OCCURRENCE IN TAMPA BAY, FLORIDA, OF IMMATURE SPECIES DOMINANT IN GULF OF MEXICO COMMERCIAL FISHERIES[1]

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ABSTRACT

Populations of finfish, crabs, and shrimp were sampled from August 1961 through November 1962 as part of Tampa Bay estuarine studies. Specimens collected were identified to species and classified as immature or adult. Twenty-three species of major importance in Gulf of Mexico commercial fisheries were found to inhabit Tampa Bay during immaturity. Seasonal and areal distribution is described for the species common to Tampa Bay biological collections and catches in the Gulf. Although most of these species were distributed throughout the Bay system, Old Tampa Bay harbored greater numbers of them than any other area. Hillsborough Bay, an area of the system similar to Old Tampa Bay in salinity regimen, harbored fewer important species than any other area. Its relatively low production is attributed to loss of the natural habitat through human alteration. The role of the estuary in producing and rearing species important in Gulf fisheries is discussed, and the need for preservation of estuarine nursery areas is stressed.

It is becoming increasingly apparent that estuaries play an important role in the production of most finfish and shellfish harvested in coastal fisheries, and that civilization influences the nutrient capacity and productivity of these areas (Skud and Wilson, 1960).

Tampa Bay is one of the larger Gulf-connected estuaries, encompassing some 350 square miles. The primary purpose of this report is to enumerate and discuss species inhabiting this estuary in early life and entering Gulf fisheries as adults. The secondary purpose is to appraise relative species production between areas of the Bay as an aid in evaluating the probable effects on biota of the various engineering projects that are being proposed.

Man's ravages of estuarine areas in Florida are progressing so rapidly that many species of fish will disappear from these areas in the near future (Springer and Woodburn, 1960). Pollution and engineering projects are the greatest threat to the survival of estuarine species (Thompson, 1961, and Sykes, 1964 and 1965). These projects include harbor improvements, navigation channels, flood- and erosion-control structures, hurricane barriers, and fills to create new waterfront land. These alterations result in reduced water area. Adjacent bottom, including submerged grass flats, is destroyed by dredging, and the regimen of salinity and water temperature is changed. Sediments are added to the water, and damaging siltation occurs on nursery areas inhabited by commercial and sport fish species.

Although the danger to native aquatic animals is recognizable, the full significance of estuaries in the production and rearing of these organisms is not completely understood. Odum (1960) emphasized the importance of conducting research at both ends of the food chain to achieve a more complete understanding of ecological systems. He also implied that too many researchers start at a point well up on the food chain—fish, for instance—and work down. The East Gulf Estua-

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rine Investigations of the Bureau of Commercial Fisheries include studies of nutrients and primary crops of estuarine waters, as well as studies of the dependence of animals such as finfish, crabs, and shrimp upon nutrients and planktonic organisms (Sykes, 1965). The research, therefore, is being conducted near both extremes of the food chain and at intermediate points. Although the value of an estuary to our social and economic system should not be measured entirely in terms of its contribution to a commercial fishery, the harvest of edible and industrial species is a major consideration and is logically one of the factors motivating estuarine research. It was, therefore, important in our investigations to determine and study the important commercial species in Gulf of Mexico fisheries that utilize estuaries as rearing and developmental areas.

TAMPA BAY, WEST FLORIDA COAST, AND GULF FISHERIES

In evaluating the importance of Tampa Bay as a nursery area for commerical species, the size and economic value of commercial catches of the Gulf of Mexico should be considered.

Fisheries in the Gulf have grown notably in the past quarter-century. In 1936, 187 million pounds or 4 percent of recorded landings were from the Gulf; in 1961, this area yielded 1.3 billion pounds or 27 percent of total recorded U.S. fishery landings (Power, 1961). Of the average annual Gulf catch for 1958, 1959, and 1960, 12 percent (131,369,000 pounds) was landed on the west coast of Florida (Power, 1960, 1961, 1962a, 1962b). Size and value of the west Florida landings were second to Texas and exceeded Louisiana, Mississippi, and Alabama.

A summary of valuation showed that the total U.S. exvessel landings in the Gulf of Mexico were worth an annual average of $85 million for the 3 years cited. West Florida landings accounted for $20 million of that amount. Catches landed in the three counties surrounding Tampa Bay (Pinellas, Hillsborough, and Manatee) averaged 26 million pounds for the 3 years and accounted for $6 million of the total (U.S. Fish and Wildlife Service, 1959; Rosen, 1959; Rosen and Robinson, 1960). Pinellas County is dominant among the three counties in landings of seafood. It has the most extensive offshore commercial and sport fishing on the Florida west coast. The county supports the

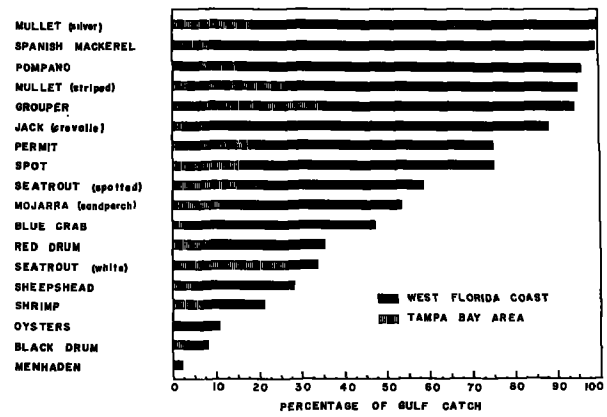

FIGURE 1.—Three year average (1958–59–60) of commercial landings on the Florida west coast and in Tampa Bay compared with total Gulf catches.

second largest fleet of commercial boats, the third largest fleet of party boats, and the sixth largest fleet of charter boats in the State (Moe, 1963).

