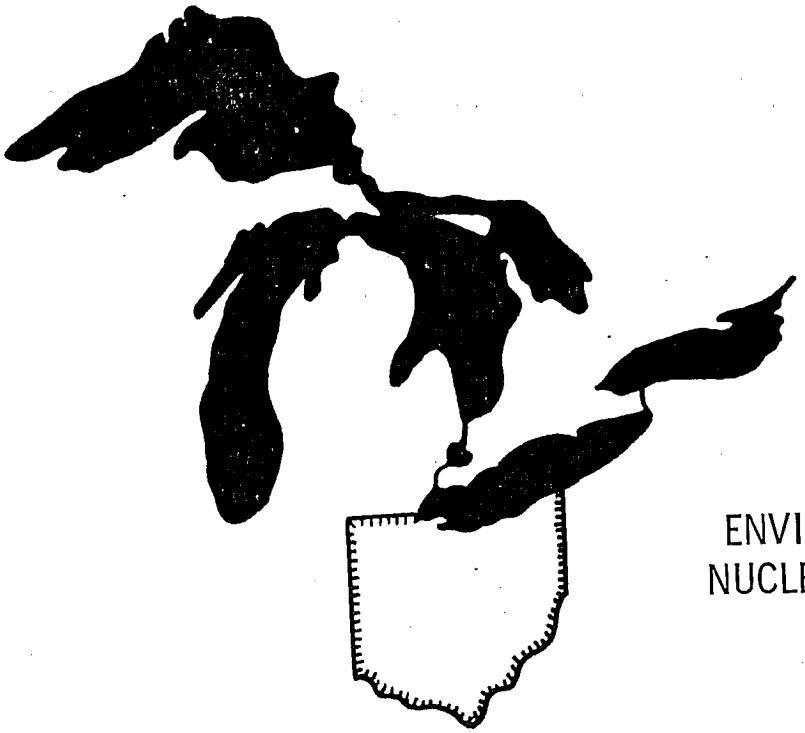
CLEAR TECHNICAL REPORT NO. 142



# ENVIRONMENTAL EVALUATION OF A NUCLEAR POWER PLANT ON LAKE ERIE

June 1969--May 1971

Prepared for

U. S. Fish and Wildlife Service
Ohio Department of Natural Resources
Division of Wildlife

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COLUMBUS, OHIO

October 1979
(Originally prepared in May 1972)

JOB COMPLETION REPORT

RESEARCH COMPLETION SEGMENT

State of: Ohio

Project No. F-41-R-3

Job No.: 1-A

Period Covered: June 1, 1969-May 31, 1972

Date: May 31, 1972

Name: Environmental Evaluation of a Nuclear Power Plant

Title: Fish Population Prior to Discharge


## ABSTRACT

Fish populations were sampled during ice-free months from June, 1969 through May, 1971 using a 150-ft. bag seine, 2750-ft. commercial seine, and three 150-ft. experimental gill nets.

Carp*, gizzard shad, freshwater drum and white bass were found during every sampling period. Carp were the most abundant over-all, normally comprising more than 80% of the sample. Drum and gizzard shad were next in abundance.

In general, the spring and early summer samples contained a greater percentage of adult fish, while the late summer and fall samples reflected the recruitment of young-of-the-year fish.

Chironomid larvae were the most frequently-found food items for most species in all months. There was little evidence of a seasonal change in food habits. Some species (drum, white bass) showed size-related changes in food habits.


* In this report, carp refers to carp, goldfish and/or carp-goldfish hybrids.

## RECOMMENDATIONS

Sampling of fish populations should be repeated after the nuclear power plant is in operation. Seasonal samples between now and then (1974) would be desirable in order to detect any major changes in the populations before discharge.

## OBJECTIVES

The objective of this job was to determine the composition and character of the fish populations in the area prior to discharge.

## TECHNIQUES USED

Sampling: Three transects in the Locust Point area were established in 1969 for sampling fish populations. The same three transects were used in 1970 and 1971 (Fig. 1). Transect 1 begins 1,000 ft. west of the Toussaint River and runs toward West Sister Island. Transect 2 runs from the mouth of the Toussaint River to Niagara Reef and Transect 3 starts 1,000 ft. east of the river and runs toward South Bass Island.

Mr. Virgil St. Clair, a commercial fisherman, operated his 2750-ft. seine east of the Toussaint River in the area of Transect 3. This net was from 12 to 16 ft. deep with 5" mesh at the outsides. The mesh gradually decreased in size toward the bat, which was 2-1/4" mesh. Fish were sampled with this gear once a month from June through October, 1969, May through October, 1970, and April and May, 1971.

The 150-ft. bag seine was fished at five locations; one haul was made at the base of each transect, one haul between Transects 1 and 2 and one haul between Transects 2 and 3. The net was 6 ft. deep with 3/4" mesh in the wings and 1/4" mesh in the bag. Fish were sampled by this method in July, August and October, 1969, May through October, 1970 and May, 1971.

Three experimental gill nets were set, one along each transect. They were fished overnight perpendicular to shore with the small mesh set closest to shore in about 8 feet of water. The nets were 6 ft. deep and 150 ft. long, consisting of contiguous 30-ft. panels of stretch mesh from 1/4" to 3". Gill nets were set once a month from August through October, 1969 and in May and August, 1970.

Species Composition: The catch of each species by each method was determined after every sampling period, as was the total catch for each gear. Except for carp all fish were weighed and measured and scales taken from representatives of each size group. When the commercial seine catch contained too many carp to process feasibly, Mr. St. Clair estimated the total catch. Catch per unit effort (CPE) was determined for each gear and a comparison was made between the relative numbers of individuals and species for each gill net and 150-ft. seine haul.

Age-Growth: Scales were read using a Bausch & Lomb microprojector and annular measurements made to enable back calculation of growth rate. Length-frequen plots were used for determining ages of shiners. Age data was compared with and supplemented by data from the Lake Erie Research Unit, Ohio Division of Wildlife, and Carlander's (1969) data for Lake Erie fishes.

Food Habits: Representatives of different size groups and species were weighed, measured and their stomachs preserved in 5% formalin as soon as possible after capture. Only live, seined fish were used for this study. Stomach contents were identified as far as possible and enumerated. Because of the small stomach volumes and diversity of food items, the numerical approach was used rather than the volumetric method.

Frequency of occurrence was calculated for each food item for each fish species. Differences from month to month were examined and food habits of different sized individuals of the same species were compared.

## FINDINGS

Species Composition: Appendix I is a list of scientific and common names of all fish taken. Table I shows the species present in each month of sampling. Altogether 33 species were found, although the greatest number for any one month was 21 (May, 1970). Fewest species (12) were taken in July and September, 1970.

Freshwater drum, carp (including goldfish and/or hybrids), gizzard shad and white bass were taken during every month sampled, while several species (spotted and white suckers, stonecat, rockbass, smallmouth and largemouth bass, green sunfish and logperch) occurred only once or twice. The number of species in part reflected the methods used, since not all sampling methods were used every month.

In every month except October, 1969 and August, 1970, carp and goldfish made up at least 60% by weight of the total sample. Next in abundance were gizzard shad and drum. In the two other months freshwater drum were most abundant. Total catches were greatest in the late spring and early fall samples and lowest in the summer months.

Tables 2, 3, and 4 show catch per unit effort (CPE) for the three sampling methods for each month. Data for the 2750-ft. seine is expressed as pounds per haul, for the 150-ft. seine as individuals per haul and for the gill nets as individuals per net. Since the 2750-ft. seine captured the large individuals of each species and too many individuals to count feasibly, the catch was expressed as pounds rather than numbers of individuals. The 150-ft. seine, on the other hand, took mostly young-of-the-year fish and shiners; thus it was more practical to express these catches as numbers of individuals.

Tables 5 and 6 are comparisons of the numbers of individuals each month at each sampling location for the gill net and 150-ft. seine catches. Since the 2750-ft. seine was pulled at only one location each month, there is no similar data for it.

The greatest numbers of individuals were taken most often West of the Toulssaint River and the fewest individuals were most often taken East of the river. No seasonal trend in numbers of species or individuals at a given location was detected, but numbers seemed lower in August and September, 1970 than the same months of 1969.

Age-Growth: Data from several sources was combined to give a view of the age structure of fishes in the Locust Point area. Table 7 shows the mean length for each age class of most species collected. The figures are from work done in this study, from the Lake Erie Research Unit of the Ohio Division of Wildlife and from Carlander's (1969) information on Lake Erie fishes.

Samples in early spring were comprised mostly of adult individuals. As the summer progressed, young-of-the-year individuals, as well as yearlings, became more abundant. Young-of-the-year white bass, shiners, drum, gizzard shad and alewife were taken only in the 150-ft. bag seine. Young-of-the-year carp and goldfish were never taken and only a few young-of-the-year channel catfish were captured.

Table 8 shows the size composition of the species frequently captured, using all three methods. This table reflects type of gear used as well as population changes, since not all sizes of fish were equally susceptible to all types of gear.

Food Habits: From June, 1969 through May, 1971, 1919 stomachs were examined, 71.8% of which contained food. The number of stomachs examined each month and the number containing food is shown in Table 9. A seasonal pattern

was evident, with a greater percentage of stomachs containing food in the summer months than in the spring and fall (Fig. 2). All the percentages may be lower than in actuality since it is common for fish to regurgitate when they are caught and handled.

Table 10 shows the frequency of occurrence of various food items in Locust Point fish stomachs from June, 1969 through May, 1971. The percent frequency of occurrence is based on the number of stomachs containing food. "Unidentifiable debris" included material too digested to be identified as well as sand, silt and gravel. Results are probably biased toward hard-to-digest organisms, since they would remain in the stomach longer.

