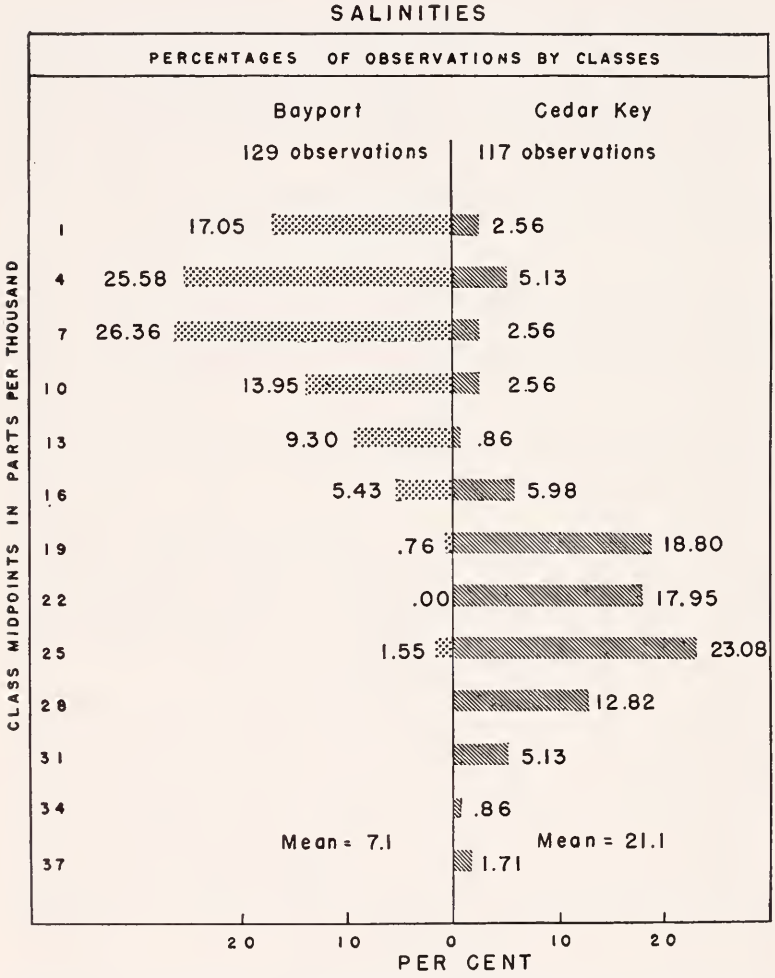

Figure 1. Salinities. Salinities, in parts per thousand, are shown by percentages of total observations for Bayport and Cedar Key respectively.

spicuous at Cedar Key.

Another major difference lies in the width of the two intertidal areas. At Bayport the zone is about one-third that at Cedar Key and this circumstance is reflected in the distribution of the fishes. At Cedar Key a fish must cross the mud-bottomed, oyster-bar-dotted embayment to move from areas near the Gulf to areas near the mainland, whereas at Bayport ready access by a much shorter route up the bayous is available for the crossing.

A third difference of importance is the influx of fresh waters into the Bayport area in sufficient quantities to affect materially the salinity, and quite possibly the temperature, of the water. The two

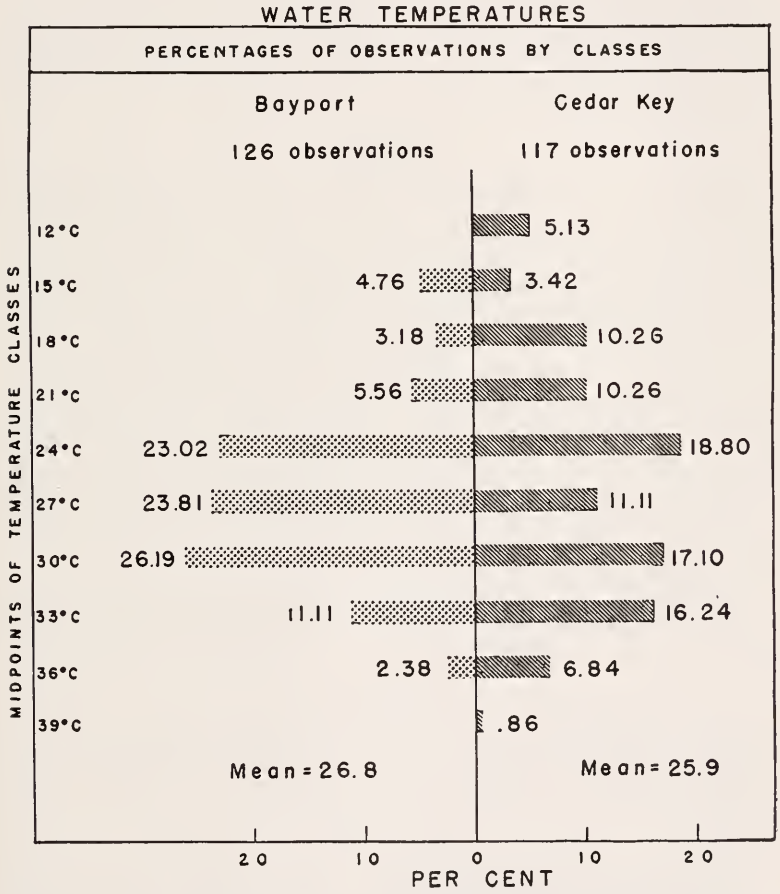

Figure 2. Water Temperatures. Temperatures, in degrees Centigrade, are shown by percentages of observations for Bayport and Cedar Key respectively.

major streams emptying into the Bayport marshes are the Mud and the Weekiwatchee rivers. Both are of spring origin and receive some contribution from runoff along their courses. The water of the two streams is faintly brackish due to the mild salinities of some of their springs. This almost-fresh water of the rivers tends to reduce salinities in the marshes and also, because of the relatively constant temperatures of the springs, to partially stabilize the temperature of the diluted marsh waters. Figure 2 presents the temperature data. As has been discussed previously, the temperatures at Bayport appear to be less variable (Coefficient of Variation = 17.4%) than those at Cedar Key (C.V. = 25.4%).

Despite these major differences, which have an effect on the fish populations, the transect method of selecting collecting stations was again employed, and the habitats worked were grouped into the same categories as described for Cedar Key. These groups are discussed in the following paragraphs, and the major features of the individual stations are summarized in Table 2.

Inner Pools

Four salt marsh pools and a group of mainland fresh water pools were selected. The inner marsh pools were near the mainland, and the fresh water ones were directly connected to brackish water by their drainages, but were elevated sufficiently to escape salt water influx except during maximum storm tides. Ordinary high tides rarely reached the inner pools of the marshes but, as a rule, the bi-weekly spring tides were sufficiently high for the purpose.

The fresh water pools differed most conspicuously from those of the marshes by being vegetated with cattail (*Typha*), pondweed (*Nais*), widgeon grass (*Ruppia*), spike rush (*Eleocharis*), and arrow head (*Sagittaria*). Together this vegetation gave a wholly fresh water aspect to the habitats. Salinity in these pools, however, reached 7.5 ppt on one occasion, but usually it was much closer to zero. The marsh pools maintained salinity means of 10.4 ppt or less, although the salinity range was from 0.0 ppt to 24.7 ppt.

The temperatures recorded showed a range of 14.5°C to 32°C.

At Cedar Key none of the inner pools was vegetated, but at Bayport some of the inner marsh pools contained submerged aquatics and these plants were present during all months.

The inner Bayport pools contained *Mollienesia latipinna, Cyprinodon v. variegatus, Gambusia affinis holbrooki, Lucania parva,* and *Fundulus confluentus* as constant and conspicuous elements of the fauna. *Adinia xenica,* which was also conspicuous in the inner pools at Cedar Key, was found only rarely at Bayport.

Outer Pools

The three outer pools were close to the bay area at Bayport and were, as at Cedar Key, very similar to the inner pools.

All of the outer pools were vegetated with *Ruppia* or a combination of *Ruppia* and *Chara.* The vegetation, however, was sparse, and

tended to be in patches. Water levels consistently rose and fell almost the full extent of the total change for the area in all of the outer pools.

Salinities showed a maximum variation at a given station of about 11 ppt, and the range for all stations taken together was 3.3 to 17.1 ppt. The mean salinities for the outer pools were 8.3, 9.1, and 10.4 ppt, which are high for the Bayport area (Table 2). Temperatures of from 14.5°C to 33°C were recorded.

The fishes which were both prominent and consistently present in the outer pool collections were *Menidia beryllina, Eucinostomus argenteus* and *Lucania parva.*

Water-courses

In keeping with the practice at Cedar Key, the channels, bayous, creeks, and tide guts were grouped into this category. Unlike the Cedar Key habitats, however, these were heavily vegetated over much of their bottoms with dense growths composed principally of *Ruppia,* which formed mats from the bottom to the surface. Open water areas existed, however, and where no vegetation grew the bottom was of sand, rock, or shells. Elsewhere, an organic mud was present and this overlaid the calcareous rock substratum for various depths up to several feet.

The water-courses facilitated the movement of tidal water and some of them assisted in the discharge of the influx from the Mud and Weekiwatchee Rivers. Currents were never more than about four miles per hour and were usually barely perceptible except in the main channels during the latter half of the ebb.

Salinities in the water-courses ranged from 1.1 ppt to 11.8 ppt and their means were between 4 and 7 ppt. Temperatures varied from 15°C to 35°C.

The water-courses contained more species of fish than any of the other groups of habitats at Bayport. This was due to the presence of both fresh water and Gulf species, which were added to the normal marsh complement.

Prominent in the list from the standpoint of both numbers and regular appearance were *Lucania parva, Menidia beryllina, Eucinostomus argenteus, Mollienesia latipinna, Gambusia affinis holbrooki* and *Fundulus g. grandis.*

Open Waters

The shallows adjacent to the Gulf beach were assigned to this category. The floor of the Gulf at Bayport slopes very gently, an estimated eight inches in the first quarter to half mile. The bottom inshore is vegetated to the normal low tide mark, and between low and high tide levels a dense stand of black rush, *Juncus Roemerianus,* is present. During low tides, seining near shore in the shallows proved to be productive and it was here that collecting was done.

Salinities ranged from 2.0 ppt to 16.2 ppt but averaged only 8.4 ppt, which indicated the diluting effects of the river discharges in

TABLE 2.

Summary Descriptions of Bayport Collecting Stations.

Station No. & Name	Location	Maximum Diameters	Min. & Max. Depths	Bottom Slope	Bottom Composition	Submerged Aquatics	Tide Influence	No. of Colls.	Salinity in PPT.		Temperature in °C.		No. of Spec.	No. of Species	Most Abundant Species (% of total catch at station shown for each species)
									Range	Mean	Range	Mean			
INNER POOLS															
1 East Pool	Close to mainland	12′x35′	1.0′-1.5′	Flat; undercut banks	Soft, black organic mud	None	Only highest tides	8	2.2-16.6	10.4	25.0-32.0	28.1	2952	14	*M. latipinna* 62.8, *J. floridae* 12.4, *C. variegatus* 6.2, *G. a. holbrooki* 5.9, *F. c. confluentus* 4.7, *L. parva* 3.9.
2 West Pool	Close to mainland	35′x60′	1.0′-1.5′	Gently shelving	Soft, calcareous ooze	A few sprigs of Ruppia	Only highest tides	10	1.1-24.7	8.6	21.0-31.0	27.6	2654	15	*M. latipinna* 46.6, *C. variegatus* 11.3, *J. Floridae* 9.8, *M. beryllina* 9.0, *L. parva* 7.9, *G. a. holbrooki* 6.4, *F. c. confluentus* 4.9.
3 Sandhill Pool	Close to mainland	15′x1000′	2.5′-2.7′	Gently shelving	Soft, calcareous mud and sand	Dense beds of Chara	Only highest tides	10	0.0-11.2	6.9	14.5-32.0	25.7	1772	19	*M. latipinna* 50.8, *G. a. holbrooki* 19.2, *L. parva* 11.8, *H. formosa* 5.8, *F. c. confluentus* 5.3, *C. variegatus* 4.1.
4 Gate Pool	Close to mainland	75′x150′	4.5′-4.5′	Precipitous	Soft, black mud	Scattered strands Ruppia	Only storm tides	4	0.1-5.2	2.8	16.0-29.0	21.0	345	9	*G. a. holbrooki* 58.0, *M. beryllina* 14.8, *C. variegatus* 13.3, *M. latipinna* 9.6, *F. c. confluentus* 1.7, *L. parva* 1.4.
5 Fresh Pools	Mainland near marsh	Several sizes	Various	Various	Soft, black mud	Ruppia, Nais, Typha	Only storm tides	9	0.0-7.5	2.4	25.0-31.0	27.1	694	16	*G. a. holbrooki* 32.0, *H. formosa* 13.7, *L. parva* 10.5, *N. c. bosci* 10.2, *L. m. purpurescens* 5.5, *C. goodei* 4.3.
OUTER POOLS															
6 Bimini Pool	Bay margin of marsh	35′x400′	0.2′-2.5′	Gently shelving	Calcareous rock, shell and mud	Patches of Ruppia & Chara	Regular	10	3.3-13.3	8.3	14.5-36.0	25.3	1895	21	*M. beryllina* 21.1, *G. a. holbrooki* 19.1, *L. parva* 19.3, *E. argenteus* 10.5, *M. latipinna* 10.4, *C. variegatus* 9.0.

7 Palm Pools	Bay margin of marsh	Several small pools	0.1′-2.5′	Gently shelving	Black organic mud	Wisps of Ruppia & Chara	Regular	10	6.2-16.7	9.1	21.0-30.5	26.9	2113	19	*C. variegatus* 18.0, *E. argenteus* 15.4, *L. parva* 12.7, *A. xenica* 10.4, *M. beryllina* 9.0, *F. grandis* 8.8, *F. confluentus* 7.9.
8 New Bridge Pool	Bay margin of marsh	25′x35′	0.5′-2.5′	Gently shelving	Sand with some mud	Thin stand of Ruppia	Regular	13	6.2-17.1	10.4	14.5-33.0	25.0	1894	22	*E. argenteus* 33.5, *L. parva* 27.0, *M. beryllina* 13.6, *C. variegatus* 10.2, *M. cephalus* 3.2, *L. rhomboides* 2.2.
WATER COURSES															
9 Brunner	Gulf edge of marsh	Indefinite	0.5′-3.5′	Flat: banks steep	Sand, mud, shells, rock	Dense mats of Ruppia	Regular	11	1.1-11.8	6.8	25.0-33.0	30.3	1962	26	*L. parva* 42.3, *M. beryllina* 20.0, *E. argenteus* 9.7, *G. a. holbrooki* 6.1, *M. latipinna* 5.6, *A. xenica* 5.0, *F. grandis* 3.3.
10 Garrison	Gulf edge of marsh	30′x400′	0.5′-3.5′	Shelving; banks steep	Black organic mud	Heavy stand of Ruppia	Regular	16	1.8-7.5	4.1	15.0-35.0	27.7	1718	21	*L. parva* 44.8, *M. latipinna* 16.7, *G. a. holbrooki* 10.1, *E. argenteus* 9.8, *M. beryllina* 5.8, *F. grandis* 5.1.
OPEN WATERS															
11 Battery	Beach shallows of Gulf	Indefinite	0.0′-4.0′	Gently shelving	Soft sand & sandy-mud	Patches & clumps-Ruppia	Regular	18	2.0-16.2	8.4	14.0-33.5	26.5	2421	23	*I. parva* 28.5, *E. argenteus* 24.7, *F. carpio* 19.7, *M. beryllina* 9.1, *F. similis* 3.8, *M. gulosus* 3.6, *E. gula* 3.1.

the area. Temperatures in the shallows varied widely from 14°C to 33.5°C.

The fishes most prominent in the collections were *Lucania parva, Eucinostomus argenteus, Floridichthys c. carpio, Menidia beryllina, Fundulus similis, Microgobius gulosus* and *Eucinostomus gula.*

The marshes of the Bayport area, like those at Cedar Key, are bordered on the seaward side by the inshore shallows of the Gulf. These shallows are much less diverse in habitats than those at Cedar Key and support a fish fauna which is limited, if not in variety of forms, then certainly in numbers of individuals. Toward the mainland, on the other hand, the marshes come in contact with the mouths of spring-fed streams, other marshes where the water is almost fresh, coastal swamp waters, and the margins of mesophytic hammocks, pine woods, and palm thickets.

Thus at Bayport the mainland waters and their fish faunas would be expected to have a marked influence on the waters and fishes of the intertidal zone. One of these influences is well illustrated by a consideration of salinity. As previously mentioned, the Bayport marshes receive a considerable amount of almost fresh water from mainland streams. Salinities varied from 0.0 ppt to 24.7 ppt and showed a mean of 7.1 ppt. The salinities in the marshes at Bayport and at Cedar Key (Mean = 21.1 ppt) were conspicuously dissimilar in distribution (fig. 1).

The more conspicuous similarities and differences between the habitats of the two areas and the physiographic features underlying those factors may be restated in tabular form as follows:

Cedar Key	*Bayport*
1. The marsh area is about three miles in width	1. The marsh area is only about a mile wide
2. Influx of fresh water is negligible, consequently: Salinity relatively high; Range: 0.8–37.6 ppt Mean: 20.5 ppt	2. Influx of fresh water from two moderately small rivers conspicuously reduces salinities, consequently: Salinity relatively low; Range: 0.0–26.1 ppt Mean: 7.1 ppt
3. Water temperatures somewhat variable Range: 11.5–37.5°C Mean: 25.9°C Coefficient of Variation = 25.4	3. Water temperatures less variable than those for Cedar Key Range: 16–35°C Mean: 26.7°C Coefficient of Variation = 17.4
4. The dominant emergent of the marshes is *Spartina alterniflora*	4. The marsh dominant is *Juncus Roemerianus*
5. Submerged hydrophytes absent from marsh pools and water-courses	5. Submerged hydrophytes abundant in water-courses and present in varying amounts in pools
6. Offshore Gulf shallows have diverse bottoms, both vegetated and clean	6. Offshore Gulf shallows are mostly smooth bottomed; only sparse patches of vegetation in limited areas

7. Eulittoral waters densely populated with fishes	7. Eulittoral waters much less densely populated

All of the fishes taken from the marshes and their immediately adjacent waters are presented in the following annotated list of species. When the data seem to warrant it, conclusions relative to the influence of some of the ecological factors on the occurrence, abundance, and distribution of certain of the fishes are advanced. Particular attention has been directed to the influence of salinity on the fishes.

Annotated List of Species

Dasyatidae: Stingrays

1. *Dasyatis sabina* (Le Sueur), Southern Stingray.

One immature specimen with a total length of 239 mm was taken in July from the channel near the public dock at Bayport. The salinity was 2.5 ppt and the water temperature 25°C.

Lepisosteidae: Gars

2. *Lepisosteus platyrhyncus* DeKay, Florida Spotted Gar.

Gars were not encountered at Cedar Key, but at Bayport they were numerous and reached sizes of about four feet in total length. Occasional individuals fed in the open waters of the Gulf at least a mile offshore, and even these few cause the bay fishermen considerable annoyance, especially during the summer. Field observations indicated that the gars were most numerous in the Weekiwatchee River, especially near its mouth, but only rarely do they enter the strictly marsh waters.

Three gars were seen in the marshes which, when collected, proved to be *L. platyrhyncus*. Two were taken in July at a salinity of 1.1 ppt and the other in November at a salinity of 2.8 ppt. All came from dense mats of *Ruppia* near the channels. The November individual was 169 mm in length; the July specimens measured 445 mm and 495 mm.

Elopidae: Tenpounders

3. *Elops saurus* Linnaeus, Ladyfish (Tenpounder).

Ladyfish occur only in the open bay at Bayport. At Cedar Key, on the other hand, twelve collections included 19 specimens ranging in size from 31 to 153 mm, with the smallest taken in May and the largest in June. These young fish were taken only during the period April-July inclusive, and only from marsh pools. Salinities at the times the fish were taken ranged from 9.0 ppt to 35.6 ppt (avg = 23.3 ppt).

In the open bay at Cedar Key ladyfish are abundant, at least seasonally, and in order to maintain the observed numbers of adults the young would necessarily have to be much more numerous than is here indicated. Thus the Cedar Key marshes probably contain only strays of the young concentrated elsewhere.

Although the number of specimens collected was small, and conse-

quently may not represent a reliable sample of the population, from the data available growth appears to be rapid. This trend is shown by the following data.

Month of Collection	Mean Length in mm	No. of Specimens
April	50	1
May	55	12
June	96	5
July	101	1

CLUPEIDAE: Herrings

4. *Harengula pensacolae* Goode and Bean, Pilchard.

