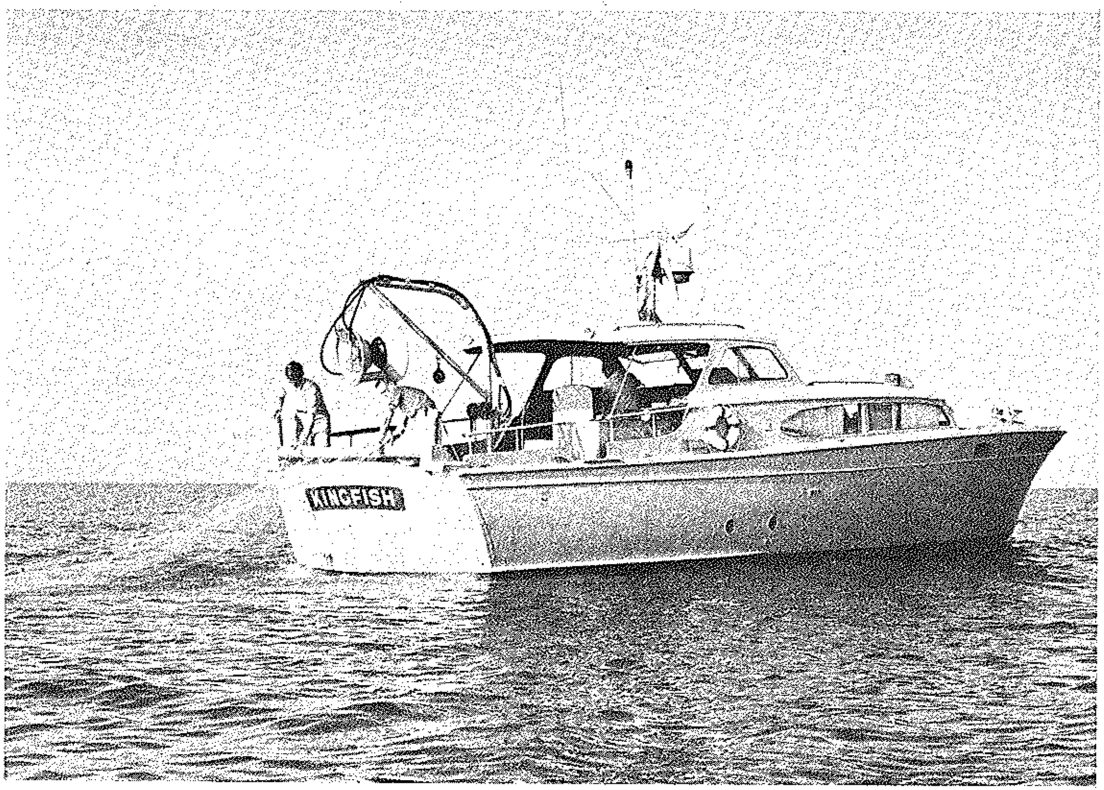
REPORT OF THE BUREAU OF COMMERCIAL FISHERIES BIOLOGICAL LABORATORY ST. PETERSBURG BEACH, FLORIDA

Fiscal Year 1967



UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

BUREAU OF COMMERCIAL FISHERIES

Circular 290

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Report of the Bureau of Commercial Fisheries Biological Laboratory St. Petersburg Beach, Florida

Fiscal Year 1967

JAMES E. SYKES, Director

Contribution No. 39, Bureau of Commercial Fisheries
Biological Laboratory, St. Petersburg Beach, Florida 33706

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Report of the Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida Fiscal Year 1967

ABSTRACT

The major goals of the Laboratory are to explore the relatively unknown scope of biological productivity in the coastal zone of the eastern Gulf of Mexico, to measure the effect of changes in that zone, and to develop methods of increasing estuarine fishery resources. The report describes current research on projects in the Estuarine and Red-Tide Programs. The projects include studies of sediments and organisms in bay bottoms, plankton crops and fishes residing in and transferring between estuaries and the Gulf of Mexico, toxicity of the red-tide organism, and experimental rearing of pompano in an impounded lagoon. A physical, hydrological, biological, and sedimentological inventory of Florida estuaries is also in progress as part of a cooperative effort with the National Oceanographic Data Center and the States of Alabama, Mississippi, and Louisiana.

REPORT OF THE LABORATORY DIRECTOR

James E. Sykes

MISSION OF LABORATORY

The Laboratory investigates the interrelation of estuarine organisms, their environmental requirements and tolerances, the biological effects of physical and chemical changes in coastal areas, and the etiology and toxicity of planktonic organisms such as the red-tide dinoflagellate, Gymnodinium breve. Its mission includes the development of methods to maintain optimal estuarine conditions for producing commercially valuable species of fish and shellfish, and the investigation of techniques related to sea farming. The biology of industrial fish is investigated, particularly the life history of thread herring, a species just beginning to be used commercially.

RESEARCH STATUS AND TRENDS

Laboratory research for the past 5 years has aided in proving when, where, and under what circumstances valuable species of marine organisms occur in the estuary. Approximately 75 percent of the research has taken place in Tampa Bay, not because it is the only important estuary on the Gulf Coast but because it is large, fertile, and representative of Gulf estuaries. Here the effects of dredging, filling, and pollution are clearly in evidence, and the results of biological research on these problems are applicable to a considerable degree in other U.S. estuaries.

Our investigations have pointed up some of the values of the estuarine resource and some of the effects of man's alterations. Many other Federal, State, and private research institutions have pooled their efforts across the nation in fact finding, publication of results, holding seminars on estuarine problems, and working with national conservation groups for the ultimate purpose of alerting the public to the importance of estuaries. Scientists now tend to believe that most conservation and political leaders understand the valuable contribution of estuaries to society. Evidence of this new understanding has asserted itself in several State legislatures and in the U.S. Congress in the form of bills for the protection of estuaries that have been submitted or passed. We now sense the urgency to begin developing techniques that will protect submerged coastal lands from further encroachment of civilization and that will increase their productivity whenever possible.

An understanding of estuarine fertility and the value of the resource has been our goal for some time, but not the only goal. While seeking this information, we have tried to use it in a practical way as we progressed. We have used the results of biological research to show the damaging effects of engineering projects, and have had some success in protecting estuaries from harmful changes. As a result of the joint efforts of this Laboratory, the Bureau of Sport Fisheries and Wildlife, the Florida Board of Conservation, and other conservation agencies, the Corps of Engineers saw fit this year to reject a dredge-fill project proposal in Florida for the first time. This is a landmark precedent, although it appears that the applicant will contest the authority of the Corps of Engineers in fish and wildlife matters.

Many facts about the biology of estuaries and the value of their resources are not yet available; the subject is so complex that its surface is barely scratched. Many of the laws necessary for protection and preservation of estuaries have not yet been enacted; opposition is strong and many proposed bills will be defeated. Some that have become law will be difficult to enforce. Nevertheless, progress in the past 2 or 3 years gives us hope that enough estuarine areas will remain undamaged so that fertility will continue and even make possible the cultivation of those areas. In considering man's need for additional protein during the coming years we think first of the sea and then of the most readily farmable portion of that sea, the shallow submerged part adjacent to the land mass--the estuary and its extension over the Continental Shelf.

Sea farming or mariculture has its best prospects in the estuary, so the Laboratory has begun experimental studies of rearing fish under semicontrolled conditions--first to test the feasibility of raising pompano on a commercial basis and then later to work with other fast-growing, hearty species that appear to be suitable for rearing in impoundments.

In this quest for protein we also have become interested in the abundant, unused pelagic fishes that school along the west coast of Florida--particularly the thread herring, a sardinelike fish for which a commercial fishery is now beginning. We hope to describe the life history of this species before rather than after the stocks have been fished without biological guidelines.

While new avenues of applied research are being explored, the more tedious and time-consuming fundamental research must continue. Ecological and taxonomic studies are illustrating the relation of food chain organisms to the sea water environment and to the all-important sea bottoms. As the bottom silts, vegetates, or erodes, the species of organisms that make up the biomass change both there and in the water column. The studies show, for instance, whether disturbed bottoms regain their fertility and, if so, how much time is required. Such facts are important in developing the best methods of maintaining and rehabilitating altered estuaries.

FACILITIES

The main Laboratory building (fig. 1), dock area, and dockside laboratories had been leased from General Services Administration since establishment of BCF (Bureau of Commercial Fisheries) research programs in St. Petersburg Beach. Ownership of the property was transferred to BCF in March 1967. Painting, repairing, and rewiring were undertaken after the transfer, to improve the buildings in keeping with acceptable community standards and to improve the research environment.

TRAINING

Formal training was reduced this year to balance increased research commitments with staff size. One employee completed a graduate course in the physiology of marine animals at the University of South Florida; one continued research toward the Ph. D. degree at the University of Florida.