Stomach contents of carp and goldfish were the most difficult to identify, but almost always included copepods and cladocerans. In addition, insects and amphipod remains were frequently found, as was plant material.

Gizzard shad stomach contents were predominantly zooplankton and phytoplankton, but most contained significant amounts of silt or sand grains.

Freshwater drum under 6 inches long ate no fish; their major food items were chironomid larvae (mostly Chironomus (Chironomus), C. (Cryptochironomus) and Glyptotendipes. Other insects and cladocerans occurred occasionally. The three species of chironomids found were the most abundant ones found in benthos samples from the area. The species were plentiful in all open-lake samples, from all substrate types and seldom occur in emergent vegetation along the shore.

Drum between 6 and 12 inches long ate primarily Chironomidae, but contained a wider variety of other insects, including Hemiptera and Odonata, than those shorter than six inches. Drum larger than 12-inches contained fish

almost exclusively. The apparent seasonal trend toward a greater occurrence of Chironomidae in late summer and fall is probably due to recruitment of young-of-the-year drum into the population rather than an actual change in food habits.

White bass showed a similar size-related pattern, the small individuals utilizing zooplankton and Chironomidae and the larger ones feeding almost entirely on fish. No such pattern was evident for yellow perch. All sizes fed about equally on Chironomidae and fish.

Emerald and spottail shiners fed mainly on insects. The large individuals utilized Cladocera and Copepoda extensively, but diets of young-of-the-year individuals (less than 2.8 inches) were not so restricted. The diversity of insects eaten (Chironomidae and other Diptera, Odonata, Trichoptera, Hemiptera and Coleoptera) indicated the shiners were feeding on the surface and in emergent vegetation, perhaps into the Toussaint River, as well as in the open lake.

Both bullheads and channel catfish were omnivorous, feeding on everything from cladocerans to fish. The occurrence of the midge Cricotopus, dipterans other than Chironomidae, and Coleoptera indicates considerable shallow-water or upstream feeding as well as open-water feeding suggested by the presence of C. (Cryptochironomus), amphipods, and Gastropoda.

Amphipods were utilized by all species of fish except gizzard shad. They occurred especially frequently in the spring, perhaps before many small fish were available as food.

All species of fish utilized food organisms found in the Locust Point area, both in the open lake and along the shore or in the river. Food items found included benthic invertebrates from all substitutes in the area (silt and sand bottom, gravel and clay bottom and the reefs). The plankters utilized corresponded with those predominant in most of the plankton samples (Daphnia retrocurva, Bosmina sp., Chydorus sp. and cyclopoid copepods).

## LITERATURE CITED

Baker, Carl. 1969. Lake Erie Fish Population Trawling Survey. Dingell-Johnson Project F-35-R-7, Job #3. 32 pp.

Carlander, K. D. 1969. Handbook of Freshwater Fishery Biology. Vol. I. Iowa State Univ. Press, Ames, Iowa. 752 pp.

Table 1. Species compositon of Locust Point fish populations in the months sampled from 1969 to 1971. The presence of a species during a given month is indicated by an X.

| | 1969 | | | | | 1970 | | | | | | 1971 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J[a*] | J[ac*] | A[abc*] | S[ab] | O[abc] | M[abc] | J[ac] | J[ac] | A[abc] | S[ac] | O[ac] | A[a] | M[ac] |
| longnose gar | | | X | | | | X | | | | | | |
| bowfin | X | X | | | | | X | | | | | | |
| alewife | | X | X | X | | X | X | | | | | | X |
| gizzard shad | X | X | X | X | X | X | X | X | X | X | X | X | X |
| coho salmon | | | | X | | | | | X | | | X | |
| American smelt | | X | | | X | X | | | X | | | | X |
| northern pike | | | | X | | X | | | X | | | | |
| carp | X | X | X | X | X | X | X | X | X | | X | X | |
| goldfish | X | X | X | X | X | X | X | X | | X | X | | X |
| carp X goldfish | X | X | X | X | X | X | X | X | X | X | X | X | X |
| silver chub | | | | | | X | X | | | | | | |
| emerald shiner | | X | X | X | X | X | X | X | X | X | X | | X |
| spottail shiner | | X | X | X | X | X | X | X | X | X | X | | X |
| spotfin shiner | | X | | | | | X | | | | | | |
| quill back | X | X | X | X | | X | | | | X | X | X | X |
| golden redhorse | X | | | X | | X | | | | | X | X | X |
| white sucker | | | | | | X | | | | | | X | |
| spotted sucker | | | | | | X | | | | | | | |
| channel catfish | X | X | X | X | | X | X | X | X | X | X | X | |
| brown bullhead | X | X | X | X | | X | X | X | X | X | X | X | X |
| stonecat | | | | | | | | | X | | | | |
| white bass | X | X | X | X | X | X | X | X | X | X | X | X | X |
| white crappie | X | X | X | X | X | X | X | X | X | | X | | X |
| black crappie | | X | X | | | X | | | | X | | X | X |
| rock bass | | | | | | | X | | | | | | |
| smallmouth bass | | | | | X | | | | | | | | |
| largemouth bass | | | | X | | X | | | | | | | |
| green sunfish | | X | | | | | | | | | | | |
| orange spotted sunfish | | X | | | | | | | | X | X | | |
| walleye | | | | | | X | | X | X | | | X | |
| yellow perch | X | X | X | X | X | X | X | X | X | X | | X | X |
| log perch | | | | | | | | X | | | X | | |
| freshwater drum | X | X | X | X | X | X | X | X | X | X | X | X | X |
| TOTAL SPECIES | 13 | 20 | 16 | 18 | 11 | 21 | 17 | 12 | 15 | 12 | 14 | 13 | 14 |

* a=commercial seine
* b=gill nets
* c=150-ft. bag seine

Table 2. Catch per unit effort (lbs/haul), using the 2750-ft. shore seine.

| | 1969 | | | | | 1970 | | | | | | 1971 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | May | June | July | Aug. | Sept. | Oct. | Apr. | May |
| Alewife | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0.6 |
| Gizzard shad | unknown | | unknown | | 58 | 17 | 23 | 8.1 | 0 | 7.2 | 207 | 6.0 | 10.1 |
| Carp | unknown | | unknown | 526 | 55 | 2055 | 1405 | 270 | 1.9 | 502 | 1026 | 14,000 | 1000 |
| Quillback | 21 | 2.8 | unknown | 1.9 | 0 | 18 | 0 | 0 | 0 | 1.8 | 2.8 | 28 | 68 |
| Channel catfish | 21 | 9.6 | unknown | 15 | 0 | 1.2 | 8.2 | 6.5 | 3.0 | 11 | 1.4 | 7.9 | 0 |
| Brown bullheads | 9.9 | 0.8 | unknown | 1.3 | 0 | 2.3 | 2.3 | 8.3 | 0.9 | 3.4 | 0.5 | 5.8 | 7.4 |
| Golden redhorse | 0.4 | 0 | 0 | 0 | 0 | 1.7 | 0 | 0 | 0 | 0 | 0.9 | 5.3 | 0.4 |
| White sucker | 0 | 0 | 0 | 0 | 0 | 7.8 | 0 | 0 | 0 | 0 | 0 | 26 | 0 |
| White bass | 4.1 | 3.3 | 4.0 | 30 | 0 | 0 | 11 | 7.0 | 0.4 | 1.5 | 0 | 9.5 | 17 |
| Crappie | 0.4 | 0 | unknown | 0.3 | 0 | 2 | 0.5 | 1.8 | 0.8 | 0.2 | 0 | 1 | 0.4 |
| Walleye | 0 | 0 | 0 | 0 | 0 | 9.4 | 0 | 0 | 0 | 0 | 0 | 2.5 | 0 |
| Yellow perch | 0.8 | 0.3 | unknown | 2.3 | 0.2 | 3.3 | 2.1 | 0.5 | 0.8 | 0.2 | 0 | 15 | 2 |
| Freshwater drum | 44 | 19 | unknown | 8.2 | 0 | 42 | 16 | 114 | 7.5 | 16.0 | 0 | 75 | 64 |
| Coho salmon | 0 | 0 | 0 | 1.6 | 0 | 0 | 0 | 0 | 1.2 | 0 | 0 | 6.8 | 0 |
| TOTAL LBS. | 101.6 | 35.8 | total unknown | 586.6 | 113.2 | 2159.8 | 1468.4 | 416.2 | 16.5 | 543.3 | 1238.6 | 14,188.8 | 1169.9 |

*excluding gizzard shad and carp

**excluding gizzard shad

Table 3. Catch per unit effort (numbers per haul), using the 150-ft. bag seine.

| | 1969 | | | | | 1970 | | | | | | 1971 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | May | June | July | Aug. | Sept. | Oct. | Apr. | May |
| Alewife | No Sample | 20 | 9.7 | No Sample | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | No Sample | 0 |
| Gizzard shad | " | 141.2 | 71.3 | " | 237 | 0 | 0 | 2519 | 33 | 13.4 | 118.6 | " | 0 |
| Carp & Goldfish | " | 4.2 | 1 | " | 0.2 | 4.6 | 1 | 0 | 0 | 0.2 | 0.2 | " | 0 |
| Emerald shiner | " | 33.4 | 24 | " | 2 | 11.8 | 53.6 | 34.8 | 3.3 | 10.6 | 0.2 | " | 264.3 |
| Spottail shiner | " | 9.6 | 3.3 | " | 6.6 | 136.2 | 22.4 | 5.2 | 3.3 | 2.8 | 0.8 | " | 11.3 |
| Channel catfish | " | 0.2 | | " | 0 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | " | 0 |
| Brown bullhead | " | 0.6 | 0.3 | " | 0 | 0 | 0 | 0 | 0 | 0 | 0 | " | 0 |
| White bass | " | 32.2 | 9.7 | " | 2.6 | 2.6 | 0 | 89 | .3 | 9 | 0 | " | 0 |
| Crappie | " | 6.8 | 0.3 | " | 0.2 | 0.8 | 0 | 0.4 | .3 | 0 | 0.8 | " | 0.3 |
| Yellow perch | " | 0.6 | 0.3 | " | 0.2 | 0.4 | 0 | 0 | 0 | 0 | 0 | " | 0 |
| Drum | " | 0.2 | 0 | " | 0 | 0.2 | 0 | 0.2 | 0 | 0.4 | 0.2 | " | 0 |
| Sunfish | " | 0.8 | 0 | " | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | " | 0 |
| Black bass | " | 0 | 0 | " | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | " | 0 |
| Smelt | " | 0.1 | 0 | " | 0 | 0 | 0 | 0 | .7 | 0 | 0 | " | 1 |
| Walleye | " | 0 | 0 | " | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | " | 0 |
| TOTAL NUMBER | | 249.9 | 119.9 | | 249.0 | 156.8 | 76.6 | 2698.8 | 40.9 | 56.6 | 121.0 | | 276.9 |