Four specimens were taken from the shallow waters of the Gulf beach at Cedar Key during April (salinity 20.8 ppt) and October (salinity 30.2 ppt). The October individuals measured 34 and 62 mm, respectively, and those of April were 115 mm and 125 mm. In both instances the tide was low but rising, the water had a milky or whitish color, the temperature of the water was the same (25°C), and *Anchoa m. diaphana* was by far the most dominant fish in the collections, constituting 81.8% of the April catch and 91.8% of the October catch.

ENGRAULIDAE: Anchovies

5. *Anchoa mitchilli diaphana* Hildebrand, Southern Bay Anchovy.

Seventeen of the Cedar Key collections included 1160 specimens of this anchovy. None was caught at Bayport. With the exception of one fish, all were taken from either the shallow waters along the shores of the Gulf or the larger bays (1152 specimens), or from marsh pools very close to the beach (7 specimens) (Table 3), and nearly all of Reid's (1954) specimens came from along the beaches. Most were collected in October (962) but some were found in February (1), April (109), June (16), July (29), August (1), November (1), and December (41) (Table 4).

Sizes of 16 to 19 mm were present in June, July, and October; specimens less than 25 mm were caught in those months, and also in December. The two largest fish were 67 mm each. The presence of the small fish in June and October indicates at least two breeding seasons, or possibly a very extended one. Emphasis on the October season is indicated by the preponderance of specimens caught at that time, and by their small sizes. Gunter (1945: 34) found strong indications of an extended breeding season, "probably extending from spring to fall," and Hildebrand and Cable (1930: 288-9) found the same season in North Carolina.

Salinities of the waters where catches included the anchovies ranged from 6.2 ppt (1 specimen) to 37.6 ppt (41 specimens), and showed a mean of 25.2 ppt. Six of the collections contained more specimens of anchovies than of any other species. These showed a salinity

range of 20.8 ppt to 37.6 ppt (mean = 28.2 ppt). The Cedar Key area anchovies are more abundant in the areas of high salinities, and the salinity index of 31.03 (Table 6) is the second highest for any species. Gunter (1945: 34) took more than eleven thousand specimens along the Texas coast; his data do not indicate that the fish show a marked preference for any particular salinity. He caught specimens in large numbers at salinities of less than 5 ppt, and in those waters his average catch per haul was slightly greater than in saltier places. His work, however, was done in open waters. Thus, on the basis of present findings and those of Gunter and of Reid, it is clear that *Anchoa m. diaphana* is a fish of the open bays, particularly their shallower parts, and that the degree of salinity is not an important factor in their local distribution, provided the water is at least mildly brackish (2.3 ppt or more).

SYNODONTIDAE: Lizard Fishes

6. *Synodus foetens* (Linnaeus), Lizard Fish.

Only five specimens were taken during the study and these were from the shallow waters along the Gulf beach at Cedar Key. A 57 mm specimen was taken in August (salinity 24.4 ppt), and the other four, ranging from 44 mm to 74 mm, were taken in November (salinity 31.2 ppt). Obviously the fish is not a marsh inhabitant.

CYPRINIDAE: Carps

7. *Notemigonus crysoleucas bosci* (Valenciennes), Southeastern Golden Shiner.

Seventy-four specimens were taken at Bayport in four collections obtained from mainland waters. Salinities varied from freshwater, in a tributary of the Weekiwatchee River, to 5.6 ppt in a pool near the marshes subject to an influx of salt water at times of abnormally high, storm tides. In this latter habitat, where both the aquatic plants and the fish population indicated a fresh water condition, 35 specimens were taken in February at a salinity of 0.8 ppt, and 36 specimens were caught in June when the salinity was 5.6 ppt. Many others, particularly adults, were observed in the Weekiwatchee River and in the spring at its head. Thus *Notemigonus crysoleucas bosci* had ready access to the coastal marshes and penetrated to their edges, but was never found where waters were more than weakly saline, although the fish is able to tolerate salinities up to at least 5.6 ppt. It appears that the fish is confined to fresh water, but in areas very near the coast it is found occasionally in slightly brackish situations.

8. *Notropis petersoni* Fowler, Coastal Shiner.

Only 37 specimens were caught and these were found in two collections. Thirty-six were taken in the mainland edge of the marshes at the mouth of the Weekiwatchee River when the salinity was 1.4 ppt. The other specimen was caught upstream at a salinity of 2.5 ppt.

Since no individuals were taken in the marshes proper, and the

fish was found only at low salinities in mainland waters, it is shown that this fresh water fish occasionally is found in weakly saline waters near the coast.

AMEIURIDAE: Catfishes

9. *Ameiurus natalis erebennus* Jordan, Southeastern Yellow Bullhead.

Ten specimens were taken in four Bayport collections but none was found at Cedar Key. Five came from the Weekiwatchee River (two collections) and the other five were caught from a pool deep within the marshes where salinities were 2.5 ppt and 15.0 ppt on the two occasions involved. These pool individuals were young, ranging in size from 53 mm to 73 mm, and were taken in February and April. The fish from the Weekiwatchee were less than 26 mm in length and were taken in July. Adults were caught by hook and line fishermen as far bayward as the Channel at Bayport and were not difficult to obtain when fished for at night in other water-courses of the vicinity. (Except for several exploratory night collections and a number of night observations at Bayport, all of the field work of this study was done during daylight hours.)

The species is a well known freshwater form which, at least at Bayport, is not uncommon in slightly saline waters and which occasionally tolerates salinities up to at least 15.0 ppt.

HEMIRHAMPHIDAE: Halfbeaks

10. *Hyporhamphus unifasciatus* (Ranzani), Ballyhoo.

Halfbeaks were caught at both Cedar Key (3 collections, 22 specimens) and Bayport (3 collections, 3 specimens). All collections were from open waters near the shores of bays or of the Gulf. Many schools of halfbeaks, presumably of this species, were observed in the shallow, open waters of the Gulf, and on several occasions much time was spent in unsuccessful attempts to catch representatives. Undoubtedly these fish are among those forms most successful at avoiding nets. They take flight at the slightest disturbance, and the term "flight" is used advisedly since they almost can leave the water, sometimes skittering fifty feet or more over the surface with only their tails submerged.

The Cedar Key specimens were taken in May, June, and July at salinities of 21.3 ppt, 24.4 ppt, and 27.2 ppt, respectively. Sizes were distributed fairly evenly between 60 mm and 95 mm. Of the three Bayport individuals two were caught in April (180 mm, salinity 7.5 ppt; and 184 mm, salinity 16.2 ppt) and one in November (186 mm, salinity not taken).

Its total absence from the marshes and its presence in the bays nearby excludes this species from consideration with the marsh fauna.

BELONIDAE: Needlefishes

11. *Strongylura notata* (Poey), Needlefish.

Seven Cedar Key collections included 14 specimens. Two were taken in June (salinities 24.7 ppt and 26.1 ppt), two in July (salinity 27.2 ppt), and ten in October (salinities 30.2, 27.3, 26.1, 27.7 ppt). Six came from tide pools adjacent to the Gulf and eight were taken from shallow water along the Gulf beach. None was collected deep within the marshes. Sizes ranged from 90 mm to 230 mm and showed no observable pattern by months.

S. notata was present in twelve Bayport collections and was represented by 40 specimens taken in March, April, June, July, and November. Sizes varied from 50 mm (April and July) to 260 mm (March and April). All were taken from either the shallow waters of the Gulf or from pools and ditches having open water connections with them. Salinities ranged from 0.8 ppt to 17.1 ppt (mean = 9.3 ppt). Temperatures varied from 25°C to 32°C.

This species and *Strongylura timucu* appear to be associated in the collections; this observation is discussed under the latter species.

12. *Strongylura timucu* (Walbaum), Needlefish, Timucu.

Nine Cedar Key collections included 40 individuals of *S. timucu.* These were taken in April, May, June, July, September, and October at salinities ranging from 4.5 ppt to 30.2 ppt (mean = 22.9 ppt). Temperatures ranged from 20°C (October) to 32.5°C (September). Four were taken near the mainland margin of the marshes. One of these was from a marsh pool and the other three were from a bayou. All others came from shallow waters along the Gulf shore except for two individuals caught in a pool close to the open Gulf. Sizes ranged from 80 mm to 190 mm. The small number of individuals and their distribution through the months by sizes gave little clue to the growth rates or to the breeding season.

Eighteen Bayport collections included 53 specimens caught in January, February, March, April, May, June, July, October, and November at salinities from 3.3 ppt to 17.1 ppt (mean = 10.0 ppt). Temperatures varied between 21.5°C and 33°C. All specimens were obtained from either Gulf shore waters or the pools and bayous directly connected to the Gulf by open water passageways. Sizes ranged from 35 mm to 440 mm but gave no conclusive information on growth rate. The 35 mm specimen was taken in June and was the only individual sufficiently small to indicate a breeding date close to that of the time of capture.

S. notata is rather weakly associated with *S. timucu* at both Cedar Key ($C = 0.38 \pm 0.10$) and Bayport ($C = 0.52 \pm 0.11$) (*cf.* p. 177).

Needlefishes were seen in the Weekiwatchee River on many occasions and they ascend that stream to its headwaters. It was thought that both species here discussed were represented, but since specimens were not collected the identifications are uncertain.

ANGUILLIDAE: Eels

13. *Anguilla bostoniensis* (Le Sueur), Common Eel.

A single 292 mm individual was taken at Bayport in November

by net from the mouth of a large bayou. The fishermen at Bayport occasionally catch a specimen from the brackish waters of the marshes where I have observed them at night on several occasions.

MYRIDAE: Worm Eels

14. *Myrophis punctatus* Lutken, Worm Eel.

A single specimen 165 mm in length was captured among the damp shells of an oyster bar exposed during an extremely low tide at Cedar Key in August, 1948. That they are more abundant than here indicated has been established by later collecting with rotenone in shell bottomed pools near the mouths of bayous.

CYPRINODONTIDAE: Killifishes

15. *Fundulus chrysotus* Holbrook, Golden Topminnow.

Nine Bayport collections included 29 specimens, but only two of these were taken in marsh waters. The others were collected in mainland swamps, streams, and springs. The presence of the two specimens in the brackish marshes is attributed to accidental straying from fresh waters nearby, but since the salinities were 15.0 ppt and 24.7 ppt at the times *F. chrysotus* was taken, it is obvious that the species can tolerate a rather high salinity, at least for short periods. The species is a resident of Salt Spring at Bayport where salinities usually are close to 1.8 ppt.

16. *Fundulus similis* (Baird and Girard), Longnose Killifish.

One thousand nine hundred fifty-four specimens were collected and of these 1750 came from 87 Cedar Key collections and 204 were from 34 Bayport collections. The species represented 5.23% of all specimens taken at Cedar Key and only 0.96% of those from Bayport.

The fish from Cedar Key ranged in size from 13 mm to 111 mm; larger specimens were observed but not caught. Bayport individuals were from 12 mm to 120 mm. Very young fish were present in the collections during all seasons at both areas. These occurred at Bayport about equally through the months, but they showed perceptible increases in January and in May at Cedar Key. These observations are in substantial agreement, but less marked, than those of Gunter (1945: 44).

Growth charts on the species were not particularly illuminating, but the one for Cedar Key suggested that the young of January probably reached a length of at least 45-55 mm by June, and that the young of May probably reached 40 mm by late July and 55 mm in late October. On this basis it might be assumed that specimens exceeding 60 mm are at least six months old. These conclusions are similar to those reached by Gunter (1945: 44).

The species is widely distributed throughout the marshes in spite of its greater abundance in the shallow shore waters and pools where salinities are constantly high (Table 3). Field observations repeatedly showed that the fish was more abundant in shore waters than elsewhere, but the catches did not reflect that abundance in its true

perspective because of the skill of the larger specimens in avoiding capture. It is certain that the proportions of large fish are less in the collections than those in the populations.

The percentage of *Fundulus similis* was greatest in catches made during the summer and early fall (Tables 4, 5).

Table 8 indicates at Cedar Key a weak positive association (0.36 ± 0.17) between *F. similis* and *Menidia beryllina,* which are both "open water" species; a negative association (-0.34 ± 0.10) with *Gambusia affinis holbrooki,* which is a "protected water" form; and a positive association (0.50 ± 0.11) with *Fundulus g. grandis,* which is a widely distributed marsh form. Other correlations are not marked and emphasize the fact that *F. similis* is widely distributed in the marshes.

Bangham (1942: 297) lists *F. similis* from the fresh waters of Silver Springs, Florida, but this is almost certainly in error as has been noted by Hubbs and Allen (1943: 22).

17. *Fundulus grandis grandis* Baird and Girard, Gulf Killifish.

One thousand nine hundred seventy-nine specimens were obtained and of these 1476 were taken in 75 collections at Cedar Key, and 503 were from 56 collections made at Bayport.

The presence of fish of all size ranges (20 mm or less to 100 mm or more) at all seasons of the year indicates a continuous breeding season. This killifish exhibited increases in abundance during May, November, and December at Cedar Key (Table 4), and during January, June, and November at Bayport (Table 5). These are not striking increases and are mentioned for comparison with Gunter's (1945: 43) findings in Texas where "the fish was caught in greatest abundance in summer and again in midwinter."

At Cedar Key *F. g. grandis* was taken at salinities from 0.8 to 35.6 ppt, and at Bayport it was taken at salinities from 0.8 to 16.2 ppt. The fish was taken in all possible salinity classes at Cedar Key and showed a slight increase above expectancy for salinities centering around both 2.5 and 22.5 ppt (Table 6). Contrarily, the species was more abundant at low salinities for Bayport (Table 7). Gunter (1945: 126) showed that his Texas specimens were more abundant at salinities less than 15 ppt. Thus it becomes clear that this species can tolerate a wide range in salinity but reaches its population peaks at salinities between about 5 and 25 ppt. The contradictory findings of the present study are resolved, to a great extent, by a consideration of habitat preferences.

F. g. grandis occurs most abundantly in outer pools, water-courses, and, to a less extent, open waters at both Cedar Key and Bayport (Table 3). And, as noted previously, the salinities of those habitats average higher at Cedar Key than at Bayport. It appears, then, that *F. g. grandis* is more responsive to the type of habitat than to the salinity of its water, provided that the water is at least brackish and not above about 25 ppt.

At Cedar Key *F. g. grandis* exhibits a moderate positive association (C is 0.50 ± 0.11) with *F. similis* and both of these species show a

preference for the same habitats. A negative association is shown with *Gambusia affinis holbrooki* by both *F. similis* and *F. g. grandis* (C is —0.62±0.12). *Gambusia* is a fish of the inner pools and sheltered places, whereas both species of *Fundulus* under consideration prefer the outer pools and shore waters. At Bayport a positive association is indicated with *Cyprinodon v. variegatus* (0.50±0.12) and with *F. similis* (0.38±0.13), and a possible negative but weak association with *Gambusia* (—0.21±0.09).

18. *Fundulus confluentus confluentus* Goode and Bean, Eastern Marsh Killifish.

One thousand six hundred seventy-nine specimens were collected from the marshes and several hundred others were taken in the inland fresh waters of Levy County many miles from the coast. The Cedar Key specimens numbered 1,080 and were included in 75 collections. Forty-eight Bayport catches accounted for the remaining 599 individuals.

Sizes ranged from 11 mm to 69 mm, but fish of less than 25 mm were poorly represented in the collections. At Bayport, however, small fish were taken with some regularity, being absent (or nearly so) only in November and December. They were also absent for these months at Cedar Key and, in addition, were not present in the March, April, and May collections. The growth charts prepared for this species are not particularly informative except to suggest that the breeding season is prolonged, the mortality rate high, and that the majority of the fish live only a single season during which they attain a maximum size of a little over 55 mm. These interpretations are tentative, and further observation on the species in these respects is needed.

At Cedar Key *F. c. confluentus* was taken in greater abundance than expected on the basis of random distribution at salinities between 20 and 30 ppt, and less than expected both above and below those limits (Table 6). The comparable optimum salinities at Bayport were between 10 and 30 ppt.

The species occurred most abundantly in the inner pools at Cedar Key, but at Bayport it occurred abundantly in both the inner and the outer pools (Table 3). These occurrences explain, for the most part, the differences in salinity distribution, since the salinities of these habitats vary in the two areas. These are correlated with the habits of the species in freshwater where they are found most abundant in sheltered pools.

A positive interspecific association is indicated at Cedar Key (Table 8) between *F. c. confluentus* and *Mollienesia latipinna* (0.94±0.13), *Adinia xenica* (0.64±0.11), *Cyprinodon v. variegatus* (0.89±0.13), and *Gambusia affinis holbrooki* (0.81±0.21). Negative associations are with *Menidia beryllina* (—0.35±0.11), *Eucinostomus argenteus* (—0.39±0.13), *Anchoa m. diaphana* (—0.81±0.17), and *Floridichthys c. carpio* (—0.64±0.23).

At Bayport (Table 9) the positive associations are with *Mollienesia*

latipinna (0.70±0.19), *Adinia xenica* (0.64±0.15), *Cyprinodon v. variegatus* (0.81±0.13), *Mugil cephalus* (0.83±0.18), *Jordanella floridae* (0.79±0.18), and *Gambusia affinis holbrooki* (0.52±0.14). Negative association is indicated possibly for *Eucinostomus argenteus* (—0.34±0.12). These associations emphasize the occurrence in the inner pools and the sparcity of numbers found in the water-courses and the shallows of the bays and Gulf.

19. *Adinia xenica* (Jordan and Gilbert), Diamond Killifish.

Five thousand three hundred and three specimens were collected; of these 4,939 were taken in 84 collections at Cedar Key, while 364 came from 22 Bayport catches.

Sizes ranged from 12 mm to 42 mm. Specimens of 15 mm or less were present in nearly all months (fig. 3). Thus the breeding season at Cedar Key seems to be continuous, except for possible breaks in the March-April period and again in December. The rate of growth appeared to be rapid. Considering the period June-September, it seems that certain of the size groups can be followed through the several months. For instance, the 19 mm group of June is possibly the 22 mm group of July, the 24 mm one of August, and the 25 mm one of September. This same trend of size increase is developed by following the maximum-size group for the same months, and is substantiated to a limited degree by the record of a 9 mm specimen of December which grew to 37 mm in twelve months in a large aquarium.

The monthly catches for Cedar Key (Table 4) indicate that the population reached a peak during the fall, maintained a high level during the winter, declined in February and March, and increased from that low through the spring and summer to the fall peak.

At Cedar Key considerably more specimens of *Adinia* were caught where salinities ranged from 20 to 24.9 ppt than from any other range of comparable size, and that the percentage (56.29%) at these salinities was greater than expected (36.68%) when assuming a random distribution (Table 6). The comparable Bayport figures (Table 7) indicate a greater abundance in salinities between 15 and 20 ppt than in any other class.

At Cedar Key this species is distributed by habitats almost the same as are all other species taken together (Table 3). There existed, however, a tendency to avoid open waters and to be more abundant in inner pools. Table 3 indicates a strong tendency at Bayport to avoid inner pools and open waters and to concentrate in the water-courses and particularly in the outer pools. These data suggest that the fish prefers medium salinities between 15 and 25 ppt, and that outer pools and water-courses are chosen for habitats. The fish occurs in much greater numbers at Cedar Key than at Bayport, possibly because the salinities in the former area more nearly meet its requirements.