PRESENTATIONS

Papers were presented at meetings of the Florida Academy of Sciences, Tampa, Fla.; the North American Wildlife and Natural Resources Conference, San Francisco, Calif.; the Louisiana State University Marsh and Estuary Symposium, Baton Rouge, La.; the National Association of Soil and Water Conservation Districts, Cincinnati, Ohio; and to local civic organizations. Our staff provided speakers at seminars of the University of South Florida, Florida State Marine Laboratory, and the BCF Tropical Atlantic Biological Laboratory.

MEETINGS AND WORK CONFERENCES

Figures in parentheses show the number of persons attending.

- American Fisheries Society, Kansas City, Mo. (1).
- Estuarine Technical Coordinating Committee--Estuarine Film Meeting, New Orleans, La. (1).
- Gulf and Caribbean Fisheries Institute, New Orleans, La. (1).
- Gulf States Marine Fisheries Commission--Estuarine Technical Coordinating Committee, New Orleans, La. (2).
- Gulf States Marine Fisheries Commission--Estuarine Technical Coordinating Committee, Brownsville, Texas (1).
- Louisiana State University Marsh and Estuary Symposium, Baton Rouge, La. (1).

Figure 1.--Main building, Bureau of Commercial Fisheries Biological Laboratory, St Petersburg Beach, Fla.

National Association of Soil and Water Conservation Districts, Cincinnati, Ohio (1).

National Oceanographic Data Center, Ad Hoc Committee on Nearshore Data Format, Washington, D.C. (1).

North American Wildlife and Natural Resources Conference, San Francisco, Calif. (1).

Conferences with staff of National Oceanographic Data Center and Gulf States representatives, Ocean Springs, Miss. (2), New Orleans, La. (2), and Washington, D.C. (1).

Regular meetings with Health Departments of Pinellas, Hillsborough, and Manatee Counties and the Federal Water Pollution Control Agency for coordination of water quality research (2).

U.S. National Museum, Washington, D.C., for identification of estuarine species (2).

ESTUARINE RESEARCH PROGRAM

The estuarine research program has five projects which involve studies of bay bottoms, plankton ecology, production of marine animals, effects of estuarine alteration, and an inventory of Gulf of Mexico estuaries.

BENTHIC PROJECT

John L. Taylor and Carl H. Saloman

Even though man eats bottom animals such as shrimp, crabs, other crustaceans, and a variety of shellfish, he does not generally consume other forms such as marine worms until their assimilation by species that are taken in commercial fisheries. Early in this century fishery biologists first recognized the role of bottom dwelling animals as fish food and began to understand that success of many fisheries depends largely upon the quantitative distribution of forage organisms in and on the sea floor.

For the past 4 years, the benthic project has been concerned with a systematic and ecological study of benthos in Tampa Bay, one of the large and productive estuaries of the Florida west coast. The first 1-1/2 years were spent in the field, collecting organisms, samples of water, and sediments. Water sampling continues daily in Boca Ciega Bay and monthly at 30 permanent stations in Tampa Bay. Hydrographic information collected from these and other locations since 1961 has been published in three Data Reports. From these data, average values of salinity, pH, dissolved nitrogen, total phosphate, and light transmission have been tabulated for subregions of the Bay (fig. 2). A report on Tampa Bay sediments is being prepared, and a reference collection now contains several hundred species of bottom invertebrates. Now our main interests are to identify organisms and analyze environmental factors that influence their numbers and distribution.

Ecological studies of individual benthic species began recently, but in general terms some features of the bottom are already apparent. One observation is that the numbers of bottom plants and animals have been greatly reduced in Hillsborough Bay and sections of Boca Ciega Bay where bayfills and pollution are causes of habitat destruction and reduction of water quality. Otherwise, the estuary is mostly unspoiled and supports a diverse and abundant assemblage of bottom organisms. Because of the low volume of fresh water entering the Bay, many of the organisms are widely distributed and brackish water is not an important limiting factor south of Interbay Peninsula (fig. 2). The distribution of echinoderms illustrates this point well. South of Interbay Peninsula, sea stars, echinoids, brittle stars, and sea cucumbers are all common. North of the peninsula, however, the sea stars and echinoids become rare and finally disappear, leaving only brittle stars and a single species of sea cucumber to represent the phylum in middle and upper Old Tampa Bay. A similar reduction of marine species toward the head of the bay occurs among other groups, too, but some species persist where water is nearly fresh and have been collected in tributaries at the upper limit of tidal influence.

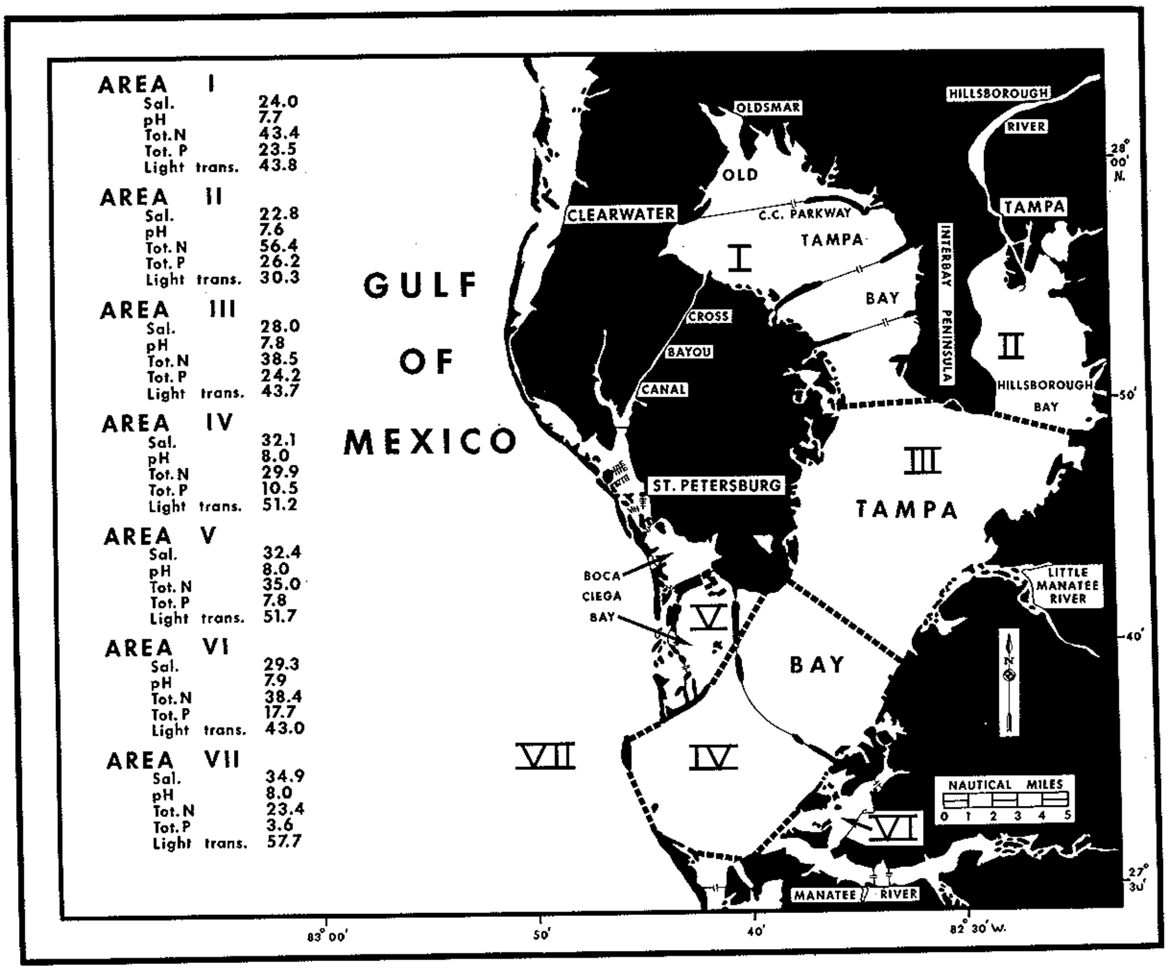

Figure 2.--Mean annual values, for subareas of Tampa Bay, Fla., 1961-64, of salinity (sal.--‰); pH; total nitrogen (Tot. N--μg.at./l.), total phosphate (Tot. P--μg.at./l.), and light transmission (light trans.--% of incident radiation).