Catch data were assembled for the important commercial species common to Gulf of Mexico, Florida west coast, and Tampa Bay fisheries (table 1). For a determination of percentages of the total Gulf catch landed on the Florida coast and in Tampa Bay (fig. 1), annual landings of these species were averaged for the three divisions of Gulf fisheries for the years 1958–60.[2] Two of the leading Gulf species, menhaden and oysters, were included even though their commercial catch in the Tampa Bay area was negligible.

More than 90 percent of the Gulf landings of silver mullet, spanish mackerel, pompano, striped mullet, and grouper were made on the Florida west coast (fig. 1). Annual landings of these species for 1958–60 averaged 12 million pounds in Tampa Bay, 45 million pounds on the west coast, and 47 million pounds in the Gulf. Species comprising 25–90 percent of Gulf catches landed on the west coast were crevalle jack, permit, spot, spotted sea trout, mojarra, blue crab, red drum, white sea trout, and sheepshead. Annual landings of these species for the 3 years averaged 1.5 million pounds in Tampa Bay, 19 million pounds on the west coast, and 38 million pounds in the Gulf. Landings on the west coast of the two most important commercial species in the Gulf (shrimp and menhaden) were each below 25 percent of total

[2] The species in table 1 and fig. 1 are listed according to percentage of Gulf catch landed on the Florida west coast rather than rank in the total Gulf catch.

TABLE 1.—*Average of 1958–60 annual landings of selected commercial species in Gulf of Mexico fisheries*

	Average Gulf landings	West Florida landings	Average 3-county [1] landings
	Pounds	*Pounds*	*Pounds*
Mullet (silver)[2]	690,300	690,300	137,900
Spanish mackerel	4,676,300	4,645,000	364,900
Pompano	506,700	486,000	66,200
Mullet (striped)	32,962,300	31,293,700	8,885,700
Grouper [2]	5,638,000	5,276,000	1,993,200
Jack (crevalle)	1,011,000	890,100	92,200
Permit	40,300	30,200	6,900
Spot	250,300	188,700	38,400
Sea trout (spotted)	4,817,700	2,821,300	652,300
Mojarra (sandperch)[2]	282,700	150,000	28,900
Blue crab	29,199,000	13,748,300	468,900
Red drum	2,009,300	712,100	152,900
Sea trout (white)	210,700	69,700	54,400
Sheepshead	378,000	107,200	23,900
Shrimp[2]	190,860,700	40,774,000	12,357,900
Oysters	13,409,000	1,380,300	1,900
Black drum	1,651,000	129,000	43,900
Menhaden [2]	678,523,000	11,092,600	4,000
Total	967,116,300	114,484,500	25,374,400

[1] Pinellas, Hillsborough, and Manatee.
[2] When several species were reported under a single common name by Federal and State statistical agents, they were listed accordingly regardless of the number of species involved.

Gulf catches. Oysters and black drum also were included in the 0–25 percent range. Average annual landings of these four species were 12 million pounds in Tampa Bay, 53 million pounds on the west coast, and 884 million pounds in the Gulf.

BIOLOGICAL COLLECTIONS

Monthly fish collections were made in the Tampa Bay area during August 1961 through November 1962. The study area encompassed the entire Tampa Bay system extending from the mouth throughout Old Tampa and Hillsborough Bays (fig. 2). The hydrological influence of the estuary extends into the Gulf for an undetermined distance; however, in this report only the semi-enclosed waters of Tampa Bay are regarded as estuarine habitat.

Gear used in collecting specimens consisted of 30-, 50-, and 70-foot minnow seines, a 10-foot shrimp trawl, a 16-foot balloon trawl, a 3 x 3-foot push net and a 6-foot cast net. Springer and Woodburn (1960) used similar seines, push nets, and, in addition, a roller frame trawl. In a qualitative assessment of the species occupying Tampa Bay and the sizes of these species, the collections by all types and sizes of gear were utilized and included in this report. When quantitatively describing occurrence by species and area, data were restricted to collections from the 10-foot shrimp trawl and the 50-foot seine. Duration of