Table 4. Catch per unit effort (numbers per net), using experimental gill nets.

| | 1969 | | | | | 1970 | | | | | | 1971 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | May | June | July | Aug. | Sept. | Oct. | Apr. | May |
| Alewife | No Sample | No Sample | 102 | 386 | 129 | 0.3 | No Sample | No Sample | 0 | No Sample | No Sample | No Sample | No Sample |
| Gizzard shad | " | " | 64.3 | 7.3 | 36 | 1.3 | " | " | 194.7 | " | " | " | " |
| Carp & Goldfish | " | " | 19.3 | 8.7 | 0.3 | 8.7 | " | " | 25 | " | " | " | " |
| Emerald shiners | " | " | 12.3 | 62 | 0 | 0.7 | " | " | 10.3 | " | " | " | " |
| Spottail shiners | " | " | 0 | | 101 | 227.7 | " | " | 0 | " | " | " | " |
| Channel catfish | " | " | 5 | 0.3 | 0 | 4.3 | " | " | 6.7 | " | " | " | " |
| Brown bullheads | " | " | 0 | 0 | 0 | 0 | " | " | 2.7 | " | " | " | " |
| White bass | " | " | 4.7 | 2.3 | 1 | 6.7 | " | " | 12.7 | " | " | " | " |
| Yellow perch | " | " | 207.7 | 85 | 29.3 | 3.7 | " | " | 50 | " | " | " | " |
| Freshwater drum | " | " | 1 | 12.3 | 2.7 | 0.7 | " | " | 6 | " | " | " | " |
| Crappie | " | " | 1.3 | 0 | 0.7 | 0 | " | " | 1 | " | " | " | " |
| Golden redhorse | " | " | 0 | 0.7 | 0 | 0 | " | " | 0 | " | " | " | " |
| Smelt | " | " | 0 | 0 | 0.3 | 0.3 | " | " | 0 | " | " | " | " |
| Walleye | " | " | 0 | 0 | 0 | 2 | " | " | 2 | " | " | " | " |
| TOTAL NUMBER | | | 417.6 | 564.6 | 300.3 | 256.4 | | | 311.1 | | | | |

Table 5. Numbers of individuals and species taken at each gill net location.

| | Transect 1 (West of river) | | Transect 2 (at river mouth) | | Transect 3 (East of river) | |
|---|---|---|---|---|---|---|
| | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. |
| 8/22/69 | 569 | 8 | 197 | 7 | 488 | 11 |
| 9/24/69 | 659 | 9 | 561 | 8 | 773 | 10 |
| 10/28/69 | 452 | 8 | 251 | 5 | 300 | 5 |
| 5/6/70 | 368 | 7 | 176 | 9 | 225 | 7 |
| 8/12/70 | 113 | 4 | 346 | 9 | 437 | 11 |

Table 6. Numbers of individuals and species taken at each 150-ft. bag seine haul location.

| | Transect 1 (West of river) | | Transect 1-2 (West of river) | | Transect 2 (river mouth) | | Transect 2-3 (East of river) | | Transect 3 (East of river) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. sp |
| 7/30/69 | 236 | 3 | 412 | 10 | - | - | - | - | 230 | 7 |
| 8/29/69 | 169 | 9 | - | - | 122 | 6 | - | - | 71 | 5 |
| 10/29/69 | 365 | 7 | 349 | 3 | 295 | 3 | 63 | 5 | 265 | 5 |
| 5/6/70 | 100 | 5 | 287 | 7 | 335 | 8 | 43 | 6 | 21 | 3 |
| 6/12/70 | 166 | 5 | 27 | 2 | 90 | 3 | 16 | 4 | 97 | 8 |
| 7/18/70 | 30 | 5 | 208 | 3 | 275 | 4 | 4113 | 3 | 3518 | 7 |
| 8/22/70 | 58 | 2 | 14 | 4 | 51 | 5 | - | - | - | - |
| 9/21/70 | 31 | 4 | 31 | 5 | 86 | 4 | 19 | 6 | 17 | 4 |
| 10/24/70 | 242 | 5 | 219 | 5 | 117 | 2 | 8 | 2 | 19 | 4 |
| 5/15/71 | 657 | 1 | - | - | 123 | 3 | - | - | 51 | 4 |

Table 7. Mean total length and range (in inches), where available, of indicated age class for some species captured in the Locust Point area.

| | 0 | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|---|
| Alewife [b] | 1.5-5.9<br>$\bar{x}$=4.4 | | | | | | |
| Gizzard shad [b] | $\bar{x}$=6.4 | $\bar{x}$=10.9 | $\bar{x}$=12.8 | $\bar{x}$=13.6 | $\bar{x}$=14.3 | | |
| Carp [c] | 0.7-8.0<br>$\bar{x}$=6.0 | $\bar{x}$=6.5 | $\bar{x}$=8.7 | $\bar{x}$=9.6 | $\bar{x}$=13.9 | $\bar{x}$=13.9 | $\bar{x}$=15.7 |
| Goldfish [c] | | x=3.5 | 5.0-6.0 | | | | |
| Quillback [c] | 1.5-2.2 | 9.5-9.7 | 10.9-15.4 | 14.9-16.5 | | | |
| Emerald shiner [ab] | 1.7-3.1[b]<br>$\bar{x}$=2.6[b] | 2.2-3.4[a] | 3.0-3.8[a] | | | | |
| Spottail shiner [ab] | 1.8-3.5[b]<br>$\bar{x}$=2.8[b] | 3.4-4.6[a] | 4.5-5.1[a] | 4.9-5.5[a] | | | |
| Channel catfish [b] | $\bar{x}$=4.8 | $\bar{x}$=7.9 | $\bar{x}$=10.1 | $\bar{x}$=12.2 | $\bar{x}$=13.2 | $\bar{x}$=15.3 | $\bar{x}$=15.9 |
| Brown bullhead [c] | 2.0-4.9 | 2.7-6.0 | | | | | |
| White bass [b] | 2.0-6.0<br>$\bar{x}$=4.1 | $\bar{x}$=10.1 | $\bar{x}$=11.8 | $\bar{x}$=12.6 | $\bar{x}$=13.4 | $\bar{x}$=14.6 | |
| Yellow perch [b] | 2.2-4.7<br>$\bar{x}$=2.6 | 5.1-6.9<br>$\bar{x}$=6.5 | 6.2-7.9<br>$\bar{x}$=7.2 | 6.5-9.8<br>$\bar{x}$=8.3 | 7.9-10.1<br>$\bar{x}$=9.0 | 8.6-10.6<br>$\bar{x}$=9.6 | |
| Walleye [b] | $\bar{x}$=9.6 | $\bar{x}$=15.2 | $\bar{x}$=16.8 | $\bar{x}$=18.4 | $\bar{x}$=19.5 | $\bar{x}$=19.9 | |
| Freshwater drum [a] | 1.5-5.6<br>$\bar{x}$=3.9 | 5.1-7.5<br>$\bar{x}$=6.4 | 6.4-9.4<br>$\bar{x}$=8.5 | 8.9-14.0<br>$\bar{x}$=11.7 | 10.2-15.4<br>$\bar{x}$=12.3 | 12.2-16.5<br>$\bar{x}$=14.6 | 12.3-16.9<br>$\bar{x}$=15.1 |
| American smelt [bc] | 1.6-3.6[b]<br>$\bar{x}$=2.4[b] | 5.6-6.2[c] | $\bar{x}$=9.5[c] | | | | |

[a]=age determined in the present study
[b]= age determined by Lake Erie Research Unit, Ohio Division of Wildlife
[c]=data from Carlander, Freshwater Fishery Biology, for Lake Erie fish

Table 8. Size range (inches) of fish captured in the Locust Point area by all three methods of capture.

