ADDITIONAL STUDIES OF THE FISHES, MACROINVERTEBRATES, AND HYDROLOGICAL CONDITIONS OF UPLAND CANALS IN TAMPA BAY, FLORIDA

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ABSTRACT

Hydrological and biological data from a concluding study of upland canals in Tampa Bay, Fla., are presented and compared with those collected the previous year. Critically low levels of dissolved oxygen occurred more frequently and over a longer period of time in the second year. Most affected were the inland portions of the canal system where the number of species declined markedly over the previous year. Impoverishment of fauna on or near the bottom is expected to recur during summer months because of oxygen depletion resulting from a combination of continuing accumulation of decomposing organic sediment, warm water, and little circulation in the dead-end canals.

In order to create waterfront property while not violating legislation that curtails dredging and filling of wetlands below the mean high-water line, land developers in Florida and elsewhere are digging access canals that lead from open water to upland acreage (Barada and Partington 1972). Florida's shoreline has already been extensively altered by such practice (McNulty et al. 1972), and further alteration can be expected because of ever-increasing demand for waterfront property. If the coastal zone is to be managed wisely, information on the suitability of these man-made waterways as habitat for aquatic organisms is urgently needed.

In June 1970 a small, upland canal system in Old Tampa Bay, Fla., was completed (Figure 1). This offered a unique opportunity to study the development of and changes in ecological conditions in upland canals. The fishes, macroinvertebrates, and hydrological conditions occurring in the canals during the first year following completion of the system were described by Lindall et al. (1973). In that study, however, the unusual occurrence of red tide (caused by *Gymnodinium breve*) and drought produced conditions that were atypical for the area. Conditions during our second year were more typical. Further studies by us are unlikely owing to closure of the laboratory at St. Petersburg Beach and relocation of personnel. Thus, we present the results from our follow-up study in this paper. We discuss the hydrological conditions and biota found in the canals during the second year and make comparisons with those found in the first year.

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STUDY AREA AND METHODS

The study area, known as Tanglewood Estates, is located on the southwest shore of Old Tampa Bay in northeast St. Petersburg, Fla. (Figure 1). Development of the canal system, sampling procedures, sampling gear, and station descriptions were reported previously (Lindall et al. 1973). Briefly, sampling consisted of trawling at each station in the canals with concomitant measurements of temperature, salinity, and oxygen. Sampling was conducted monthly from October 1971 through September 1972.

TEMPERATURE

Water temperatures at the control and canal stations are shown in Figure 2. At the control station (Station 1) surface and bottom temperatures ranged from 20.0° to 29.3°C and were nearly identical in any one sampling period. The greatest difference was in December when the bottom was 1.1°C higher than the surface. Canal stations showed greater temperature ranges than the control station. They ranged from 20.0° to 30.6°C at the surface and 17.8° to 29.7°C at the bottom. With few exceptions, water temperature at the bottom

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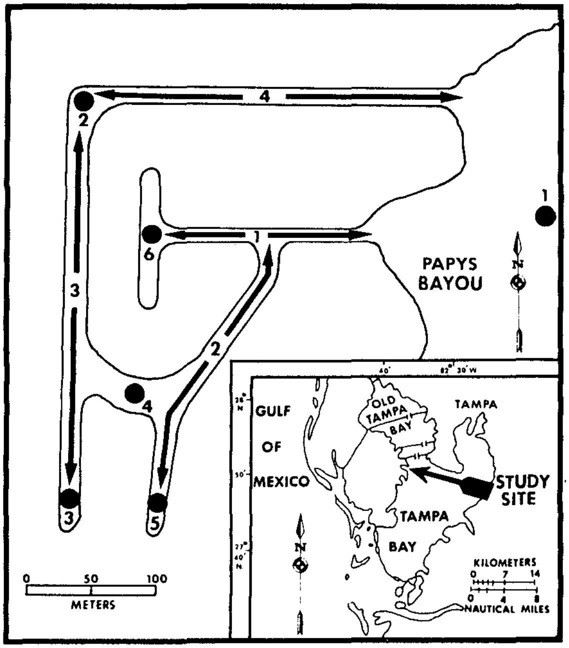

FIGURE 1.—Tampa Bay, Fla., showing location of study area and sampling stations (hydrologic station • ; trawl station ⟵⟶).