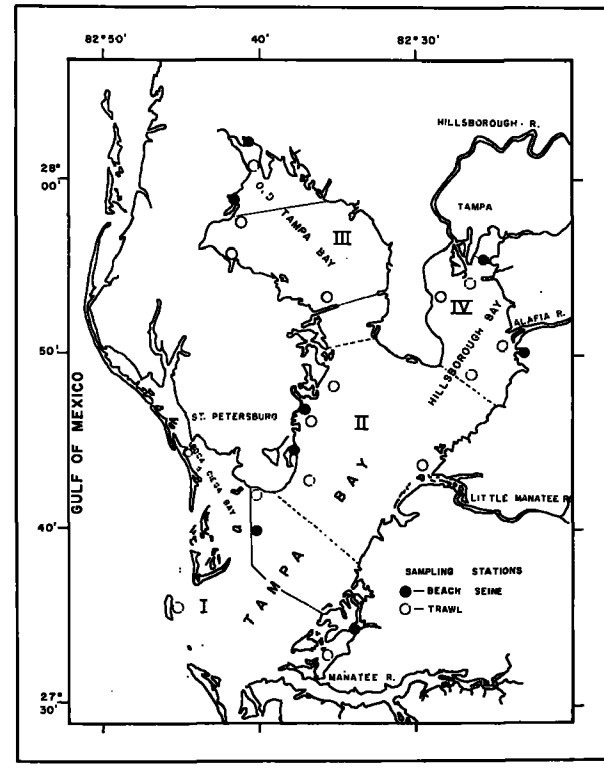

FIGURE 2.—Study areas and station locations in Tampa Bay.

each trawl haul was 10 minutes at 3–4 knots. Seine operation was as similar as possible at each station throughout the study period to insure comparability of results in catch per unit of effort.

Sampling stations were stratified throughout the Bay to collect specimens from the full salinity range. For comparison of species occupancy by area and salinity range, the stations were grouped to represent four areas based on salinity data from Saloman, Finucane, and Kelly (1964): Area I—lower Tampa Bay (salinity range, 21.92–37.16 °/oo, mean—31.95°/oo); Area II—central Tampa Bay (salinity range, 15.88–33.53°/oo, mean—24.48°/oo); Area III—Old Tampa Bay (salinity range, 0.09–31.83°/oo, mean—24.53°/oo); and Area IV—Hillsborough Bay (salinity range, 1.58–30.46°/oo, mean—23.63°/oo) (fig. 2).

The separation of specimens into immature or adult classes was based upon (1) observations of gonad development in relation to length frequency data compiled at the Bureau of Commercial Fisheries Biological Station at St. Petersburg, Beach, (2) published data on individual species

(Anderson, 1957; Anderson, 1958; Gunter, 1945; Guest and Gunter, 1958; Gunter and Christmas, 1960; Frisbie, 1961; Fields, 1962; Springer and Woodburn, 1960; and Rathbun, 1930), and (3) personal communication (Bonnie Eldred—Florida State Marine Laboratory, St. Petersburg, Fla. and George H. Rees—Bureau of Commercial Fisheries Biological Laboratory, Beaufort, N.C.).

Specimens were preserved in 10 percent formalin, and fish were measured to the nearest millimeter in standard length. The carapace of crabs (width) and shrimp (length) was measured by micrometer to the nearest one-tenth millimeter.

SUMMARIZED DATA

Fish and crustaceans from all stations and gear were classified as immature or adult to aid in assessing the utilization and dependency of each species on the estuary during early life. Although some adults were captured—and Tampa Bay sport fisheries take large numbers of them—specimens in sampling gear were limited largely to small forms. Size ranges and occurrence by section of Tampa Bay were noted (tables 2–5).

Trawl and seine catches of the commercially important finfish, shrimp, and crabs were compiled

TABLE 2.—*Size by season of commercial species of fish and crustaceans in Lower Tampa Bay—Area I, December 1961–November 1962*