Two animals that typify the areal distribution of bottom dwellers in Tampa Bay are the brachiopod, Glottidia pyramidata (fig. 3), and the lancelet, Branchiostoma floridae (fig. 4). The range of each is illustrated on the basis of locality records of our 1963 benthic survey (fig. 5). Both animals are subtidal, suspension feeders that live in clean, fine sand. Neither is of direct importance to fisheries in this country but both are of special interest as "indicator organisms." Large, easily recognized, widespread, numerous, and intolerant of pollution, these animals serve to identify parts of Tampa Bay that are relatively unspoiled. Of the two animals, Branchiostoma is more common and therefore more reliable as an indicator of bottom conditions. The difference in numbers between brachiopods and lancelets per dredge haul is less apparent in Old Tampa Bay. The reason may be that predators of Glottidia in the lower bay cannot survive the more brackish water of the upper bay. At the present rate of coastal development, we suspect that faunal charts for Glottidia and Branchiostoma 10 years hence will show them confined to lower Tampa Bay and the Gulf of Mexico, at best.

The disappearance of unspoiled estuaries bordering the Gulf of Mexico is cause for concern because of the commercially important species they contain. Some of the most valuable animals are bottom-living invertebrates: shrimp, blue crab, oyster, and southern quahog (also called hard clam). All of these except the quahog (Mercenaria campechiensis) are fished commercially in Tampa Bay. Absence of a quahog fishery is due to undependable annual recruitment (possibly a result of disease and predation). Under favorable conditions, however, quahogs set well and grow rapidly in the estuary. Annual growth has been recorded for quahogs in Boca Ciega Bay since 1964 (fig. 6). To these data we have added the mean length of quahogs that we assume are 6 years old because they were collected in 1966 from a canal dredged in 1960 (fig. 7).

We have also measured growth rate of northern quahogs (M. mercenaria) transplanted in Tampa Bay. These clams came to us in two size groups--hatchery stock reared at Oyster Bay, Long Island, N.Y., average length, 2.5 mm. (0.1 inch), and seed clams from Great South Bay, Long Island, average length, 48 mm. (1.9 inches). All of the hatchery clams and some of the seed clams were set out in holding boxes covered with hardware cloth; other seed clams were broadcast near a station marker. After 6 months, hatchery clams more than doubled their length, and seed clams grew about 4 mm. (0.2 inch). Sometime thereafter, all the hatchery clams and the seed clams confined to boxes were suffocated by an accumulation of sediment. Fortunately, the broadcast seed clams survived and increased 8 mm. (0.3 inch) to a length of 56 mm. (2.2 inches) in 12 months. This amount of growth is about one-third that of the southern quahog in the area; however, a more critical comparison of growth of the two species should be made before the northern clam is ruled out for potential culture in southern waters.

The high-salinity habitat of Boca Ciega Bay is well suited for southern quahogs. Unfortunately they cannot be harvested efficiently there without disrupting grass beds and many associated plants and animals. The benthic survey of Tampa Bay showed, however, that quahogs also live on unvegetated bottom, and excepting Hillsborough Bay, they occur throughout the estuary north to the vicinity of Courtney Campbell Parkway. This knowledge prompted us to set out quahogs in experimental lots to determine growth and survival on bottom free of grass.

Briefly, the experiment involved setting out 72 marked southern quahogs, equally divided among three size classes, at each of 20 stations in Tampa Bay. After 12 months, clams recovered from each station were identified by number and remeasured. At stations in Old Tampa Bay, average growth of clams was 9 mm. (0.4 inch). Those recovered from central Tampa Bay showed average growth of 11.5 mm. (0.5 inch), and growth of clams set out in lower Tampa Bay averaged slightly more than 12 mm. (0.5 inch). Greatest growth by an individual was 24 mm. (1.0 inch) (for a small clam set out in lower Tampa Bay). The average growth figures and the exceptional growth noted for the small clam planted in the lower bay are similar to growth records of clams growing under natural conditions in Boca Ciega Bay (fig. 6).

On the basis of these preliminary data we believe that a southern quahog fishery could be established on the expansive, unvegetated bottom areas of Tampa Bay south of Interbay Peninsula. Perhaps we will see our hypothesis verified, but certainly not if coastal development in Tampa Bay continues without regard for fishery resources.

GULF OF MEXICO ESTUARINE INVENTORY PROJECT

J. Kneeland McNulty

The purpose of the inventory is to produce a base line of essential information--a yardstick--against which to measure future changes in the estuaries of the Gulf of Mexico. The information is to be compiled in the form of an atlas that will contain physical, chemical, and biological data which the participants from States bordering the Gulf have agreed are essential.

The idea of an inventory of Gulf estuaries has been favored by many biologists for several years, but the lack of funds delayed the

Figure 3.--The brachiopod, G. pyramidata, from Tampa Bay, Fla. Specimen at bottom has a gastropod (C. maculosa) attached to one valve (1 cm. = 0.39 inch).

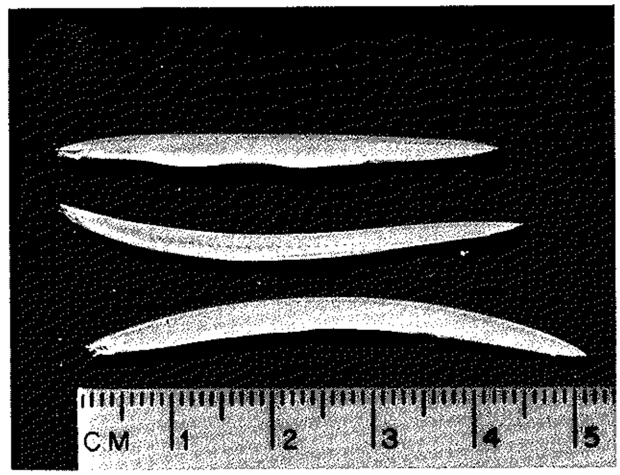

Figure 4.--The lancelet, B. floridae, from Tampa Bay, Fla. (1 cm. = 0.39 inch).

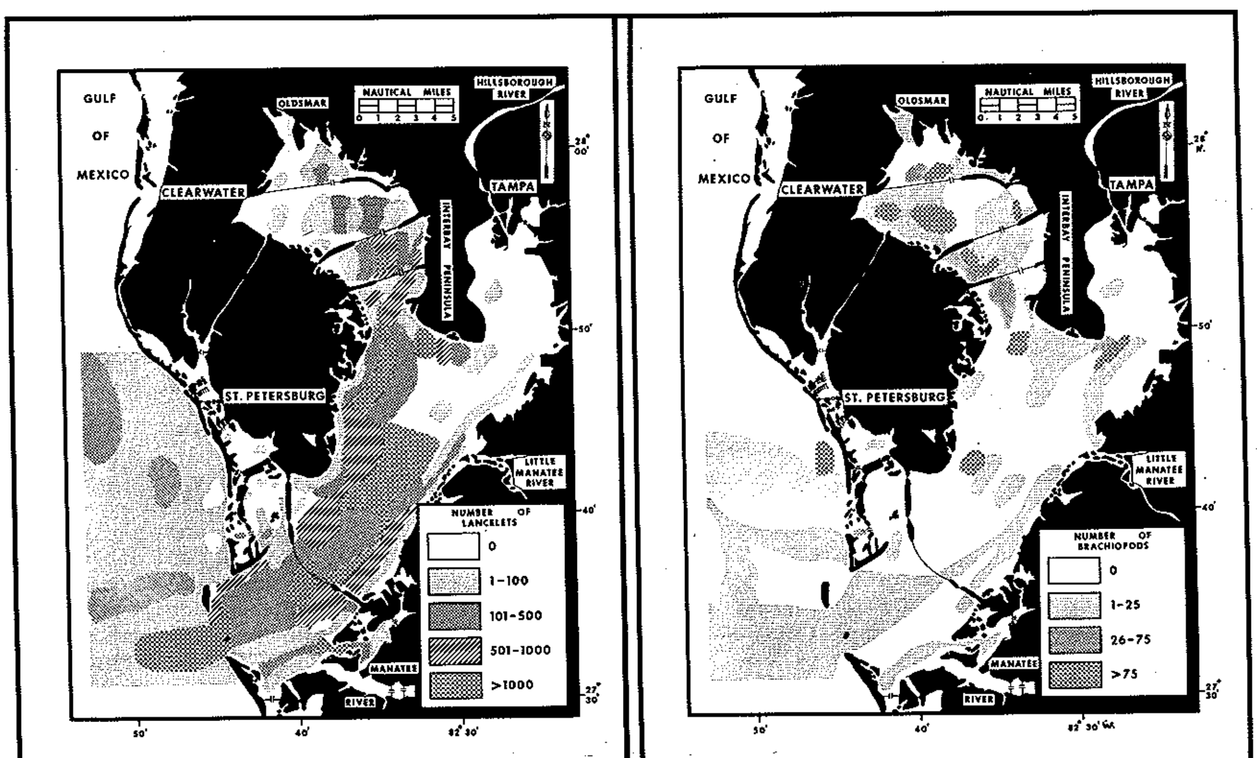

Figure 5.--Quantitative distribution (number per sample of about 300 cm.^{2}--46.5 square inches) of the lancelet, B. floridae, and the brachiopod, G. pyramidata, in Tampa Bay, Fla.