At Cedar Key *Adinia xenica* showed a positive association (Table

8) with *Mollienesia latipinna* (0.72±0.11), *Cyprinodon v. variegatus* (0.70±0.11), *Gambusia a. holbrooki* (0.77±0.25), and *Fundulus c. confluentus* (0.64±0.11). Negative association was indicated between it and *Menidia beryllina* (—0.35±0.11) and *Anchoa m. diaphana* (—0.67±0.15). These associations add strength to the indications that this species avoids open waters and is most abundant in medium salinities. Positive Bayport associations are with *M. latipinna* (0.67±0.32), *C. variegatus* (0.89±0.23), *F. c. confluentus* (0.64±0.15), and possibly *Floridichthys c. carpio* (0.37±0.12). No negative associations are shown. This emphasizes the scattered nature

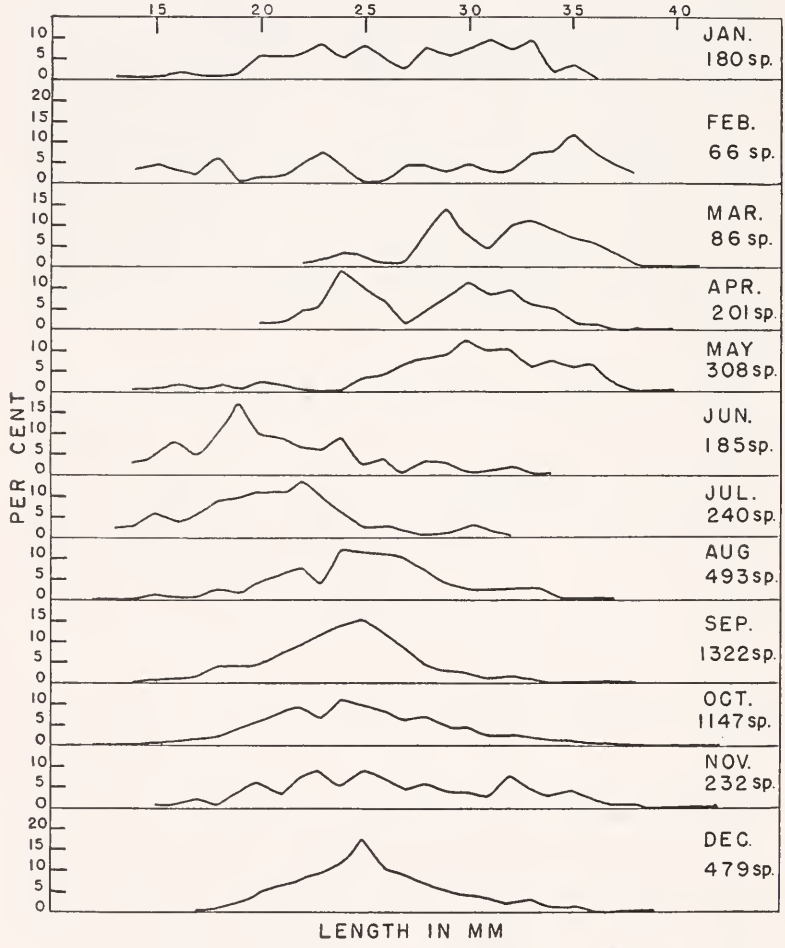

Figure 3. *Adinia xenica*, Cedar Key specimens. Monthly length-frequency curves.

of the population at Bayport where the species is not abundant and where it is probably finding difficulty in adapting itself to a habitat in which salinities are bordering on the unsuitable.

20. *Lucania parva* (Baird and Girard), Rainwater Killifish.

Four thousand two hundred and five specimens were obtained. Ninety-eight collections at Bayport included 4,192 of these and the other 13 specimens were taken in nine collections at Cedar Key.

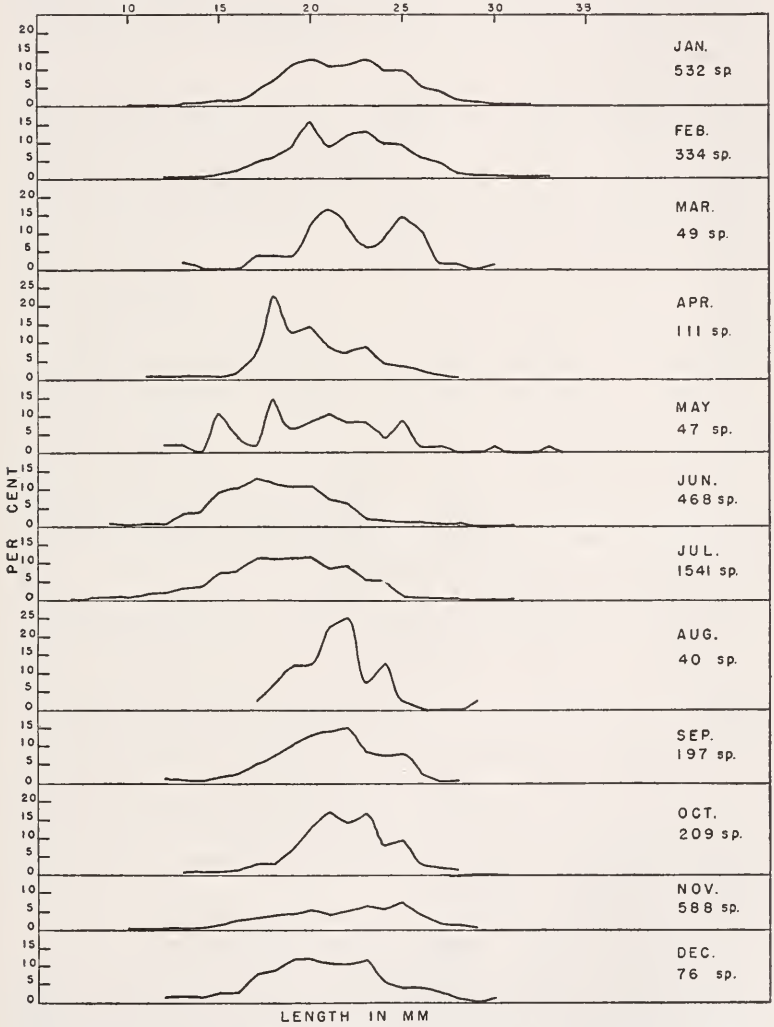

Figure 4. *Lucania parva*, Bayport specimens. Monthly length-frequency curves.

Reid (1954: 28) found only three individuals in the shallow offshore waters of the Gulf at Cedar Key.

Sizes ranged from 7 to 39 mm and young were present in all seasons. The size distribution by months at Bayport (fig. 4) indicates a more or less continuous breeding season but is not informative relative to growth rates. The use of time intervals shorter than a month for making collections in the study of this species might have given more growth rate information. The absence of any determinable trends in the growth of the population renders further speculation on the matter inadvisable.

Lucania parva was second only to *Mollienesia latipinna* in abundance at Bayport and it was found in more collections (98) than any other species (Table 5). Its relative abundance, however, fluctuated widely from month to month. Over the year it averaged 19.64% of all specimens taken, but in January it constituted nearly 55% of the total catch, and in May it made up only a little more than 2% of all the fish taken. It showed a decrease from the January peak through the months to June when it began an ascension lasting through August. Another peak was present in November and for December the population took its average position for the year.

Salinities at which the species was taken varied from 0.1 to 28.2 ppt; however, 81% of all specimens were taken from waters of 10 ppt or less (Table 7).

A positive association existed at Bayport between *Lucania parva* and *Cyprinodon v. variegatus* (0.52 ± 0.13), *Menidia beryllina* (0.66 ± 0.14), and *Eucinostomus argenteus* (0.49 ± 0.16). No negative associations were evident (Table 9).

The positive association indicated with *C. v. variegatus* is due in part to the wide distribution of the latter in the Bayport marshes and, it is believed, in part to collecting errors. As is shown later, *C. v. variegatus* is most abundant in unvegetated waters, whereas *L. parva* appears to avoid such places. In seining at Bayport, however, it is difficult to avoid encompassing both situations in a given seine haul. The same error is present in the case of *Menidia beryllina,* and to a lesser extent in the association with *Eucinostomus argenteus.* All of these forms, however, occupied the water-courses and thus show an association which would not be in evidence if the seining could have been sufficiently selective.

21. *Chriopeops goodei* (Jordan), Redtail Killifish.

One hundred twenty-six specimens of *Chriopeops goodei* (*Lucania goodei* of several recent authors) were obtained from fifteen Bayport collections and none was taken at Cedar Key. The data on these fish are summarized:

Month	No. of Colls.	No. of Spec.	Size (mm)	Sal. (ppt)	Temp. (°C)
Feb.	1	1	27	0.8	25
June	3	27	12 – 29	1.4, 5.6, 10.3	27, 31, 25.5
July	8	87	9 – 30	0.0 – 7.5 Mean: 2.8	24.5 – 26 Mean: 25.6
Sept.	2	8	15 – 24	0.0 – 1.8	24, 24
Nov.	1	3	20 – 27	—	—

All but four of the specimens were taken from mainland waters where the salinities recorded were due to a mild or periodic influx of tide water or were derived from slightly saline springs. The four individuals which constituted exceptions were from the Gulf edge of the marsh and possibly were stragglers. The occasional tolerance, however, of salinities up to 10.3 ppt would definitely enable this species to penetrate into brackish waters and thus have an added chance for wider distribution by moving from one drainage system to another by way of the coastal marshes which connect their mouths.

22. *Cyprinodon variegatus variegatus* Lacépède, Southern Sheepshead Killifish.

A total of 6,191 specimens was collected. Of these 4,747 were in 91 collections from Cedar Key and 1,444 were found in 75 Bayport catches.

Sizes of individuals ranged from 8 mm to 63 mm. Young fish of 15 mm or less were present during all months except January, February and March, when fewer specimens were taken than for any other period of equal length (fig. 5). In a study conducted at Beaufort, N. C., Hildebrand (1917) found that *C. variegatus* had a long breeding season, both individually and collectively. For example, one of his females laid eggs over a period of about five consecutive months, and other females were found in spawning condition from mid-March to October. Thus in the warmer waters of the Gulf, it would not be surprising to find the species spawning on a year-round basis.

Little information on the rate of growth is obtainable from length-frequency curves (fig. 5).

Cyprinodon v. variegatus was taken from waters of salinities varying between 0.0 and 35.6 ppt. A preference was shown by the fish for salinities less than 20 ppt at both Bayport and Cedar Key (Tables 6, 7).

At Bayport the species exhibited a decided preference for outer pools and a lesser one for inner pools (Table 3). At Cedar Key the preference appeared to be for inner pools and water-courses (Table 3). These choices placed the fish in waters of the two areas where the submerged aquatics were either absent or not particularly abundant, and at the same time permitted it to avoid the shallows of the open bays and of the Gulf. This agrees with the findings of Reid (1954: 29) who found no individuals in the open Gulf at Cedar

Key except in the shallows very near the marsh borders of islands. Field observations were consistent with these conclusions in that this species was encountered with practical certainty where areas of unvegetated bottom were present in pools and water-courses. During extremely low tides the fish were found buried in the detritus and mud of the bottoms where they also went when disturbed.

At Cedar Key *C. v. variegatus* showed a positive association with *Fundulus c. confluentus* (0.89±0.13) and negative associations with *Menidia beryllina* (—0.56±0.15), *Eucinostomus argenteus* (—0.35±0.10), *Anchoa m. diaphana* (—0.77±0.13), and *Floridichthys c. carpio* (—0.61±0.17) (Table 8). These associations emphasize the preference exhibited by *C. v. variegatus* for marsh waters rather than for the shallows along the shores of the bays and Gulf.

At Bayport *C. v. variegatus* exhibits a positive association with all but three of the twelve species with which it is compared in Table 9,

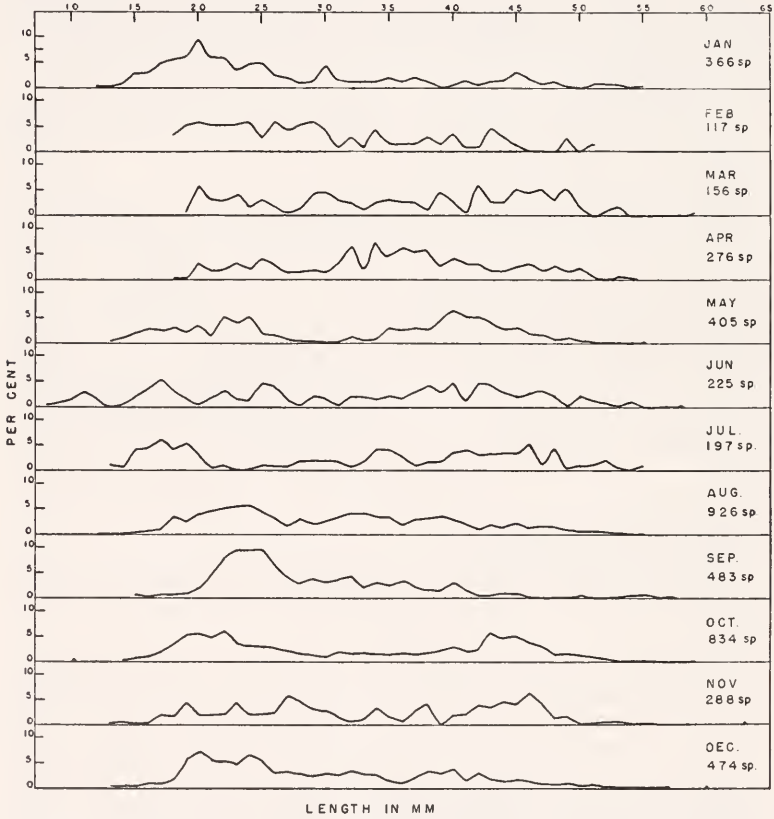

Figure 5. *Cyprinodon v. variegatus*, Cedar Key specimens. Monthly length-frequency curves.

and which constitute the bulk of the marsh fishes in that area. In short, at Bayport *C. v. variegatus* is distributed throughout the marshes to such an extent that it is to be found almost everywhere other fish occur, despite its evident habitat preferences.

23. *Floridichthys carpio carpio* (Günther), Florida Goldspotted Killifish.

Seven hundred eleven specimens were obtained. Thirty-six Bayport collections included 663 examples, and 48 were taken in ten collections from Cedar Key. Reid (1954: 29) found four individuals in trawl catches from open Gulf waters at Cedar Key and four others on shallow flats in the vicinity of islands.

Sizes ranged from 12 to 58 mm. With the exception of March, when very few (17) specimens were taken, and April and August when none was caught, young specimens of 15 mm or less appeared in all months. These young were particularly abundant from late May until mid-July at Bayport, and scattered in the remaining portion of the year. From February through July the fish were of two distinct sizes: less than 29 mm and greater than 30 mm. The young fish averaged approximately 19 mm, whereas the older group averaged about 50 mm. Except for a few stragglers, the older group disappeared during late July and the young group grew rapidly to average about 34 mm by late October. In November and December very few (35) specimens were taken at Bayport and only 39 specimens were caught at Cedar Key. These indicated that growth was slower during the colder months, but some individuals of the year reached 45 mm in December. Growth is rapid during the first several months and adulthood is reached in one year. Fish larger than sizes reached the first year are very rare. This may be the result of decreased growth rate or a failure to survive the breeding season for any appreciable time. While at Bayport the fish is most abundant during the summer, at Cedar Key only two specimens were caught between January and October.

At both Cedar Key and Bayport, *F. c. carpio* was found exclusively in two habitats (outer pools and open waters) and in both 70% of the specimens were taken from open waters (Table 3).

At Cedar Key no specimens were caught at salinities below 20.0 ppt or above 37.6 ppt; at Bayport all specimens came from salinities between 2.0 and 15.8 ppt. These data indicate that the fish is more severely restricted by habitat than by salinity, and that the combined favorable conditions, *i.e.* open waters plus moderate salinities, possibly are accountable for the greater density of population at Bayport than at Cedar Key.

As would be expected, *F. c. carpio* is shown (Table 9) at Bayport to have a positive association with species which have some preference for open waters, such as *Menidia beryllina* (0.47 ± 0.15), *Fundulus similis* (0.47 ± 0.09), *Eucinostomus argenteus* (0.74 ± 0.13), and *Adinia xenica* (0.37 ± 0.12), as well as with the ubiquitous *Cyprino-*

don variegatus (0.68±0.16). At Cedar Key, however, a negative association (—0.61±0.17) exists between *F. carpio* and *Cyprinodon variegatus,* which illustrates very nicely the fact that *Cyprinodon* and *Floridichthys* occupy different habitats when permitted to do so by the availability of their choices. *Cyprinodon* is a fish of the marshes, whereas *Floridichthys,* at least in the Bayport and Cedar Key areas, mostly occurs in the shallow shore waters of the Gulf which lie at the very edges of the marshes.

24. *Jordanella floridae* Goode and Bean, Flagfish.

Six hundred forty-four examples were taken in fifteen Bayport collections and none has been recorded for Cedar Key.

Sizes ranged from 12 mm to 39 mm and specimens less than 20 mm were taken during all seasons. Nearly 500 were caught in May and the numbers taken during the other months ranged from five to eighty-four. An inspection of the growth charts prepared for the species showed no recognizable growth rate trends.

This fish was found in waters where the salinity varied from 1.1 to 26.1 ppt, but since only 44 individuals were from salinities below 10 ppt and over 600 were from higher salinities, the data suggest that this species prefers saltier waters. This is not in agreement with the known distribution of the fish, however, for it is found in entirely freshwater situations at many points in Florida. The anomaly arises from the fact that those pools in the salt marshes where *J. floridae* was found normally have much lower salinities than happened to be present when the two collections, which contained the majority of the specimens under consideration, were made. Their presence in the waters of high salinity, however, demonstrates their tolerance of salt for at least limited periods, and this would allow the species to use the marshes as avenues in range extension. Since no specimens were taken at Cedar Key, it is assumed that the salinities of that area, which are higher than at Bayport, may act as a barrier.

All of the Bayport specimens were taken from marsh pools near the mainland and, insofar as I am aware, these records are the first to extend the ecological range of the species into brackish waters.

POECILIIDAE: Poeciliids

25. *Gambusia affinis holbrooki* Girard, Eastern Gambusia.

Eighty Bayport collections included 2026 specimens, and 29 collections from Cedar Key yielded 1,132 to make a total of 3,158, which is not a high number for *G. a. holbrooki* in Florida. In fresh waters, where it invades every possible type of habitat, I have taken over 4,000 specimens in a single short haul with a ten-foot net, and, judging from field observations, it is not unlikely that it is both the most abundant and the most frequently encountered fish in Florida fresh waters.

In the brackish marshes fish were caught which ranged from 7 mm to 47 mm. Gravid females were taken in all months of the year, as were young fish of 18 mm or less, and at any season it would have

been possible to take a very small fish by using fine nets in the waters where vegetation or other cover was present.

At Cedar Key specimens were collected only from the inner pools near the mainland. Salinities in these pools are often high, sometimes quite low, and changes are rapid. At Bayport the fish was found everywhere except in open waters, but was most abundant in the inner pools and in the heavily vegetated waters. These places at Bayport normally have rather low salinities. It thus appears that the fish is most numerous in protected waters such as shallow pools and vegetated areas where the salinities are lowest, at least periodically, but it can tolerate salinities up to at least 26 ppt (Table 6).

Table 8 indicates that *G. a. holbrooki* is positively associated at Cedar Key with *Mollienesia latipinna* (1 ± 0.31), *Adinia xenica* (0.77 ± 0.25), and *Fundulus c. confluentus* (0.81 ± 0.21), and at Bayport with *M. latipinna* (0.64 ± 0.11) and *F. c. confluentus* (0.52 ± 0.14), all of which occur in the same protected waters. Fishes not of the protected water group such as *Menidia beryllina* (-0.61 ± 0.18) and *Fundulus similis* (-0.34 ± 0.10) at Cedar Key, and *Eucinostomus argenteus* (-0.44 ± 0.10) at Bayport show negative associations (Tables 8, 9).

26. *Mollienesia latipinna* LeSueur, Sailfin Molly.

Cedar Key Area.—Ten thousand eight hundred and forty-six specimens representing 32.43% of all the fish caught at Cedar Key were of this species which occurred in 93 of the 119 collections studied. On this basis, this species was more than twice as abundant and slightly more frequently encountered than the next most abundant species, *Adinia xenica*, which totaled 4,939 specimens in 84 collections.

Sizes ranged from 12 mm to 69 mm as shown by the length-frequency curves (fig. 6). Individuals less than 20 mm were encountered during all months of the year except March and April. Sizes of from 12 mm to 14 mm were obtained from mid-May to the last of September and indicate a prolonged breeding season during the warmer months of the year, at least.

In general, the size groups tend to segregate, and it was not unusual to find the entire sample of several hundred specimens from a shallow pool deep within the marshes restricted to fish of less than 35 mm in length. On the same day, a collection from a deeper pool might not contain a single specimen less than 37 mm, and yet a third collection would contain fish from 14 mm to 64 mm.

The calculation of growth rates from length-frequency curves is unreliable when it is impossible to follow the development of any one age group for consecutive months. Such a situation exists with *M. latipinna* because of the extended breeding season, the tendency to segregate into size groups, and possibly other reasons.

M. latipinna tolerates a wide salinity range and occurs in Florida in inland freshwater habitats, as well as along the coasts in protected areas of brackish water. At Cedar Key, specimens were collected in waters of salinities varying from 1.2 ppt to 37.6 ppt. Temperatures

ranged from 11.5°C to 37°C. Open waters of the Gulf, bays, and bayous were avoided (Table 3). Nearly every collection made in the small marsh pools revealed the species, but it was absent in 14 of the 16 collections along the Gulf beaches and, except for one instance, all the other collections in which it was not found were from the shores of bays, from creeks or bayous, or from pools very close to the open Gulf beaches. Gunter (1945: 46) obtained only a single specimen during his work in Texas bays where the open waters, rather than the sheltered places, were studied, and Reid (1954: 29) took none in trawl catches in the Gulf at Cedar Key.