| | 1969 | | | | |
|---|---|---|---|---|---|
| | June[a] | July[ac] | Aug.[abc] | Sept.[ab] | Oct.[abc] |
| Gizzard shad | 7.0-16.5 | 1.5-15.8 | 1.2-12.0 | 4.9-14.6 | 2.4-16.6 |
| Alewife | 0 | 1.3- 2.2 | 1.4- 4.1 | 4.1- 5.1 | 3.6- 5.4 |
| Carp & Goldfish | 6.2-29.4 | 9.5-23.2 | 5.9-19.7 | 4.1-19.8 | 4.3-24.6 |
| Quillback | 9.6-16.3 | 12.4-13.3 | 9.3-13.0 | 9.3-13.0 | 14.9 |
| Emerald shiners | 0 | 2.4- 4.4 | 1.9- 4.8 | 4.1- 5.3 | 2.4- 3.7 |
| Spottail shiners | 0 | 1.8- 5.4 | 1.9- 4.7 | | 2.6- 5.5 |
| Channel catfish | 7.2-16.3 | 2.9-16.1 | 5.5-18.0 | 13.6-19.7 | 0 |
| Brown bullheads | 7.3-11.6 | 4.1-10.4 | 6.7 | 6.1- 9.4 | 0 |
| Golden redhorse | 9.5 | 0 | 0 | 13.2-13.9 | 0 |
| White sucker | 0 | 0 | 0 | 0 | 0 |
| White bass | 5.4-9.9 | 1.5- 7.9 | 1.8-10.6 | 3.6-12.4 | 2.7- 6.0 |
| Yellow perch | 6.5- 8.3 | 5.0- 8.9 | 5.8-11.5 | 5.6- 9.4 | 5.2-11.5 |
| Black bass | 0 | 0 | 0 | 13.0 | 3.2 |
| Sunfish | 0 | 2.6- 3.0 | 0 | 0 | 0 |
| Crappie | 8.3 | 4.1- 8.9 | 6.0-10.3 | 7.5 | 2.8- 3.5 |
| Walleye | 0 | 0 | 0 | 0 | 0 |
| Freshwater drum | 9.3-21.3 | 6.3-20.9 | 5.5-18.5 | 2.6-16.1 | 3.3-15.0 |
| Coho salmon | 0 | 0 | 0 | 16.3 | 0 |
| Smelt | 0 | 3.3 | 0 | 0 | 7.6 |

=commercial seine
=gill net
=150-ft. bag seine

Table 8. Size range (inches) of fish captured in the Locust Point area by all three methods of capture.

| | 1970 | | | | | |
|---|---|---|---|---|---|---|
| | May[abc] | June[ac] | July[ac] | Aug.[abc] | Sept.[ac] | Oct.[ac] |
| Gizzard shad | 6.7-14.9 | 6.9-15.5 | 1.2-11.0 | 1.0-15.1 | 1.4-13.1 | 2.1-13.4 |
| Alewife | 6.7 | 6.6- 7.4 | 0 | 0 | 0 | 0 |
| Carp & Goldfish | 6.5-27.3 | 8.8-16.3 | 6.2-23.1 | 7.4-18.1 | 6.7- 8.6 | 6.9-16.3 |
| Quillback | 9.8-16.6 | 0 | 0 | 0 | 5.6-13.9 | 13.1-13.3 |
| Emerald shiners | 1.8- 4.7 | 1.8- 4.2 | 2.0- 5.2 | 3.0- 5.1 | 1.4- 4.3 | 3.6 |
| Spottail shiners | 3.2- 5.3 | 3.0- 4.8 | 1.3- 3.7 | 1.0- 4.6 | 2.6- 4.9 | 3.4- 4.4 |
| Channel catfish | 2.9-18.9 | 2.3-16.5 | 13.4-17.4 | 4.8-17.9 | 14.0-17.7 | 16.2 |
| Brown bullheads | 8.5-11.5 | 7.5-10.6 | 5.1-10.9 | 6.1-11.4 | 6.7-10.7 | 8.3- 8.4 |
| Golden redhorse | 16.6 | 0 | 0 | 0 | 0 | 14.7 |
| White sucker | 9.2-17.0 | 0 | 0 | 0 | 0 | 0 |
| White bass | 4.4-15.6 | 5.1-11.6 | 1.5- 7.5 | 1.6-11.1 | 2.0-11.7 | 2.4-10.6 |
| Yellow perch | 6.2- 9.3 | 6.8- 9.0 | 6.8- 7.3 | 5.6- 9.2 | 7.4 | 0 |
| Black bass | 10.4 | 0 | 0 | 0 | 0 | 0 |
| Sunfish | 0 | 0 | 0 | 0 | 1.6 | 3.7 |
| Crappie | 3.3-14.2 | 6.3- 7.9 | 1.3- 7.6 | 3.3- 7.8 | 7.8 | 2.9- 4.1 |
| Walleye | 9.4-12.5 | 0 | 4.1 | 6.2-12.8 | 0 | 0 |
| Freshwater drum | 6.1-17.9 | 6.6-15.9 | 3.7-14.0 | 3.9-17.4 | 1.1-15.8 | 0 |
| Coho salmon | 0 | 0 | 0 | 14.1 | 0 | 0 |
| Smelt | 6.6- 7.3 | 0 | 0 | 1.9- 2.3 | 0 | 0 |

=commercial seine
=gill net
=150-ft. bag seine

Table 8. Size range (inches) of fish captured in the Locust Point area by all three methods of capture.

| | 1971 | |
|---|---|---|
| | Apr.[a] | May[ac] |
| Gizzard shad | 13.0-13.2 | 8.1-16.1 |
| Alewife | 0 | 6.7- 7.3 |
| Carp & Goldfish | 8.0-19.1 | 8.3-12.3 |
| Quillback | 16.0-20.6 | 5.2-18.3 |
| Emerald shiners | 0 | 1.9- 4.3 |
| Spottail shiners | 0 | 3.1- 4.8 |
| Channel catfish | 11.7-19.1 | 0 |
| Brown bullheads | 8.7-11.7 | 7.5-11.4 |
| Golden redhorse | 13.8-16.2 | 7.8- 8.1 |
| White sucker | 13.3-18.9 | 0 |
| White bass | 6.5-12.2 | 5.6-14.6 |
| Yellow perch | 6.6-12.4 | 7.1- 9.3 |
| Black bass | 0 | 0 |
| Sunfish | 0 | 0 |
| Crappie | 9.0- 9.3 | 7.5- 8.1 |
| Walleye | 9.1-14.6 | 0 |
| Freshwater drum | 7.5-17.6 | 5.3-20.7 |
| Coho salmon | 18.3-20.4 | 0 |
| Smelt | 0 | 5.0- 5.9 |

=commercial seine .
=gill net
=150-ft. bag seine

Table 9. Number of fish stomachs examined each month and number containing food, June, 1969 - May, 1971.

| Sample Date | Stomachs examined | Stomachs containing food | Percent containing food |
|---|---|---|---|
| 1969 | | | |
| June 26 | 140 | 120 | 85.7 |
| July 4 | 149 | 127 | 85.0 |
| July 26 | 92 | 72 | 78.0 |
| July 30 | 130 | 107 | 82.0 |
| Aug. 24 | 0 | - | - |
| Sept.24 | 80 | 51 | 63.8 |
| Oct. 29 | 140 | 88 | 62.9 |
| 1970 | | | |
| May 8 | 298 | 172 | 57.7 |
| June 22 | 255 | 181 | 71.0 |
| July 18 | 208 | 178 | 85.6 |
| Aug. 22 | 72 | 60 | 83.3 |
| Sept.12 | 89 | 71 | 79.8 |
| Oct. 10 | 33 | 23 | 69.7 |
| 1971 | | | |
| April 17 | 83 | 51 | 61.4 |
| May 15 | 150 | 76 | 50.7 |
| TOTAL | 1919 | 1377 | 71.8 |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 197

| Fish species Date sampled & number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Carp | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 17 | 22 | 22 | | | | | | | | | | | | | | | | 11 | | | | | 100 |
| 7/4/69 - 3 | | | | | | | | | | | | | | | | | 67 | | | | | | 100 |
| 7/26/69 - 4 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/30/69 - 1 | 100 | 100 | | | | | | | | | | | | | | | | 100 | | | | | 100 |
| 9/27/69 - 2 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 10/18/69 - 6 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 5/8/70 - 12 | | | | | | | | | | | | | | | | | | 17 | | | | | 83 |
| 6/12/70 - 3 | 33 | | | | | | | | | | | | | | | | | | | | | | 67 |
| 7/18/70 - 3 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 8/22/70 - 1 | | | | | 100 | | 100 | | | | | | | | | | | | | | | | |
| 9/12/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 10/10/70 - 1 | | | | | | | | | | | | 100 | | | | | | | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/15/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Goldfish | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 21 | 67 | 48 | | | | | | | | | | | | | | | | 14 | | | | | 100 |
| 7/4/69 - 5 | 20 | | | | | | | | | | | | | | | | 20 | | | | | | 100 |
| 7/26/69 - 14 | 15 | 7 | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/30/69 - 2 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 9/27/69 - 1 | 100 | | | | | | | | | | | | | | | | | | | | | | |
| 10/18/69 - 3 | 67 | 33 | | | | | | | | | | | | | | | 33 | | | | | | 33 |
| 5/8/70 - 8 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 6/12/70 - 2 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/18/70 - 4 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 8/22/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 9/12/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 10/10/70 - 1 | 100 | 100 | | | | | | | | | | | | | | | | | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/15/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 19
continued