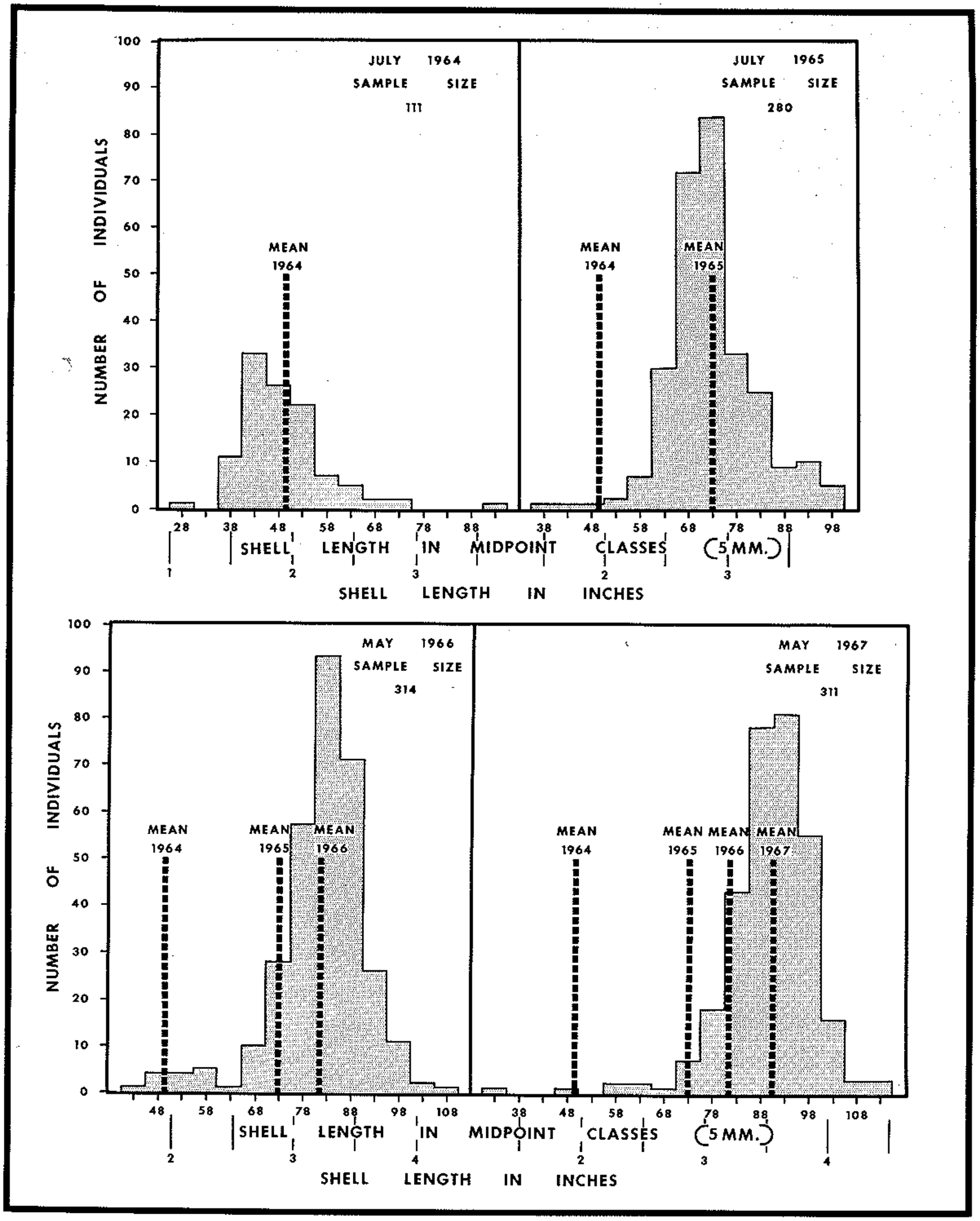

Figure 6.--Size frequency distribution and average shell length (vertical line) of southern quahogs (M. campechiensis) from a year-class population in Boca Ciega Bay, Fla., 1964-67 (1 mm. = 0.04 inch).

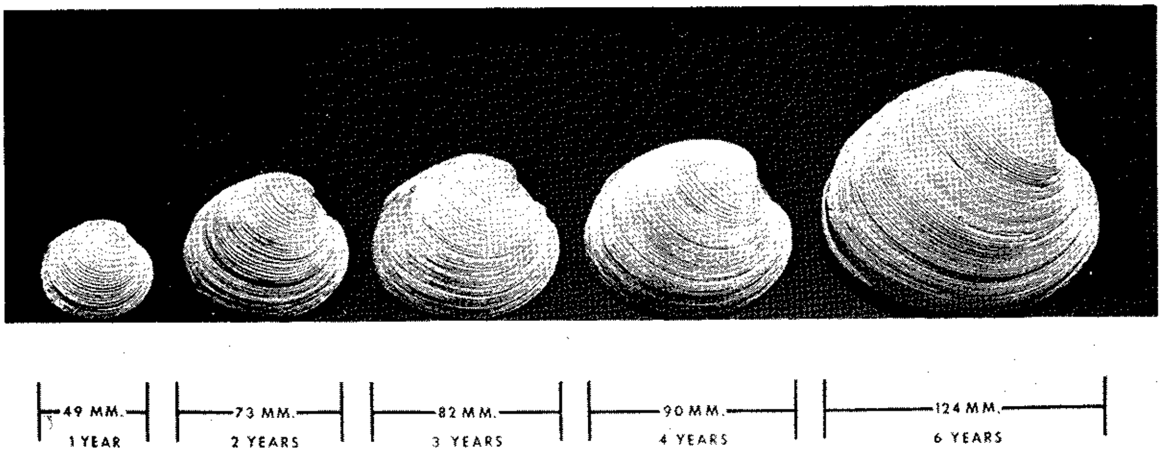

Figure 7.--Relation between age and average shell length of southern quahogs (M. campechiensis) from Boca Ciega Bay, Fla. (1 mm. = 0.04 inch).

project until recently. In 1966, Federal Aid funds (PL 88-309) became available and provided means of financing a thorough estuarine inventory. Leaders of marine ecological research in Louisiana, Mississippi, and Alabama took this opportunity to support the idea of an inventory and to become active participants. Although Texas and Florida are not participating actively, the necessary data for estuaries of those States are being accumulated by this Laboratory and the BCF Biological Laboratory in Galveston.

The development of written outlines, approved by all participants, has first priority. The outlines define the basic essentials of data to be collected by the participants and thereby ensure uniformity of the material collected for the atlas. The outlines of all four phases--area description, hydrology, sedimentology, and biology--are now approved. The participants have agreed that in calendar year 1968 biological sampling will be done simultaneously. This agreement means that for the first time in the history of marine biological work biologists in all five States bordering the Gulf will use the same collecting gear in the same way and will apply the same analytical procedures.

New impetus to a joint computer analysis program was given recently by NODC (National Oceanographic Data Center), Washington, D.C., at a meeting of participants. Coordinated action was proposed in the form of a plan developed jointly by NODC and this Laboratory. The plan was enthusiastically received. A working group was appointed and directed to develop the necessary formats for the raw data as soon as possible. The group has made excellent progress.

This Laboratory has accepted responsibility for the Florida section of the inventory. Much of the area description phase has been accomplished, and we have made significant progress on other phases by acquiring some of the equipment and information needed to accomplish the remaining work. For example, a review of river discharge data shows that the preponderance of fresh water flows to estuaries north of Tampa Bay (fig. 8).

Another example of information collected for the area description phase is that obtained on submerged vegetated areas. Project personnel have examined all available aerial photographs from Tampa Bay southward to the Florida Keys and have charted all areas of submerged vegetation shown on the photographs (fig. 9). The total area of submerged vegetation in all estuaries from Tampa Bay south is 1,396 $km.^2$ (539 sq. mi.), of which 1,039 $km.^2$ (401 sq. mi.) are in Florida Bay. Thus, a unified start toward production of an atlas of all Gulf of Mexico estuaries has been made.

PLANKTON ECOLOGY PROJECT

(Chemical Environment)

J. Kneeland McNulty

Primary productivity and ultraviolet absorption studies, begun in February 1963, have continued. The purpose is to determine the primary productive capacities of the Tampa Bay estuary and the adjacent nearshore Gulf of Mexico. The data are used to compare Tampa Bay with other estuaries, to detect unusual changes in the environment, and to learn more about the relation between commercial fisheries and primary production. New data are interpreted with increasing confidence because the observations extend over the past several years. Samples have been collected monthly at 10 stations since the beginning of the study; weekly samples have been taken at 4 key stations from July 1965 to the present.