With a single exception, *M. latipinna* was dominant in the fish fauna of all pools located deep within the marshes and without direct connections with the bays or bayous. The number of individuals was as high as 61.1% of the total catch at one such pool, and as low as 43.9% in another. In pools having direct connections with larger

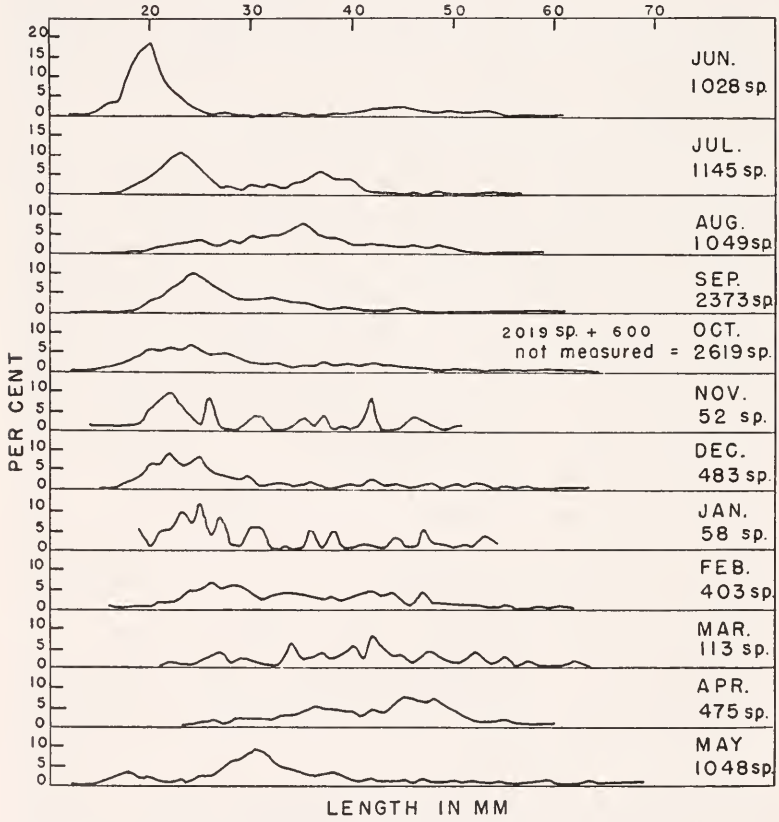

Figure 6. *Mollienesia latipinna*, Cedar Key specimens. Monthly length-frequency curves.

bodies of water, *M. latipinna* was the dominant species in numbers in two instances, but was exceeded by another species in one instance. In the bayous, along the bay shores, and at the open Gulf beach it totaled between 4% and 5.6% of the catches for the year, and from 4 to 5 species exceeded it in abundance at those stations.

At Cedar Key, *M. latipinna* appeared to be associated positively (Table 8) with *Adinia xenica* (0.72 ± 0.11), *Cyprinodon v. variegatus* (0.60 ± 0.03), *Gambusia affinis holbrooki* (1 ± 0.31), and *Fundulus c. confluentus* (0.94 ± 0.13). All of these species are conspicuous in the fauna of the sheltered waters. Negative associations existed between *M. latipinna* and *Menidia beryllina* (-0.59 ± 0.15), and *Anchoa m. diaphana* (-0.40 ± 0.12). Both of these species occur most abundantly in open water.

Bayport Area.—From the Bayport area 4,889 specimens of *M. latipinna* were collected and these accounted for 22.91% of all the fishes caught there. This species was taken from all the habitats studied and occurred in 95 of the 130 collections made. The next most abundant species was *Lucania parva* with 4,192 specimens (19.64%) in 98 of the 130 collections.

Sizes varied from 9 mm to 60 mm, and specimens less than 20 mm were found in all months except February, March, and December. Sizes of 14 mm or less were taken in June, July, September, October and November (fig. 7).

Segregation into size groups was apparent at times, but was not as pronounced as at Cedar Key. As was the case at Cedar Key, an inspection of the length-frequency curves gave no recognizable information on growth rates.

M. latipinna was taken at Bayport in salinities ranging from 0.0 ppt to 26.1 ppt but the distribution of the species in the marshes is not a matter of salinity, but rather one of habitat. In marsh pools isolated from water-courses, *i.e.,* the most sheltered places, 42 collections were made and *M. latipinna* was present in all but two of them. On the other hand, 42 collections were made in unsheltered places including the Gulf beach and the marsh water-courses and *M. latipinna* was absent from 19 of those collections. In 26 collections made in partially sheltered situations within the marshes *M. latipinna* was absent in five instances.

At Bayport *M. latipinna* appeared to be associated positively (Table 9) with sheltered water species including *Gambusia a. holbrooki* (0.64 ± 0.11), and *Fundulus c. confluentus* (0.70 ± 0.19). No negative associations were indicated.

Summary.—At both Cedar Key and Bayport *M. latipinna* was the most abundant species in the collections. In both areas it was found in all of the habitats studied, and showed greatest abundance in sheltered pools deep within the marshes. Frequently such pools at Bayport were vegetated, principally with *Chara* and *Ruppia,* whereas those at Cedar Key were not. Salinities appeared to have no determinable effect on distribution.

At Bayport a higher proportion of small fish and a lower percentage of large specimens were taken than at Cedar Key. The very small individuals were collected, almost invariably, from the heavily vegetated areas and, as has been mentioned, submerged vegetation was much more abundant at Bayport than at Cedar Key. It is assumed that many of the very small fish at Cedar Key were not collected because they were localized in the shallows in emergent vegetation where effective seining was not possible.

The smallest specimens and the greatest abundances of the small sizes were found during the warmer months of the year at both areas, which indicate an extended breeding season and eliminate the possibility of calculating growth rates by an examination of the collections. Size segregation was noticeable but not absolute. The smaller sizes were found in the shallowest and most sheltered pools, and

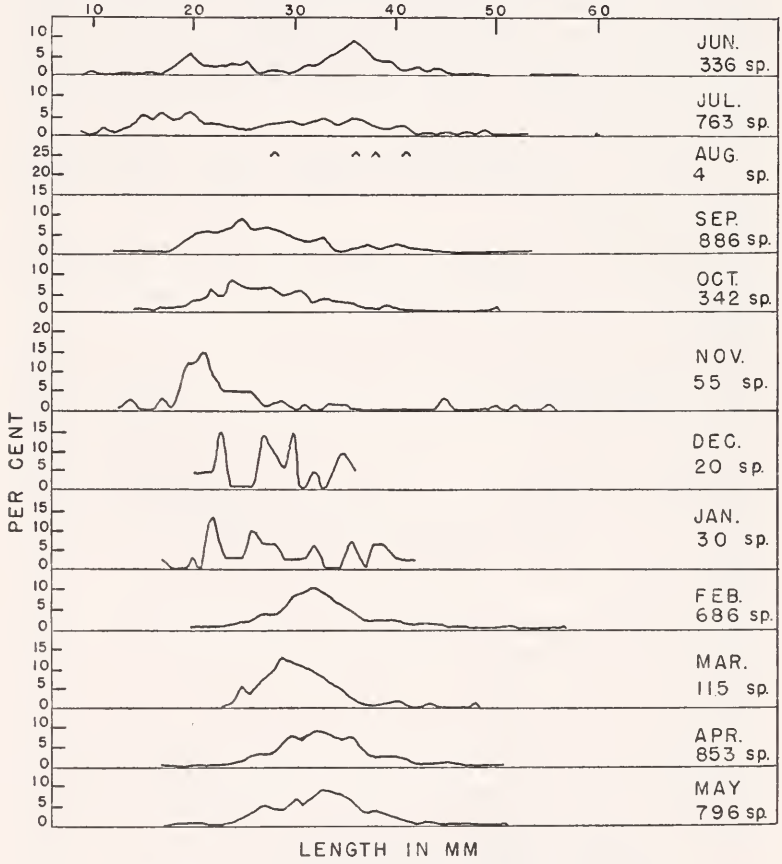

Figure 7. *Mollienesia latipinna,* Bayport specimens. Monthly length-frequency curves.

larger fish in the deeper and less sheltered places.

The total Cedar Key fish population was composed of a greater proportion (32.43%) of *M. latipinna* than the one at Bayport (22.91%). Two very obvious differences existed between the two areas: Cedar Key stations showed a higher mean salinity (20.9 ppt) than Bayport (7.1 ppt) and a paucity of the submerged aquatic plants which were fairly abundant in the Bayport habitats. Since the species occurs abundantly in fresh water, and was more abundant at Cedar Key than at Bayport, and since Cedar Key salinities were higher than the Bayport ones, salinity was not considered a major factor in the distribution or abundance of the species. On the other hand, *M. latipinna* was almost always the dominant species in numbers at those stations, both Bayport and Cedar Key, where the following conditions obtained: soft mud bottom, no submerged aquatics, sheltered pool not directly connected with a large body of water or marsh water-course. At Bayport it was frequently dominant in numbers, even when submerged aquatics were present, in the mud-bottomed, sheltered pools, but the degree of dominance was less conspicuous in these places than in the non-vegetated pools described.

27. *Heterandria formosa* (Agassiz), Least Killifish.

Four hundred seventy specimens were present in a total of 30 Bayport collections, but none was encountered at Cedar Key.

Sizes ranged from 5 mm to 23 mm. Most of the specimens (331) were taken in July, but this was due to their presence in a half dozen exploratory collections during which vegetated waters were searched intensively. Permanent, although small, populations lived in the marshes on a year-round basis. During months other than July, individuals appeared in the collections at a rate believed to reflect their relative position in the populations of these marshes much more accurately than did the large catches of July. Young fish of 15 mm or less were found at all seasons and gravid females were present during all months in which specimens were captured.

H. formosa was confined in the marshes to waters which were vegetated heavily with submerged aquatics. These places were, in order of the abundance of the vegetation, water courses, inner pools, and outer pools. The order of abundance for the fish is the same, with emphasis on numbers from the water courses (Table 3).

Although the species is a well known fresh water form in Florida and, from my observations, occurs most abundantly where the submerged vegetation is thickest, it is certain that the fish can also live in brackish marshes where it can maintain a population provided salinities are mild and cover is abundant. *H. formosa* was taken at salinities of 0.0 to 15.0 ppt, but most of the specimens were found where and when salinities were between 0.0 and 4.9 ppt (Table 7). On the basis of these data this fish may be characterized as a fresh water species which sometimes invades heavily vegetated coastal waters of low salinity.

MONACANTHIDAE: Filefishes

28. *Stephanolepis hispidus* (Linnaeus), Common Filefish.

A single 18 mm example was taken in July at Bayport from shallow, sand-bottomed, shore-waters of the Gulf (salinity 12.0 ppt, temperature 26.5°C). Exploratory collecting offshore in the bay at Cedar Key indicated that this fish was not uncommon in the areas where the bottom was vegetated.

TETRADONTIDAE: Swellfishes

29. *Spheroides nephelus* (Goode and Bean), Florida Swellfish.

Sixteen immature individuals were taken in seven collections at Cedar Key. The data on the Cedar Key collections is summarized as follows:

Month Taken	No. Colls.	No. Spec.	Sizes (mm)	Sal. (ppt)	Temp. (°C)
Apr.	1	5	10 – 25	21.2	24.5
May	1	2	16 – 17	—	—
Oct.	2	5	15 – 32	25.9 & 27.7	21.5 & 31
Nov.	2	3	20 – 25	21.2 & 31.1	22 & 25
Dec.	1	1	18	37.6	19

All were taken from mud flats or mud-bottomed marsh tide pools at the edge of the Gulf. They are frequently found on the offshore bottoms in the Gulf at both Cedar Key, where Reid (1954: 71) found it not uncommon, and at Bayport.

SPHYRAENIDAE: Barracudas

30. *Sphyraena barracuda* (Walbaum), Great Barracuda.

One immature specimen, 48 mm in length, provisionally assigned to this species, was taken in October from a pool near the Gulf edge of the marsh at Bayport. The salinity was 16.7 ppt, and the temperature 28.5°C.

MUGILIDAE: Mullets

During this study more than two thousand young mullet were collected and their identification was difficult, principally because of my inexperience with the fish. During one phase of the study I was convinced that all my material was one species, *Mugil cephalus* (Kilby 1949). Fortunately, Dr. Carl L. Hubbs read that paper, kindly directed my attention to the possibility of the presence of other species in the material, and furnished me with his notes on the characteristics of the several forms. Those notes, and examination of specimens at the Museum of Zoology, University of Michigan, enabled me to review the material and to identify three species in it. Dr. Hubbs then verified the identifications of representative samples of the three species, *M. cephalus, M. curema* and *M. trichodon.*

31. *Mugil cephalus* Linnaeus, Striped Mullet.

Two thousand one hundred thirty specimens were taken: 1,924 in 37 collections from Cedar Key; 203 in 19 Bayport catches.

Sizes ranged from 16 mm to 103 mm. This latter specimen is not shown on figure 8 which illustrates the size distribution of the fish by months. The growth of the young has been discussed previously (Kilby 1949: 19), and subtraction of the specimens of *M. curema* and *M. trichodon* from the specimens used does not change the conclusions reached on either the length of the breeding season or the rate of growth. In summary, the breeding season is long, extending from October through May at Cedar Key and from December through July at Bayport. The rate of growth, which agrees with that of Texas fish studied by Gunter (1945: 51-2), permits an October individual of approximately 18 mm to reach about 65 mm by mid-April, at which time the fish begins an exodus from the marshes

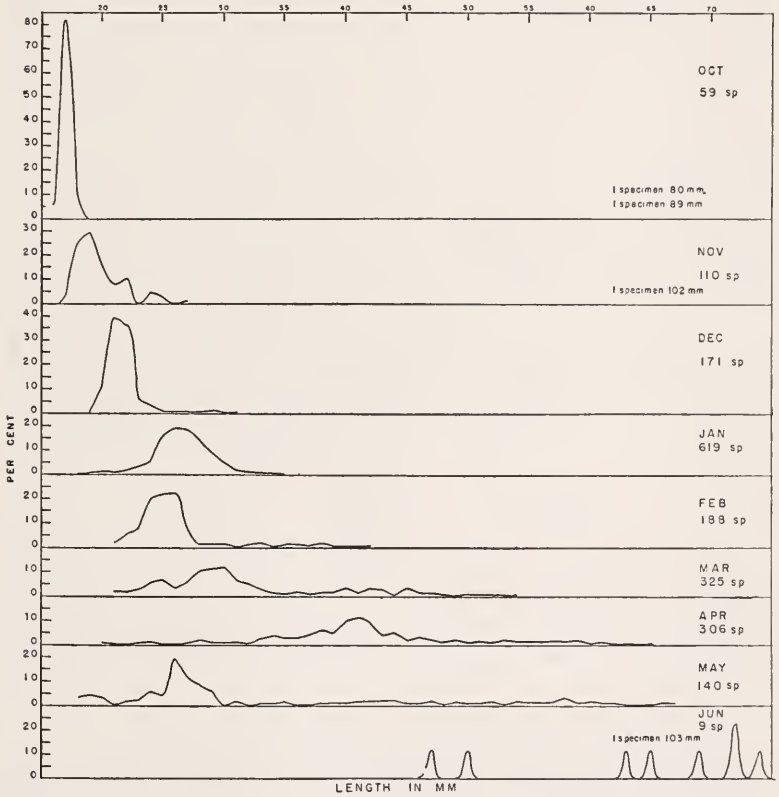

Figure 8. *Mugil cephalus,* Cedar Key specimens. Monthly length-frequency curves.

resulting at Cedar Key in a depletion of the marsh population by June. At Bayport the trends are not as sharply defined, and this is due, probably, to temperatures, which are more moderate than at Cedar Key.

At Cedar Key the young appeared in October collections and became more prominent in the fauna until January, when they constituted 39.13% of the specimens caught. Through April the young were conspicuous in the catches, but declined in May, and by the end of June disappeared entirely. At Bayport the young first appeared in November, reached a peak of 10.57% of the catches in December, and then continued irregularly in the collections through September. None was found in October, although a thorough search was conducted for them during that month.

Young *M. cephalus* were restricted almost entirely to the pools (outer and inner) at both Cedar Key and Bayport (Table 3). The open water specimens at Cedar Key were less than 20 mm in length, and it was believed that these would have entered the marshes at the next high tide, thus vacating the beach waters where they were taken.

Although *M. cephalus* was taken at salinities ranging from 2.5 ppt to 35.6 ppt at Cedar Key, most of the specimens there came from waters with salinities between 15 and 30 ppt (Table 6). The Bayport specimens were restricted largely to waters with salinities between 5 and 20 ppt. These differences are understandable when it is noted that the young fish are found most often in sheltered, mud-bottomed pools which are devoid of submerged aquatics. Both the inner and outer pools (low salinities) at Bayport, and the outer pools (high salinity) at Cedar Key, met those habitat requirements. Since during comparable collecting about ten times as many specimens were taken at Cedar Key as at Bayport, it may be that the combination of high salinity with other requirements accounts for the greater density of the former population. However, the adult population in the bay at Cedar Key is much denser than the one at Bayport, and that probably affects the number of young produced.

At Cedar Key *M. cephalus* exhibited no conspicuous association (Table 8) with any of the species with which it was tested, but at Bayport it appeared to be associated with *Jordanella floridae* (0.53 ± 0.10), *F. c. confluentus* (0.83 ± 0.16), and *Cyprinodon variegatus* (0.88 ± 0.25). These associations reflect its occurrence in the pools of that area.

32. *Mugil curema* Cuvier and Valenciennes, White Mullet.

Fifty-three were taken in eight collections at Cedar Key and eight were caught in six Bayport collections. The data on these are summarized as follows:

Month	No. of Colls.	No. of Spec.	Size (mm)	Sal. (ppt)	Temp. (°C)
			Cedar Key		
Mar.	2	2	30, 30	19.1 – 15.4	19.5 – 23
Apr.	2	3	29 – 31	21.2 – 20.8	24.5 – 25
May	3	40	24 – 65	20.6 – 25.2	32 – 33
June	1	8	24 – 36	24.7	35.4
			Bayport		
May	1	1	53	24.7	24.5
June	2	2	35, 38	11.8 – 11.2	29.5 – 32
July	1	3	36 – 38	17.8	31
Aug.	1	1	65	4.1	27
Sept.	1	1	49	4.8	29

All of the Cedar Key specimens were collected in mud-bottomed, marsh pools which were very close to the open Gulf, thus accounting for the rather high salinities observed. On the other hand, all of the Bayport fish were taken from mud-bottomed, marsh pools which were near the mainland side of the marshes and (except for two specimens) at times when the salinities were relatively high for Bayport situations.

Their absence during the colder months is a reflection, perhaps, of the greater abundance of the species in more tropical waters, although it is recorded from Cape Cod on the Atlantic coast. Breeding is accomplished at Cedar Key, as is attested by the presence of specimens 24 mm in length. The season is lengthy, as fish of 30 mm or less were found from March to June. The greatest number (40) of these were caught in May.

33. *Mugil trichodon* Poey, Fan-tail Mullet.

Only 44 specimens of this interesting little mullet were caught. All came from three collections made at Cedar Key. The data recorded are summarized as follows:

Month	No. of Spec.	Sizes (mm)	Sal. (ppt)	Temp. (°C)
May	15	23 – 30	24.7	32.0
Jun.	4	47 – 58	24.7	34.5
Nov.	25	19 – 24	30.7	24.5

All were caught in mud-bottomed tide pools in the marshes adjacent to the open Gulf where the salinities were relatively high.

ATHERINIDAE: Silversides

34. *Membras vagrans vagrans* (Goode and Bean), Rough Silversides.

One hundred and ten specimens were taken in five collections at

Cedar Key. None was encountered at Bayport. The data are summarized as follows:

Month	No. of Spec.	Sizes (mm)	Sal. (ppt)	Temp. (°C)
Apr.	9	53 – 62	21.3	30
May	3	30 – 45	20.8	25
Jun.	31	26 – 43	24.4	31
Jul.	58	40 – 59	27.2	31
Oct.	9	40 – 52	30.2	25

Each collection was made in the shallow waters along the Gulf beach when the salinity was high; no specimens were encountered in the marshes.

35. *Menidia beryllina* (Cope), Glassminnow.

Three thousand seven hundred sixty-eight glassminnows were collected during this study. Sixty-nine of the Bayport collections included 1,913 individuals; the remaining 1,855 were in fifty-two of the catches at Cedar Key.