| Fish species Date sampled & number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Gizzard shad** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/25/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 7/4/69 - 9 | 89 | 56 | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/26/69 - 16 | 94 | 94 | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/30/69 - 52 | 46 | 19 | | | | | | | | | | | | | | | | | | | | | 83 |
| 9/27/69 - 10 | 90 | 50 | | | | | | | | | | | | | | | | | | | | | 100 |
| 10/18/69 - 42 | 64 | 56 | | | | | | | | | | | | | | | | | | | | | 100 |
| 5/8/70 - 10 | | | | | | | | | | | | | | | | | | | | | | | |
| 6/12/70 - 2 | 100 | 100 | | | | | | | | | | | | | | | | | | | | | |
| 7/18/70 - 2 | 100 | 50 | | | | | | | | | | | | | | | | | | | | | 50 |
| 8/22/70 - 1 | | 100 | | | | | | | | | | | | | | | | | | | | | |
| 9/12/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 10/10/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/15/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| **Freshwater drum** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 10 | | | | | | 10 | | | | | | | | | | | | | 10 | | | 90 | |
| 7/4/69 - 1 | 100 | 100 | | | | | | | | | | | | | | | | 100 | | | | | 100 |
| 7/26/69 - 12 | 38 | | | | | | | | | | | | | | | | 16 | | | | | 33 | |
| 7/30/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 9/27/69 - 7 | 14 | | | | | 86 | | | | | | | | | | | 28 | | | | | 14 | |
| 10/18/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/8/70 - 1 | | | | | | | | | | | | | | | | | | | | | | 100 | |
| 6/12/70 - 14 | | | | | 21 | | 21 | | | | | | | | | | | 7 | | | | 50 | 29 |
| 7/18/70 - 20 | 20 | | 5 | | | | 85 | 10 | | 5 | 5 | | | | | | | 20 | | | | 5 | |
| 8/22/70 - 10 | | | | | 10 | | 90 | 40 | 20 | 10 | | | | | | | 10 | 10 | | | | 20 | |
| 9/12/70 - 9 | 11 | | | | 33 | | 56 | 33 | 22 | 11 | 11 | 11 | 11 | | 33 | | | | | | | 56 | |
| 10/10/70 - 1 | | | | | | | 100 | | | | | | | | | | | 100 | | | | | |
| 4/17/71 - 7 | | | | | | | | | | | | | | | | | | 86 | | | | | 14 |
| 5/15/71 - 6 | | | 17 | | | | 67 | 50 | | | | | | | | | | 50 | | | | | |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 19

continued

| Fish species<br>Date sampled &<br>number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **White bass** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 18 | | | | | | 6 | | | | | | | | | | | | | 31 | | | 94<br>15 | 46 |
| 7/4/69 - 13 | 54 | 8 | | | | | | | | | | | | | | | 13 | | | | | 63 | 6 |
| 7/26/69 - 16 | 75 | | | | | 6 | | | | | | | | | | | | 5 | | | | 58 | 10 |
| 7/30/69 - 19 | 42 | 16 | | | | 5 | | | | | | | | | | | | | | | | 100 | |
| 9/27/69 - 14 | | | | | | | | | | | | | | | | | 20 | 10 | | | | | 70 |
| 10/18/69 - 10 | 20 | 20 | | | | 30 | | | | | | | | | | | 8 | 8 | | | | 25 | 25 |
| 5/8/70 - 12 | 8 | | | | | | 25 | | | | 17 | | | | | | | | | | | 92 | 5 |
| 6/12/70 - 37 | | | | | 5 | | | | | | | | | | | | | | | | | 21 | |
| 7/18/70 - 68 | 72 | 79 | | | 3 | | | | | | | | | | | | | | | | | 100 | |
| 8/22/70 - 18 | 6 | | | | 83 | | 83 | | 6 | | | 6 | | | | | | | | | | 6 | 6 |
| 9/12/70 - 17 | 29 | 24 | | | 29 | | 24 | | 12 | | | | 12 | | 29 | 12 | | | | | | 50 | |
| 10/10/70 - 4 | 25 | | | | | | | | | | | | | | | | 25 | | | | | | |
| 4/17/71 - 7 | | | | | | 14 | | 14 | | | | | | | | | | 86 | | | | 90 | 20 |
| 5/15/71 - 20 | | 5 | | | | 10 | | | | | | | | | | | | | | | | | |
| **Yellow perch** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 7/4/69 - 3 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/26/69 - 1 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/30/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 9/27/69 - 3 | | | | | | | | | | | | | | | | | | | | | | 100 | |
| 10/18/69 - 2 | | | | | | 50 | | | | | | | | | | | | 50 | | | | | 50 |
| 5/8/70 - 4 | | | | | | | | | | | | | | | | | | | | | | 25 | 75 |
| 6/12/70 - 9 | 11 | | | | 78 | | | | | | | | | | | | | | | | | 11 | 11 |
| 7/18/70 - 3 | | | 33 | | | | | 33 | | | | | | | | | 33 | | | | 33 | 33 | 33 |
| 8/22/70 - 4 | | | | 25 | 25 | | 50 | | 25 | | | | | | | | | | | | | 75 | |
| 9/12/70 - 1 | | | | | | | 100 | 100 | | | | | | | | | | | | | | 100 | |
| 10/10/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 4/17/71 - 8 | | | | | | 25 | 25 | | | | | | | | | | | 75 | | | | 13 | |
| 5/15/71 - 3 | | | | | | | | | | | | | | | | | | 33 | | | | 67 | |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 197

continued

| Fish species<br>Date sampled & number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Channel catfish** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 24 | | | | | 17 | 25 | | | | | | | | | | | 21 | 4 | | | | 46 | 100 |
| 7/4/69 - 2 | 50 | | | | | | | | | | | | | | | | 100 | | | | | | 50 |
| 7/26/69 - 10 | | | 10 | | 10 | | | | | | | | | | | | | | | | | 60 | 50 |
| 7/30/69 - 1 | | | | | | 100 | | | | | | | | | | | | | | | | | |
| 9/27/69 - 7 | | | | 29 | 43 | | | | | | | | | | | | 14 | | | | | 71 | |
| 10/18/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/8/70 - 2 | | | | | | | | | | | | | | | | | | | | | | 50 | 50 |
| 5/12/70 - 18 | 11 | 6 | 6 | 6 | 28 | | 11 | 11 | | | 6 | 6 | | | | | | | | | | 50 | |
| 7/18/70 - 4 | | 25 | 25 | | | | 25 | | | | | | | | | | 25 | | | | | 100 | |
| 8/22/70 - 1 | | | | | | | 100 | | 100 | | | | 100 | | | | 100 | 100 | | | | | |
| 9/12/70 - 6 | | | | | 83 | | 67 | 17 | 17 | | | 33 | 17 | | | | 17 | | | | | 83 | |
| 10/10/70 - 1 | | | | | | | 100 | 100 | | | | 100 | | | | | | | | | | | |
| 4/17/71 - 2 | | | | | | | 50 | 50 | | | | | | | | | | | | | | 50 | |
| 5/15/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| **Brown bullhead** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 14 | | | | | | 14 | | | | | | | | | | | 7 | | | | | | 100 |
| 7/4/69 - 6 | | | | | | | | | | | | | | | | | 33 | 17 | | | | | 100 |
| 7/26/69 - 2 | | | | | | | | | | | | | | | | | | | | | | 50 | 50 |
| 9/27/69 - 2 | | | | | | | | | | | | | | | | | 50 | 50 | | | | 50 | 50 |
| 10/18/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/8/70 - 3 | | | | | 33 | | 100 | 67 | | | 100 | 100 | | | | | 100 | 67 | 33 | | | | |
| 6/12/70 - 5 | 20 | | 20 | 20 | 80 | | 60 | | | | 20 | | | | | | | 20 | | | | | 20 |
| 7/18/70 - 29 | 100 | 62 | 7 | | 3 | | | | | | | | | | | | | 3 | | | | 7 | |
| 8/22/70 - 1 | | | | 100 | 100 | | 100 | 100 | 100 | | | | 100 | | 100 | | 100 | 100 | | | | | |
| 9/12/70 - 3 | | | | | 67 | | | | | | | | | | | | | | | | | | 33 |
| 10/10/70 - 1 | | | | | | | 100 | | | | | 100 | | | | | | | | | | | |
| 4/17/71 - 10 | | | | | | 20 | 60 | | | | | 10 | | | | | | 90 | 10 | | | 30 | |
| 5/15/71 - 13 | | | | | | 8 | 69 | 69 | | 8 | 69 | 23 | | | | | | 38 | | | | | 38 |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 197

continued

| Fish species<br>Date sampled &<br>number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Emerald shiner** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/23/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | 78 |
| 7/4/69 - 27 | 63 | 11 | | | | | | | | | | | | | | | | | | | | | |
| 7/26/69 - 0 | | | | | | | | | | | | | | | | | 13 | | | | | | 47 |
| 7/30/69 - 15 | 13 | 7 | | | | 53 | | | | | | | | | | | | | | | | | |
| 9/27/69 - 0 | | | | | | | | | | | | | | | | | 33 | | | | | | 17 |
| 10/18/69 - 6 | 33 | 17 | | | | 17 | | | | | | | | | | | | | | | | | |
| 5/8/70 - 18 | 6 | 6 | | | | 6 | 11 | | | | 6 | | | | | 6 | 11 | | | | | | 50 |
| 6/12/70 - 27 | 4 | | | | 15 | | | | | | | | | | | | 7 | 4 | | | | | 67 |
| 7/18/70 - 21 | | | | | | | | | | | | | | | | | 10 | | | | | | 90 |
| 8/22/70 - 8 | | | | | 75 | 25 | 13 | | | | | | | | | | | | | | | | 25 |
| 9/12/70 - 6 | | | | | 33 | | 17 | | | | | | | | | | 17 | | | | | | 50 |
| 10/10/70 - 1 | | | | 100 | | 100 | | | 100 | | | | | | | | | | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | 17 |
| 5/15/71 - 6 | 50 | | | 17 | | 33 | | | | | | | | | | | | | | | | | |
| **Spottail shiner** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/23/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 7/4/69 - 38 | 26 | | | | | 3 | | | | | | | | | | | 11 | | | | | | 95 |
| 7/26/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 7/30/69 - 3 | | | | | | 67 | | | | | | | | | | | | | | | | | 33 |
| 9/27/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 10/18/69 - 19 | 26 | 37 | | | | 32 | | | | | | | | | | | 37 | | | | | | 64 |
| 5/8/70 - 64 | | | 2 | 13 | 16 | 3 | 21 | 21 | 2 | | 11 | | | 2 | 2 | | 5 | 6 | | | | | 47 |
| 6/12/70 - 52 | 8 | 4 | 2 | | 4 | | | | | | | | | | | | 2 | 4 | | | | | 37 |
| 7/18/70 - 11 | 9 | | | | | | | | | | | | | | | | | | | | | | 91 |
| 8/22/70 - 8 | | | | 13 | 100 | | 75 | 13 | 25 | | | 13 | 13 | | | | 25 | | | | | | |
| 9/12/70 - 9 | | | | 22 | 67 | | 56 | 22 | 11 | | | | | | | | | | | | 11 | | |
| 10/10/70 - 4 | 25 | | 25 | 50 | 50 | | 50 | 25 | | | | | | | | | 25 | 25 | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/15/71 - 10 | | | | | | | 30 | | | | | | | | | | | 10 | | | | | 80 |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 1971.(co