Species	WINTER (Dec.-Feb.)				SPRING (Mar.-May)				SUMMER (June-Aug.)				FALL (Sept.-Nov.)			
	Immature		Adult		Immature		Adult		Immature		Adult		Immature		Adult	
	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range
		Mm.		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*
Mugil curema (silver mullet)									14	51–107			2	114–121		
Mugil trichodon (silver mullet)	94	17–157			23	34–113			58	10–90			444	16–161		
Scomberomorus maculatus (spanish mackerel)									2	35–41			1	94		
Do													6	*133–158		
Trachinotus carolinus (pompano)									2	44–56			70	42–167		
Do									64	*23–87						
Mugil cephalus (striped mullet)	817	17–32			1,234	21–86	1	230	101	50–137			41	90–154		
Mycteroperca microlepis (gag)									5	160–263			15	160–195		
Epinephelus morio (red grouper)									2	84–92						
Caranx hippos (crevalle jack)	53	120–347							4	25–52			3	37–90		
Trachinotus sp. (permit)	1	150							20	21–83			69	35–109		
Do	9	*60–74							112	*8.5–68.5			76	*24–144		
Leiostomus xanthurus (spot)	888	12–147	37	151–175	823	21–143	29	150–175	47	61–142	12	150–175	10	94–130	38	147–248
Cynoscion nebulosus (spotted seatrout)	9	43–134			1	*5.9			29	19–91	2	180–448	85	13–140	1	180
Eucinostomus gula (mojarra)	322	7–54	172	57–105	151	24–54	99	55–115	917	14–54	138	55–90	1,866	16–53	307	55–92
Eucinostomus argenteus (mojarra)	5	14–47	7	60–103	8	31–49	40	65–115	93	26–54	90	55–111	336	15–53	64	55–80
Diapterus plumieri (mojarra)	10	50–63							1	32			1	39		
Callinectes sapidus: (blue crab):																
Male	40	15.1–82.8	3	98.0–140.0	5	46.0–80.9	4	96.3–150.0	11	46.0–89.4	1	97.3	97	12.3–89.0	6	103.0–190.0
Female	38	14.8–95.6	1	168.0	10	42.8–92.1	1	138.0	11	46.4–95.2			95	11.7–96.2	2	131.0–202.2
Sciaenops ocellata (red drum)	45	18–55	1	270	2	100–124							20	19–30		
Cynoscion arenarius (white seatrout)	1	75	8	180–225	2	27–50	6	175–210	11	25–75	12	166–206	20	16–165	23	172–223
Archosargus probatocephalus (sheepshead)	3	81–170	4	185–325	2	19–21	2	180–275	14	25–44			3	51–155	10	172–285
Penaeus duorarum (pink shrimp)	290	4.8–20.0	11	20.5–26.6	16	11.1–19.9	15	20.7–28.7	664	5.2–18.0			1,070	4.3–20.0	5	20.2–24.2
Pogonias cromis (black drum)							1	*593	2	116–128			1	170		
Brevoortia patronus (menhaden)					1	75			5	70–78						
Brevoortia smithi (menhaden)					2	25–76			3	71–75					3	135–185

*From Springer and Woodburn (1960).

TABLE 3.—*Size by season of commercial species of fish and crustaceans in Central Tampa Bay—Area II, December 1961–November 1962*

Species	WINTER (Dec.–Feb.)				SPRING (Mar.–May)				SUMMER (June–Aug.)				FALL (Sept.–Nov.)			
	Immature		Adult		Immature		Adult		Immature		Adult		Immature		Adult	
	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range
Mugil curema (silver mullet)	3	*Mm.* 122–153		*Mm.*		*Mm.*		*Mm.*	1	*Mm.* 74		*Mm.*		*Mm.*		*Mm.*
Mugil trichodon (silver mullet)	53	28–143	7	175–234	7	121–137										
Scomberomorus maculatus (spanish mackerel)																
Trachinotus carolinus (pompano)																
Mugil cephalus (striped mullet)	187	18–24			157	24–71			16	53–87						
Mycteroperca microlepis (gag)																
Epinephelus morio (red grouper)																
Caranx hippos (crevalle jack)									2	25–45				*186–246		
Trachinotus sp. (permit)																
Leiostomus xanthurus (spot)	256	17–30			176	24–60			21	64–130	11	165–180	13	86–125	16	152–165
Cynoscion nebulosus (spotted seatrout)	3	52–86							11	18–132			54	27–80		
Eucinostomus gula (mojarra)	241	17–49	30	66–80	366	19–52	44	57–85	90	31–53	131	55–93	423	15–53	46	57–90
Eucinostomus argenteus (mojarra)	35	36–54	42	57–100	79	26–52	51	55–95	22	42–54	20	59–101	151	21–53	38	56–106
Diapterus plumieri (mojarra)													1	47		
Callinectes sapidus (blue crab):																
Male	4	13.3–46.5			3	46.0–63.0	3	92.0–144.0	10	12.7–78.0	5	90.0–113.5	25	14.3–69.0	2	135.0–154.5
Female	7	18.5–50.9			9	40.2–110.0			3	54.2–65.7			13	15.5–68.0	4	145.0–200.0
Sciaenops ocellata (red drum)	30	21–71			1	82							18	14–37		
Cynoscion arenarius (white seatrout)									15	14–125	12	165–200	1	35	12	184–227
Archosargus probatocephalus (sheepshead)					11	19–35			6	24–30			3	65–81		
Penaeus duorarum (pink shrimp)	27	6.3–15.1	2	29.7–31.8	3	12.8–16.0	1	23.2	334	5.3–19.5			422	5.0–19.7	1	20.3
Pogonias cromis (black drum)																
Brevoortia patronus (menhaden)																
Brevoortia smithi (menhaden)					2	31–36			1	*43.8					2	170–180

*From Springer and Woodburn (1960).

by month and area to compare abundance of immature animals (table 6). Catches included were from four selected trawl stations and two selected seine stations in each of the four sampling areas fished monthly. The catches of these six fishing operations in each area during 1 month represent one unit of effort. Thus, 72 hauls (12 standard units of effort) took place in each of the four areas during a 12-month period. The data allowed comparison of abundance between individual species by season and area (fig. 3). For this estimate, effort expended and numbers of specimens caught per species were combined for 3-month intervals; winter, spring, summer, and fall.