The fish were caught during all months of the year at both areas, and sizes ranged from 10 to 99 mm. The Bayport fish seldom reached 50 mm, whereas the ones from Cedar Key were about as well represented in sizes larger than 50 mm as they were in the smaller sizes. The largest fish at Cedar Key (99 mm) probably constitutes a size record. Very young fish were taken in all seasons at both localities.

An inspection of size charts prepared by months gave no definite clue to the growth rate, although field experience suggested a very rapid turnover in the population. Gunter (1945: 49) suggested a short life cycle for Texas representatives.

At Cedar Key the fish was most abundant during March and September, and at Bayport it remained a conspicuous element in the population during all seasons. The relatively large numbers taken in August were due, in part at least, to selective collecting, and thus are not to be judged as comparable to the figures for the other months.

Field experience showed that *M. beryllina* was most abundant in open waters at all sizes above about 35 mm. Below that size, particularly at Bayport, the fish was found frequently near, or more often in, the open water just above the dense mats of submerged aquatics. In a water-course or pool, however, where a central area of open water existed, even if this open water was limited to a surface stratum only a few inches in depth, *M. beryllina* could be observed in schools which kept out of the vegetation and very near the surface. Unfortunately it was not practicable to make the regular collections in a manner that would demonstrate this obvious occupancy of the open waters and, consequently, the data recorded in the vegetated areas at Bayport are misleading on this point. The almost total lack of aquatics at Cedar Key presented a different situation;

there *M. beryllina* was most abundant in the larger water bodies and tended to congregate in the centers of pools rather than in the shallows near shore. In all cases, however, the fish remained near the surface and, unless disturbed, assembled in the top twelve or eighteen inches of water.

Most of the specimens from Cedar Key were taken in the outer pools and the open waters along the Gulf shore (Table 3). At Bayport (Table 3) the species was most abundant in the outer pools and water courses, but occurred also in the open waters and the inner pools. Of these latter situations it preferred those with submerged aquatics, and few specimens were taken elsewhere.

The fish at Cedar Key were taken substantially from salinities between 15 and 30 ppt, but some were found where the salinity was as low as 2.5 ppt and others where the salinity reached 35.6 ppt (Table 6). More than half of the Bayport specimens (Table 7) were taken at salinities between 5 and 10 ppt, and almost all of the others came from within 5 ppt above or below those limits. Since this fish was about as abundant at Cedar Key as at Bayport, it appears that the degree of salinity is not important to this species, although at Cedar Key, where the salinity was higher than at Bayport, the fish grew to larger size. Gunter (1945: 44) found the fish at salinities of 0.0 ppt and on one occasion at 71.3 ppt, and in summary stated "this species was more or less equally distributed in all salinities."

At Cedar Key *M. beryllina* (Table 8) was associated positively with *E. argenteus* (0.45 ± 0.15), *A. m. diaphana* (0.90 ± 0.20) and *F. c. carpio* (0.82 ± 0.27) which are all characterized as open water and/or outer pool species. Negative association at Cedar Key is shown with such protected water species as *M. latipinna* (-0.59 ± 0.15), *A. xenica* (-0.48 ± 0.13), *C. variegatus* (-0.56 ± 0.15), *G. a. holbrooki* (-0.61 ± 0.18) and *F. c. confluentus* (-0.35 ± 0.11).

Because of the non-selective character of the seining operations at Bayport, as explained above, the associations at that area may not be characteristic.

CENTRARCHIDAE: Sunfishes

36. *Micropterus salmoides floridanus* (LeSueur), Florida Largemouth Bass.

Eighteen specimens were taken by seining at Bayport, and hundreds were observed in the channels where it is difficult to seine with sufficient rapidity to catch so wary a fish. Hook and line techniques give good results in the brackish waters if cut bait is used, and many of the local fishermen depend on the fish as a mainstay of their sport. The bass bite best during low, or nearly low, tides, and appear to favor a late afternoon feeding period. Stomachs examined contained blue crabs, needlefish, pinfish, snappers, mojarras, shrimp, *Gambusia* and catfish.

No bass were taken from the marsh pools, although the fish was common in the adjacent channels, and adults were observed on

numerous occasions apparently feeding in the marshes at high tide. Thus, by avoiding the pools, the fish also avoided high salinities, and only one specimen was taken where the salinity reached 11.8 ppt.

Specimens as small as 16 mm were taken in the marshes in July but since only 18 small fish were taken, no definite conclusions could be reached relative to growth rates or the length of the breeding season in the marshes. Marjorie Carr (1942) has discussed the early development and growth of young bass from Florida waters.

37. *Lepomis punctatus punctatus* (Valenciennes), Eastern Spotted Sunfish.

One hundred sixty-six specimens were present in 28 Bayport collections, but none was found at Cedar Key.

Sizes ranged from 12 to 128 mm in the net catches, but larger specimens were taken by local sport fishermen. Very young fish were present in all seasons and nesting was observed during all months of the year, although field observation indicated that the height of the season was reached in mid-summer.

The adult fish were caught on hook and line as far out as the open bay, but, in general, the fish tended to occur abundantly only in the very mildly brackish waters near the mainland where the salt was usually less than 5 ppt. The salinity range was from 0.0 to 11.8 ppt.

The species was found at Bayport almost exclusively in inner pools and water-courses, and exhibited a decided preference for the latter (Table 3). It was absent almost invariably from all situations where the submerged aquatic vegetation was not abundant, and thus at Bayport would be restricted to the two stated habitats.

38. *Lepomis microlophus* (Günther), Redear Sunfish.

Thirty-eight specimens were obtained; these were found only in the Bayport area at salinities of 12.3 ppt or less. Five of the nine collections including this species were from the brackish channels and pools of the marshes. The other four collections were from mainland pools nearby, where occasional storm tides bring in salt water which raises the pool salinities to at least 5.6 ppt. On the Gulf side, the water yielding *L. microlophus* showed salinities up to 5.3 ppt, and in marsh pools up to 12.3 ppt, but nearly 90% of the individuals were caught where the salt was less than 5 ppt.

The smallest specimens taken were in June (12 mm) and in November (19 mm). A graph of the distribution in time by sizes, however, failed to indicate the growth rate. The breeding season is obviously a long one, since individuals 30 mm or less were taken from January through November.

Like *L. p. punctatus,* the species showed preference for the vegetated waters, particularly the inner pools, and occasionally it ventured into heavily vegetated water-courses (Table 3).

39. *Lepomis macrochirus purpurescens* Cope, Southeastern Bluegill.

Thirty-eight bluegills were taken from mainland fresh waters at

Bayport. However, one collection in June from a pool separated from the marshes by the width of a road yielded nineteen specimens at a salinity of 5.6 ppt. A month later the salinity of this pool was down to 1.2 ppt and *L. m. purpurescens* was still abundant. No specimens were encountered in the brackish marshes, although the species had ready access to those places in the Bayport area. Fish as small as 13 mm were taken in July and 16 mm specimens were found in June.

40. *Chaenobryttus coronarius* (Bartram), Warmouth.

Many specimens were collected from fresh water habitats near Bayport during the course of this study, but only three individuals were found in brackish waters. It was never taken at salinities above 1.8 ppt, but it is a resident of Salt Creek at Bayport where the salinity is usually around 1.5 ppt. Its ready access to the marshes, and its almost total absence there, is a strong indication that the fish is practically restricted to fresh water.

41. *Elassoma evergladei* Jordan, Everglades Pigmy Sunfish.

Specimens were locally abundant in the swamp waters of the mainland at Bayport and pathways were available for its emigration to the marshes nearby, but no individual was discovered in these marshes, nor in any nearby mainland waters showing the least hint of tide water influence. On this basis, the species appears to be entirely restricted to fresh water.

LUTJANIDAE: Snappers

42. *Lutjanus griseus* (Linnaeus), Gray Snapper.

Three snappers were caught in as many collections at Cedar Key, and seventeen specimens were taken in a total of eight catches at Bayport. It is much more abundant at Bayport (and possibly at Cedar Key) than the catches indicate. The bottoms of the channels at Bayport literally are covered with schools of individuals during the summer and winter months, and at low tide almost every nook and crevice in the rocks and shells contains at least one individual, even if the fish had to curl into a ball to squeeze itself into a niche. Occasional specimens would bite a baited hook, but nearly all individuals were incredibly successful at avoiding nets of any type. For instance, schools of snappers in less than five inches of water would repeatedly escape a cast net thrown over scores of them.

Longley, in Longley and Hildebrand (1941: 115-116), made interesting notes on this snapper at Tortugas, where it is "in many respects the dominant fish in the local fauna." Herald and Strickland (1949: 105) recorded it as "fairly common" in the fresh waters of Homosassa Springs, Florida.

The data for the fish caught in the present study are summarized as follows:

Month	No. of Colls.	No. of Spec.	Size (mm)	Sal. (ppt)	Temp. (°C)
			Cedar Key		
Sep.	1	1	55	24.6	31.5
Oct.	1	1	49	4.5	24.0
Nov.	1	1	57	5.5	23.0
			Bayport		
Apr.	2	2	118 – 122	7.5, 17.1	25, 26
Jun.	2	8	75 – 128	10.2, 11.8	25, 29.5
Jul.	1	1	113	7.7	33
Sep.	1	2	41 – 49	8.5	32
Nov.	2	4	41 – 115	— and 3.9	— and 22

The three Cedar Key specimens were taken from shallow bayous and marsh pools near the mainland edge of the brackish marshes. Three of the Bayport fish were from marsh pools, and the others were caught in channels of the marshes. Salinity does not appear to be a primary factor in their distribution at Bayport, as they ascend both the Weekiwatchee River and Salt Creek where salinities are usually less than 2.0 ppt.

GERRIDAE: Mojarras

43. *Eucinostomus gula* (Cuvier and Valenciennes), Common Mojarra.

A total of 312 specimens was obtained. Of these, 211 were in 9 Cedar Key collections, and 101 came from 14 catches at Bayport.

Sizes ranged from 13 to 77 mm in the marshes, but larger specimens were observed in the nets of fishermen operating offshore. At both Bayport and Cedar Key the first specimens appeared in June and by early December the species was no longer present. Gunter (1945: 65) also found it absent from his early year catches, which covered the deeper waters of the bay extending into the Gulf, as well as the shallows. Since only immature fish were taken, it appears almost certain that the adults spawn in the open Gulf and the young fish make some use of the marshes. No clue to growth rate was discernible in the charts showing monthly distribution by size.

At Cedar Key nearly all specimens were taken from the shallow waters along the Gulf beach, and at Bayport most (73%) came from the same category of habitat while, except for a few specimens, the remainder (26%) were in outer pools close by the Gulf (Table 3).

At Bayport (Table 7) nearly 90% of the specimens of *E. gula* were from waters of 5 to 15 ppt salt, whereas at Cedar Key (Table 6) over 96% were taken where the salinity was between 20 and 30 ppt. In both instances, however, the fish occupied the waters furthest from the mainland regardless of salinity, type of bottom, or vegetation.

Concerning the habits of the fish during the early part of the

calendar year, apparently little is known for the Gulf coast. A part of the lack may be due to the confusion of this species with *E. argenteus,* for several authors have mentioned experiencing that difficulty.

44. *Eucinostomus argenteus* Baird and Girard, Silver Mojarra.

Two thousand four hundred seventeen individuals were collected and most of these were from Bayport (2,141 specimens in 62 catches). The remainder (276 in 26 collections) were from Cedar Key.

Sizes ranged from 10 mm to 90 mm. At Bayport the species is a year round resident of the marshes where young fish of 16 mm or less were present during all months. At Cedar Key no specimens were found in catches for the January through April period, and very young fish were taken there only in May, October, December. Very few of the individuals were larger than 50 mm in either area, and consequently it appeared that only the young made any appreciable use of the marshes or the inshore waters of the Gulf. The young fish were most abundant at both Cedar Key and Bayport during the period May through October, but at Cedar Key a drop in numbers occurred in July, August and September.

E. argenteus, although found in all habitats, showed concentrations at Cedar Key in water courses and open waters, whereas at Bayport the concentrations were in the outer pools and the open waters (Table 3). The chart also points out the ecological difference between *E. gula* and *E. argenteus.* At both localities *E. gula* reaches the marsh area from the Gulf side but does not penetrate it to any appreciable extent, while *E. argenteus* not only reaches the marsh from the Gulf, but also conspicuously enters all its habitats except the inner pools, where it occurs rarely.

As indicated by Tables 6 and 7, salinity preferences of the two species are close, but at both Cedar Key and Bayport *E. argenteus* was found distributed throughout the possible salinities and *E. gula* was confined to a much narrower range. *E. argenteus* was recorded by Herald and Strickland (1948: 106) from the fresh waters of Homosassa Springs, Florida.

Table 8 indicates that *E. argenteus* is associated positively at Cedar Key with such open water forms as *M. beryllina* (0.45 ± 0.15) and *A. m. diaphana* (0.62 ± 0.12), and negatively with the protected water species represented by *Adinia xenica* (-0.35 ± 0.11), *Cyprinodon variegatus* (-0.35 ± 0.10), and *F. c. confluentus* (-0.39 ± 0.13). At Bayport its positive association with *M. beryllina* (0.49 ± 0.10) and *Floridichthys c. carpio* (0.74 ± 0.13) indicates its preference for the open waters, whereas its additional preference for the watercourses is shown by the positive association with *Lucania parva* (0.49 ± 0.16). Negative associations at Bayport with *Gambusia a. holbrooki* (-0.44 ± 0.10), and *Jordanella floridae* (-0.72 ± 0.26) are reflections of the tendency of *E. argenteus* to avoid the inner pools.

CARANGIDAE: Pompanos, Jacks.

45. *Chloroscombrus chrysurus* (Linnaeus), Bumper.

Six specimens were taken in a single collection from the shallows of the Gulf beach at Cedar Key during October. Sizes ranged from 42 to 46 mm; salinity, 30.2 ppt; temperature, 25°C. None was caught at Bayport.

46. *Oligoplites saurus* (Bloch and Schneider), Leather-jacket.

Seventy-three specimens were taken in a total of twelve Cedar Key collections, but none was caught at Bayport. A summary of the data is presented:

Month	No. of Colls.	No. of Spec.	Sizes (mm)	Sal. (ppt)	Temp. (°C)
Jun.	2	6	29 – 39	24.4, 24.7	31, 34.5
Jul.	2	23	30 – 79	26.7, 27.2	31, 33
Sep.	1	2	40, 46	28.1	30
Oct.	7	42	25 – 68	27.7 – 30.2	21.5 – 34.5

All the fish were taken from shallows along the Gulf beach or from similar shallows along the shores of the largest bays. No specimens were found inside the marshes, although their presence in the bays would probably permit them to wander into the larger channels of the marshes on occasions.

The sizes of the smallest specimens from Cedar Key indicated an extended breeding season of at least four months, but since the data did not give a clue to growth rates, the time of the season is not determinable.

47. *Trachinotus falcatus* (Linnaeus), Round Pompano.

Only a single specimen (43 mm) of this pompano was encountered. It came from shallows of the bay east of Cedar Key where the bottom was of soft mud liberally mixed with shells.

HAEMULIDAE: Grunts

48. *Orthopristis chrysopterus* (Linnaeus), Pigfish.

Two specimens were taken. One individual (173 mm) was caught in April (salinity 20.8 ppt, temperature 25°C) in the shallows along the Gulf beach at Cedar Key, and the other (143 mm) was taken in November from a marsh channel at Bayport (salinity and temperature not recorded).

SPARIDAE: Porgies

49. *Lagodon rhomboides* (Linnaeus), Pinfish.

Pinfish are very conspicuous in the offshore fauna of the Gulf at both Cedar Key and Bayport wherever the shallows are vegetated. At Cedar Key Reid (1954: 44) took over five thousand individuals from the open waters of the Gulf. Inshore they also show a preference for vegetated areas and at Bayport the channels contain both the

plants and the pinfish. The catches at Bayport do not reflect the true abundance of this form because pinfish are adept at escaping capture.

Seven Cedar Key catches netted 116 specimens, and 41 of the Bayport collections totalled 190 individuals. Sizes ranged from 13 to 146 mm, but more than half of the fish were less than 50 mm in length.

The smallest fish were taken between late December and late February, and the growth charts prepared (but not included here) indicated that two size groups were present in January. The first was of small fish between 13 and 20 mm. The second group was less defined and included sizes from about 50 mm. By the end of the year the small group had reached sizes of between 45 and 80 mm and were approximately one year old. By July the larger group was represented by specimens of 100 mm or greater. The lack of large numbers of specimens does not permit precise analysis of these growth trends, but they are in substantial agreement with the Texas findings of Gunter (1945: 63) and the Cedar Key conclusions of Reid (*loc. cit.*).

At Cedar Key 85% of the specimens were from outer pools and nearly all of the remainder (14%) were taken from the shallows along the shore of the Gulf and of the bays. At Bayport the fish seldom was taken from the inner pools but was found in all other habitats (Table 3). Preference there was for the heavily vegetated water-courses and this preference is reflected in the salinity figures.

At Bayport the species preferred low salinities and more than half of the specimens were taken from waters of 5 to 10 ppt salt (Table 7). The remainder were mostly from waters within 5 ppt above and below that range. Substantially those salinities are the ones of the water-courses. At Cedar Key the salinities at which *L. rhomboides* was found are higher (15 to 30 ppt), and correspond to the salinities of the outer waters there. Herald and Strickland (1949: 106) reported the species in the fresh waters of Homosassa Springs, Florida.

In summary, as also concluded by Gunter (1945: 63), the fish does not seek out a particular salinity, and the evidence of the present study indicates that aquatic vegetation is of greater importance than the degree of salinity in the choice of habitat.

50. *Archosargus probatocephalus* (Walbaum), Sheepshead.

Only one sheepshead, a specimen of 23 mm, was taken. It came from a July collection (salinity 2.2 ppt, temperature 33°C) made in the dense mats of *Ruppia maritima* in a marsh channel at Bayport. This and other channels at Bayport contained hundreds of larger sheepshead which were repeatedly observed at night by the aid of lights. Most of these fish were 120 mm to 250 mm in length, but fishermen occasionally take larger individuals.

At Bayport the sheepshead ascends the Weekiwatchee River for at least a mile, where it was observed in waters of 1.2 ppt salinity in July. Herald and Strickland (1948: 106) record the species as common in the fresh waters of Homosassa Springs, Florida.

SCIAENIDAE: Croakers and Drums

51. *Bairdiella chrysura* (Lacépède), Silver Perch, Yellow Tail.

Eight fish were caught at Cedar Key and three at Bayport. The data are listed:

Month	No. of Spec.	Size (mm)	Sal. (ppt)	Temp. (°C)
		Cedar Key		
Apr.	1	141	20.8	25.0
Jun.	4	66 – 76	26.1	34.5
Oct.	3	97 – 108	27.3	20.0
		Bayport		
Jul.	2	34 and 53	6.4	30
Jul.	1	47	5.6	31

The April specimen from Cedar Key was caught in the shallows along the Gulf beach and all others were taken in a nearby marsh pool. Both collections at Bayport were at dead low tide at the head of the Channel in dense mats of *Ruppia maritima.*

Hildebrand and Cable (1930: 411) found *B. chrysura* spawning from late April to mid-July at Beaufort, N. C.; Welsh and Breder (1924: 171) found the height of the North Carolina season to be in May; and Gunter (1945: 66) found fish in breeding condition in April, May, and June in Texas. The sizes of specimens taken at Bayport and Cedar Key indicate a spring and early summer breeding season. Welsh and Breder discussed the growth rates and stated that the first breeding occurs at twenty-four months after hatching.

52. *Cynoscion nebulosus* (Cuvier), Spotted Sea Trout.

Six specimens were caught at Cedar Key and three at Bayport. The data are as follows:

Month	No. of Spec.	Size (mm)	Sal. (ppt)	Temp. (°C)
		Cedar Key		
Jun.	1	35	24.7	34.5
Jul.	1	53	26.7	33
Oct.	3	30, 38, 45	25.9	31
Nov.	1	58	31.1	25
		Bayport		
Jul.	2	100, 109	12.3	26
Jul.	1	130	5.1	30

One of the Cedar Key specimens was from the beach-line waters of the Gulf, another came from a nearby mud flat, and the others were taken in the marsh tide pools near the Gulf.

