Fish Mariculture: Progress and Potential[1]

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Abstract

Progress in the culture of certain marine fish suitable for farming is reviewed. New data are given on availability and ecology of beach-caught fry of the Florida pompano. Food and diseases of the pompano in nature and in captivity and growth in captivity are discussed. Results of palatibility tests of cultured and wild Florida pompano and of related fish are included.

INTRODUCTION

A PRELIMINARY REPORT on Florida pompano biology, fisheries and farming potential (Berry and Iversen, 1967) was prepared because of the growing interest in the farming of pompano. Since that report was issued, interest in pompano mariculture has increased. In the present report, we discuss briefly some other species of fish suitable for mariculture, but our emphasis is on the Florida pompano (*Trachinotus carolinus*)—because at this time it has great farming potential in terms of market value, palatibility, consumer demand and research progress.

The common name "Florida pompano" is used in this paper for *Trachinotus carolinus,* although this species has previously been referred to only as "pompano" (Anon., 1960: 30). We consider this change in common name necessary and desirable because "pompano" is a generic term that refers to the 22 or more species of *Trachinotus.* Also other, less desirable species are imported into the United States and sold as "pompano" (for example, *Trachinotus ovatus* from West Africa and *Parona signata* from eastern South America). The change in common name to Florida pompano has been recommended to and provisionally accepted by the Common Names Committee of the American Fisheries Society.

The metric system is usually preferable to English weights and measures for research. We realize that a commercial mariculture operation will use the English system, and so provide the following conversions: 1 millimeter = 0.039 inch; 1 inch = 25.4 mm; 1 gram = 0.0022 pound; 1 pound = 453.6 grams. For methods of measuring standard length (SL), fork length (FL) and total length (TL), see Berry and Iversen (1967, Fig. 5).

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Moe, Lewis and Ingle (1968) added substantially to the information on the biology of the Florida pompano and its possible role in mariculture. Finucane (1968) studied the ecology and farming potential of pompano at St. Petersburg, Florida. Several private and institutional experiments have begun, such as at the Battelle Memorial Laboratory, Daytona Beach, Florida and Nicholls State College, Louisiana.

Our current studies have been concentrated on obtaining better estimates of abundance for young pompano on Florida's east coast. We have sampled most of the east coast, most intensively the area from Vero Beach to St. Augustine. Fry were most abundant on low-energy beaches (those with a long gradual slope; these beaches also have isolated sloughs in which pompano are at times concentrated in large numbers. Few fry are found on steep, high-energy beaches with heavy surf; also it is difficult to operate collecting gear on such beaches.

Our collecting methods, although not strictly quantitative, indicate that young pompano seem to occur in highest abundance on falling tides. The collections also suggest that fry in commercial numbers do not exist south of Cape Kennedy (except early in the spawning period.) Abundance is greatest from about New Smyrna Beach north to St. Augustine, where most of the gently sloping beaches occur.

In general the size range of young pompano increased as the season progressed. In May and June at St. Augustine, sizes varied little, but later in the year when the abundance was lower the range of sizes was greater. The availability of a narrow range of sizes is of course desirable in sea farming, to minimize the amount of sorting necessary prior to and after stocking ponds or tanks.

By plotting values of fork length (FL) and total length (TL) against standard length (SL) for several hundred Florida pompano, we have determined conversion ratios (with an accuracy of about ± 1.5%), where to convert one length to another, it should be multiplied by one of the following factors:

	TL ⅓ - 4 in. (8.5 - 102 mm)	TL 4 - 13½ in. (102 - 343 mm)
SL to TL	x1.32	x1.29
SL to FL	x1.13	x1.085
FL to SL	x0.88	x0.922
FL to TL	x1.14	x1.19
TL to SL	x0.76	x0.775
TL to FL	x0.88	x0.84

Stomach contents revealed the usual food items reported in the literature. The Coquina clam (*Donax*) and the mole shrimp (*Emerita*) were the most important foods. Occasionally young pompano were found with their stomachs completely packed with those species. Large numbers of insects appeared in the guts of young pompano taken in one sample.

Diseases

Parasites of the Florida pompano were examined by Charles E. Brown, who worked under a grant from the National Science Foundation. In 74 beach-caught juveniles he found four species of cestodes, one nematode, one monogenetic trematode, at least seven species of digenetic trematodes and three species of sporozoans. The monogenetic trematode and the three species of sporozoans have direct life cycles and are probably important in mariculture of pompano. The monogenetic trematode has demonstrated its effects on pompano in captivity by damaging the epithelial layers of the gills and apparently interfering with respiration in stocks of young held at the Miami Seaquarium. Routine prophylaxis with copper sulfate proved effective against these helminths. Sporozoans have not caused problems to date but further study is needed because they do have direct life cycles and an ability to cause epidemics in captive fish.