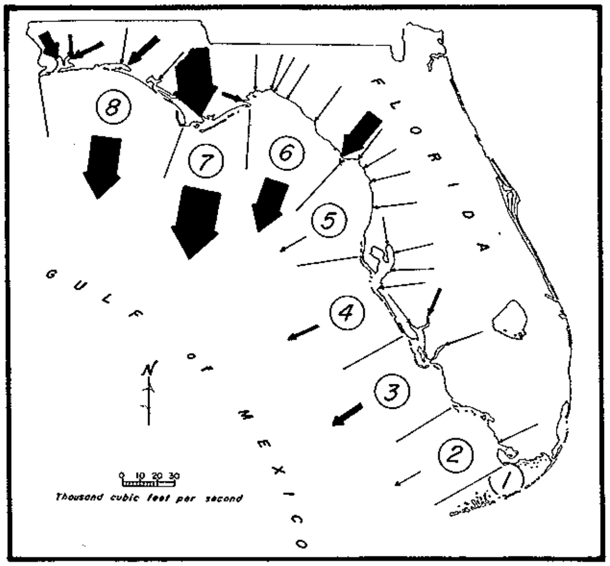

Figure 8.--Average annual streamflow to Florida estuaries. The arrows in the Gulf of Mexico show total discharges for large segments of the coastline. The scale applies to the width of the arrows. To convert from thousands of cubic feet per second to cubic meters per second, divide thousands of cubic feet per second by 28.3.

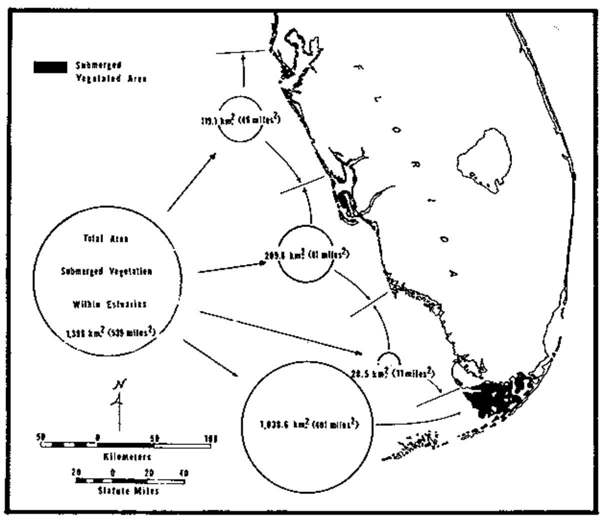

Figure 9.--Areas of submerged vegetation in Florida estuaries from Tampa Bay to the Florida Keys.

The method of determining primary productivity by the light- and-dark-bottle technique was described in detail in the Annual Report for Fiscal Year 1966 (U.S. Fish and Wildlife Service Circular 257). The results repeat, with variations, the same seasonal and areal relations observed since 1963. All of the data from fiscal year 1967 were grouped by month, averaged, and plotted to show seasonal relations (fig. 10). Productivity is relatively low

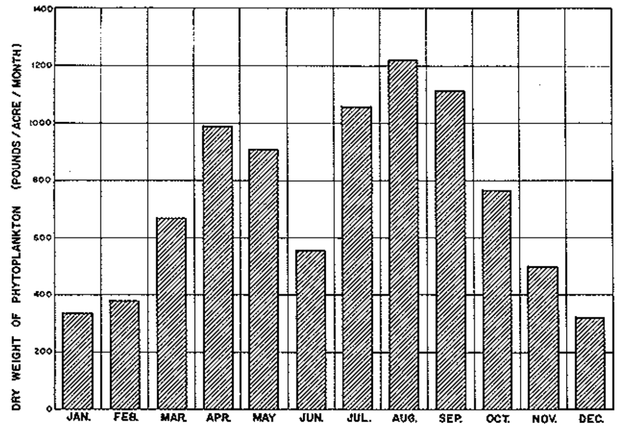

Figure.--Average seasonal changes to phytoplankton production in Tampa Bay, 1966-67. To convert pounds per acre per month to kilograms per hectare per month, multiply pounds per acre per month by 0.921.

in winter and high in summer. The summer high is about four times the winter low. The June dip in productivity is more pronounced in some years than in others, but each year there is a decline in late spring. The decline occurs because the early spring bloom of phytoplankton uses all the available nutrients, which are not recycled fast enough to maintain high production. In late spring, sediments remain relatively undisturbed because winds are usually light to moderate and river discharges, which carry nutrient supplies from land drainage, are at a seasonal low. Thus, for various reasons, the early-spring bloom runs its course and is followed by a late-spring decrease. This decrease is followed by the 3 months of highest annual productivity--July, August, and September. This cycle of productivity has been repeated during each of the 4 years of observation.

The relation of primary production to commercial fisheries is a difficult subject because complex food chains are involved. It has been said, "you can't eat primary production"; yet it can be said with equal truthfulness, "you can't eat without primary production." The base for all commercial fisheries is primary production. The best available evidence is that a harvest of fish equal to 1 to 2 percent of primary production by weight is excellent. An essential assumption is that suitable habitat, such as vegetated shallows, is available in sufficient quantity and quality to permit utilization of the primary production. One to two percent of the primary production of Tampa Bay is about 48.5 to 96.9 million kg. (107-214 million pounds) of whole moist organic material per year (based on the sum of reasonable estimates of the weights of phytoplankton, attached vegetation, and benthic microflora).

We have no estimate at present of the total annual production of fish in Tampa Bay, so we cannot compare actual production with that which is theoretically possible. Future research may provide the necessary data, and, when such data become available, information on primary production will become one more practical tool in the management of estuaries for maximum usefulness.

Determination of ultraviolet absorption is a quick, easy measure of the quantity of dissolved organic material present in water. The method used in this Laboratory was described in the Annual Report for Fiscal Years 1962-64 (U.S. Fish and Wildlife Service Circular 239). The determination has been found useful elsewhere--off southern California, for example, where it has been used successfully to trace sewage fields. Its use in Tampa Bay was initiated to test the idea that red-tide blooms require dissolved organic materials and that knowledge of the relation between ultraviolet absorption and red-tide blooms might lead to methods of predicting, or even controlling, the outbreaks.

Because only one sizable red-tide outbreak has developed since the start of the ultraviolet sampling routine (within 2 months after the start of sampling), there has been little opportunity to test its utility. Meanwhile, there can be no doubt that ultraviolet absorption is a satisfactory measure of the quantity of dissolved organic materials and that there is a meaningful relation between ultraviolet absorption and salinity (hence land runoff). The data of fig. 11 are taken from field records for March 1967, a month in which the relations were illustrated well, but not significantly better than in many other months. The linear correlation coefficients of the illustrated data are 0.921 and -0.977 respectively, for nitrogen-ultraviolet absorption and salinity-ultraviolet absorption.

Chemically, Tampa Bay is the best known estuary in Florida, and in time will be one of the best known in the Nation. Daily temperature and salinity records extend back to early 1947. In 1960 and 1961, sampling for various nitrogen and phosphorus components became

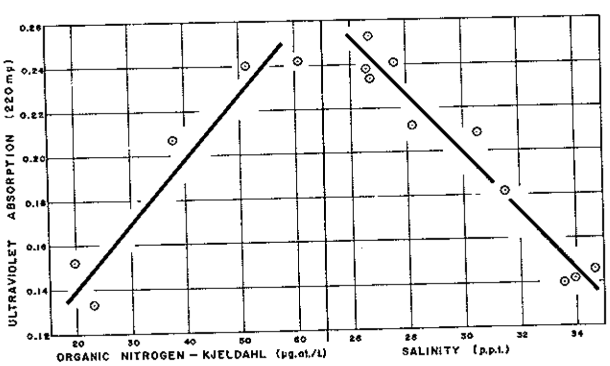

Figure 11.--The relations between organic nitrogen (Kjeldahl) and ultraviolet absorption, and salinity and ultraviolet absorption for March 1967.

frequent, although there is not an unbroken series of data back to that time. The one exception is total phosphorus, for which an almost unbroken monthly series of determinations is available for the past 7 years. The data will show extremely valuable trends and relations, such as the trend toward overfertilization resulting from increasing pollution.

Most past data were collected for various projects at this Laboratory. In the past year the total output of the chemistry laboratory was 10,017 items of data. Seventy-six percent were for the plankton ecology project, which involved field trips throughout Tampa Bay and the immediate nearshore area. The remaining 24 percent were for other Laboratory projects, and included 2,417 determinations of organic nitrogen (Kjeldahl), total phosphorus, pH, oxygen, salinity, and chlorophyll a. Thirty-eight percent of the total of 10,017 determinations were for organic nitrogen (Kjeldahl) and total phosphorus.