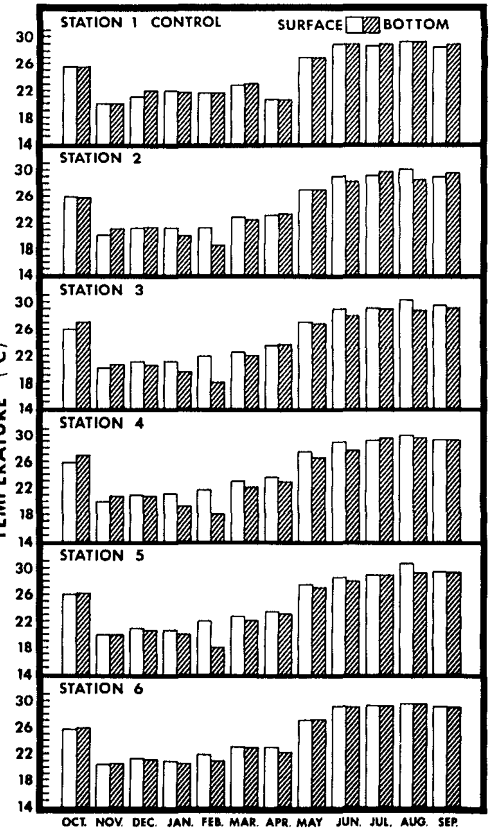

FIGURE 2.—Monthly water temperature at the surface and bottom of all hydrologic stations, October 1971-November 1972.

of the canals was lower than at the surface in any one sampling period. A definite thermocline was noted in January and February with the most inland stations exhibiting the greatest differences between surface and bottom temperatures. The greatest difference was at Station 5 in February when the bottom was 4.0°C lower than the surface.

In the previous year's study, the greatest difference was at Station 4 (February 1971) when the bottom was 1.8°C lower than at the surface (Lindall et al. 1973).

SALINITY

Surface and bottom salinities at the control station ranged from 19.1 to 28.0‰ during the study and were nearly identical in any one sampling period (Figure 3). The greatest difference was in May when the bottom was 0.7‰ lower than the surface. Surface salinities at canal stations were similar to those at the control station, ranging from 19.1 to 28.5‰. With few exceptions, however, salinity at the bottom of the canals was higher than at the surface in any one sampling period. The greatest difference was at Station 3 in October when the bottom was 4.5‰ higher than the surface.

Stratification of salinity was also noted in the previous year's study (Lindall et al. 1973). Differences between surface and bottom were not as pronounced during most of that study because drought conditions prevailed throughout most of the year. Heavy rains in August 1971 ended the drought. Thus, greater differences between surface and bottom salinities (as much as 15‰) were recorded in the previous study than in the present study.

OXYGEN

Dissolved oxygen levels at each station are shown in Figure 4. Only at the control station were surface and bottom values similar, differing no more than 0.3 ml/liter in any one sampling period. At this station the lowest observed concentration was 2.2 ml/liter (July 1972). Surface oxygen values in the canals ranged from 2.4 to 6.2 ml/liter and were similar to those at the control station throughout the year. Oxygen at the bottom

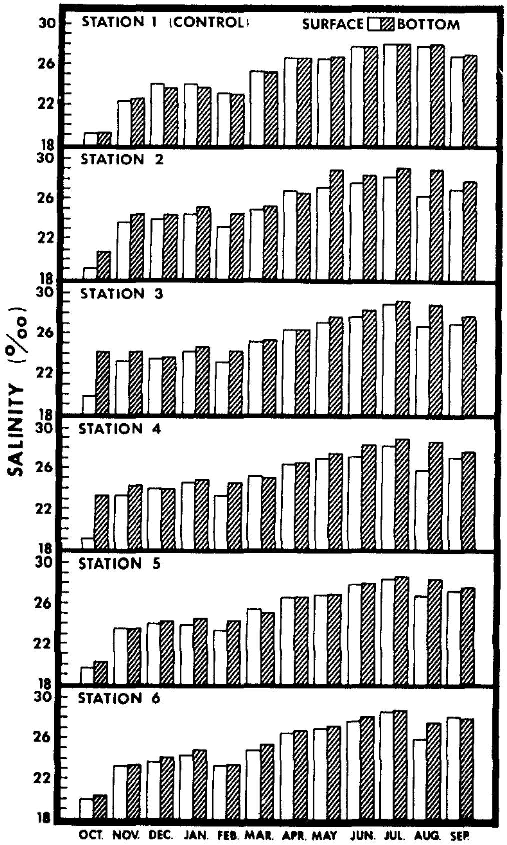

FIGURE 3.—Monthly salinity at the surface and bottom of all hydrologic stations, October 1971-November 1972.