| Fish species Date sampled & number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crappie | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 7/4/69 - 21 | 90 | 38 | | | | | | | | | | | | | | | 5 | 5 | | | | 10 | 29 |
| 7/26/69 - 1 | | | | | | | | | | | | | | | | | | | | | | 100 | |
| 7/30/69 - 12 | 67 | 8 | | | | | | | | | | | | | | | | | 8 | | | 25 | 50 |
| 9/27/69 - 1 | | | | | | 100 | | | | | | | | | | | | | | | | 100 | |
| 10/18/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/8/70 - 10 | | | | 10 | | | 10 | | 10 | | | | | | | | 10 | | | | | 80 | 10 |
| 6/12/70 - 3 | | | | | 33 | | | | | | | | | | | | | | | | | 100 | |
| 7/18/70 - 12 | 67 | 42 | | | 25 | | 25 | | | | | | | | | | 8 | 8 | | | | 92 | |
| 8/22/70 - 5 | | | | | 60 | | 100 | | 20 | | | 20 | | | | | | | | | | 100 | |
| 9/12/70 - 1 | | | | | | | | | | | | | | | | | | | | | | | |
| 10/10/70 - 4 | 75 | 75 | | | | | 25 | | | | | | | | | | 25 | | | | | 100 | 25 |
| 4/17/71 - 1 | | | | | | | | | | | | | | | | | | | | | | 100 | |
| 5/15/71 - 2 | | | | | | | | | | | | | | | | | | | | | | | |

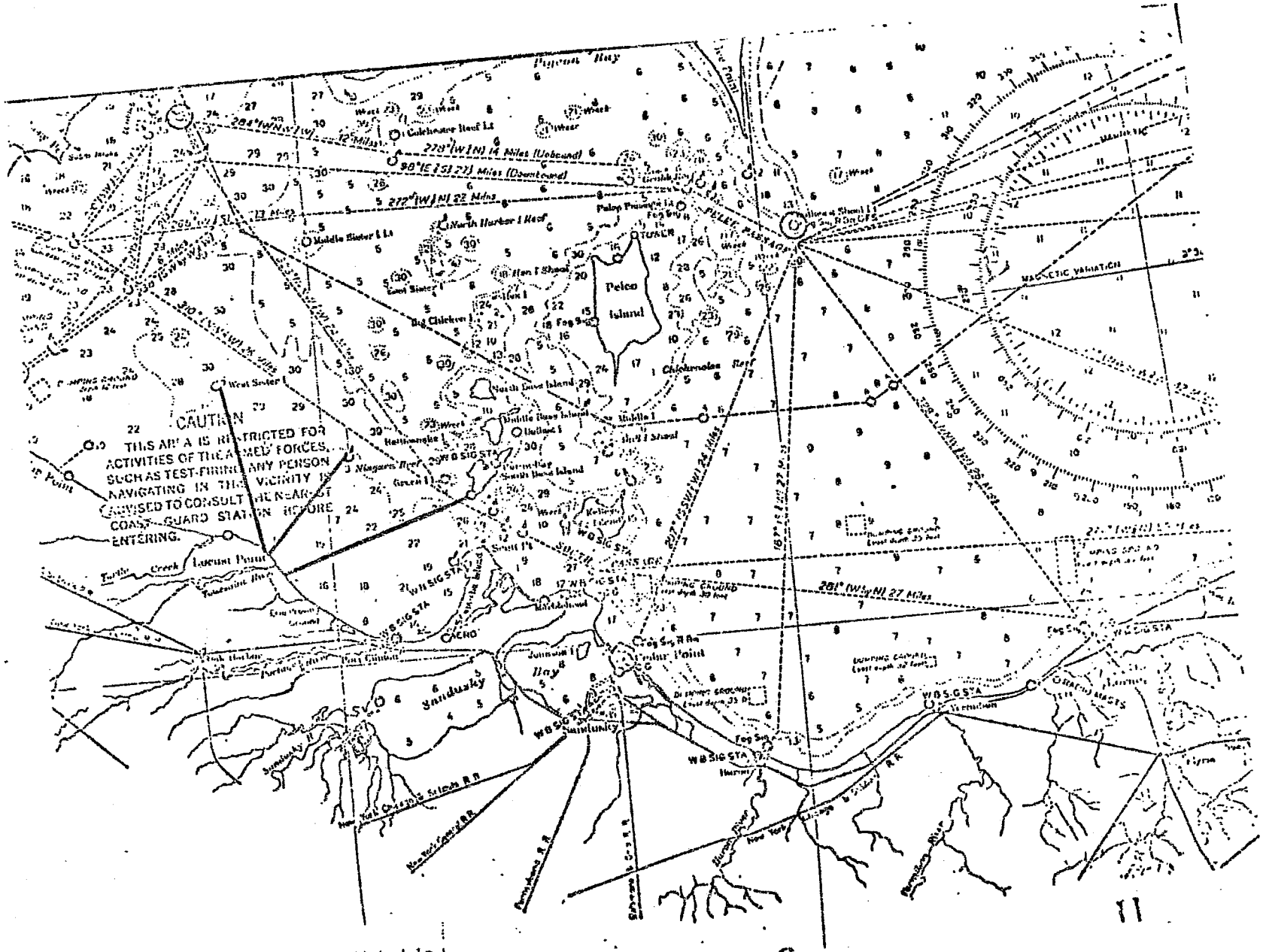


Fig. 1. Three transects established in
the Locust Point area.

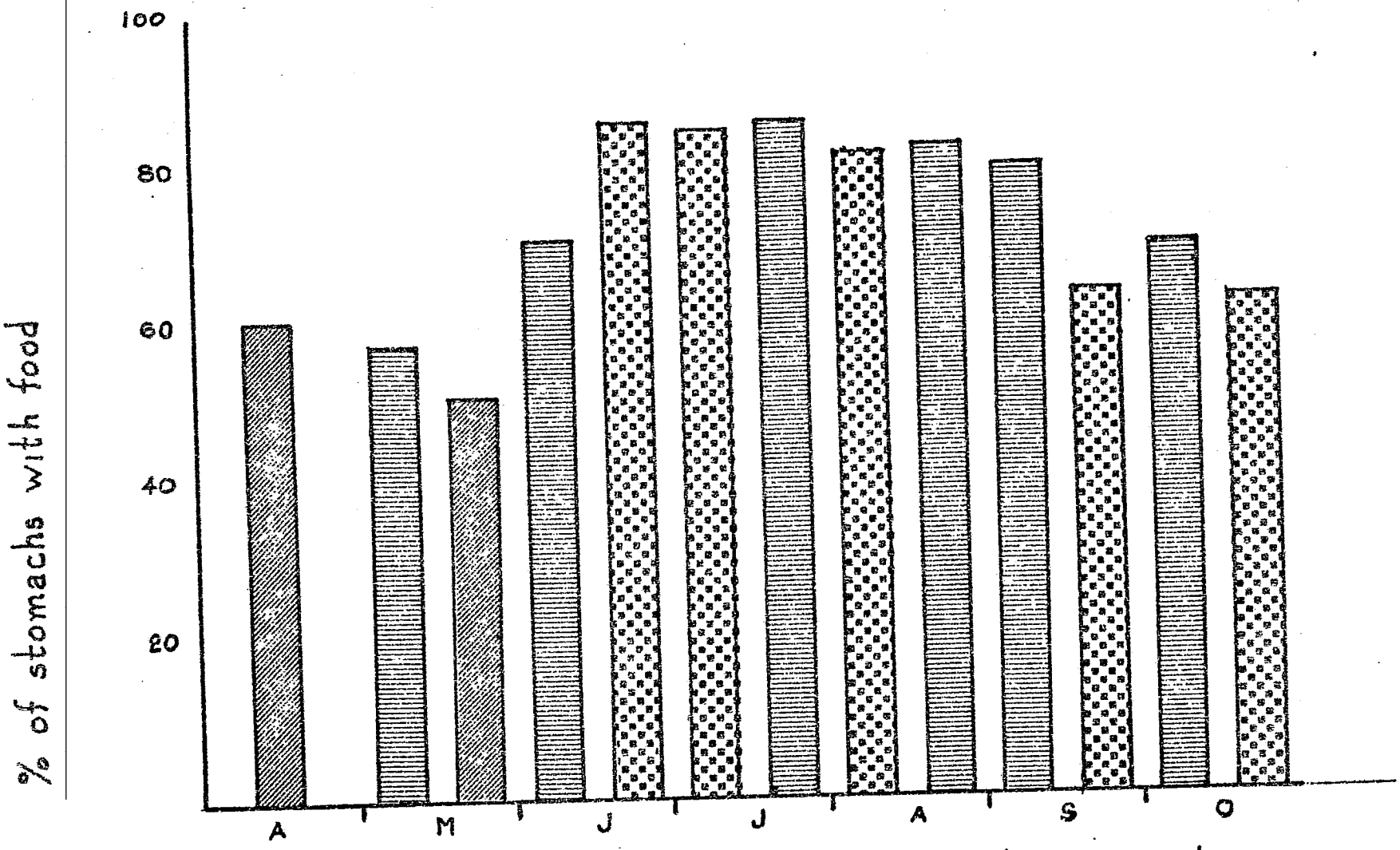


Figure 2. Percent of examined stomachs containing food

1969,, 1970, 1971

Appendix 1. Scientific names of fishes found in the Locust Point area, June, 1969 - May, 1971.