We lost about 100 pompano in an aquarium at the Institute of Marine Sciences to an unknown disease similar to "gas bubble" (bug-eye). The cause of the disease is not known, though it may have been bacteria.

Growth in captivity

In 1968, growth of Florida pompano held in tanks was measured at Miami Seaquarium. Florida pompano fry obtained by seining off St. Augustine on June 28, 1968, were transported to Seaquarium in boxes of filtered water supplied with compressed oxygen. In Miami they were placed in a 1,800-gallon tank which was fed with filtered water from Biscayne Bay that was exchanged about five times a day. The fry were fed a mixture of thawed fish (ground whole) of various species and commercial trout food. The fry were 14.5 to

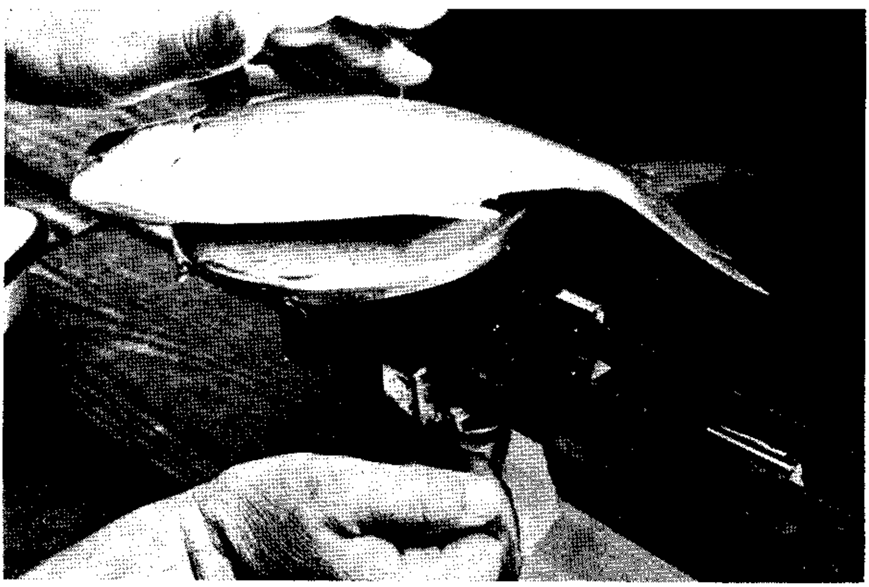

FIG. 1. A phase of the Seaquarium pompano experiment. This fast-growing individual was caught as a surf-zone fry at a weight of 20 gm (0.04 lb.) or less. After 4.5 months of tank-culture it weighed 413 gm (0.9 lb.) at a length of 240 mm FL (9.4 in.). Photograph by J. W. Latourrette, Wometco Miami Seaquarium.