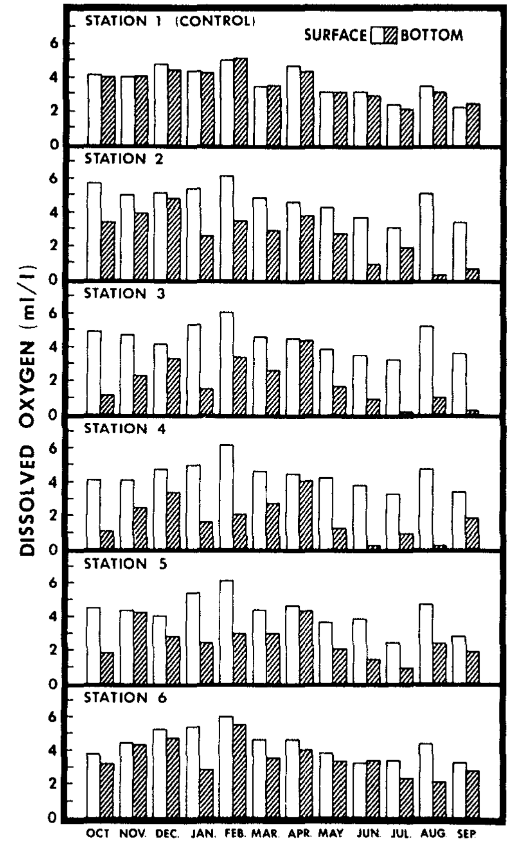

FIGURE 4.—Monthly dissolved oxygen at the surface and bottom of all hydrologic stations, October 1971-November 1972.

of the canals was always less than at the surface with the single exception of Station 6 in June. Moreover, about 50% of the bottom samples taken throughout the year at stations farthest from the bayou (Stations 3-5) contained less than 2.0 ml/liter of oxygen; several were anoxic or nearly so. At Station 6, closest to the bayou, oxygen levels were never observed to be less than 2.1 ml/liter. Trent et al. (1972) also reported oxygen depletion at inland portions of housing development canals in Galveston Bay, Tex., during the summer.

Results of the previous year's study showed severe oxygen depletion in the canals during the summer months following a red tide (caused by *Gymnodinium breve*) outbreak (Lindall et al. 1973). In that study decaying fish killed by the red tide placed additional oxygen demand on the system and precluded the determination of the extent to which dissolved oxygen would have been depressed in the absence of red tide. In the present study, no red tide occurred, but oxygen was again depleted at the bottom of the most inland stations in the canals during the summer. In fact, low dissolved oxygen occurred more frequently and over a longer period of time (October 1971 and May through September 1972) than in the previous year.

FISHES AND MACROINVERTEBRATES

Thirty-eight species and 9,502 individuals of vertebrates and invertebrates were collected in the canals during the year (Table 1). Of the 38 species, 34 were finfish, 1 was the diamondback terrapin, *Malaclemys terrapin*, and 3 were commercially important invertebrates (blue crab, *Callinectes sapidus*; pink shrimp, *Penaeus duorarum*; and brief squid, *Lolliguncula brevis*). Fourteen of the 34 species of finfish did not occur in the previous year's catch. These 14 species, however, made up less than 1% of the total catch.

TABLE 1—Monthly occurrence and number of individuals of vertebrates and invertebrates collected with otter trawl at all stations from October 1971 through September 1972.