Thus, extensive documentation of water quality in Tampa Bay continues. We have begun to use an AutoAnalyzer,[1] which automates several key chemical tests. It will greatly facilitate the collection of standard water quality data.

FAUNAL PRODUCTION PROJECT

(Life History of Pompano)

John H. Finucane

As part of a broad faunal program on the ecology of finfish and shellfish in Tampa Bay, Fla., a preliminary aquiculture study was started on the life history and experimental rearing of pompano. Salt-water fish farming will increase in this country, and Statewide interest has already developed in raising pompano commercially. In our first studies on the feasibility of rearing fishes commercially, we put young pompano (Trachinotus carolinus) in an experimental impoundment in Fort De Soto Park at the mouth of Tampa Bay (fig. 12). This fish was selected because of its high market value--about 80 cents per pound wholesale--and its apparent adaptability to impoundment and artificial diet.

A manmade bay fill of about 2.4 hectares (6 acres) was stocked with 6,000 young pompano, 25 to 100 mm. (1-4 inches) (fig. 13), that had been seined from Florida beaches. The fish withstood well the handling and transport. The impoundment was enclosed with screening and an inner liner of nylon net. The lagoon has an average depth of about 2.1 m. (7 ft.), although some areas are as deep as

[1] References to trade names in this publication do not imply endorsement of commercial products.

Figure 12.--Pompano fish-farming site in Fort De Soto Park, Fla.

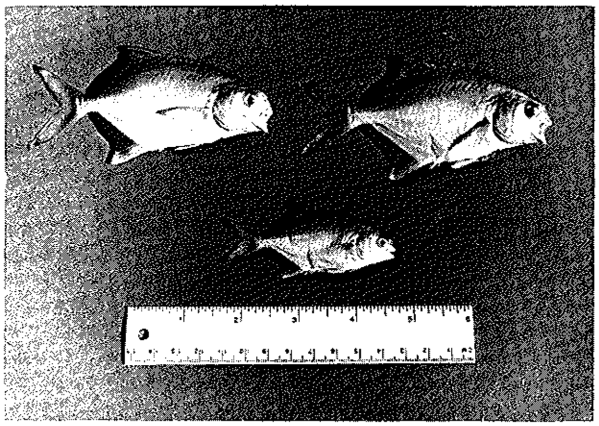

Figure 13.--Young pompano (T. carolinus) used in fish farming experiment at Fort De Soto Park, Fla. (1 cm. = 0.39 inch).

3.3 m. (11 ft.) at high tide. The bottom consists of sand, shell, and silt and, because of the pond's depth and turbidity, is free of attached vegetation. Water circulation is principally tidal; normal tidal amplitude seldom exceeds 0.9 m. (3 ft.). Before stocking, the area was treated with a fish toxicant to remove predators and competing fish species.

Initial feeding trials showed that pompano can adjust to a variety of natural and artificial foods. We have chosen a 40 percent protein dry ration for the basic diet because it is easier to store and handle than most other foods and is superior to them in nutrition. The fish are being fed at the rate of about one-tenth of their body weight per day. Amounts of food, particle size, and frequency of feeding are adjusted to obtain the lowest possible conversion rate (pounds of food needed to produce 1 pound of fish). The fish seem to be healthy and growing rapidly.

Pompano in the Tampa Bay area may spawn throughout most of the year, although most spawn from May through November. Spawning this year began much earlier than usual because water temperatures were above average for the season. Young fish less than 25 mm. (1 inch) long were collected on the Gulf beaches in April and May, showing that spawning must have occurred in March and April--probably in the Gulf of Mexico.

The principal foods of young pompano are the coquina (Donax variabilis) and the mole shrimp (Emerita talpoida). The hard shells of these animals are easily crushed by the pharyngeal plates of the fish. We have not found fish in their stomachs, even though young scaled sardines (Harengula pensacolae) abound in the same beach habitat.

Growth of pompano is variable in nature, but under a favorable environment the fish grow about 20 to 25 mm. (0.8-1 inch) per month. Captive stocks in some instances have equalled this growth and have often exceeded 454 g. (1 lb.) in a year.

Pompano favor the marine habitat of the Gulf beaches or lower Tampa Bay and are generally found at salinities above 32 p.p.t. Laboratory and other field studies show that they can adapt to salinities as low as 10 p.p.t. The range of water temperature in which we have found young pompano most frequently extends from 17 to 32° C. In captivity, pompano survived temperatures below 13° C. for a short period but did not feed.

BIOGEOCHEMICAL ALTERATION AND EFFECT PROJECT

Charles M. Fuss, Jr. and John A. Kelly, Jr.

The practice of modifying shorelines to create salable land has produced an extensive series of manmade marine habitats that are relatively barren. The so-called finger-fill canals (fig. 14) and lagoons are replacing natural productive shallows. The dredged areas contribute little to the benthic productivity of an area; bottom communities are sparse, and the rapid deposition of silt hinders

Figure 14.--A typical finger-fill canal in Boca Ciega Bay.

their development. A need currently exists for methods to restore such areas to a level of biological productivity at least commensurate with the natural environments that they replaced.

One of the most obvious deficiencies of dredged canals and lagoons is the complete absence of sea grasses (marine flowering plants), which were formerly abundant. Grass beds are a valuable asset to the marine ecosystem because they provide nursery and feeding grounds for many fish, shrimp, and other marine animals. The reestablishment of sea grasses is therefore of the utmost importance. Studies on the feasibility of transplanting two locally abundant sea grasses (turtle grass, Thalassia testudinum, and shoal grass, Diplanthera wrightii) were begun in fiscal year 1965 and continued throughout this year. The first aim of the studies was to determine the relative survival and growth rates of the two species under semicontrolled conditions in trays within an open sea-water system. Field transplant studies begun in 1966 will end in August 1967.

An additional study was initiated in October on attractants for stone crabs (Menippe mercenaria). The current status of the above studies is discussed below.

Studies of Semicontrolled Transplants of Sea Grass

Sea grasses were transplanted in trays suspended in experimental tanks. The trays were divided; turtle grass was planted on one side and shoal grass on the other. Trays of the grasses were examined 6, 8, 10, and 12 months after transplanting, and the plants were compared with those from natural grass beds.

Turtle grass survived transplanting and grew rather well, putting out new leaves, roots, and some rhizomes. Shoal grass, however, generally declined after transplanting, and few plants survived. Leaf growth of turtle grass transplants was good, actually more than plants in the field. The original roots of plant fragments did not survive transplanting, and most new roots developed on the erect leaf-bearing short-shoots. New roots originating from rhizomes were found only on fragments that had an active rhizome tip when transplanted. As with roots, original rhizome fragments of turtle grass did not survive transplanting unless the active tip was present. New rhizomes originated as branches of erect short-shoots (about 12 percent of the transplants). Figure 15 shows new rhizome growth of a transplant without an active rhizome tip. The presence of these new rhizomes showed that vegetative reproduction was possible from fragment transplants which did not have active rhizome tips. All new erect short-shoots produced by transplants developed on new rhizomes.

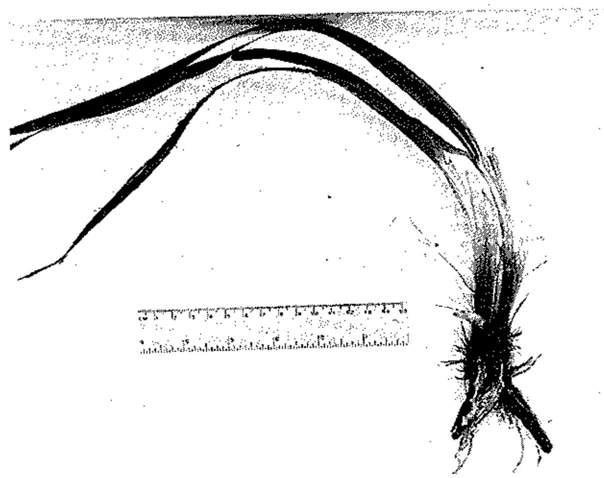

Figure 15.--New rhizome growth of a turtle grass transplant (1 cm. = 0.39 inch).

The results show that turtle grass is much better suited than shoal grass for transplanting and culture under the experimental conditions. Possibly the artificial substrate and water depth of the system were more conducive to the survival of turtle grass. Fragments of turtle grass seem to require about a year to recover after transplanting. Vegetative growth is restricted to branching of erect leaf-bearing shoots and to rhizome fragments that originally possessed active tips. This study shows that fragment transplanting of turtle grass is possible when the environment is favorable for plant growth.

Restoration of Sea Grass in Dredged Areas

Studies were begun last year to seek methods of transplanting sea grasses from natural beds to dredged areas. Turtle grass was selected for the experiments as a result of tests in the sea-water system. Experimental plots were established in a finger-fill canal and in a denuded area of a natural grass bed. It was evident from the beginning that one of the main obstacles to overcome in field transplanting was erosion by tidal currents. Turtle grass is buoyant, and the transplants readily float to the surface when the substrate covering their roots is washed away.