Two of the Bayport fish were from the Gulf margin, and the other

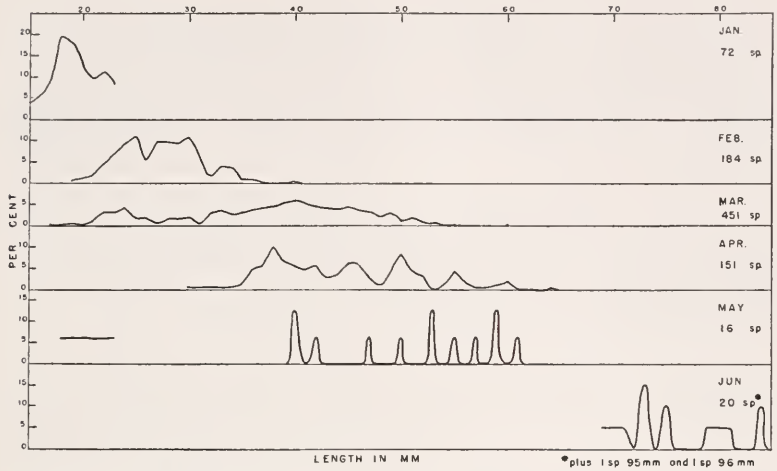

Figure 9. *Leiostomus xanthurus,* Cedar Key specimens. Monthly length-frequency curves.

from a marsh pool.

Reid (1954: 53-54) found this species not uncommon at Cedar Key and summarized Moody's (1950) study of the form in the Cedar Key area. Moody's findings were in substantial agreement with those of both Pearson (1929) and Gunter (1945: 76-78).

53. *Cynoscion arenarius* Ginsburg, Silver Sea Trout.

Four specimens were caught at Cedar Key and none at Bayport. Two (19 mm and 66 mm) were taken in June (salinity 24.4 ppt, temperature 31° C) from the Gulf beach, and two July specimens (56 mm and 70 mm) were from a mud-bottomed, tide pool near the Gulf beach (salinity 26.7 ppt, temperature 33°C).

54. *Leiostomus xanthurus* Lacépède, Spot.

Eight hundred eighty-nine spots were collected at Cedar Key. These were contained in twenty catches. Only 39 specimens were caught at Bayport and these were in five collections.

Sizes at Cedar Key (fig. 9) ranged from 15 to 96 mm. Specimens less than 20 mm were present during January, February, March and May; these small individuals indicate a breeding season lasting about the first three months of the year. Some spawning may occur for the next two months, but it is not pronounced. The length-frequency curves (fig. 9) indicate rather strongly that the January young reach sizes between about 70 and 85 mm in June, when they were taken for the last time during the year. Apparently the fish move out of the marshes in June when they have reached lengths of about 80 mm. These observations correspond with the conclusions of Reid (1954: 49-50) and of Gunter (1945: 70), who also summarized previously reported accounts. According to Gunter, spawning occurs offshore

during the winter, and the young spread into the inshore shallows.

The spot showed a rather high incidence of occurrence at salinities between 15 and 20 ppt at Cedar Key (Table 6) and between 5 and 10 ppt at Bayport (Table 7). At both Cedar Key and Bayport, however, the fish was particularly partial to outer pools and was found rarely, or not at all, in the other habitats, with the exception of the water-courses (Table 3). Thus it appears that habitat, rather than salinity, is the deciding factor accounting for the young in the marshes. On the basis of these findings and those of Gunter(*op. cit.)*, it is thought that the young which penetrated into the marshes at Cedar Key and Bayport were part of a much larger population which concentrated in the nearby shallows of the bays and of the Gulf.

55. *Pogonias cromis* (Linnaeus), Black Drum.

Nine specimens were taken in six May and June collections at Cedar Key. The seven May fish ranged from 17 to 43 mm, and the two June ones were 49 and 83 mm respectively. All specimens came from tide pools near the open Gulf. Salinities ranged from 20.6 to 26.1 ppt, and showed a mean of 24.3 ppt. Temperatures were all high (32°C to 34.5°C; mean 33.2°C).

56. *Sciaenops ocellata* (Linnaeus), Redfish.

One hundred forty specimens were taken at Cedar Key in a total of twenty-four collections. Only eleven redfish were caught at Bayport and these appeared in three November collections.

Sizes were from 12 to 146 mm, excluding specimens taken by hook and line. The smallest fish appeared in the fall catches (September and October at Cedar Key, and November at Bayport). The Cedar Key fish grew rapidly, by late November their sizes centering around 46 mm, and by the following March most of these passing 100 mm in length.

These conclusions are not at variance with the findings of Pearson (1929) and Gunter (1945) who concluded that their Texas specimens were a year old at about 300 mm.

At Cedar Key the young redfish were most abundant in open waters, outer pools, and water-courses, in that order (Table 3). At Bayport, the few fish caught came from open waters and water-courses.

More than half of the specimens taken at Cedar Key were from waters where the salinity ranged between 25 and 30 ppt, but the fish was also caught at salinities which went as low as 0.8 ppt and as high at 37.6 ppt (Table 6).

The adults are well known, marine littoral fish which feed both on the bottom and pelagically, and my field experience supports the findings of Gunter (1945) and Pearson (1929) in these respects. Night observations in the clear waters at Bayport showed that the adults were most abundant in the channels, and almost invariably they were seen on, or very near, the bottom where they appeared to be searching for food.

EPHIPPIDAE: Spadefishes

57. *Chaetodipterus faber* (Broussonet), Spadefish.

One 20 mm specimen was taken in October at Cedar Key from the inshore shallows of the bay. The salinity was 26.5 ppt and the temperature 26°C. The bottom was of mud and shell, soft and unvegetated.

TRIGLIDAE: Sea Robins

58. *Prionotus tribulus* (Cuvier), Bighead Sea Robin.

Seven of these sea robins were caught in a total of five Cedar Key collections, but none was taken at Bayport. The catches were made in February (1 specimen of 30 mm, salinity 27.2 ppt, temperature 24°C), October (2, 10 and 14 mm; 25.9 ppt; 31°C), October (2, 20 and 24 mm; 27.7 ppt; 21.5°C), November (1, 13 mm; 23.8 ppt; 17.3°C), and November (1, 13 mm; 21.2 ppt; 22°C). All of the catches were made where the Gulf meets the marsh, and at times of relatively low temperatures and high salinities.

BATRACHOIDIDAE: Toadfishes

59. *Opsanus beta* (Goode and Bean), Toadfish.

Nineteen specimens were taken in three Cedar Key collections and sixteen were included in nine Bayport catches. Sizes ranged from 19 to 175 mm at Bayport, and from 32 to 130 mm at Cedar Key. The species is a secretive form and hides in any cover available. It is abundant about oyster bars; 18 of the 19 Cedar Key specimens were caught in the Gulf shallows by hand at low tide from tiny basins of water under clumps of exposed oyster shells. The Bayport specimens were obtained by seining in dense mats of *Ruppia maritima.*

The smallest Bayport individuals were caught in two July collections, and by November this age group may have grown to approximately 65 mm in length.

At Bayport, salinities ranged from 1.8 to 7.9 ppt (mean, 5.5 ppt) and temperatures 23°C to 32°C (mean, 27.5°C). The Cedar Key salinities were 24.4, 27.7, and 37.6 ppt; the respective temperatures were 31°C, 21.5°C, and 19°C. These collections were in August, October, and December, while the Bayport ones were made in February, June, July, September and November.

The species is undoubtedly more abundant than is indicated for either area, but it is not a marsh form. It occasionally may be found on the Gulf edge of the marshes, and may even penetrate into them where cover in the form of shells or vegetation is available in the channels.

SYNGNATHIDAE: Pipefishes and Seahorses

60. *Syngnathus scovelli* (Everman and Kendall), Scovell's Pipefish.

Twenty specimens were taken: twelve from Cedar Key in two collections, and eight from Bayport in eight collections. Sizes ranged

from 33 to 78 mm at Bayport and from 35 to 78 mm at Cedar Key. Specimens 35 mm or less were taken in November at Cedar Key and in June at Bayport.

The Cedar Key individuals were all taken in November, where the salinities were 31.1 and 23.8 ppt, and the respective temperatures 25°C and 17°C, from a shallow tide basin on the beach (11 specimens) or in the adjacent shallows of the open Gulf (1 specimen).

All of the Bayport individuals were taken in seine hauls over *Ruppia* covered bottoms in either the exposed Gulf beach situations, or in waters directly connected with those places. Salinities ranged from 4.8 to 11.8 ppt (mean = 7.6 ppt). Temperatures of 14.5°C to 33.5°C were recorded (mean = 29.2°C). Specimens were taken at Bayport in June (3), July (3), September (1), and November (1). No individuals were encountered in the interior of the marshes or in the fresh waters of the nearby streams, although the fish has been shown to be an abundant, year-round, continuously breeding, resident of the inshore Gulf waters at Cedar Key (Reid 1954: 24-25).

61. *Syngnathus floridae floridae* (Jordan and Gilbert), Florida Pipefish.

Twenty-one specimens were caught at Cedar Key. Nineteen of these came from a shallow tide basin on the open sand beach of the Gulf (salinity 31.1 ppt, temperature 25°C) during November, and the others were taken from the nearby shallow, shore-line waters of the open Gulf in November (salinity 23.8 ppt, temperature 17°C) and December (salinity and temperature not taken). Sizes ranged from 58 to 102 mm in November, and the December specimen was 74 mm in length. The species is met with frequently in the grassy areas of the open Gulf, as shown by Reid (1954: 26).

62. *Syngnathus louisianae* (Günther), Louisiana Pipefish.

Two specimens were taken from a very small tide basin on the open sand beach at Cedar Key in November. The salinity was 31.1 ppt, the temperature 25°C, and the sizes of the fish 89 mm and 164 mm. The species is not a common resident in the nearby shallows of the open Gulf where Reid (1954: 25) took only thirteen specimens during his intensive survey.

63. *Micrognathus crinigera* (Bean and Dresel), Least Pipefish.

One diminutive specimen of 42 mm was found during November in a tiny tide basin on the open sand beach of the Gulf at Cedar Key where the water was only about two inches deep. At the same time, thirty-two other pipefish, representing the previously mentioned three species, were taken, but subsequent collecting in the same basin failed to produce specimens of any of the forms. The pipefish were caught in water which had a salinity of 31.1 ppt and a temperature of 25°C. Reid (1954: 27) found them regularly, but not abundantly, in his collections in the offshore waters at Cedar Key.

64. *Hippocampus hudsonius punctulatus* Guichenot, Seahorse.

One specimen of 26 mm (salinity 31.1 ppt, temperature 25°C) was taken in November and another of approximately 100 mm (salinity and temperature not recorded) was caught in December. Both came from vegetated bottoms in the shallow waters along the Gulf margin at Cedar Key. No seahorses were taken at Bayport.

GOBIIDAE: Gobies

65. *Bathygobius soporator catulus* (Girard), Mapo.

Four Cedar Key collections included one specimen each and all were taken from shallow, shore-line waters of the Gulf, or from a nearby tide pool in the marsh. The data are: February (64 mm, salinity 26.1 ppt, temperature 25°C), November (30 mm, 23.8 ppt, 17°C), December (26 mm, 37.6 ppt, 19°C; 37 mm, 28.1 ppt, 23°C).

66. *Microgobius gulosus* (Girard), Large-mouthed Goby.

Two hundred fifty-six specimens of this fish were caught. The majority (235) were taken in fourteen collections at Cedar Key; twenty-one came from ten Bayport catches.

Sizes ranged from 12 to 62 mm. The smallest fish were taken at Bayport in late September and at Cedar Key during May. This indicates an extended breeding season, and the presence of individuals of 25 mm or less during all seasons of the year indicates either a continuous breeding season, or very slow growth of the young. Although the data do not prove the point, the growth charts prepared suggest a rather rapid development which produced 35 mm specimens in approximately one year; these reached maximum sizes within the next six to eight months.

The majority of the Cedar Key specimens were taken from outer pools and the few Bayport individuals were scattered throughout the possible habitats (Table 3). It was noted at Bayport, however, that the fish were taken almost exclusively where the bottom was muddy and the submerged aquatic vegetation was dense, and that at Cedar Key the species was most abundant in the deepest part of a mud-bottomed, outer pool.

At Bayport *M. gulosus* was never taken in water above salinity 10.5 ppt, and at Cedar Key it was never found below 15.4 ppt. This indicates that salinity is not of prime consideration, although the greater abundance of the species at Cedar Key may be a reflection of the higher salinities there. On the other hand, its occurrence in the St. Johns River as far south as Welaka, where the water is almost fresh, strengthens the idea of wide salinity tolerance (Everman and Kendall 1900: 91).

67. *Gobiosoma bosci* Lacépède, Naked Goby.

Four collections at Cedar Key yielded twenty-nine specimens. The collections were made in February (11 specimens; salinity 26.1 ppt; temperature 25°C), April (13, 20.8 ppt; 25°C), May (3, 24.7 ppt; 32°C), and July (2, 26.1 ppt; 32°C). None was caught at Bayport, and all of those from Cedar Key came from one marsh pool near the

open Gulf. The smallest specimen (15 mm) was caught in February and the largest (46 mm) in May. The size distribution by months does not give information regarding growth trends.

68. *Gobionellus stigmaturus* Goode and Bean, Spot-tailed Goby.

Two specimens were obtained at Cedar Key. One was caught in October (salinity 22.9 ppt, temperature 27°C) and the other in November (salinity 21.2 ppt, temperature 22°C). Both were in Gulf shore waters with mud bottoms. None was found at Bayport and, since Reid (1954: 58) did not find the species at Cedar Key, the form appears to be rare in the areas studied.

69. *Gobiosoma robustum* Ginsburg, Robust Goby.

Five specimens were collected at Cedar Key in two December catches (salinity 37.6 ppt, temperature 19°C, and salinity 28.1 ppt, temperature 23°C). Two were taken at Bayport in one January catch (salinity 7.0 ppt, temperature 18°C). All specimens were from Gulf shore waters where the bottom was muddy. Sizes ranged from 16 mm to 28 mm in December, and from 18 mm to 21 mm in January.

Reid (1954: 59) found *G. robustum* abundant on the shallow flats at Cedar Key, but much less so in deeper waters. These data indicate that the species lives in the bays and approaches the shore only in the coldest months of the year.

Blenniidae: Blennies

70. *Chasmodes saburrae* Jordan and Gilbert, Florida Blenny.

In July, 1947, at Bayport there was an extremely low tide which lasted most of the night of the sixth. While walking on the exposed bottom of the Gulf approximately half a mile from the normal shoreline, I found one 27 mm specimen of *C. saburrae* in a half-cup of water under a cluster of oyster shells. Many specimens of sizes ranging up to 103 mm have been taken from the open Gulf at Cedar Key by myself and by Reid (1954: 61-62), but at no time was the form found in the marshes.

Bothidae: Left-eyed Flounders

71. *Etropus crossotus atlanticus* (Parr), Atlantic Fringed Flounder.

One 60 mm specimen was taken in August from the shallow water near the Gulf beach at Cedar Key where the salinity was 24.4 ppt and the temperature 31°C. Reid (1954: 64) regularly encountered it in small numbers at Cedar Key, particularly in channels and on deep flats of the open Gulf.

72. *Paralichthys albigutta* Jordan and Gilbert, Gulf Flounder.

A single, 65 mm specimen was caught at Cedar Key from a marsh pool near the open Gulf in April (salinity 20.8 ppt, temperature 25°C). Reid (1954: 65) found it not uncommon at Cedar Key where he took many small individuals from the grassy flats near shore and larger fish from the deeper waters worked by trawl.

ACHIRIDAE: Broad Soles

73. *Trinectes maculatus fasciatus* (Lacépède), Southern Hogchoker.

Five Cedar Key collections included nine specimens of *T. m. fasciatus* (*Achirus fasciatus* Lacépède of many authors) and none was taken at Bayport, although the form is locally abundant in Weekiwatchee Spring at the head of the Weekiwatchee River. It has also been recorded from a number of other fresh water situations in Florida reaching from tributaries of the Apalachicola River in Liberty County to Silver Springs in Marion County.

The Cedar Key specimens were taken in March (salinity 2.5 ppt, temperature 15.5°C), April (19.6 ppt, 29°C), and October (18.8, 19.4 and 21.8 ppt; 33.5°C, 34.5°C, and 28°C). Sizes of individuals ranged from 10 to 30 mm in October to 24 to 36 mm in March and April. All specimens were taken from shallows with mud bottoms, either in marsh pools or imediately adjacent to the marshes in the shore waters of the smaller bays. Reid (1954: 66) encountered the species irregularly in trawl catches at Cedar Key.

Gunter (1945: 87-88) found the fish an inhabitant of both Gulf and bay habitats, and he caught most of his specimens in bottom trawls where the salinity was above 10.0 ppt. The species inhabits fresh, brackish, and saline waters along the Gulf coast and thus may be said to be euryhaline.

74. *Achirus lineatus* (Linnaeus), Striped Sole.

Twelve Cedar Key collections included a total of 46 specimens of this sole and two were taken at Bayport in as many collections. The Cedar Key fish were from three areas; fourteen were caught from a small cove of the Gulf, 24 were in a marsh pool near the Gulf, and eight were found in marsh pools close to high ground of the mainland. All were taken from mud bottoms. Seventeen of the smallest specimens were taken in late October from waters no more than an inch deep in a Gulf cove where the mud was soft, deep, and mixed with oyster shells. Three of these fish were 11 mm, and twelve were less than 17 mm. Subsequent catches indicate a fairly regular growth through the months until the following September, when the smallest was 33 mm. Although the total number of specimens involved was small, no exceptions to this growth rate were observed. It is possible, then, that the breeding season is restricted to the early fall or late summer and that growth is slow: from 11 mm in October to approximately 33 mm a year later. Reid (1954: 67), who took thirty-three specimens at Cedar Key from a number of habitats, agrees with this assumption of a slow growth rate.

One specimen was taken when the salinity was 2.5 ppt. The others were all caught when it was from 19.6 to 30.2 ppt. Temperatures varied from 15°C to 31°C.

The two Bayport specimens were both taken from shallows at the edge of the open Gulf in September (salinity 5.4 ppt, temperature

30.5°C) and October (salinity 2.0 ppt, temperature 25°C), and were possibly year old fish of 28 mm and 33 mm respectively.

Gunter (1945: 88) caught 125 of these soles from the bays and Gulf. His data on temperature and salinity are in striking agreement with those presented here.

Considering both the findings of Gunter (*op. cit.*) and those of the present study, *A. lineatus* appears to be a slow-growing, bottom species inhabiting the bays where salinities are moderate, but occasionally wandering into bay and marsh areas of low salinity, and also into the more saline Gulf waters.

CYNOGLOSSIDAE: Tonguefishes

75. *Symphurus plagiusa* (Linnaeus), Tonguefish.

Two specimens, one in March (83 mm), one in December (30 mm), were taken at Cedar Key from waters of salinities 15.4 and 37.6 ppt respectively. Both came from muddy bottoms of waters near the open Gulf: one from a shallow cove, the other from a marsh pool. Water temperatures were relatively low, 23°C in March, and 19°C in December.

DISCUSSION

It will be recalled that compared with Bayport, the Cedar Key marshes were described as being much wider, more saline, less intimately interdigitating with freshwater habitats, almost lacking in submerged aquatics, and having more variable water temperatures.