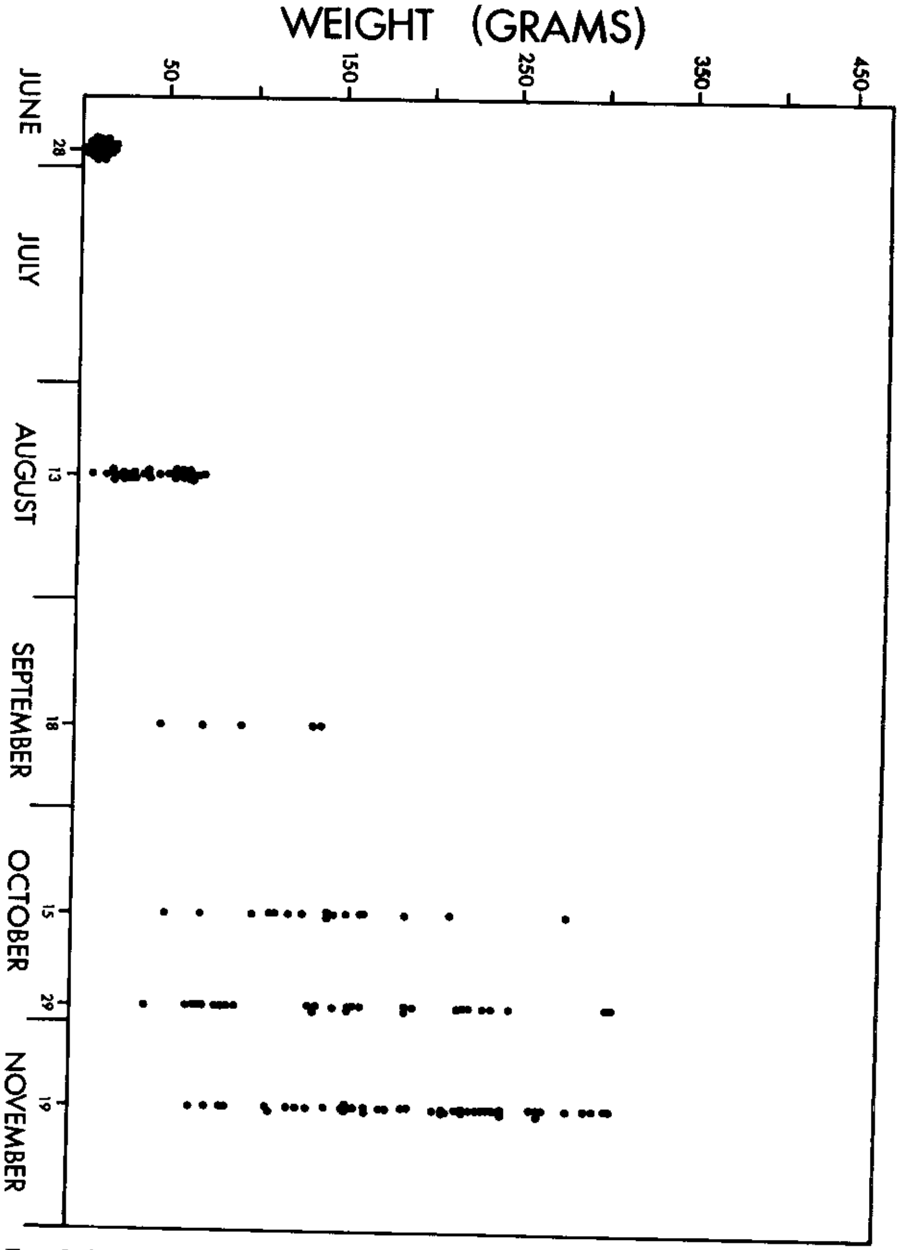

FIG. 2. Weight increase of fish in one of the Florida pompano experiments at the Seaquarium. The fish sampled are individually plotted. See Table 1 for size ranges and average sizes of each sample.

99 mm long (FL) and 0.036 to 20.3 gm when captured. Two days after capture about 1,000 fry were placed in a tank of approximately 11,000 gallons with a daily water exchange of about 10 to 14 times between August 13 and November 12. The first sample was caught with a seine, handled alive, without anesthesia and replaced; the second was caught with a baited hook and sacrificed; and three others were caught by scoop net in the intake flume on lowered water, anesthetized with MS222 at a concentration of 1:13,000, and returned rapidly to the tank (Fig. 1). Several of these fish were marked by clipping the dorsal or anal fin lobes at about the distal third, but some of the clipped lobes were noted to have regrown almost completely within about 2 months.

Plots of the individual weights of these six samples are shown in Figure 2 and weights and fork lengths are summarized in Table 1.

TABLE 1
WEIGHTS AND FORK LENGTHS OF FLORIDA POMPANO REARED IN CAPTIVITY

		Weight (gm)		Length (mm)	
Date	Number	Range	Mean	Range	Mean
28 June	91	0.03-20	5.0	14-99	55.9
13 Aug.	35	18-71	42.9	80-140	115.9
18 Sept.	5	48-140	98.0	119-169	147.8
15 Oct.	16	54-284	143.8	129-215	170.7
29 Oct.	28	42-305	158.4	130-225	174.6
12 Nov.	45	85-305	203.4	139-240	191.1

Average weight increased almost 200 gm over the 4.5-month period. A decrease in this growth rate can be anticipated at lower winter temperatures, even in south Florida. If the fish had been obtained in early May (when they were first abundant on the beaches), and had been fed a ration more suitable to their needs and growth, they might have been raised to a 1-pound size by December (a pound is the current minimum market size).

The average increase in fork length was about 130 mm in 4.5 months. A similar interpretation of the hypothetical growth curve of Florida pompano reared in a pond with tidal exchange suggests that a somewhat longer period (6 months) is required for the same growth (based on Moe, Lewis and Ingle, 1968, Fig. 13). We speculate that the faster growth of the Seaquarium reared fish resulted from more consistent feeding, better water conditions, and the more suitable environment of southern Florida.

One of the more striking features of the Miami Seaquarium experiment was the individual disparity of growth. The older fish in the experiment showed considerable individual variation in growth rate (Fig. 2 and Table 1) that suggests production might be greater if the faster growing fish were segregated.