DISCUSSION

Most of the species landed by Gulf of Mexico commercial fisheries inhabit estuaries as immature, developing forms. It is assumed, therefore, that these estuaries are prime suppliers for the Gulf fisheries. Power (1962b) stated that five species—menhadan, shrimp, crabs, oysters, and mullet—comprised a catch of 1,131 million pounds or 89.3 percent of the Gulf commercial catch in 1960. Our investigations showed that 23 commercially important species including the dominant ones listed by Power (1962b) occupy Tampa Bay while immature.[3] All of these species are caught as

[3] Oysters are included in this number but were not collected by sampling gear.

TABLE 4.—*Size by season of commercial species of fish and crustaceans in Old Tampa Bay—Area III, December 1961–November 1962*

Species	WINTER (Dec.–Feb.)				SPRING (Mar.–May)				SUMMER (June–Aug.)				FALL (Sept.–Nov.)			
	Immature		Adult		Immature		Adult		Immature		Adult		Immature		Adult	
	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range
		Mm.		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*
Mugil curema (silver mullet)					1	44			1	52						
Mugil trichodon (silver mullet)	60	15–101			7	41–134			49	22–84			159	15–101		
Scomberomorus maculatus (spanish mackerel)													1	*36		
Trachinotus carolinus (pompano)																
Mugil cephalus (striped mullet)	1,011	17–32	4	155–165	3,434	21–130			511	42–122			3	92–126	1	210
Mycteroperca microlepis (gag)																
Epinephelus morio (red grouper)																
Caranx hippos (crevalle jack)																
Trachinotus sp. (permit)																
Leiostomus xanthurus (spot)	1,279	12–135	17	151–157	3,170	21–139	15	149–190	486	40–137	20	155–189	262	66–133	61	150–185
Cynoscion nebulosus (spotted seatrout)	1	36–105	1	210	1	29	1	180	158	14–147	5	165–225	37	33–147	1	410
Eucinostomus gula (mojarra)	8	30–52	37	62–90			11	55–84	9	32–50	8	65–73	25	26–48	17	55–80
Eucinostomus argenteus (mojarra)	175	13–50	29	59–85	30	34–50	18	56–86	48	21–46	11	57–74	253	12–50	52	56–83
Diapterus plumieri (mojarra)	153	55–75							728	15–65	7	87–103	123	27–74		
Callinectes sapidus (blue crab):																
Male	40	12.3–88.0	8	93.6–195.0	47	40.0–88.7	16	90.5–180.0	19	39.0–87.0	59	92.0–140.0	30	18.0–83.5	38	90.5–163.0
Female	21	16.0–108.0	1	150.0	52	20.0–127.0	2	135.0–145.0	16	12.5–115.8	11	130.0–155.0	36	16.0–125.0	2	150.0–152.0
Sciaenops ocellata (red drum)	55	24–89			2	102–114							147	14–62		
Cynoscion arenarius (white seatrout)	6	55–140	2	192–198	6	35–49	3	210–258	307	17–95	6	155–195	164	20–118	4	160–215
Archosargus probatocephalus (sheepshead)	1	125			7	16–30			3	40–63			4	66–132	1	171
Penaeus duorarum (pink shrimp)	31	5.7–19.5	12	20.5–30.1	4	13.3–19.8	9	21.1–30.1	124	6.5–18.8	7	20.7–28.9	478	3.5–19.8	9	20.5–25.8
Pogonias cromis (black drum)									5	37–156			1	197		
Do					1,064	*20–75			57	*66–110						
Brevoortia patronus (menhaden)	1	*22.1			135	24–74			33	58–115			1	105		
Do									8	*55–108						
Brevoortia smithi (menhaden)					263	21–46			19	59–91						
Do						*19–29.1										

*From Springer and Woodburn (1960).

adults in Gulf of Mexico commercial fisheries and Tampa Bay sport fisheries. Few constitute important commercial fisheries in Tampa Bay. The significance of the estuary lies more in the growth of species for later harvest in Gulf fisheries than in catches of adults in nursery areas.

Shrimp comprise the most valuable fishery in the Gulf of Mexico (Power, 1962b). Commercial catches consist primarily of three species: the brown shrimp, *Penaeus aztecus;* the white shrimp, *P. setiferus;* and the pink shrimp, *P. duorarum* (Kutkuhn, 1962). Young of several species in developmental stages have been found in Tampa Bay (Eldred, Ingle, Woodburn, Hutton, and Jones, 1961)—the penaeid shrimp, *Trachypeneus constrictus* and *P. duorarum*, and the rock shrimp, *Sicyonia laevigata* and *S. typica*. These and one additional penaeid species, *Trachypeneus similis*, were identified in our collections (Saloman, 1964).