| | |
|---|---|
| Alewife | Alosa pseudoharengus |
| American smelt | Osmerus eperlanus mordax |
| Black crappie | Pomoxis nigromaculatus |
| Bowfin | Amia calva |
| Brown bullhead | Ictalurus nebulosus |
| Carp | Cyprinus carpio |
| Channel catfish | Ictalurus punctatus |
| Coho salmon | Oncorhynchus kisutch |
| Common emerald shiner | Notropis atherinoides |
| Common white sucker | Catostomus commersoni |
| Freshwater drum | Aplodinotus grunniens |
| Gizzard shad | Dorosoma cepedianum |
| Golden redhorse | Moxostoma erythrurum |
| Goldfish | Carassius auratus |
| Green sunfish | Lepomis cyanellus |
| Largemouth bass | Micropterus s. salmoides |
| Logperch | Percina caprodes |
| Longnose gar | Lepisosteus osseus |
| Northern pike | Esox lucius |
| Orangespotted sunfish | Lepomis humilis |
| Quillback | Carpiodes cyprinus |
| Rock bass | Ambloplites rupestris |
| Silver chub | Hybopsis storeriana |
| Smallmouth bass | Micropterus d. dolomieui |

Appendix 1. (cont'd)

| | |
|---|---|
| Spotted sucker | *Minytrema melanops* |
| Spotfin shiner | *Notropis spilopterus* |
| Spottail shiner | *Notropis hudsonius* |
| Stonecat | *Noturus flavus* |
| Walleye | *Stizostedion v. vitreum* |
| White bass | *Morone chrysops* |
| White crappie | *Pomoxis annularis* |
| Yellow perch | *Perca flavescens* |

JOB COMPLETION REPORT

RESEARCH PROGRESS SEGMENT

| | | | |
|---|---|---|---|
| State of: | Ohio | Date: | May 31, 1972 |
| Project No.: | F-41-R-3 | Name: | Environmental Evaluation of a Nuclear Power Plant |
| Job No.: | 2-A | Title: | Temperature Preferences of Locust Point Fishes |
| Period Covered: | June 1, 1971-May 31, 1972 | | |


## ABSTRACT

Temperature preferences were determined for adult and young-of-the-year white bass, smallmouth bass, yellow perch and emerald shiners during four seasons from July, 1971 through May, 1972.

Fish specimens for experiments were collected from local areas by shore seining, trap netting, hook-and-line fishing and from commercial fishermen. Most fish were held in the laboratory at or near ambient lake temperatures for only short periods prior to testing. Fish tested in winter were caught during late fall and held at ambient temperatures until they were tested.

Seasonal differences in temperature selection existed for all four species within the 2-3 day testing periods. With the exception of emerald shiners in summer, all species preferred above ambient lake temperatures each season. In general, white bass and smallmouth bass selected similar high temperatures, yellow perch preferred intermediate temperatures while emerald shiners selected low water temperatures. Fish were distributed about a narrow range of temperatures in the summer and were widely distributed over a large range of temperatures during fall. A relatively constant temperature preference was reached within several hours in summer, but required 2-3 days of progressive acclimation in the temperature gradient during winter. Young

yellow perch and emerald shiners selected temperatures differing from those selected by the adults during the same season, while the young and adults of white bass and smallmouth bass preferred very similar temperatures.

## RECOMMENDATIONS

The study of the seasonal temperature preferences of fishes should continue with emphasis on species from the bottom habitat of the Locust Point area. Effort should be expended to obtain healthy test specimens and any differences in temperature selection between healthy and unhealthy individuals should be clearly defined.

## OBJECTIVE

The objective of this job is to determine the temperature preferences of Locust Point fishes.

## TECHNIQUES USED

A horizontal temperature gradient approximately 24 m in length and 25 cm in depth was established for testing the temperature preferences of fish during four seasons of the year. Within a wooden tank 8.72 m long, 79.0 cm wide and 50 cm high, a system of alternating transverse baffles formed a series of 28 compartments without greatly restricting the movements of fish. Filtered lake water (1-2 l/min) passed through 1/4" Tygon tubing within a cooling reservoir and into the low temperature end of the gradient; the water was then heated progressively higher by immersion heaters as it flowed to a standpipe at the opposite end of the trough.

A Vicore 500 watt heater, ARC static switch relay and corresponding Juno thermoregulator maintained a constant water temperature $\pm$ 0.15C in the center

of each compartment. Each season a different gradient was established by controlling the temperature at the thermoregulator of each compartment 0.5-1.0C above that of the previous compartment. The gradient ranged from a low of several degrees below ambient lake temperature (summer, fall and spring), or slightly above ambient (winter), to high of 15-26C above ambient.

Aeration from three air stones in each compartment greatly reduced vertical temperature stratification of the water column (Table 1) and created saturated, or nearly saturated, $O_2$ levels during all seasons (Table 2). Oxygen measurements were made each season using a model 54 YSI oxygen meter and probe.

Most fish were caught by trapping, shore seining and hook-and-line fishing near the F. T. Stone Laboratory on South Bass Island. Adult fish were sexually mature. Young fish were primarily young-of-the-year, although some immature (1+ year old) perch and smallmouth were tested in spring. Fish for winter experiments were caught during November and held at ambient lake temperatures until they were tested. During other seasons fish were held only for short periods of time at lake temperatures. Fish were maintained and tested under normal seasonal photoperiods. Natural lighting from windows in north and west walls was adequate for almost all observations.

Prior, to testing, each fish or group of fish was held in an acclimation tank similar to the gradient apparatus for 24-48 hrs. The acclimation tank was half the length of the gradient tank, identical to it in compartmentation (without heaters and thermoregulators) and maintained at ambient lake temperatures. In the acclimation tank fish were observed for visible signs of poor condition, aggressive behavior and randomness of distribution.

Fish were then transferred from the behavioral acclimation tank to the compartment of the gradient with a temperature nearest the ambient lake temperature. The number of fish tested at one time varied with the species and size of individual fish. Large smallmouth bass were tested singly, while

young-of-the-year emerald shiners were run in groups of 20-25 fish. After the transfer, fish moved freely about the thermal gradient for 4-6 hours before the first observation period. In summer, the gradient ranged from below ambient to 36C. During fall and winter, the testing procedure was modified because many fish moved into temperatures beyond their upper lethal limits while exploring the gradient trough. Fish were screened within a limited gradient with a maximum temperature below the suspected upper lethal temperature of each species, and were allowed into progressively higher temperatures as their selected temperatures increased.

Observations of fish distribution within the test apparatus were initiated approximately 4-6 hours after fish had been introduced into the temperature gradient. Fish were observed from behind a blind during three periods each day. The number of fish in each compartment was recorded every 10 min. for 80-100 min. in the morning, at mid-day and just before sunset. The water temperatures at the center of every other compartment were measured with a YSI multi-channel telothermometer (with fixed probes) and were recorded before and after each observation period. The water temperatures in compartments without temperature probes were interpolated from adjacent water temperatures and periodically confirmed by actual measurement.

During the summer and fall most preference tests lasted 48-hours (6 observation periods). Spring tests for each species group consisted of one 72 hr. test followed by one or more test of 48 hrs. Winter tests were 72 hours long. Five day (120 hr.) tests were conducted for three of the four species in summer and occasionally during the remaining seasons.

## FINDINGS

Temperatures selected by each species during the 2-3 day tests changed progressively through the four seasons. Seasonal thermal preferences are represented by the modes in the distributions of each species about temperatures in the laboratory gradient (Figures 1,2,3,4). Although white bass, smallmouth bass and yellow perch preferred temperatures above ambient lake temperatures during the four seasons, the interval between the selected temperature and ambient varied from season to season. The smallest difference between the seasonal preferred temperatures and ambient temperatures occurred in summer. The largest difference was during winter when the preference was not considered stable until fish had been in the gradient for 2 to 3 days. The difference between temperatures selected during summer and winter was greatest (11-17C) for emerald shiner, about 10C for white bass and yellow perch and least (5C) for smallmouth bass. Temperatures selected by most fish during the fall (falling field temperatures) were similar to those preferred in summer. However, temperatures selected in spring (rising field temperatures) were nearest winter preference values. Emerald shiners, the exception, selected very similar temperatures during fall and spring.

Although variation existed between temperatures selected during a given test and those selected in replicate tests, each species appeared to prefer a relatively precise zone of temperatures in the thermal gradient. Figures 2,3,4 and 5 show the variability of modal temperatures selected within given tests, between replicate tests and between species. Temperature selection appeared most consistent during summer and least definite in fall when wide differences existed within tests and between replicate tests. During all seasons, most emerald shiners selected a narrow range of temperatures (± 2C about their preference temperatures) with little differences between

tests or over successive observation periods within a test. White bass and smallmouth bass, also, were fairly precise in thermal selection, although preferences of these species changed over successive observation periods, especially during winter. Yellow perch were the least precise species in selecting a temperature. Yellow perch formed tight schools at ambient temperatures in the behavioral acclimation tank, but were widely spaced in the temperature gradient and moved as a group back and forth between high and low temperature areas. This behavior usually resulted in fairly reliable modal temperature values (with a wide range in observed distribution), but periodically produced erratic modal values.