The length-weight relation of the Seaquarium-reared Florida pompano is plotted in Figure 3; the calculated regression line is: log weight = -4.7365 + 3.0756 log length. Regression lines obtained for pond-reared and wild stock at St. Augustine by Moe, Lewis and Ingle (1968: 35) are shown also. The three curves indicate that fish reared under conditions like those at Seaquarium have a higher condition factor than wild stocks raised under pond conditions like those at St. Augustine. The regression for Seaquarium-reared Florida pom-

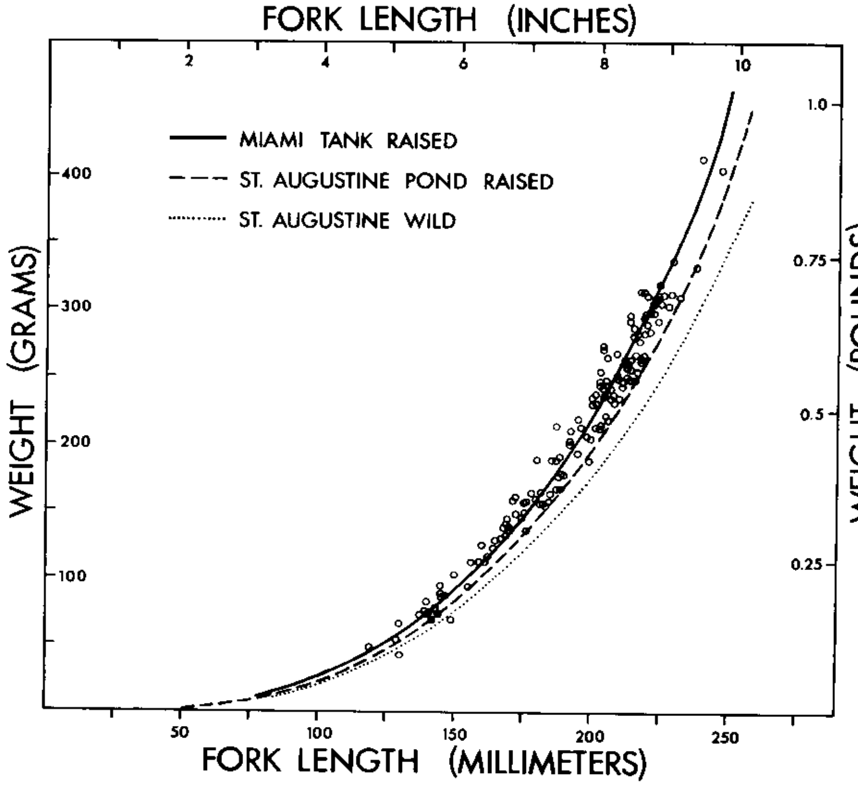

FIG. 3. Length-weight relationship of Florida pompano from three sources—a Seaquarium experiment at Miami, a pond at St. Augustine, and the beach near St. Augustine. See text for source and explanation of the calculated regression lines.

pano also suggests that the fish may weigh more than 1 pound at the minimum legal size of 10 inches.

Mortality in the Seaquarium experiments varied. Although some were as high as 40%, we believe that death rates can be kept at less than 10%, by relatively minor improvements in the food and artificial environment and by adequate preparations to handle emergencies such as mechanical failures, human errors, epizootics and hurricanes. The 10% estimate includes transporting the beach-caught fry more than 300 miles, as well as rearing in tanks for 12 months or more.

Collection of beach fry

Juvenile Florida pompano apparently have an optimum habitat in the surf zone along open beaches with gradual slopes. Our collections along the east coast of Florida in 1968 (Table 2) yielded information on the occurrence of Florida pompano in relation to size, season, locality and abundance.

TABLE 2

Records of Beach Seine Collections of Surf-zone Florida Pompano[1]