The important Gulf shrimp collected in Tampa Bay was *P. duorarum*. It is estimated that 75 percent of the shrimp brought to dock in the three-county area surrounding Tampa Bay are *P. duorarum* and 25 percent *P. setiferus*. Ninety-eight percent of the total is actually caught on the Campeche grounds (personal communication, Robert Benton—Bureau of Commercial Fisheries Biological Laboratory, Galveston, Texas). In Tampa Bay, *P. duorarum* is caught for a bait-shrimp market only. During October 1961

TABLE 5.—*Size by season of commercial species of fish and crustaceans in Hillsborough Bay—Area IV, December 1961–November 1962*

Species	WINTER (Dec.–Feb.)				SPRING (Mar.–May)				SUMMER (June–Aug.)				FALL (Sept.–Nov.)			
	Immature		Adult		Immature		Adult		Immature		Adult		Immature		Adult	
	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range	No.	Size range
		Mm.		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*		*Mm.*
Mugil curema (silver mullet)																
Mugil trichodon (silver mullet)	3	29–35			4	71–96							19	15–25		
Scomberomorus maculatus (spanish mackerel)															1	240
Trachinotus carolinus (pompano)																
Mugil cephalus (striped mullet	10	19–100			83	22–88			63	56–115			4	121–153		
Mycteroperca microlepis (gag)																
Epinephelus morio (red grouper)																
Caranx hippos (crevalle jack)																
Trachinotus sp. (permit)																
Leiostomus xanthurus (spot)	12	18–30			367	27–137	18	158–176	25	70–135	3	155–175	3	95–110	12	145–165
Cynoscion nebulosus (spotted seatrout)	5	91–109							5	42–88			1	86		
Eucinostomus gula (mojarra)	2	19–53	3	.75–85	1	42							1	43		
Eucinostomus argenteus (mojarra)	70	25–50	7	58–85	9	35–51	10	63–91	73	24–50	1	65	156	16–51	17	60–68
Diapterus plumieri (mojarra)	81	33–77	4	131–145					2	30–45			14	47–74		
Callinectes sapidus (blue crab):																
Male	7	40.4–79.6	1	106.0	30	11.0–80.2	19	92.0–153.0	3	53.2–87.2	5	97.1–149.0	13	11.8–87.3	23	93.0–163.0
Female	6	28.0–87.2	2	132.0–175.0	19	42.0–120.0							7	20.5–115.0	1	164.0
Sciaenops ocellata (red drum)	131	27–72											3	21–55		
Cynoscion arenarius (white seatrout)	11	114–153	4	170–221	14	18–45	10	170–210	29	17–83	1	181	36	17–142	36	166–248
Archosargus probatocephalus (sheepshead)	17	111–170			1	24			5	30–133			13	93–167		
Penaeus duorarum (pink shrimp)	18	10.5–18.4	12	29.1–33.5					3	9.9–17.4			47	5.9–19.4	10	20.6–27.3
Pogonias cromis (black drum)									16	48–114	1	278	1	165		
Brevoortia patronus (menhaden)					1	55										
Brevoortia smithi (menhaden)					7	23–28	1	241	179	33–69			2	87–93	2	159–172

TABLE 6.—*Numbers of immature specimens of fish and crustaceans taken in sampling gear by month, December 1961–November 1962, Tampa Bay, Fla.*

	Numbers of fish, shrimp, crabs				Total per month
	Area I	Area II	Area III	Area IV	
1961					
Dec.	54	22	103	35	214
1962					
Jan.	102	76	539	14	731
Feb.	315	414	627	36	1,392
Mar.	182	261	1,975	164	2,582
Apr.	22	277	2,016	254	2,569
May	13	259	725	96	1,093
Jun.	33	107	1,028	260	1,428
July	252	157	641	44	1,094
Aug.	674	122	493	88	1,377
Sept.	346	215	76	100	737
Oct.	325	531	249	36	1,141
Nov.	227	258	116	88	689
Total per area	2,545	2,699	8,588	1,215	15,047
Catch/unit effort	212.1	225.0	715.7	101.2	

through April 1962, 71,000 pounds of bait shrimp were caught in this fishery (Saloman, 1965).

Eldred et al. (1961) described recruitment of postlarval *P. duorarum* into Tampa Bay and a movement of larger shrimp from the Bay to offshore waters. Their observations on migration and our collections of larvae suggest that at least part of the Gulf shrimp fishery for that species depends upon populations developed in Tampa Bay.

Menhaden ranks first in size of catch and next to shrimp in value for all species landed in the Gulf of Mexico. The fishery in the Gulf depends upon catches of *Brevoortia patronus* (Gunter and Christmas, 1960). *B. smithi* and *B. gunteri* have been found in the Gulf, and probably comprise a very small fraction of the commercial catch.

There is no menhaden fishery in Tampa Bay, and landings of menhaden on the Florida west coast are minor in relation to total Gulf landings.