Species	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total No.	Total %
Vertebrates:														
Anchoa mitchilli	429	1,360	3,368	1,516	296	360	0	1,005	42	6	22	449	8,853	93.2
Anchoa hepsetus	0	0	0	0	0	0	0	208	1	0	1	0	210	2.3
Bairdiella chrysura	0	0	19	0	0	0	4	29	41	1	1	0	95	1.1
Chaetodipterus faber	0	0	9	0	0	0	1	1	16	5	1	1	34	0.5
Syngnathus scovelli[1]	0	0	0	0	4	1	0	7	5	0	0	0	17	0.2
Lagodon rhomboides	0	0	0	0	0	2	6	3	3	0	0	0	14	0.1
Gobiosoma bosci	0	1	1	0	2	4	0	2	3	0	0	0	13	0.1
Pogonias cromis	0	0	1	1	0	2	8	0	0	0	1	0	13	0.1
Lucania parva[1]	0	0	1	1	2	2	0	4	0	0	0	0	10	0.1
Diapterus plumieri[1]	0	0	4	0	2	0	0	0	0	0	2	1	9	0.1
Eucinostomus argenteus	0	0	7	1	0	0	0	1	0	0	0	0	9	0.1
Menticirrhus americanus	0	1	0	0	0	0	0	5	0	2	1	0	9	0.1
Cynoscion arenarius	0	0	0	0	0	0	0	3	0	1	2	2	8	0.1
Orthopristis chrysoptera	0	0	0	0	0	0	4	1	0	0	0	0	5	0.1
Eucinostomus gula	0	0	0	0	0	0	0	0	4	0	0	0	4	0.1
Trinectes maculatus[1]	0	0	4	0	0	0	0	0	0	0	0	0	4	0.1
Cynoscion nebulosus	0	0	0	0	0	0	0	3	0	0	0	0	3	0.0
Microgobius gulosus	0	0	0	0	0	0	0	0	0	1	1	1	3	0.0
Opisthonema oglinum	0	0	0	0	0	0	1	2	0	0	0	0	3	0.0
Sciaenops ocellata	0	0	1	1	1	0	0	0	0	0	0	0	3	0.0
Sphoeroides nephelus	0	2	0	0	1	0	0	0	0	0	0	0	3	0.0
Chilomycterus schoepfi[1]	0	0	0	0	0	0	0	1	1	0	0	0	2	0.0
Epinephelus itajara[1]	0	0	0	1	0	0	0	0	0	1	0	0	2	0.0
Gobiosoma robustum[1]	0	0	0	0	0	1	0	1	0	0	0	0	2	0.0
Hippocampus erectus[1]	0	0	0	0	1	0	0	0	0	0	1	0	2	0.0
Leiostomus xanthurus	0	0	0	0	0	2	0	0	0	0	0	0	2	0.0
Malaclemys terrapin	0	0	0	0	0	0	0	0	1	0	0	1	2	0.0
Monacanthus hispidus[1]	0	0	0	0	0	1	0	1	0	0	0	0	2	0.0
Syngnathus louisianae[1]	0	0	0	0	0	0	0	1	0	1	0	0	2	0.0
Archosargus probatocephalus	0	0	0	0	0	0	0	0	1	0	0	0	1	0.0
Arius felis	0	0	0	0	0	0	0	0	0	0	1	0	1	0.0
Elops saurus[1]	0	0	0	0	1	0	0	0	0	0	0	0	1	0.0
Harengula pensacolae[1]	0	0	0	0	0	0	0	1	0	0	0	0	1	0.0
Hippocampus zosterae[1]	0	0	0	0	0	0	0	0	0	1	0	0	1	0.0
Lactophrys quadricornis[1]	0	0	0	0	0	0	0	0	0	1	0	0	1	0.0
Invertebrates:														
Lolliguncula brevis	0	0	1	0	1	11	7	17	21	13	0	15	86	0.9
Callinectes sapidus	0	4	11	8	5	4	10	2	3	0	1	1	49	0.5
Penaeus duorarum	0	1	5	6	1	0	0	1	1	3	3	2	23	0.2
Total species	1	6	13	8	12	11	8	22	14	12	13	9	38	
Total individuals	429	1,369	3,432	1,535	317	390	41	1,299	143	36	38	473	9,502	100.0

[1]Did not occur in catches from August 1970 through August 1971 (Lindall et al. 1973).

The four species of finfish caught in greatest abundance represented 97% of the total number of specimens (Table 1). They were the bay anchovy, *Anchoa mitchilli*; striped anchovy, *A. hepsetus*; silver perch, *Bairdiella chrysura*; and Atlantic spadefish, *Chaetodipterus faber*. The bay anchovy alone accounted for more than 93% of the total number caught.