State and Location	Date (1968)	Number Pompano	Size Range (mm-SL)	Mean Size (mm-SL)	Salinity (ppt)	Temp. °F
South Carolina	5/3	0	-	-	-	75.0
Isle of Palms	5/10	10	11-15	13.9	-	73.4
"	5/17	130	13-32	16.5	-	75.2
"	5/24	302	16-43	21.7	-	78.8
Georgia	4/29	0	-	-	-	72.4
St. Simons Island	5/3	0	-	-	-	77.0
"	5/10	8	11-14	13.5	-	71.5
"	5/17	51	12-22	16.3	-	75.2
"	5/24	22	17-34	24.0	-	74.0
"	5/31	75	33-66	40.5	-	73.5
Florida	4/2	0	-	-	35.7	71.6
St. Augustine area	4/17	5	13-20	15.0	-	-
"	4/18	1	12	-	36.2	73.0
"	4/20	8	15-17	15.8	36.1	72.0
"	4/22	57	13-34	17.1	-	-
"	4/25	15	12-25	16.2	-	-
"	4/27	20	12-20	15.8	-	74.3
"	4/27	11	20-40	25.7	36.4	74.3
"	5/5	625	11-53	23.5	-	-
"	6/1	259	14-77	24.6	-	-
"	6/16	178	17-103	41.8	32.5	78.8
"	6/28	329	12-90	48.1	-	-
"	7/12	120	23-83	40.8	36.1	78.8
"	7/24	201	36-78	48.3	-	-
"	7/25	17	35-71	46.3	-	86.9
"	7/29	16	36-73	42.4	-	-
"	8/7	295	19-94	46.4	35.5	81.5
"	9/15	112	21-115	38.9	31.7	79.9
Flagler Beach	4/18	0	-	-	36.2	72.0
Ormond Beach	4/18	0	-	-	36.2	72.5
New Smyrna Beach	4/2	0	-	-	36.1	69.8
"	4/18	19	11-30	17.4	36.3	72.0
"	4/18	62	11-23	15.3	36.2	71.2
"	4/27	68	11-44	14.8	36.2	77.9
"	5/23	112	11-75	42.2	32.9	82.4
"	6/16	92	16-112	52.3	32.1	77.9
"	7/12	159	10-117	53.2	33.3	77.0
"	7/24	13	11-87	61.2	-	86.9
"	9/15	12	22-107	46.1	32.1	82.2
"	10/19	40	14-84	33.2	-	-
Cocoa Beach	4/17	10	11-19	14.4	36.1	75.2
"	4/27	162	10-46	16.4	36.0	77.2
"	4/28	280	10-43	16.8	36.3	78.0
"	5/7	9	14-28	19.7	33.7	77.9
"	5/23	160	12-94	32.3	32.9	79.7
"	6/15	183	16-111	42.7	32.1	78.8
"	7/11	70	12-111	29.6	35.4	71.6
"	7/24	40	19-104	39.5	-	84.2
"	9/15	31	27-111	42.5	35.3	84.2
Sebastian Inlet	4/17	1	13	-	35.7	73.4
Vero Beach	4/2	0	-	-	36.1	77.0
"	4/18	3	13-14	13.7	36.1	77.0
"	4/27	90	12-35	17.7	36.1	76.7
"	5/6	192	15-47	28.0	32.1	82.4
"	5/23	15	17-73	41.8	32.4	81.1
"	6/15	50	54-100	73.9	32.1	76.1
"	7/11	1	97	-	35.4	68.9
"	7/24	1	27	-	-	84.2
"	9/15	4	33-109	69.8	35.3	82.4
Jensen Beach	4/17	7	-	-	36.3	74.3
"	4/28	9	12-23	18.7	36.1	80.1
"	5/6	12	17-41	23.6	32.9	79.7
Jupiter Inlet	4/18	0	-	-	36.9	77.9
"	4/28	49	12-29	16.4	36.2	80.6
"	5/4	11	17-24	21.4	33.7	78.8
Lake Worth	4/28	0	-	-	36.2	82.6
"	5/4	0	-	-	33.2	80.6
Delray Beach	5/4	2	18-30	24.0	33.6	80.6
Pompano Beach	4/28	0	-	-	-	83.4
"	5/4	2	23-26	24.5	32.9	80.6
Fort Lauderdale	5/4	0	-	-	32.9	80.6
Miami Beach	5/4	0	-	-	32.9	80.6

*Florida sampling was done with a 15 x 14 ft. seine from April through May 7, and with a 20 x 5 ft. seine subsequently. Collections in South Carolina and Georgia were with 70 ft. long seines. The mean size does not reflect the true average size where more than one modal size occurs in a sample (see Fig. 4).

Juvenile Florida pompano enter the surf zone when they measure about 12 mm TL and move out of it at about 150 mm TL (10 to 120 mm SL). The smallest specimen we caught by seine in the surf zone measured 10 mm SL. The smallest specimen reported in a 6-year study along open beaches at Brunswick, Georgia, was 9 mm SL (Fields, 1962: 218). The largest specimen we took in the surf zone by seine was 117 mm SL.

In Florida east coast collections, Florida pompano were not taken in the surf zone on April 2, 1968, but were on April 17 (Table 1). Florida pompano were not taken on April 2, 1967, but were present on April 5 at Matansas Inlet, St. Augustine (Moe, Lewis and Ingle, 1968: 9-10). In 1964, they were taken April 11 from Jupiter Inlet (Christensen, MS). The earliest the fish were reported from St. Simons Island, Georgia, was April 16 (Fields, 1962: 218). Florida pompano are reported to remain in the surf zone around St. Augustine until mid-November (Moe, Lewis and Ingle, 1968: 8), and they were taken off St. Simons Island, Georgia as late as December 8 (Fields, 1962: 208).