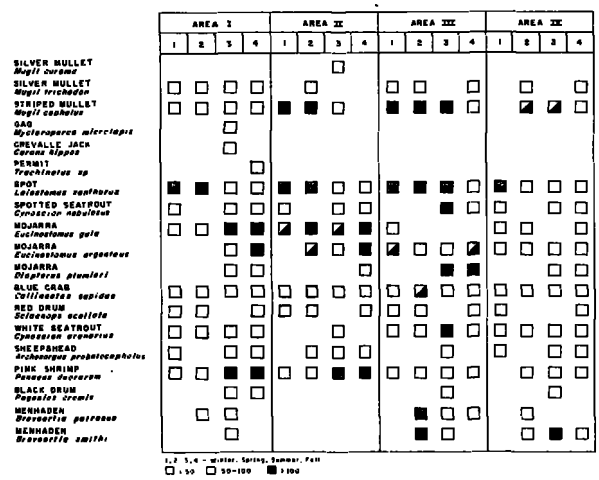

FIGURE 3.—Occurrence of immature commercial species of fish and crustaceans by season and area, Tampa Bay, Fla., December 1961–November 1962.

Gunter and Christmas (1960) and Reintjes (1961) observed that menhaden spawn at sea and subsequently move as larvae into estuaries which serve as nursery areas for further development. Collections in Tampa Bay by our staff and by Springer and Woodburn (1960) showed that Tampa Bay is a rearing area for two species of menhaden: *B. patronus* and *B. smithi*. *B. smithi* was more abundant and more widely distributed in our samples than *B. patronus;* the reverse of their occurrence in Gulf catches. Suttkus (1958) stated that *B. smithi* occurs in the eastern Gulf and that *B. patronus* overlaps *B. smithi* in the northeastern Gulf at Cedar Keys, Fla. Tabb and Manning (1960) reported only one species, *B. smithi,* from Florida Bay in the southern portion of the State. These findings suggest that normally *B. smithi* would be more abundant than *B. patronus* in central Florida or the Tampa Bay area.

Mullet ranked third in pounds landed in the Gulf and second both in Tampa Bay and on the Florida west coast. Heavy dependence upon the estuary was exhibited in that three species, *Mugil cephalus*, *M. trichodon*, and *M. curema*, were found in immature and adult stages. The striped mullet, *M. cephalus*, is dominant in Bay catches (Rosen and Ellis, 1958).

The blue crab, *Callinectes sapidus*, besides being prominent in Gulf fisheries, is harvested commercially in Tampa Bay. Also, it is the object of a large sport fishery. The species forms the most rapidly expanding fishery in Florida (Rosen and Robinson, 1960). Approximately 50 percent of the reported Tampa Bay landings (table 1) were actually caught in the Bay, and the remaining 50 percent were caught in Citrus County to the north of Tampa Bay and adjacent to the Gulf of Mexico.

C. sapidus was the dominant portunid in collections of metamorphosed and identifiable specimens. Numerous portunid zoeae and megalops also were taken. We were unable to make positive species identification at these stages and therefore cannot estimate the proportion of *C. sapidus* in the collections. Sandoz and Rogers (1944) stated that a salinity range of 23–30°/₀₀ is ideal for hatching blue crabs. Thus, from a salinity standpoint, the Bay appears to offer a favorable environment for hatching and development of blue crabs. This fact and the presence of adult blue crabs as well as portunid larvae led us to believe that the blue crab is reared within the confines of Tampa Bay. In addition to mature adults, the young identifiable metamorphosed forms (50-mm. carapace width) which inhabit the Bay are most abundant in winter.

The American oyster (*Crassostrea virginica*) is an estuarine resident and supports relatively small but growing commercial and sport fisheries in Tampa Bay. The actual harvest in the Bay is probably many times larger than the reported harvest (table 1). A portion of the beds is public, and fleets of small, privately owned boats tong for oysters there. In recent years, interest has been generated toward the possibility of increasing the numbers and sizes of the beds in Tampa Bay. Decreased oyster production in Chesapeake Bay has brought some oystermen into Florida from that area.

Of the 19 species of fish and crustaceans (fig. 3), 13 were taken in all four sections of Tampa Bay. This indicates that all of the Bay is used as a nursery area. Eighteen species were taken in the lower, high salinity portion of the Bay (Area I), 13 in the central portion (Area II), 15 in Old Tampa Bay where lowered salinities prevail (Area III), and 15 in Hillsborough Bay (Area IV), also an area of reduced salinity. The commercially important species of fish, shrimp, and crabs are euryhaline and, as expected, were distributed throughout the Bay system. The differ-

ences among numbers of species inhabiting sections of the Bay appeared to be of little or no consequence. This appraisal, however, is exclusive of those species not considered to be of commercial importance in this report.

Catch per unit of effort data made it possible to determine whether immature animals had a preference of habitat among areas of the Tampa Bay system (table 6). An overwhelming preference was apparent for Old Tampa Bay (Area III) where there were three times as many total animals as in either Lower or Central Tampa Bay (Areas I and II) and seven times as many as in Hillsborough Bay (Area IV). Abundance in Area III exceeded that of Areas I, II, and IV during 9 months out of 12. Although peak abundance varied between areas and time periods, March and April produced the greatest number of specimens per unit of effort from the collective areas.

Data on abundance of individual species by area and season also indicate an areal preference (fig. 3). Seven species were taken in numbers greater than 100 during at least one season (three units of effort) in Area III, five in Area II, four in Area I, and two in Area IV. The data indicate, therefore, that Area III (Old Tampa Bay) produces or develops more individuals during a greater portion of the year than any other area of the Tampa Bay system, and that Hillsborough Bay is the least productive of commercially important species.