In the previous year's study (Lindall et al. 1973) the four dominant species of fish, representing 92% of the catch, were bay anchovy (7,557 individuals—72%); spotfin mojarra, *Eucinostomus argenteus* (921 individuals—8.8%); spot, *Leiostomus xanthurus* (821 individuals—7.8%); silver jenny, *Eucinostomus gula* (372 individuals—3.5%). The latter three species combined consisted of only 15 individuals in the present study and made up only 0.2% of the catch (Table 1). Each of these three species is a bottom feeder (Darnell 1958; Springer and Woodburn 1960; Carr and Adams 1973), and the prolonged period of low dissolved oxygen at the bottom of the canals probably accounted for the 99% reduction in their numbers.

The brief squid was the most abundant invertebrate (54% of all invertebrates collected) and made up about 1% of all animals collected during the year. Based on the previous year's catch, the number of squid in the canal system declined by about 78%, while the total numbers of pink shrimp and blue crab remained about the same.

Of the 38 species collected during the year, most occurred at Station 4 (28 species), followed by Station 1 (21 species), Station 3 (18 species), and Station 2 (14 species). Compared with the previous year, the number of species collected at Stations 1 and 4 were about the same, but those at Stations 2 and 3 declined markedly (30% and 50% respectively). We were not surprised to find fewer species at Stations 2 and 3, because these stations are farthest from the bayou and were most affected by the critically low oxygen levels. As evidence, catches at the four trawl stations during the summer period of low dissolved oxygen (July-August) are compared in Figure 5. The vast majority of species and individuals occurred nearest the bayou (Stations 1 and 4) during this period of stress.

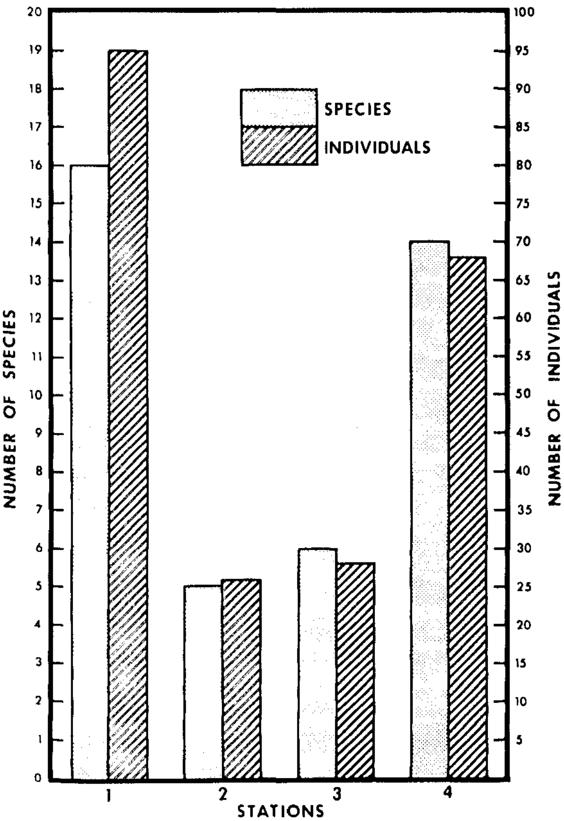

FIGURE 5.—Number of species and individuals caught at each trawl station during the summer period of low dissolved oxygen (June through August 1972).

CONCLUSIONS

The upland canal system known as Tanglewood Estates is poorly designed with respect to providing year-round, quality habitat for estuarine species of fish and shellfish. Apparently caused by prolonged periods of low dissolved oxygen at the bottom of the canals, the numbers of squid (*Lolliguncula brevis*) and three species of finfish (*Eucinostomus argenteus*, *E. gula*, and *Leiostomus xanthurus*) were drastically reduced in the second year of the system's existence. We believe that the ability of the canal system to provide adequate oxygen for respiration of bottom-dwelling fishes is becoming progressively worse. The main causative factors are: 1) lack of water exchange with the adjacent bayou, 2) water depths greater than the depth of the photic zone, thus preventing photosynthesis by benthic flora, and 3) continuing accumulation of decomposing soft sediments (Hall and Lindall[4]).

The major advantages of upland canal development, as opposed to bayfill development, are that bay bottom is not adversely altered and water circulation patterns are not altered significantly. In fact, estuarine area is increased. However, as long as land developers continue to design upland canals with dead ends and excessive depths, oxygen depletion and the resulting impoverishment of fauna on or near the bottom can be expected to be a recurring problem in summer months.

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