Experiments to determine the best and most economical way of anchoring plants in the substrate began in August 1966. Perforated quart-size (1.1-liter) tin cans were used, and concrete blocks were placed on the bottom to deflect the current. When the grass was dug, we fitted the rhizomes, roots, and substrate into the can. We then inserted the cans into holes dug with a post-hole digger. Grass was also placed directly into holes without the tin can anchoring device. Half of the transplants (40 plants) were made inside of four 0.3 by 3.6 m. (1 by 12 ft.) rectangular concrete block enclosures and half outside.

Plants have now been in the experimental plots for almost a year. During that time they have passed through a period of winter leaf kill and have entered the summer period of maximum growth. Plants bearing new leaves can be considered survivors but not successful transplants until the rhizomes and roots are examined for new growth. Table 1 gives a summary of transplant survivors to date.

Survival data show that plants in the finger-fill canal needed the protection afforded by the concrete block enclosures but did not benefit from the root anchoring device. Those planted in the denuded area of the grass bed seemed to have benefited from the tin cans but not from the block enclosures; possibly the growth of algae (Gracilaria sp.) in the block enclosures was heavy enough to reduce light to a limiting level, or the accumulation of decomposing organic material from the algae was sufficient to produce excessive concentrations of hydrogen sulfide. The generally lower survival in the finger-fill canal may have been caused by limiting factors other than those associated with erosion by tidal currents.

In March 1967, a new transplant series was begun. Plants were anchored to the bottom by running their upright leaf shoots through the holes in clay construction brick, 3.5 by 9 by 29 cm. (1.4 by 3.5 by 11.3 inches), and through 5.1- to 7.6-cm. (2- to 3-inch) lengths of 2.5- and 5.1-cm. (1- and 2-inch) diameter iron pipe. They were also anchored by binding the leaf-bearing short-shoots to 15.2-cm. (6-inch) lengths of steel construction rod with plastic-coated tie wire. Transplants anchored with bricks were placed on the bottom, and those anchored by the other methods were planted in holes. To date, all plants anchored

Table 1.--Survival of turtle grass after being transplanted in tin cans and without tin cans (August 1966 - July 1967)

Environment and exposure	Survival	
	In tin cans	Without tin cans
Denuded area of natural grass bed:	Percent	Percent
Within concrete block enclosure............	50	30
Outside concrete block enclosure............	100	80
Within concrete block		
Finger-fill canal:		
Within concrete block enclosure............	20	40
Outside concrete block enclosure............	0	0

with construction rods have survived in both the natural grass bed and canal areas. Visible leaf growth has not been observed on other transplants.

A complete evaluation of the various methods of transplanting cannot be made until all of the surviving plants are removed to measure root and rhizome growth. The results, however, are encouraging because two of the transplant methods (tin cans outside block enclosures in the natural grass bed area and steel construction rod in both areas) seem to be very effective. Transplanting sea grasses in dredged canals and lagoons may well be an important first step in returning such areas to a desirable level of biological productivity.

Stone Crab Attractants

During transplant studies we observed that many stone crabs were attracted to the concrete block current deflectors in the finger-fill canal plot. This crab is a highly prized delicacy and of significant local economic value. If the canals are provided with suitable artificial habitats it may be possible to attract a sizable population of stone crabs and thereby improve the biological potential of these unproductive areas.

We made a study from November 1966 through March 1967 (the period when adult crabs are plentiful in the area) to select commonly available materials which might be used for crab habitats. As test materials we used a concrete block, automobile tire, glass jar, and clay drain tile. The tests were in a 2.4 by 2.4 by 0.9 m. (8 by 8 by 3 ft.) plywood tank enclosed with canvas sides. The bottom of the tank was covered with white sand, and one of the test structures was placed in each corner. Crabs were released singly from the center of the tank during the late afternoon and recovered the next morning. The location of the crab was recorded along with its size and sex.

The drain tile was preferred by 43 percent of the stone crabs tested. Thirty-five percent were found in the tire, and the remainder were either in the concrete block or burrowed in the sand. Small crabs, 6.0 to 7.0 cm. (2.4-2.8 inches) carapace width, preferred the tire, and medium-size, 7.0 to 8.0 cm. (2.8-3.2 inches) wide, and large, 8.0 to 9.0 cm. (3.2-3.6 inches) wide, crabs preferred the drain tile. Male crabs were more often found in the tire; females showed equal preference for the tire and tile. The results suggest that old tires and drain tiles are effective stone crab attractants but conclusions as to their value in increasing numbers of crabs must await testing in the field.

The standard trap used by Florida fishermen (and the one used most often in this study) is made of wood lath; the entrance is at the top, and the bait is wired to the floor. Crabs exposed to this type of trap in the observation tank would frequently circle the trap and then burrow under it, reaching up through the slots to pinch off pieces of the bait. Crabs did not always climb to the top entrance. The observations showed that the traps probably could be improved if they had a side entrance and the bait were placed in the center of the trap.

BIOLOGY OF THREAD HERRING

Charles M. Fuss, Jr., and John A. Kelly, Jr.

A new project was started during this fiscal year to study the life history, migrations, and behavior of the thread herring, Opisthonema oglinum (fig. 16). Aerial reconnaissance and surface cruises have shown that large concentrations of thread herring are present on the coastal shelf of southwest Florida, at certain times of the year. The schools have been sighted on infrared radiation temperature surveys, surveillance flights for industrial fish spotting, and cruises by the BCF Exploratory Fishing Base at Pascagoula and this Laboratory. Thread herring undoubtedly represent a large, unused resource in this area, but very little documented information is available on the biology of the species.

Recent interest in the industrial use of thread herring has necessitated this investigation. A reduction plant is under construction at Fort Myers, Fla., and may begin operating in the fall of 1967. Thread herring will be the principal species used for meal, oil, and solubles. Commercial harvesting of thread herring is desirable because of recent declines in Atlantic menhaden stocks and increases in fishing by other nations off our coasts; however, a thorough understanding of certain basic biological concepts will be necessary for future management and orderly development of the fishery. Timely activation of this study should provide an unusual opportunity to observe the effects of a developing fishery on a previously unused resource in a relatively small area.

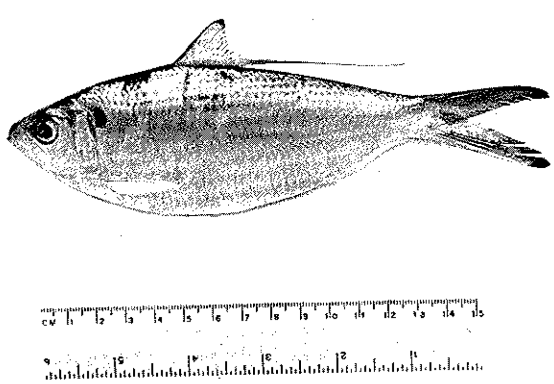

Figure 16.--An adult thread herring (O. oglinum) (1 cm. = 0.39 inch).

The aims of the study are:

1. To describe the life history of thread herring.
2. To determine seasonal and annual migration patterns and fluctuations in abundance through systematic sampling.
3. To understand the influence of the environment on the movements and concentrations of the fish.
4. To document the importance of contiguous estuaries and determine the origin of stocks.
5. To contribute to the taxonomic literature of the species, particularly in juvenile and postlarval stages.
6. To determine behavioral patterns which include feeding habits, schooling characteristics, diel activity, and responses to natural stimuli.
7. To attempt estimates of maximum sustainable yield and advise on future management of the fishery.

Previous studies by this Laboratory under the estuarine program have provided data that are useful in the life history phase of this investigation. Field sampling in Tampa Bay and Charlotte Harbor-Pine Island Sound has shown that thread herring spend a good portion of their life in estuarine waters. In addition, we have obtained, compiled, and published oceanographic data in the study area for the past 4 years. Some of these data have been plotted in vertical section and are now being entered on Hollerith cards. A backlog of oceanographic data will be useful in studies of distribution and migrations.

Field sampling of adult thread herring was begun in March of this year in the shallow waters offshore from Tampa Bay. Monofilament gill nets of various mesh size, which have proven to be effective in the capture of adult thread herring (fig. 17), were obtained from the Exploratory Fishing and Gear Research Base at Pascagoula. Sampling techniques were developed aboard the R/V Kingfish. The vessel has been equipped with a hydraulic power block to expedite fishing. We sample locally each week to provide specimens for length-weight measurements and information on gonad development. Our operations will be expanded soon to include the inshore waters between Tampa Bay and Cape Romano.