Based on the known salinity preference of many euryhaline animals, it was expected that the greatest abundance of important species would be found in the low salinities of Old Tampa and Hillsborough Bays. Pearson (1929) and Gunter (1945, 1950) showed that a cycle of spawning, growth, and movement bore a distinct relation to salinity for many valuable fishes and invertebrates on the Gulf of Mexico coast. Salinity lower than that which is characteristic of the ocean is one of the requisites in early development of these animals. Abundance in Hillsborough Bay, however, was not nearly as great as in Old Tampa Bay. Because annual salinity patterns of Hillsborough Bay and Old Tampa Bay are similar, the difference in abundance of valuable species between the two areas must result from other environmental factors.

The introduction of industrial and domestic sewage is common in Hillsborough Bay. Natural flushing has not kept pace with the deposition of the effluents and has resulted in the accumulation of silt-size sediments throughout the Bay. Noxious compounds in solution, unstable and uninhabitable sediments, and insufficient dissolved oxygen appear to have contributed to a decline in Hillsborough Bay fisheries within a relatively short period of time.

As a nursery area for fish and crustaceans, Hillsborough Bay is no longer productive. Commensurate with alterations in bottom type and water quality, littoral areas which once supported a luxuriant growth of marine grasses are now barren except for the seasonal appearance of some red and blue-green algae.

In contrast, Old Tampa Bay remains in a relatively undisturbed state supporting blue crab, bait shrimp, and oyster fisheries, and serving as a nursery area for estuarine dependent fauna. Although industrial and residential interests continually threaten this area, it is vegetated with turtle grass (*Thalassia testudinum*), shoal grass (*Diplanthera wrightii*), cord or manatee grass (*Syringodium filiforme*), the red mangrove (*Rhizophora mangle*), and the black mangrove (*Avicennia nitida*) (Springer and Woodburn, 1960). The emergent vegetation aids in controlling the introduction of particulate detritus in surface water run-off before it enters the Bay.

Biologically, the water quality is good, and the predominantly firm sediment pattern creates a substrate suitable for the habitation of dense aggregations of benthic invertebrates. The stability of the bottom also promotes water clarity necessary for the existence of dense stands of marine algae and sea grasses which extend around the entire periphery of the area. The algae-sea grass ecosystem appears to be absolutely essential for survival and growth of juvenile stages of many commercially important species.

We conclude that the relatively undisturbed conditions of Old Tampa Bay and the fact that its salinity distribution is ideally suited to the development of many euryhaline fishes are responsible for its comparatively good productivity.

Many species recorded as inhabiting the estuary were omitted from our lists in this report. Some of these contribute indirectly but significantly to commercial fisheries by serving as food for marketable species. An example of an outstanding forage species is the scaled sardine (*Harengula pensa-*

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colae). It is produced in and inhabits the Tampa Bay area in great abundance throughout most of the year. The sardine is utilized heavily as a live bait in Tampa Bay and the adjacent Gulf areas. Other forage species abundant in the estuary are the tidewater silverside (*Menidia beryllina*), the bay anchovy (*Anchoa mitchilli*), the pinfish (*Lagodon rhomboides*), the thread herring (*Opisthonema oglinum*), and the silver perch (*Bairdiella chrysura*).

The number of species of finfish, shrimp, and crabs recorded from the Tampa Bay area now stands at 265 (Springer and Woodburn, 1960; Dragovich and Kelly, 1964). Most of these probably occupy an important ecological niche in the estuary and supply food to commercial and sport species of both Gulf and Bay. Obviously, a portion of the harvest of major fisheries in the Gulf is connected directly to the production and development of young forms in Tampa Bay. This is especially true of species found in catches of the eastern Gulf or on the Florida west coast. This estuary, of course, is not the only one important in the role of supplying Gulf fisheries. Sykes (1965) estimated that some 7,500 square miles or 4.8 million acres of estuarine area exist on the periphery of the Gulf.

The general public tends to view Tampa Bay either as an area of good but declining sport fishing or as an area for waterfront homesites. The present and future importance of Tampa Bay as a food source should be taken into account when proposals are filed for permission to enclose areas with bulkheads or create land masses in the estuary. This is especially true when such structures will divert currents, allow encroachment of high-salinity waters into upper areas, or otherwise significantly alter rearing areas of the species discussed.

SUMMARY

Biological collections showed that the five most important species in Gulf of Mexico commercial fisheries inhabit Tampa Bay in immature stages of development. Eighteen species of less importance in Gulf catches were also found in immature stages in the Bay. The qualitative distribution of species exhibited little difference between salinity range and area of the Bay system but numerically Old Tampa Bay, an area of relatively low salinity contained the greatest number of animals. The importance of Tampa Bay as a nursery area for species of fish, crustaceans, and mollusks comprising the most valuable portions of the commercial fisheries in the Gulf has not been stressed in the past. This role now must be recognized because of acceleration of engineering projects in the estuary that impair its value as a nursery ground.

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