Florida pompano fry occur in the surf zone along the eastern seaboard of the United States from Pompano Beach, Florida, at least to Chesapeake Bay, and probably to New Jersey and New York. Small Florida pompano "from 3 to 8 inches in length" were reported to be common along the shores of lower Chesapeake Bay from late summer to fall (Hildebrand and Schroeder, 1928: 231). Our record of two small specimens from Pompano Beach (Table 2) represents the southernmost known occurrence of Florida pompano fry in the surf zone along the east coast of Florida. The smallest pompano we recorded (110 mm SL) from between Pompano Beach and Key West was taken at the surface of Bear Cut, Virginia Key, with a dip net (by night light) on October 21, 1957. The second smallest Florida pompano (143 mm SL) from the same area was caught by hook and line on December 17, 1956. Small Florida pompano are known along the U.S. coast of the Gulf of Mexico, and they are recorded from as far south as Bonito Springs Beach in southwest Florida (13 to 65 mm SL, June through August). Examination of many preserved specimens in museums provide us with records of small Florida pompano (13 to 100 mm) from Yucatan, Mexico; Tortuguero, Costa Rica; Toro Point, Panama; Sabanilla, Colombia; Piedras Bay, Venezuela; Fortaleza and Santos, Brazil; Tobago, Trinidad and Puerto Rico. From these records, the species does not seem to be nearly as abundant in the West Indies as along the continents.

Florida pompano are very abundant seasonally in the surf zone of the St. Augustine—Matansas Inlet, Florida area, and collections for experimental and commercial efforts have been sizeable. Our 1968 collections between St. Augustine and Miami indicated that juvenile pompano are most abundant in the St. Augustine area most of the year, but that they are more abundant in the Cocoa Beach area during April. The abundance at a particular area is sometimes impressive—three sets made with a 4- x 15-foot bait seine took 30,000 juveniles at Butler Beach in May 1967 (Moe, Lewis and Ingle, 1968: 11). In our collecting with a 4- x 15-foot seine along Cocoa Beach in late April 1968, we estimated a density of about 65 fry at a size range of 10 to 46 mm SL in each 100 feet of beach frontage. The fry are more randomly distributed in the surf zone along the open beach than in tidal sloughs (we estimated concentrations in the sloughs of as many as six fish per linear foot seined).