There can be little doubt that these and other differences are reflected in the fish populations. Figure 10 shows the percentage of the total catch at Bayport represented by each of the most abundant fifteen species and the comparable percentages for fourteen species at Cedar Key. The figure makes it clear that, although there is considerable similarity in population composition by species, there is a marked difference in abundance of most of the species between the two areas. A consideration of the entire species list, however, showed other conspicuous differences. These are summarized as follows:

	Cedar Key	*Bayport*
Number of species collected	55	49
Number of species found in one area but not in the other	26	20
Number of species known to be permanent residents of fresh water but also found in brackish water	5	19
Number of marine species also found in brackish water	36	17

Twenty-nine species were found at both Cedar Key and Bayport. Only five of these were restricted to the brackish marshes and the immediately adjacent waters. These were: *Fundulus similis, Fundulus grandis grandis, Adinia xenica, Cyprinodon variegatus variegatus,*

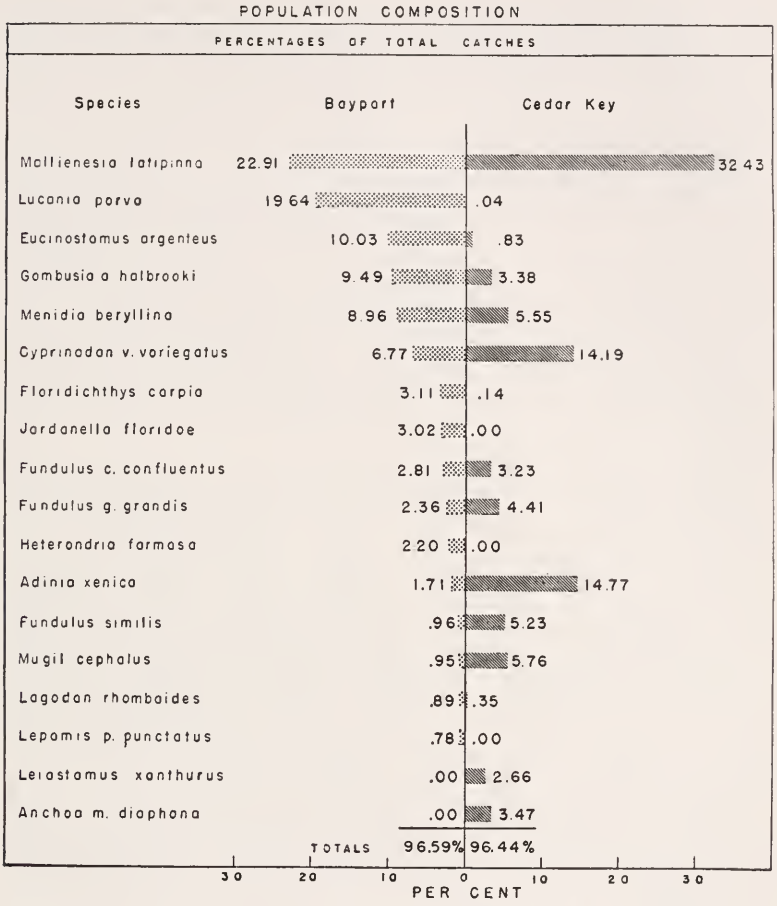

Figure 10. Population composition for Bayport and Cedar Key fishes. Percentage composition is shown for the most abundant species.

and *Floridichthys carpio carpio*.

These species are all members of the family *Cyprinodontidae* and their numbers constituted 38.75% of all fish taken at Cedar Key and 14.8% of the total at Bayport. If other cyprinodontid fishes which are adapted equally to brackish and to fresh waters were included, the list would show the addition of *Fundulus confluentus confluentus, Lucania parva, Gambusia affinis holbrooki,* and *Mollienesia latipinna.*

The equivalent percentages of the total catch would be raised to 77.84 at Cedar Key and to 69.74 for Bayport, and the fact that the two percentages are now subequal re-emphasizes that the primary ecological difference between the Cedar Key and Bayport habitats is

one of salinity. A reflection of this same difference may be seen in the composition of the lists of the species which occurred at one of the two areas but not at the other. These species can be characterized briefly as marine (M), fresh water (F), catadromous (C), and fresh water and marine (FM). The lists are as follows:

Species found only at Bayport

Dasyatis sabina (M), *Lepisosteus platyrhyncus* (F), *Notemigonus chrysoleucas bosci* (F), *Notropis petersoni* (F), *Ameiurus natalis erebennus* (F), *Anguilla bostoniensis* (C), *Fundulus chrysotus* (F), *Chriopeops goodei* (F), *Jordanella floridae* (F), *Heterandria formosa* (F), *Stephanolepis hispidus* (M), *Sphyraena barracuda* (M), *Micropterus salmoides floridanus* (F), *Lepomis punctatus punctatus* (F), *Lepomis microlophus* (F), *Lepomis macrochirus purpurescens* (F), *Chaenobryttus coronarius* (F), *Elassoma evergladei* (F), *Archosargus probatocephalus* (M), and *Chasmodes saburrae* (M). Totals: Fresh water species, 14; Marine, 5; Catadromous, 1.

Species found only at Cedar Key

Elops saurus (M), *Harengula pensacolae* (M), *Anchoa mitchilli diaphana* (M), *Synodus foetens* (M), *Myrophis punctatus* (M), *Spheroides nephelus* (M), *Mugil trichodon* (M), *Membras vagrans vagrans* (M), *Chloroscombrus chrysurus* (M), *Oligoplites saurus* (M), *Trachinotus falcatus* (M), *Pogonias cromis* (M), *Chaetodipterus faber* (M), *Prionotus tribulus* (M), *Syngnathus floridae floridae* (M), *Syngnathus louisianae* (M), *Micrognathus crinigera* (M), *Hippocampus hudsonius punctulatus* (M), *Bathygobius soporator catulus* (M), *Gobiosoma bosci* (M), *Gobionellus stigmaturus* (M), *Etropus crossotus atlanticus* (M), *Paralichthys albigutta* (M), *Trinectes maculatus fasciatus* (FM), *Symphurus plagiusa* (M). Totals: Fresh water species, 1 (?); Marine, 25.

Thus it is evident that those species peculiar to Cedar Key include, at best, only one freshwater representative. On the other hand, more than two-thirds of those found only at Bayport live principally in fresh waters.

On the basis of these differences in population composition, there appears little doubt that salinity is an important factor in shaping the faunas of these two brackish marshes. Other possibly significant factors have been suggested previously. Among these the availability of species capable of adjusting to the total ecology of the marshes must be considered.

Both of the areas studied border directly on the shallow, eulittoral zone of the Gulf of Mexico and, although this zone has not been studied at Bayport as intensively as it has at Cedar Key, it is obvious to anyone familiar with both localities that the offshore fish faunas are similar, if only their qualitative make up be considered. Equally obvious, however, is the fact that the overall population density at Cedar Key far exceeds that at Bayport. It seems very likely that this greater population density would provide more opportunity for in-

dividual marine fish to invade the brackish marshes there than in the case of Bayport waters. Contrariwise, fresh waters at Bayport, occupied by a variety of fishes, intimately interdigitate with the brackish marshes, while at Cedar Key such fresh waters are limited and discontinuously distributed. Thus, to the factors of propinquity and accessibility alone may be attributed part of the faunal divergence (both quantitative and qualitative) of the two areas. Obviously, however, an accurate appraisal of the contribution of these influences, as compared to other ecological factors, would be difficult, if not impossible, to make.

Regardless of the relative importance of the factors of salinity and the availability of species, the fishes which occur in greatest abundance in the brackish marshes at both Cedar Key and Bayport are mostly species which belong to freshwater groups. Sixteen species contributed more than 96% of the total catch of individuals at Bayport (fig. 10). Of these, only three (*Eucinostomous argenteus, Mugil cephalus* and *Lagodon rhomboides*) can be considered euryhaline representatives of marine groups of fishes. The other thirteen, clearly belonging to freshwater families, contributed 87.72% of the total catches of individuals. In like manner, fourteen species account for more than 96% of the catches at Cedar Key. Of these, only five (*Eucinostomous argenteus, Mugil cephalus, Lagodon rhomboides, Leiostomus xanthurus* and *Anchoa m. diaphana*) are from marine families, while the remaining nine, all of freshwater groups, contributed 83.37% of the Cedar Key total. Expressing this another way, approximately 85% of the specimens caught during this study in the brackish marshes were of species belonging to freshwater, or to freshwater-brackish water, groups.

It is also of interest that within this list of five marine species, none is known to breed in the marshes. Contrarily, all of the nonmarine group of species not only breed in the brackish marshes but maintain permanent populations there. On the basis of these data rests the conclusion that the brackish waters of the intertidal marshes at Cedar Key and at Bayport are populated principally by species which have freshwater, rather than marine, affinities. Moreover, although many marine species invade the brackish marshes temporarily, it is the freshwater fishes which are contributing most conspicuously to the permanent occupancy of the marshes by their establishment of resident breeding populations.

In general, the above condition usually obtains in Florida waters, but there are several striking exceptions of typically marine groups with species which have established breeding populations in fresh waters. Also an imposing list of typically marine species temporarily go far inland in Florida fresh waters.

Summary

A study was made of the fish faunas of two coastal marshes on the Gulf Coast of Florida to determine, primarily, the composition of

TABLE 3.

DISTRIBUTION OF FISHES BY HABITATS FOR CEDAR KEY AND BAYPORT. SHOWN ARE THE TOTAL NUMBER OF SPECIMENS BY SPECIES AND THE PERCENT OF THIS TOTAL COLLECTED FROM THE SEVERAL HABITATS. FOR COMPARISON, THE HABITAT DISTRIBUTION OF THE TOTAL CATCH IS SHOWN.

Species	CEDAR KEY					BAYPORT				
	Total Number of Specimens	Habitats and Percentage of Specimens				Total Number of Specimens	Habitats and Percentage of Specimens			
		Inner Pools	Outer Pools	Water Courses	Open Waters		Inner Pools	Outer Pools	Water Courses	Open Waters
Total All Species	33,443	50.38	35.89	2.92	10.81	21,343	39.44	27.65	21.57	11.34
Dasyatis sabina	0	—	—	—	—	1	—	—	100.00	—
Lepisosteus platyrhyncus	0	—	—	—	—	3	—	—	100.00	—
Elops saurus	19	47.37	42.11	—	10.53	0	—	—	—	—
Harengula pensacolae	4	—	—	—	100.00	0	—	—	—	—
Anchoa m. diaphana	1,160	—	.78	.08	99.14	0	—	—	—	—
Synodus foetens	5	—	—	—	100.00	0	—	—	—	—
Notemigonus c. bosci	0	—	—	—	—	74	95.96	—	4.04	—
Notropis petersoni	0	—	—	—	—	37	—	—	100.00	—
Ameiurus n. erebennus	0	—	—	—	—	10	50.00	—	50.00	—
Hyporhamphus unifasciatus	22	—	—	—	100.00	3	—	—	66.67	33.33
Strongylura notata	14	—	42.86	—	57.14	40	2.50	17.50	2.50	77.50
Strongylura timucu	40	2.50	5.00	7.50	85.00	53	—	18.87	32.08	49.06
Anguilla bostoniensis	0	—	—	—	—	1	—	—	100.00	—
Myrophis punctatus	1	—	—	—	100.00	0	—	—	—	—
Fundulus chrysotus	0	—	—	—	—	29	37.93	—	62.07	—
Fundulus similis	1,750	30.00	40.91	8.00	21.09	204	17.65	36.76	.49	45.10
Fundulus g. grandis	1,476	30.08	51.02	11.72	7.18	503	7.36	45.13	30.42	17.10
Fundulus c. confluentus	1,080	67.87	30.83	.18	1.11	599	61.77	33.22	5.01	—
Adinia xenica	4,939	59.71	35.92	2.59	1.78	364	1.37	71.43	26.92	.27
Lucania parva	13	30.77	69.23	—	—	4,192	14.58	27.31	41.65	16.46
Chriopeops goodei	0	—	—	—	—	126	29.37	—	70.63	—
Cyprinodon v. variegatus	4,747	57.49	31.47	7.18	3.86	1,444	41.62	51.45	3.81	3.12
Floridichthys c. carpio	48	—	20.83	—	79.17	663	—	28.05	—	71.95
Jordanella floridae	0	—	—	—	—	644	100.00	—	—	—
Gambusia a. holbrooki	1,132	100.00	—	—	—	2,026	54.64	22.21	23.15	—
Mollienesia latipinna	10,846	74.85	23.94	.51	.70	4,889	82.59	6.97	10.21	.23
Heterandria formosa	0	—	—	—	—	470	42.13	.85	57.02	—
Stephanolepis hispidus	0	—	—	—	—	1	—	—	—	100.00
Sphoeroides nephelus	16	—	37.50	—	62.50	0	—	—	—	—
Sphyraena barracuda	0	—	—	—	—	1	—	100.00	—	—
Mugil cephalus	1,927	5.09	79.87	.73	14.32	203	59.61	40.39	—	—

Mugil curema	53	—	100.00	—	—	8	87.50	12.50	—	—
Mugil trichodon	44	—	100.00	—	—	0	—	—	—	—
Membras v. vagrans	110	—	—	—	100.00	0	—	—	—	—
Menidia beryllina	1,855	2.86	71.37	1.35	24.42	1,913	17.41	45.27	25.77	11.55
Micropterus s. floridanus	0	—	—	—	—	18	72.22	—	27.78	—
Lepomis p. punctatus	0	—	—	—	—	166	36.14	.60	63.25	—
Lepomis microlophus	0	—	—	—	—	38	84.21	—	15.79	—
Lepomis m. purpurescens	0	—	—	—	—	38	100.00	—	—	—
Chaenobryttus coronarius	0	—	—	—	—	22	81.82	—	18.18	—
Elassoma evergladei	0	—	—	—	—	3	100.00	—	—	—
Lutjanus griseus	3	33.33	—	66.67	—	17	5.88	29.41	64.71	—
Eucinostomus gula	211	—	.47	—	99.53	101	—	25.74	.99	73.27
Eucinostomus argenteus	276	6.52	38.04	13.77	41.67	2,141	.51	54.18	17.33	27.98
Chloroscombrus chrysurus	6	—	—	—	100.00	0	—	—	—	—
Oligoplites saurus	73	—	4.11	—	95.89	0	—	—	—	—
Trachinotus falcatus	1	—	—	—	100.00	0	—	—	—	—
Orthopristis chrysopterus	1	—	—	—	100.00	1	—	—	100.00	—
Lagodon rhomboides	116	—	85.34	.86	13.79	190	1.05	34.21	45.26	19.47
Archosargus probatocephalus	0	—	—	—	—	1	—	—	100.00	—
Bairdiella chrysoura	8	—	87.50	—	12.50	3	—	—	100.00	—
Cynoscion nebulosus	6	—	33.33	—	66.67	3	—	33.33	—	66.67
Cynoscion nothus	4	—	50.00	—	50.00	0	—	—	—	—
Leiostomus xanthurus	889	1.57	86.84	2.70	8.89	39	—	76.92	23.08	—
Pogonias cromis	9	—	88.89	—	11.11	0	—	—	—	—
Sciaenops ocellatus	140	2.86	32.86	20.71	43.57	11	—	—	9.09	90.91
Chaetodipterus faber	1	—	—	—	100.00	0	—	—	—	—
Prionotus tribulus	7	—	14.29	—	85.71	0	—	—	—	—
Opsanus beta	19	—	—	—	100.00	16	—	50.00	43.75	6.25
Syngnathus scovelli	12	—	—	—	100.00	8	—	37.50	12.50	50.00
Syngnathus floridae	21	—	—	—	100.00	0	—	—	—	—
Syngnathus louisianae	2	—	—	—	100.00	0	—	—	—	—
Micrognathus crinigera	1	—	—	—	100.00	0	—	—	—	—
Hippocampus h. punctulatus	2	—	—	—	100.00	0	—	—	—	—
Bathygobius s. catulus	4	—	25.00	—	75.00	0	—	—	—	—
Microgobius gulosus	235	.43	95.32	—	4.26	21	28.57	28.57	9.52	33.33
Gobiosoma bosci	29	—	100.00	—	—	0	—	—	—	—
Gobiosoma robustum	5	—	—	—	100.00	2	—	—	—	100.00
Gobionellus stigmaturus	2	—	50.00	—	50.00	0	—	—	—	—
Chasmodes saburrae	0	—	—	—	—	1	—	—	—	100.00
Etropus c. atlanticus	1	—	—	—	100.00	0	—	—	—	—
Paralichthys albigutta	1	—	100.00	—	—	0	—	—	—	—
Trinectes m. fasciatus	9	88.89	11.11	—	—	0	—	—	—	—
Achirus lineatus	46	17.39	45.65	—	36.96	2	—	—	—	100.00
Symphurus plagiusa	2	—	50.00	—	50.00	0	—	—	—	—

TABLE 4.

DISTRIBUTION OF MONTHLY CATCHES OF CEDAR KEY FISHES BY SPECIES.

Species	Percentages of Monthly Catches												No. of Spec.	% of Total Catch
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.		
Mollienesia latipinna	3.7	28.4	5.5	25.0	35.6	48.0	55.4	34.3	47.5	34.4	3.4	22.5	10,846	32.43
Adinia xenica	11.4	4.6	4.2	10.6	10.5	8.6	11.6	16.1	26.4	15.1	15.3	22.3	4,939	14.77
Cyprinodon v. variegatus	23.1	8.2	7.6	14.5	13.8	10.5	9.5	30.3	9.7	11.0	19.0	22.1	4.747	14.19
Mugil cephalus	39.1	13.2	15.8	16.1	4.8	.4	—	—	—	.8	7.3	8.0	1,927	5.76
Menidia beryllina	.8	7.3	27.6	5.9	3.0	5.5	4.0	.3	.6	6.3	11.1	4.1	1,855	5.55
Fundulus similis	5.4	3.0	6.3	2.6	3.3	6.3	7.2	10.0	2.0	4.4	15.2	4.3	1,750	5.23
Fundulus g. grandis	11.0	2.3	6.1	1.4	4.9	.8	1.6	2.3	3.9	3.7	15.7	6.4	1,476	4.41
Anchoa m. diaphana	—	.1	—	5.7	—	.8	1.4	.03	—	12.6	.1	1.9	1,160	3.47
Gambusia a. holbrooki	.4	9.2	.8	.8	9.1	5.7	1.5	.5	1.6	5.6	.2	.9	1,132	3.38
Fundulus c. confluentus	.4	2.0	.8	1.1	7.8	5.3	1.8	4.8	4.9	1.6	1.9	4.0	1,080	3.23
Leiostomus xanthurus	4.6	13.0	22.0	8.0	.5	.7	—	—	—	—	—	—	889	2.66
Eucinostomus argenteus	—	—	—	—	1.8	1.8	.8	.1	.3	1.6	1.0	.9	276	.83
Microgobius gulosus	.1	5.9	.6	4.7	1.0	.3	—	—	—	.1	—	.1	235	.70
Eucinostomus gula	—	—	—	—	—	.1	—	.9	3.0	.3	.3	.1	211	.63
Sciaenops ocellatus	—	.2	.3	.2	.1	—	—	—	.04	.8	3.5	.4	140	.42
Lagodon rhomboides	—	1.3	1.7	1.2	.4	1.3	—	—	—	—	—	—	116	.35
Membras v. vagrans	—	—	—	.5	.1	1.5	2.8	—	—	.1	—	—	110	.33
Oligoplites saurus	—	—	—	—	—	.3	1.1	—	.04	.6	—	—	73	.22
Mugil curema	—	—	.1	.2	1.4	.4	—	—	—	—	—	—	53	.16
Floridichthys c. carpio	—	.1	.1	—	—	—	—	—	—	.1	.9	1.2	48	.14
Achirus lineatus	—	.3	.2	.3	.1	—	—	.1	.04	.3	.4	.1	46	.14
Mugil trichodon	—	—	—	—	.5	2	—	—	—	—	1.7	—	44	.13
Strongylura timucu	—	—	—	.1	.03	1.0	.4	—	.02	.1	—	—	40	.12
Gobiosoma bosci	—	.8	—	.7	.1	—	.1	—	—	—	—	—	29	.09
Hyporhampus unifasciatus	—	—	—	—	.3	.1	.4	—	—	—	—	—	22	.07
Syngnathus floridae	—	—	—	—	—	—	—	—	—	—	1.3	.1	21	.06
Opsanus beta	—	—	—	—	—	—	—	.2	—	.2	—	.1	19	.06
Elops saurus	—	—	—	.1	.4	.2	.1	—	—	—	—	—	19	.06

Sphoeroides nephelus	—	—	—	.3	.1	—	—	—	—	—	.1	.2	.1	16	.05
Strongylura notata	—	—	—	—	—	.1	.1	—	—		.1	—	—	14	.04
Lucania parva	—	.1	.1	.1	.03	—	—	—	.02	.01	—		.2	13	.04
Syngnathus scovelli	—	—	—	—	—	—	—	—	—	—		.8	—	12	.04
Trinectes m. fasciatus	—	—	.1	.1	—	—	—	—	—	.1	—	—		9	.03
Pogonias cromis	—	—	—	—	.2	.1	—	—	—	—	—	—		9	.03
Bairdiella chrysoura	—	—	—	.1	—	.2	—	—	—	.04	—	—		8	.02
Prionotus tribulus	—	.1	—	—	—	—	—	—	—	.1	.1	—		7	.02
Chloroscombrus chrysurus	—	—	—	—	—	—	—	—	—	.1	—	—		6	.02
Cynoscion nebulosus	—	—	—	—	—	.1	.1	—	—	.04	.1	—		6	.02
Gobiosoma robustum	—	—	—	—	—	—	—	—	—	—	—		.2	5	.01
Synodus foetens	—	—	—	—	—	—	—	.03	—	—	.3	—		5	.01
Cynoscion nothus	—	—	—	—	—	.1	.1	—	—	—	—	—		4	.01
Harengula pensacolae	—	—	—	.1	—	—	—	—	—	.03	—	—		4	.01
Bathygobius s. catulus	—	.1	—	—	—	—	—	—	—	—	.1	.1		4	.01
Lutjanus griseus	—	—	—	—	—	—	—	—	.02	.01	—		.1	3	.01
Syngnathus louisianae	—	—	—	—	—	—	—	—	—	—	.1	—		2	.005
Hippocampus h. punctulatus	—	—	—	—	—	—	—	—	—	—	.1	.1		2	.005
Gibionellus stigmaturus	—	—	—	—	—	—	—	—	—	.01	.1	—		2	.005
Symphurus plagiusa	—	—	.1	—	—	—	—	—	—	—	—	.1		2	.005
Orthopristis chrysopterus	—	—	—	.1	—	—	—	—	—	—	—	—		1	.003
Myrophis punctatus	—	—	—	—	—	—	—	.03	—	—	—	—		1	.003
Trachinotus falcatus	—	—	—	—	—	—	—	—	—	.01	—	—		1	.003
Chaetodipterus faber	—	—	—	—	—	—	—	—	—	.01	—	—		1	.003
Micrognathus crinigera	—	—	—	—	—	—	—	—	—	—	.1	—		1	.003
Etropus c. atlanticus	—	—	—	—	—	—	—	.03	—	—	—	—		1	.003
Paralichthys albigutta	—	—	—	.1	—	—	—	—	—	—	—	—		1	.003
Total Specimens	1582	1421	2052	1899	2941	2144	2067	3058	5001	7613	1518	2147	33,443		

TABLE 5.