Samples taken in the Gulf just offshore of St. Petersburg Beach have produced thread herring

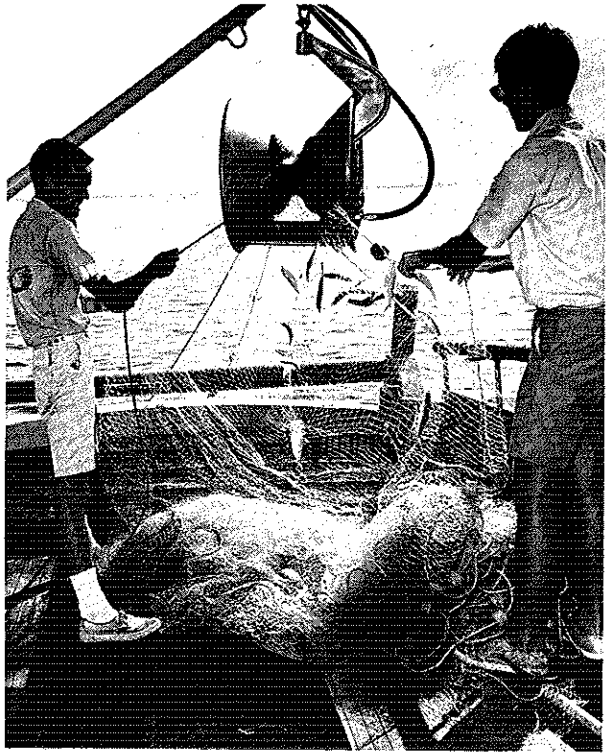

Figure 17.--Gill net sampling for thread herring in the Gulf of Mexico.

140 to 165 mm. (5.6-6.6 inches) long (fork length) weighing 37 to 68 g. (1.2-2.2 oz.). Mean length and weight were 152 mm. (6.1 inches) and 49 g. (1.6 oz.). These fish had fully developed gonads in early April and began spawning (some had spent gonads) in late May, when surface water temperature approached 27° C. Plankton tows were made at each station, and the samples preserved. The collection and analysis of field data have not progressed sufficiently for the inclusion of any results in this report.

Laboratory studies on induced spawning and artificial fertilization were begun recently. Live fish are easily obtained from field sampling, and a free-flowing sea-water system is available for holding the fish. Ripe fish are injected with various doses of anterior pituitarylike chorionic gonadotropin in attempts to induce spawning. Chorionic gonadotropin has been used successfully by others to cause the release of gametes in certain fresh-water and anadromous species but apparently has not been tested on marine fishes. Results to date are inconclusive but if future experiments are successful, a means will be provided for obtaining the viable eggs and sperm (at preplanned times) necessary for artificial fertilization studies. Artificial propagation could provide much needed information on the identification, ecology, physiology, and behavior of the thread herring during the early stages of its life.

RED-TIDE PROGRAM

Toxin Research

The University of South Florida in Tampa has a contract with this Laboratory to isolate and characterize the fish-killing toxin of red tide. The chemical oceanography group at the University of South Florida includes Dean F. Martin, A. B. Chatterjee, and W. Karl Olander.

Research accomplishments in the past year include the following:

DEVELOPMENT OF COMPETENCE IN CREATING ARTIFICIAL RED TIDES

Before the fish-killing toxin could be isolated, it was necessary to have a ready supply of the organism (Gymnodinium breve) which is responsible for red tide in Florida waters. For this reason, artificial red tides were created in the laboratory. Successful culture of the organism required a special light, good temperature control (typically 25° C.), and supercleaned glassware. Laboratory concentrations reached levels of 40 million organisms per liter. Blooms in the Gulf reach levels of 60 million per liter, but the distribution is not uniform.

THE EFFECT OF METALS ON RED TIDE

Two trace metals, titanium and zirconium, seem to be associated with red tide, according to published reports. Preliminary laboratory studies now indicate that extremely small doses of titanium completely destroy red tide in initial stages of an outbreak; zirconium seems to have no effect. These observations need to be followed up because they suggest that the amount of titanium in coastal waters of west Florida may control the red-tide outbreaks. Whether titanium tetrachloride smoke (as used in skywriting) could be used to stop a red-tide outbreak economically and without damage to the ecological balance is a question that deserves consideration.

ISOLATION OF TOXIN IN A CRUDE FORM

A crude toxin has been isolated by shaking a flask containing red-tide organisms and chloroform. The toxin appears at the interface of the chloroform and water. The toxin is drained off with the chloroform in a special funnel which can also be used to separate the toxin from the chloroform layers.

CHARACTERIZATION OF THE STABILITY OF THE TOXIN

It was necessary to know how long the toxin would remain stable at room temperature or at higher temperatures before experiments with the substance could be continued. Investigations of durability showed that it was stable for several days at room temperature. Two drops of the crude toxin were placed in 1,000 to 2,000 drops of water. Some killifish, Fundulus similis, were placed in water containing toxin, and others were placed in water that had no toxin. Even though killifish are relatively resistant to red tide, according to field observations, the fish in the toxin solution died in 6 to 7 minutes. The fish in the control solution survived for 2 hours, after which time they were returned to the aquarium.

PROGRESS IN THE PURIFICATION OF THE TOXIN

Toxins can be purified in several ways, depending upon the nature of the toxin and of the impurities. Selective removal of the toxin by use of solvents (ether, chloroform, alcohol) has been tried and separation by means of ether appears promising. The ether can be evaporated at ice-water temperatures, and the residue is toxic to fish. Although this procedure does provide toxic material, it needs improvement because apparently more than one toxin is present. The investigation of other methods of separation is necessary.

PUBLICATIONS

DRAGOVICH, ALEXANDER, and JOHN A. KELLY, JR.
1966. Distribution and occurrence of Gymnodinium breve on the west coast of Florida, 1964-65. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 541, iii + 15 pp.

DRAGOVICH, ALEXANDER, and JAMES E. SYKES.
1967. Oceanographic atlas for Tampa Bay, Florida, and adjacent waters of the Gulf of Mexico, 1958-61. U.S. Fish Wildl. Serv., Circ. 255, 466 pp.

FINUCANE, JOHN H., and ALEXANDER DRAGOVICH.
1966. Hydrographic observations in Tampa Bay, Florida, and adjacent Gulf waters--1963. U.S. Fish Wildl. Serv., Data Rep. 14, ii + 81 pp. on 2 microfiches.

KELLY, JOHN A., JR., and ALEXANDER DRAGOVICH.
1967. Occurrence of macrozooplankton in Tampa Bay, Florida, and adjacent Gulf of Mexico waters. U.S. Fish Wildl. Serv., Fish. Bull. 66: 209-221.

ROUNSEFELL, GEORGE A., and WALTER R. NELSON.
1966. Red-tide research summarized to 1964 including an annotated bibliography. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 535, iii + 85 pp.

ROUNSEFELL, GEORGE A., and ALEXANDER DRAGOVICH.
1966. Correlation between oceanographic factors and abundance of the Florida red tide (Gymnodinium breve Davis), 1954-61. Bull. Mar. Sci. 16: 404-422.

SYKES, JAMES E.
1967. Report of the Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida, Fiscal Year 1966. U.S. Fish Wildl. Serv., Circ. 257, iii + 18 pp.

MANUSCRIPTS IN PRESS

DRAGOVICH, ALEXANDER
Preliminary observations of morphological variations of Gymnodinium breve Davis under natural conditions. J. Fla. Acad. Sci.

FINUCANE, JOHN H., and RALPH W. CAMPBELL, II.
Attachment, growth, and survival of American oysters in Old Tampa Bay, Florida. J. Fla. Acad. Sci.

FINUCANE, JOHN H., and GORDON R. RINCKEY.
A study of the African cichlid, Tilapia heudeloti Dumeril, in Tampa Bay, Florida. Proc. Southeast Game Fish Comm. 18th Annu. Sess.

SALOMAN, CARL H.
Diel and seasonal occurrence of pink shrimp, Penaeus duorarum Burkenroad, in two divergent habitats of Tampa Bay, Florida. Spec. Sci. Rep. Fish. 561, ii + 6 pp.

SALOMAN, CARL H., DONALD M. ALLEN, and THOMAS J. COSTELLO.
Distribution of three species of shrimp (genus Penaeus) in waters contiguous to Southern Florida. Bull. Mar. Sci.

SYKES, JAMES E.
The role of research in the preservation of estuaries. Trans. 32d N. Amer. Wildl. Natur. Resourc. Conf.

Commercial values of estuarine-generated fisheries in the south Atlantic and Gulf of Mexico coasts. Proc., Symposium on Marsh and Estuary Management, La. State Univ., Baton Rouge, La., July 19-20.

TAYLOR, JOHN L., and CARL H. SALOMAN.
The oarfish, Regalecus glesne; a new occurrence and previous records from the Gulf of Mexico. Copeia.

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