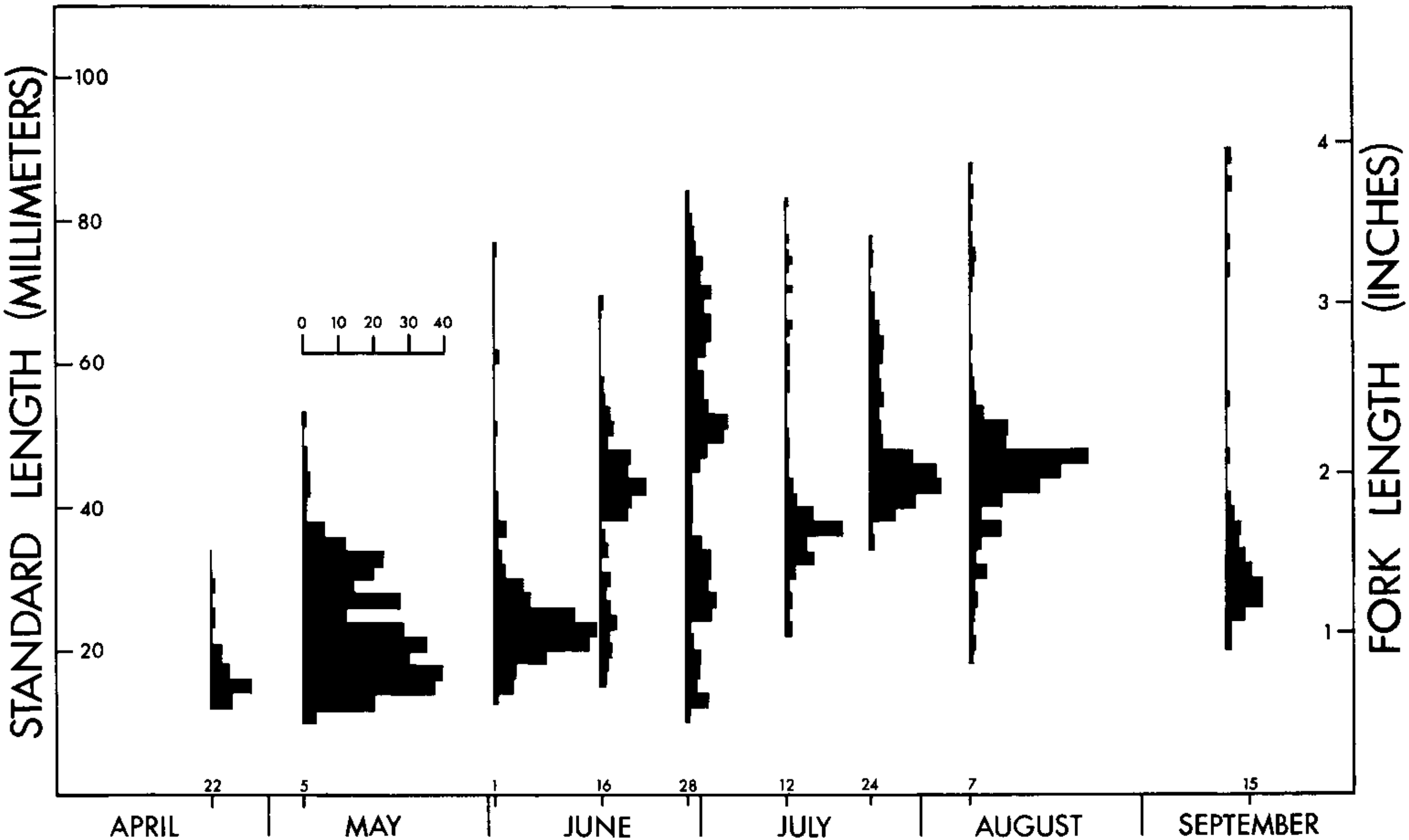

FIG. 4. Length-frequency distributions, by date of collection, of surf-zone Florida pompano caught in the St. Augustine area, 1968.

Recruitment of the developing fry to the surf zone continued from April into September of 1968 in the St. Augustine area, New Smyrna Beach and Cocoa Beach (Table 2 and Fig. 4). Several of our collections showed three or four closely spaced modal sizes of surf-zone fry; one made on May 5, 1968, in the St. Augustine area showed modes at 16, 20, 27 and 33 mm SL. The distribution of these modes suggest either or a combination of the following: (1) recruitment results from different and closely spaced peaks of spawning in a single area: (2) as spawning progresses northward offshore the recruits are moving northward in the surf zone.

Increasing modal sizes in Figure 4 might be interpreted as growth rate of the surf-zone fry in the St. Augustine area. Over the 40-day period, June 28 to August 7, the shift of the modes from about 33 to 53 mm FL, suggests growth at about 0.5 mm per day. Figures given by Moe, Lewis and Ingle (1968: 36) can be interpreted as indicating a daily length increase of 0.64 to 0.75 mm FL for the somewhat larger fish raised in ponds at St. Augustine. Figures for pompano raised in tanks at the Miami Seaquarium (Table 1) suggest a growth of 1.3 mm per day (mean size increase from 56 to 116 mm FL in 46 days).

We tentatively interpret these data and other meager information as follows: (1) Spawning begins in late March, perhaps offshore and between West Palm Beach and Cocoa Beach. (2) Spawning progresses northward, possibly to North Carolina by May or June, and some spawning continues off the Cape Kennedy area until at least late September. (3) The developing fry move northward along the coast and reach New York by September or October, but the majority of the surf-zone fry remain in the northern Florida area. (4) The fry move out of the surf-zone at about 150 mm TL, and move southward along the coast in response to colder temperature.

Artificial propagation

Two years ago we commented that spawning of Florida pompano had neither been observed nor documented, an opinion that still holds true (the same comment applies to the 34 other species of Carangidae and the great majority of other fishes in the western Atlantic area.)

Our collections indicate that the natural supply of surf-zone pompano fry is tremendous and that the stocks along the Florida east coast could support extensive commercial mariculture without damage to the spawning stock or to the existing commercial fishery. We believe that the use of this natural supply of fry should be properly controlled by the responsible government agency, and that commercial mariculture will be more efficient and secure when it can supply and improve its own growing stock through artificial fertilization and rearing of the larvae.

We believe that the potential of pompano farming warrants the establishment of intensive research on artificial fertilization and the rearing of larvae through the critical period following the yolk-sac stage. We visualize a versatile research program that would: (1) locate near-ripe males and females in natural conditions through extant commercial fisheries, (2) stimulate gonad maturation (spawning) of ripe fish by hormone injection or other mechanisms, (3) search for concentrations of naturally spawning Florida pompano, through the monitoring of physico-chemical factors that may trigger spawning, and the collecting of plankton to locate and identify pompano eggs and larvae and (4) find laboratory techniques for culturing eggs and larvae artifically and then meeting their requirements. Subsequent genetic experiments could concentrate on improvement of stocks.

Palatability

Florida pompano is generally considered one of the most delicious (and expensive) of marine fish. Other similar species of fish are sold by commercial vendors under the name "Florida pompano," which would have an effect on the consumer's opinion of flavor and quality. Several months ago, we made arrangements for a quality comparison test of the several species of fish that have been sold as Florida pompano. The species compared with Florida pompano were Atlantic permit (*Trachinotus falcatus*); Atlantic palometa (*T. goodei*) and parona (*Parona signata*), a crangid fish that is not a member of the pompano subfamily Trachinotinae. The parona were imported frozen from Brazil. One sample of Florida pompano was ocean-caught and another was Seaquarium-cultured.

The five samples were of generally similar but not identical quality. They were filleted and broiled about 5 minutes each side with small amounts of salt, pepper, olive oil, and lemon juice. The samples were coded then tasted by 11 panelists who were unaware of the identities and two who were. The fish were graded on a 5-point system: 5 superlative, 4 above average, 3 average, 2 below average and 1 objectionable. The ratings of the 13 panelists varied slightly but were generally similar (Table 3).