DISTRIBUTION OF MONTHLY CATCHES OF BAYPORT FISHES BY SPECIES.

Species	Percentages of Monthly Catches												No. of Spec.	% of Total Catch
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.		
Mollienesia latipinna	3.1	44.2	28.0	50.9	34.9	11.3	12.4	4.7	43.0	25.5	4.0	5.2	4,889	22.91
Lucania parva	55.0	21.5	11.9	6.6	2.1	15.8	25.0	46.5	9.6	15.6	40.8	19.6	4,192	19.64
Eucinostomus argenteus	1.1	1.4	—	1.9	12.1	23.2	11.4	2.3	7.7	14.3	3.5	2.3	2,141	10.03
Gambusia a. holbrooki	8.6	4.3	14.1	11.9	8.8	13.0	7.6	—	9.2	4.9	12.1	34.0	2,026	9.49
Menidia beryllina	.8	1.3	11.4	.7	8.4	8.7	15.0	30.2	5.8	4.2	12.6	17.5	1,913	8.96
Cyprinodon v. variegatus	10.9	9.4	7.5	2.8	6.1	6.8	5.3	1.2	8.3	11.5	6.9	5.4	1,444	6.77
Floridichthys c. carpio	—	.5	3.9	—	1.5	4.2	5.4	—	2.8	4.6	2.3	.5	663	3.11
Jordanella floridae	—	1.1	1.2	5.0	21.4	.8	.1	—	.6	.5	—	—	644	3.02
Fundulus c. confluentus	6.0	4.1	3.7	9.7	3.1	.7	.7	2.3	3.3	5.3	1.5	1.3	599	2.81
Fundulus g. grandis	4.3	1.7	1.0	.4	.2	3.5	3.5	1.2	1.3	1.1	3.7	.5	503	2.36
Heterandria formosa	2.1	.2	—	1.8	—	1.3	5.4	—	1.5	1.0	.1	—	470	2.20
Adinia xenica	3.0	.6	—	—	—	.2	1.7	—	1.7	9.5	3.5	1.6	364	1.71
Fundulus similis	—	.2	—	1.5	.1	1.6	.6	9.3	1.3	.6	3.0	1.0	204	.96
Mugil cephalus	1.6	.6	5.1	4.1	1.0	.2	.2	1.2	.2	—	.1	10.6	203	.95
Lagodon rhomboides	1.6	1.4	4.6	.4	.2	.8	1.4	—	—	—	1.0	.3	190	.89
Lepomis p. punctatus	.7	1.6	—	—	—	2.1	.5	—	.7	—	2.0	—	166	.78
Chriopeops goodei	—	.1	—	—	—	1.0	1.4	—	.4	—	.2	—	126	.59
Eucinostomus gula	—	—	—	—	—	.4	.8	—	1.1	1.0	.4	—	101	.47
Notemigonus c. bosci	—	2.3	—	—	—	1.2	.1	—	—	—	—	—	74	.35
Strongylura timucu	.1	.4	3.7	.4	.1	.3	.2	—	—	.1	.3	—	53	.25
Strongylura notata	—	—	2.0	1.1	—	.03	.2	—	—	—	.1	—	40	.19
Leiostomus xanthurus	.3	1.9	1.5	—	—	—	—	—	—	—	—	.3	39	.18
Lepomis microlophus	—	.8	—	.1	—	.5	.02	—	.05	—	.4	—	38	.18
Lepomis m. purpurescens	—	—	—	—	—	.6	.2	—	.2	—	—	—	38	.18
Notropis petersoni	—	—	—	—	—	1.2	.02	—	—	—	—	—	37	.17
Fundulus chrysotus	.1	—	—	.1	.1	—	.1	—	.8	.3	—	—	29	.14
Chaenobryttus coronarius	.1	.5	—	—	—	—	.2	—	.1	—	—	—	22	.10
Microgobius gulosus	.5	.1	.5	.3	.1	—	—	—	.3	—	—	—	21	.10

Micropterus s. floridanus	—	—	—	—	—	.1	.2	—	.1	—	—	—	18	.08
Lutjanus griseus	—	—	—	.1	—	.3	.02	—	.1	—	.3	—	17	.08
Opsanus beta	—	.1	—	—	—	.03	.2	—	.1	—	.2	—	16	.07
Sciaenops ocellatus	—	—	—	—	—	—	—	—	—	—	.8	—	11	.05
Ameiurus n. erebennus	—	.1	—	.2	—	—	.1	—	—	—	—	—	10	.05
Mugil curema	—	—	—	—	.1	.1	.1	1.2	.1	—	—	—	8	.04
Syngnathus scovelli	—	—	—	—	—	.1	.1	—	.1	—	.1	—	8	.04
Bairdiella chrysoura	—	—	—	—	—	—	.1	—	—	—	—	—	3	.01
Hyporhampus unifasciatus	—	—	—	.1	—	—	—	—	—	—	.1	—	3	.01
Lepisosteus platyrhyncus	—	—	—	—	—	—	.03	—	—	—	.1	—	3	.01
Cynoscion nebulosus	—	—	—	—	—	—	.1	—	—	—	—	—	3	.01
Elassoma evergladei	—	—	—	—	—	—	.1	—	—	—	—	—	3	.01
Achirus lineatus	—	—	—	—	—	—	—	—	.1	.1	—	—	2	.009
Gobiosoma robustum	.2	—	—	—	—	—	—	—	—	—	—	—	2	.009
Anguilla bostoniensis	—	—	—	—	—	—	—	—	—	—	.1	—	1	.005
Archosargus probatocephalus	—	—	—	—	—	—	.02	—	—	—	—	—	1	.005
Chasmodes saburrae	—	—	—	—	—	—	.02	—	—	—	—	—	1	.005
Dasyatis sabina	—	—	—	—	—	—	.02	—	—	—	—	—	1	.005
Orthopristis chrysopterus	—	—	—	—	—	—	—	—	—	—	.1	—	1	.005
Sphyraena barracuda	—	—	—	—	—	—	—	—	—	.1	—	—	1	.005
Stephanolepis hispidus	—	—	—	—	—	—	.02	—	—	—	—	—	1	.005
Total Specimens	968	1551	411	1676	2280	2967	6175	86	2060	1340	1441	388	21,343	

TABLE 6.

DISTRIBUTION BY SALINITIES OF SELECTED CEDAR KEY FISHES.

Species	Number of Spec.	Percentages of Specimens by Salinity Classes								Not Rec.	Minimum, Maximum Salin.	Salin. Index*
		0-4.9	5-9.9	10-14.9	15-19.9	20-24.9	25-29.9	30-34.9	35-39.9			
Anchoa m. diaphana	1,160	.00	.00	.00	.09	10.78	10.17	75.43	3.53	.00	17.5-37.6	31.03
Floridichthys c. carpio	48	.00	.00	.00	.00	29.16	16.67	2.08	50.00	2.08	20.0-37.6	31.17
Eucinostomus gula	211	.00	.00	.00	.00	14.69	81.52	2.37	1.42	.00	22.9-37.6	26.98
Microgobius gulosus	235	.00	.00	.00	5.53	49.79	40.85	.00	.00	3.83	15.4-27.7	24.29
Menidia beryllina	1,855	.05	1.24	.22	29.76	22.64	41.56	3.29	.05	1.19	3.5-37.6	23.17
Lucania parva	13	.00	.00	.00	15.38	61.54	23.08	.00	.00	.00	15.4-28.2	22.84
Fundulus c. confluentus	1,080	1.76	2.50	.09	11.67	55.19	27.22	.93	.09	.56	0.8-35.6	22.60
Eucinostomus argenteus	276	12.32	3.26	.00	1.09	36.96	36.96	5.78	3.62	.00	4.5-37.6	22.41
Mugil cephalus	1,927	1.14	1.40	1.09	20.45	56.14	14.95	4.46	.05	.31	2.5-35.6	22.09
Adinia xenica	4,939	2.83	1.50	1.48	14.23	56.29	21.52	1.13	.18	.83	0.8-37.6	22.01
Gambusia a. holbrooki	1,132	7.07	10.78	.00	5.65	32.16	44.35	.00	.00	.00	1.2-25.2	21.36
Mollienesia latipinna	10,846	2.99	9.29	.02	21.54	35.82	26.30	3.48	.42	.15	1.2-37.6	21.09
Sciaenops ocellatus	140	20.00	.00	.00	7.14	17.14	52.86	.00	2.14	.71	0.8-37.6	21.05
Lagodon rhomboides	116	.00	.00	.00	31.03	18.16	39.66	.00	.00	11.20	4.5-26.1	22.95
Fundulus similis	1,750	7.09	3.43	6.06	22.74	31.37	23.60	3.54	.57	1.60	0.8-37.6	20.37
Leiostomus xanthurus	889	.67	.00	2.02	56.47	16.87	22.27	.00	.00	1.69	1.2-26.1	20.36
Fundulus g. grandis	1,476	9.69	.61	4.61	17.27	46.07	18.97	.95	.54	1.29	0.8-35.6	20.19
Cyprinodon v. variegatus	4,747	9.25	7.69	1.50	32.74	23.17	22.44	2.72	.21	.29	0.8-35.6	19.17
Total All Species	33,443	4.09	5.18	1.09	20.82	36.68	25.68	5.35	.53	.60	0.8-37.5	21.60

* The salinity index is the mean of the salinities calculated on the basis of the salinity class midpoints and the percentages of fish in each salinity class.

TABLE 7.

Distribution by Salinities of Selected Bayport Fishes

Species	Number of Spec.	Percentages of Specimens by Salinity Classes								Minimum, Not Rec.	Maximum Salin.	Salin. Index*
		0-4.9	5-9.9	10-14.9	15-19.9	20-24.9	25-29.9	30-34.9	35-39.9			
Jordanella floridae	644	6.52	.00	7.76	10.09	34.32	41.30	.00	.00	.00	0.0-26.1	21.93
Mugil cephalus	203	5.42	22.17	20.69	40.89	7.88	2.96	.00	.00	.00	1.1-26.1	14.08
Fundulus c. confluentus	599	21.04	25.54	22.37	19.53	6.68	4.84	.00	.00	.00	0.1-26.1	11.44
Mollienesia latipinna	4,889	35.41	16.20	15.73	16.61	10.55	5.34	.00	.00	.16	0.0-26.1	10.79
Adinia xenica	364	27.75	31.31	6.59	34.34	.00	.00	.00	.00	.00	1.1-16.5	9.83
Fundulus similis	204	16.18	50.00	16.18	17.65	.00	.00	.00	.00	.00	0.8-16.2	9.22
Eucinostomus gula	101	8.91	49.50	37.62	2.97	.00	.00	.00	.00	.99	2.0-16.5	9.20
Cyprinodon v. variegatus	1,444	27.00	32.48	26.80	11.15	2.08	.48	.00	.00	.00	0.0-26.1	8.96
Gambusia a. holbrooki	2,026	36.87	20.73	27.79	3.70	6.32	3.55	.00	.00	1.04	0.0-26.1	9.04
Microgobius gulosus	21	9.52	57.14	33.33	.00	.00	.00	.00	.00	.00	2.9-10.5	8.64
Eucinostomus argenteus	2,141	10.65	62.21	18.78	7.52	.28	.00	.00	.00	.56	1.1-24.7	8.66
Floridichthys c. carpio	663	11.46	63.05	22.32	3.17	.00	.00	.00	.00	.00	2.0-15.8	8.31
Sciaenops ocellatus	11	.00	100.00	.00	.00	.00	.00	.00	.00	.00	5.3- 5.3	7.45
Menidia beryllina	1,913	23.94	55.57	19.45	.58	.37	.00	.00	.00	.05	0.1-24.7	7.33
Lagodon rhomboides	190	17.89	55.26	17.89	2.63	.00	.00	.00	.00	6.32	1.4-15.8	7.73
Leiostomus xanthurus	39	23.08	58.97	17.95	.00	.00	.00	.00	.00	.00	2.9-11.8	7.19
Lucania parva	4,192	30.03	51.88	14.27	3.10	.14	.00	.00	.00	.57	0.1-24.7	6.99
Fundulus g. grandis	503	33.20	45.92	16.90	2.78	.00	.00	.00	.00	1.19	0.8-16.2	6.90
Heterandria formosa	470	68.09	12.34	15.32	.21	.00	.00	.00	.00	4.04	0.0-15.0	4.72
Total All Species	21,343	28.72	36.40	17.86	8.80	4.55	3.00	.00	.00	.67	0.0-26.1	9.08

* The salinity index is the mean of the salinities calculated on the basis of the salinity class midpoints and the percentages of fish in each salinity class.

TABLE 8.
Interspecific Association Coefficients of Selected Species from Cedar Key

Lucania parva	9*	*Lucania parva*												
Mollienesia latipinna	93	.49±.61	*Mollienesia latipinna*											
Gambusia a. holbrooki	29	−.09±.56	1±.31	*Gambusia a. holbrooki*										
Cyprinodon v. variegatus	91	1±.58	.60±.03	.85±.29	*Cyprinodon v. variegatus*									
Menidia beryllina	52	.61±.28	−.59±.15	−.61±.18	−.56±.15	*Menidia beryllina*								
Eucinostomus argenteus	26	.15±.17	−.11±.09	.53±.31	−.35±.10	.45±.15	*Eucinostomus argenteus*							
Fundulus g. grandis	75	.40±.42	.16±.13	−.62±.12	.32±.13	.17±.13	.06± 23	*Fundulus g. grandis*						
Fundulus c. confluentus	75	.40±.42	.94±.13	.81±.21	.89±.13	−.35±.11	−.39±.13	.02±.09	*Fundulus c. confluentus*					
Floridichthys c. carpio	10	.03±.10	−.36±.16	− 1±.53	−.61±.17	.82±.27	.10±.16	.46±.39	−.68±.23	*Floridichthys c. carpio*				
Fundulus similis	87	.59±.53	−.14±.28	−.34±.10	.17±.10	.36±.17	.43±.29	.50±.11	.01±.11	.26±.50	*Fundulus similis*			
Adinia xenica	84	.24±.49	.72±.11	.77±.25	.70±.11	−.48±.13	−.35±.11	.23±.11	.64±.11	−.29±.20	−.04±.23	*Adinia xenica*		
Mugil cephalus	37	.36±.22	.01±.26	−.22±.24	.31±.25	.18±.12	−.51±.26	.49±.18	.27±.18	.57±.20	.30±.23	.08±.21	*Mugil cephalus*	
Anchoa m. diaphana	17	−.22±.78	−.40±.12	− 1±.40	−.77±.13	.90±.20	.62±.12	−.16±.17	−.81±.17	.30±.12	−.12±.14	−.67±.15	−.43±.33	*Anchoa m. diaphana*

* The whole numbers following the species name indicate the number of collections in which the species was taken at Cedar Key.

TABLE 9.
Interspecific Association Coefficients of Selected Species from Bayport.

Lucania parva	98*	*Lucania parva*												
Mollienesia latipinna	95	.08±.09	*Mollienesia latipinna*											
Gambusia a. holbrooki	80	.08±.12	.64±.11	*Gambusia a. holbrooki*										
Cyprinodon v. variegatus	75	.52±.13	.32±.12	.04±.09	*Cyprinodon v. variegatus*									
Menidia beryllina	69	.66±.14	.10±.13	−.17±.12	.32±.10	*Menidia beryllina*								
Eucinostomus argenteus	62	.49±.16	−.21±.13	−.44±.10	.13±.11	.49±.10	*Eucinostomus argenteus*							
Fundulus g. grandis	56	.43±.17	.22±.16	−.21±.09	.50±.12	.25±.11	.15±.10	*Fundulus g. grandis*						
Fundulus c. confluentus	48	.34±.20	.70±.19	.52±.14	.81±.13	.12±.12	−.34±.12	.36±.10	*Fundulus c. confluentus*					
Floridichthys c. carpio	36	.12±.24	−.05±.09	−.50±.36	.68±.16	.47±.15	.74±.13	.18±.12	.24±.19	*Floridichthys c. carpio*				
Fundulus similis	34	.07±.25	.14±.24	−.28±.12	.79±.17	.38±.16	.33±.14	.38±.13	.26±.11	.47±.09	*Fundulus similis*			
Adinia xenica	22	.82±.33	.67±.32	.42±.24	.89±.23	.33±.21	.14±.18	.21±.17	.64±.15	.37±.12	.33±.12	*Adinia xenica*		
Mugil cephalus	19	.37±.37	.62±.34	.46±.27	.88±.25	.56±.22	−.56±.22	.36±.18	.83±.16	−.43±.34	.15±.13	.05±.10	*Mugil cephalus*	
Jordanella floridae	15	−.11±.14	1±.39	.83±.30	.69±.28	.01±.26	−.72±.26	.07±.21	.79±.18	−1±.39	−.49±.41	−1±.54	.53±.10	*Jordanella floridae*

* The whole number following the species name indicates the number of collections in which the species was taken at Bayport.

those faunas and to discover, if possible, the more obvious ecological factors which were shaping them.

The two areas were different ecologically. The one at Bayport had less saline waters and more stable temperatures than the one at Cedar Key in addition to other differences which were described.

Seventy-five species were recorded during the study and species data are presented in an annotated list. This treatment is supplemented by tables, graphs, and other compilations designed to present certain of the data which could be summarized.

Five species, *Fundulus similis, Fundulus grandis grandis, Adinia xenica, Cyprinodon variegatus variegatus,* and *Floridichthys carpio carpio* were found only in the brackish waters of the marshes or immediately adjacent brackish waters. These are considered to be brackish zone fishes and are all members of the family Cyprinodontidae. They comprized 14.89% of the total catch at Bayport and 38.75% of that from Cedar Key. If four other cyprinodontids which reside in both brackish and fresh waters are added to the list, the respective percentages of the total catches are raised to 69.74 for Bayport and 77.84 for Cedar Key. Thus the cyprinodontids were the dominant family of fishes in the brackish waters studied.

The availability of species capable of adjusting to the total ecology of the brackish marshes was considered. At Cedar Key, where mainland fresh water is at a minimum, dense populations of eulittoral marine species were available to the marshes. At Bayport the marine fishes, although substantially equal to those at Cedar Key in species present, occurred in much fewer numbers of individuals, but the propinquity of fresh waters permitted easy access to the marshes for many freshwater fishes.

Despite the relative importance of the factors of salinity and the availability of species, it was noted that the fishes which occur in greatest abundance in the brackish marshes at both Cedar Key and Bayport belong to freshwater groups. In other words, approximately 85% of the specimens caught in the brackish marshes during this study are of species representing either freshwater or freshwater-brackish water groups of fishes. Furthermore, of the sixteen species at Bayport contributing 96% of the total catch only three represented marine species, and of the fourteen species at Cedar Key contributing 96% of the total catch only five were marine. None of these five marine species (*Eucinostomus argenteus, Mugil cephalus, Lagodon rhomboides, Leiostomous xanthurus* and *Anchoa mitchilli diaphana*) is known to breed in the brackish marshes, whereas all of the freshwater affinates in reference not only breed in the marshes but also maintain permanent populations there. Thus it is concluded that the intertidal marshes at Cedar Key and at Bayport are populated principally by fishes with freshwater, rather than marine affinities.

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