TABLE 3

TASTE PANEL RESULTS

	Average Score			
	Flavor	Texture	Appearance	Aroma
Florida pompano (wild)	3.9	4.1	4.2	3.9
Florida pompano (cultured)	3.9	3.8	4.0	3.6
Atlantic permit	2.9	3.1	3.9	3.4
Atlantic palometa	2.3	3.1	3.6	3.1
Parona	2.3	2.5	3.1	2.9

These results imply that Florida pompano is superior, and that wild and cultured adults are alike in palatibility.

MARICULTURE OF OTHER FINFISH

A number of other species of southern fishes may be suitable for sea farming.

The Atlantic permit, *Trachinotus falcatus,* has potential for mariculture. Permit seemingly have a faster growth rate and wider salinity tolerance than the Florida pompano. However, young are not found in large concentrations and they have not been spawned in captivity. The taste is probably less desirable than pompano and market value is lower.

Among other species is the spotted seatrout, *Cynoscion nebulosus*. The biology of this fish is well known—especially its growth rates and feeding habits (Tabb, 1966). The seatrout, which spawns in deep holes and channels in estuaries and lagoons, is apparently mostly non-migratory—tagged specimens seldom move more than 30 miles from the point of release. Apparently rate of growth is rapid. In Florida, fish about 1 year old measured 150 mm long, and at the end of the second year they measured about 230 mm long. Figures are for seatrout from the Indian and Banana River Lagoons (Florida) where cool winter temperatures may slow growth. The use of heated waste water from industrial plants on shore might increase this growth rate substantially in the colder winter months. The species is carnivorous and apparently will eat any prey available. Seatrout subsist largely on fish and crustaceans—striped mullet *(Mugil cephalus)* and pinfish *(Lagodon rhomboides)* are common in stomachs, as are pink shrimp *(Penaeus duorarum)*. The growth rates presumably could be increased with artificial feeding. Recently the spotted seatrout has been reared from the egg (caught in plankton nets at sea) to the juvenile size by Mr. C. Mayo, graduate student at the Institute of Marine Sciences, University of Miami. The seatrout is of considerable economic importance. In 1964 over 10 million pounds were landed by U. S. fishermen. The average price per pound was about $0.25.

The red drum *(Sciaenops ocellata)* is another species that could be cultured commercially. The biology of this species was studied by Yokel (1966). Growth rate is rapid—in South Carolina, red drum in ponds reach 368 mm 672 grams in their second year (Bearden, 1967). The fish were not artificially fed, but lived in ponds with a number of other species. The red drum apparently spawns offshore and the young drift into estuarine areas on tidal currents. Landings in 1964 amounted to more than 3 million pounds, worth about $500,000 to fishermen. The average price is generally about $0.12 per pound at the dock. There is a large sport fishery for red drum in the Everglades National Park.

The red snapper *(Lutjanus aya* or *blackfordi)* and other related species are popular commercially. The production of red snappers in the U. S. reached over 13 million pounds in 1964, valued at more than $4 million. The true red snapper *(L. aya)* is found from Massachusetts to Brazil; the largest concentrations are in the Gulf of Mexico. Little is known of the biology of the species. Spawning is usually in offshore waters late in the summer, and the juveniles appear in the shallower waters along shore. The young fish eat crabs, fishes, shrimps and octopuses, and apparently grow rapidly. In its first year, a red snapper may reach 200 to 250 mm; they are believed to attain maturity and spawn by the end of their first year. Growth is slower in the second year, during which about 760 mm are added. Red snappers are generally taken at considerable depths, which raises a question as to whether the species could be farmed in shallow ponds.

The grey snapper, *L. griseus,* may also be suitable for farming since it apparently grows rapidly—about 152 mm in the first year.

The flounders are valuable market fish and may have farming potential. The difficulty of identifying the species has held up biological studies. Some flounders grow rapidly—the summer flounder, *Paralichthys dentatus,* of Chesapeake Bay reaches about 180 mm in its first year. More than 176 million pounds of flounders valued at more than $15 million were landed in the U. S. in 1964.

There has been considerable discussion of the value of mullet mariculture in the U. S. and some experimental pond rearing of this less valuable species. The striped mullet *(Mugil cephalus)* appears most suited to rearing in captivity, but it has not been spawned in captivity. The fish does not require expensive feed since it is omniverous and can find much of its food in ponds. Mullet may have considerable value as a cultured pond fish if a demand can be stimulated in the U. S. In many countries the species is raised in large quantities in brackish-water ponds and is a very desirable fish.

The same problems associated with the farming of pompano are true of these other species as well. We must be able to induce artificial spawning, find cheap foods that will produce rapid growth and create conditions which will ensure high survival rates.

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