The time required for fish to select a relatively constant zone of temperatures varied seasonally. Although most groups of fish demonstrated a precise temperature preference within several hours during summer months, a few groups (especially yellow perch) remained inactive at ambient or near-ambient temperatures for almost a day before initiating exploratory behavior in the gradient and then making a temperature selection. Temperature frequency distribution of fish within the gradient of temperatures were pooled at 2C temperature intervals. The data were analyzed by Spearman's rank correlation coeficients to determine differences between temperatures selected during successive days from the initiation of each test. Results indicated that no significant difference existed for any species between temperatures selected the first day and those selected the second day during the summer. A standard 2-day test period was established during summer to insure adequate time for selection of temperatures and to allow time for changes in temperature preference. Tests of 5-days duration were conducted once during summer on most species age groups. Only slight fluctuations (1-4C) occurred in thermal preferences made by fish through the 5th or 6th day in the gradient (where data was available).

During fall, selected temperatures fluctuated widely with successive observations but definite upper and lower preference limits were evident for each species within the 2-day test period. Preferendum temperatures were below those of the same species during the summer period. During winter, higher temperatures were preferred during the first day and, generally, the fish moved toward a temperature below the summer selected temperatures, with the exception of young white bass and smallmouth bass. Young-of-the-year white bass appeared to select decreasing temperatures after the 2nd day. Young and adult smallmouth bass (small sample sizes) selected temperatures after 3-days near temperatures preferred in summer. In spring, smallmouth bass, young yellow perch and adult white bass preferred increasing temperatures during the first day, as in winter. However, other species and age groups made relatively stable selections shortly after their introduction.

Differences between temperatures selected by young and adults were largest in yellow perch and emerald shiners. During all seasons young perch selected temperatures 4C or more above temperatures preferred by adults. Adult emerald shiners chose temperatures higher than young in summer, fall and spring, but preferred waters about 5C lower than young in winter. Very similar temperatures were selected by the young and adults of both white bass and smallmouth bass.

Table 1. Seasonal temperatures (°C) of surface (S) and bottom (B) waters of the temperature gradient apparatus.

| Compartment No. | SUMMER | | FALL | | WINTER | | SPRING | |
|---|---|---|---|---|---|---|---|---|
| | S | B | S | B | S | B | S | B |
| 1 | 20.8 | 20.5 | 11.0 | 10.7 | 2.0 | 2.0 | 9.9 | 9.8 |
| 2 | 21.0 | 20.8 | 13.5 | 13.3 | 5.0 | 5.0 | 12.2 | 12.0 |
| 3 | 21.2 | 21.0 | 14.0 | 14.0 | 6.0 | 6.0 | 12.5 | 12.5 |
| 4 | 21.8 | 21.6 | 15.5 | 15.5 | 6.8 | 6.8 | 13.1 | 3.0 |
| 5 | 22.2 | 22.0 | 16.2 | 16.0 | 7.5 | 7.5 | 14.1 | 14.1 |
| 6 | 22.5 | 22.3 | 17.0 | 17.0 | 8.4 | 8.4 | 15.0 | 15.0 |
| 7 | 22.7 | 22.6 | 17.2 | 17.2 | 9.8 | 9.8 | 15.3 | 15.2 |
| 8 | 23.0 | 23.0 | 18.0 | 18.0 | 10.2 | 10.2 | 16.1 | 16.0 |
| 9 | 23.8 | 23.6 | 18.5 | 18.5 | 11.2 | 11.2 | 17.2 | 17.2 |
| 10 | 24.0 | 24.0 | 19.3 | 19.2 | 12.2 | 12.2 | 18.0 | 18.0 |
| 11 | 24.7 | 24.6 | 20.0 | 20.0 | 13.5 | 13.2 | 19.0 | 19.0 |
| 12 | 25.5 | 25.2 | 20.5 | 20.5 | 14.2 | 14.2 | 20.2 | 20.0 |
| 13 | 25.5 | 25.4 | 21.6 | 21.5 | 15.2 | 15.2 | 20.5 | 20.5 |
| 14 | 25.9 | 25.6 | 22.3 | 22.1 | 16.0 | 16.0 | 22.1 | 22.1 |
| 15 | 26.6 | 26.5 | 23.0 | 23.0 | 17.0 | 17.0 | 23.6 | 23.5 |
| 16 | 27.2 | 27.2 | 24.2 | 24.2 | 18.0 | 18.0 | 24.2 | 24.2 |
| 17 | 28.0 | 28.0 | 25.0 | 25.0 | 18.9 | 18.8 | 25.7 | 25.5 |
| 18 | 28.8 | 28.8 | 26.0 | 26.0 | 19.8 | 19.8 | 26.0 | 26.0 |
| 19 | 2918 | 29.8 | 27.7 | 27.5 | 21.0 | 21.0 | 27.1 | 27.0 |
| 20 | 30.8 | 30.6 | 29.0 | 29.0 | 22.1 | 22.1 | 28.3 | 28.0 |
| 21 | 31.6 | 3.15 | 30.0 | 30.0 | 23.0 | 23.0 | 29.2 | 29.0 |
| 22 | 32.5 | 32.5 | 32.2 | 32.2 | 23.9 | 23.9 | 30.2 | 30.2 |
| 23 | 33.3 | 33.4 | 33.0 | 33.0 | 25.0 | 25.0 | 31.2 | 31.1 |
| 24 | 34.5 | 34.3 | 34.1 | 34.0 | 26.1 | 26.0 | 32.7 | 32.5 |
| 25 | 35.6 | 35.5 | 35.4 | 35.3 | 27.5 | 27.4 | 33.7 | 33.5 |
| 26 | 36.1 | 36.0 | 35.9 | 35.8 | 28.1 | 28.1 | 34.1 | 34.0 |
| 27 | 36.0 | 35.9 | 36.0 | 36.0 | 29.1 | 29.1 | 34.3 | 34.2 |
| 28 | 35.9 | 35.8 | 35.8 | 35.8 | 29.5 | 29.5 | 35.0 | 34.8 |

Table 2. Seasonal oxygen concentrations (mg/l) in surface (S) and bottom (B) waters of the temperature gradient apparatus.

| Compartment No. | SUMMER | | FALL | | WINTER | | SPRING | |
|---|---|---|---|---|---|---|---|---|
| | S | B | S | B | S | B | S | B |
| 1 | 8.1 | 8.1 | | | 11.2 | 11.2 | 10.4 | 10.4 |
| 2 | 8.2 | 8.2 | 10.0 | 9.9 | 11.0 | 11.0 | 10.4 | 10.4 |
| 3 | 8.2 | 8.2 | 10.0 | 9.8 | 10.9 | 10.9 | 10.4 | 10.4 |
| 4 | 8.2 | 8.2 | 9.8 | 9.7 | 10.8 | 10.8 | 10.4 | 10.4 |
| 5 | 8.1 | 8.1 | 9.8 | 9.6 | 10.6 | 10.6 | 10.2 | 10.2 |
| 6 | 8.1 | 8.1 | 9.8 | 9.6 | 10.4 | 10.4 | 10.2 | 10.2 |
| 7 | 8.1 | 8.1 | 10.0 | 9.6 | 10.2 | 10.2 | 10.1 | 10.0 |
| 8 | 8.0 | 8.0 | 10.0 | 9.4 | 10.0 | 10.0 | 10.0 | 10.0 |
| 9 | 8.0 | 8.0 | 9.6 | 9.4 | 9.8 | 9.7 | 9.9 | 9.9 |
| 10 | 8.0 | 8.0 | 9.6 | 9.2 | 9.6 | 9.6 | 9.7 | 9.7 |
| 11 | 7.9 | 7.9 | 9.7 | 9.2 | 9.5 | 9.5 | 9.7 | 9.7 |
| 12 | 7.9 | 7.9 | 9.8 | 8.9 | 9.2 | 9.2 | 9.6 | 9.5 |
| 13 | 7.8 | 7.8 | 9.4 | 8.9 | 8.8 | 8.8 | 9.5 | 9.5 |
| 14 | 7.7 | 7.7 | 9.3 | 8.7 | 8.6 | 8.6 | 9.1 | 9.1 |
| 15 | 7.7 | 7.6 | 9.1 | 8.6 | 8.5 | 8.5 | 8.8 | 8.8 |
| 16 | 7.6 | 7.5 | 9.6 | 8.4 | 8.4 | 8.4 | 8.7 | 8.7 |
| 17 | 7.4 | 7.3 | 9.0 | 8.3 | 8.2 | 8.2 | 8.6 | 8.6 |
| 18 | 7.3 | 7.3 | 9.5 | 8.2 | 8.0 | 8.0 | 8.6 | 8.5 |
| 19 | 7.2 | 7.1 | 9.0 | 8.0 | 7.9 | 7.9 | 8.4 | 8.4 |
| 20 | 7.0 | 7.0 | 9.5 | 7.8 | 7.8 | 7.7 | 8.3 | 8.3 |
| 21 | 7.0 | 6.9 | 9.5 | 7.6 | 7.6 | 7.6 | 8.2 | 8.1 |
| 22 | 6.8 | 6.8 | 9.9 | 7.5 | 7.5 | 7.5 | 8.0 | 8.0 |
| 23 | 6.7 | 6.7 | 9.3 | 7.4 | 7.4 | 7.4 | 7.8 | 7.8 |
| 24 | 6.6 | 6.6 | 9.4 | 7.2 | 7.3 | 7.3 | 7.5 | 7.5 |
| 25 | 6.6 | 6.5 | 9.4 | 7.2 | 7.2 | 7.2 | 7.4 | 7.4 |
| 26 | 6.6 | 6.6 | 9.4 | 7.2 | 7.0 | 7.0 | 7.4 | 7.4 |
| 27 | 6.6 | 6.6 | 9.5 | 7.1 | 7.0 | 7.0 | 7.5 | 7.5 |
| 28 | 6.6 | 6.6 | 9.1 | 7.1 | 6.9 | 6.9 | 7.4 | 7.5 |

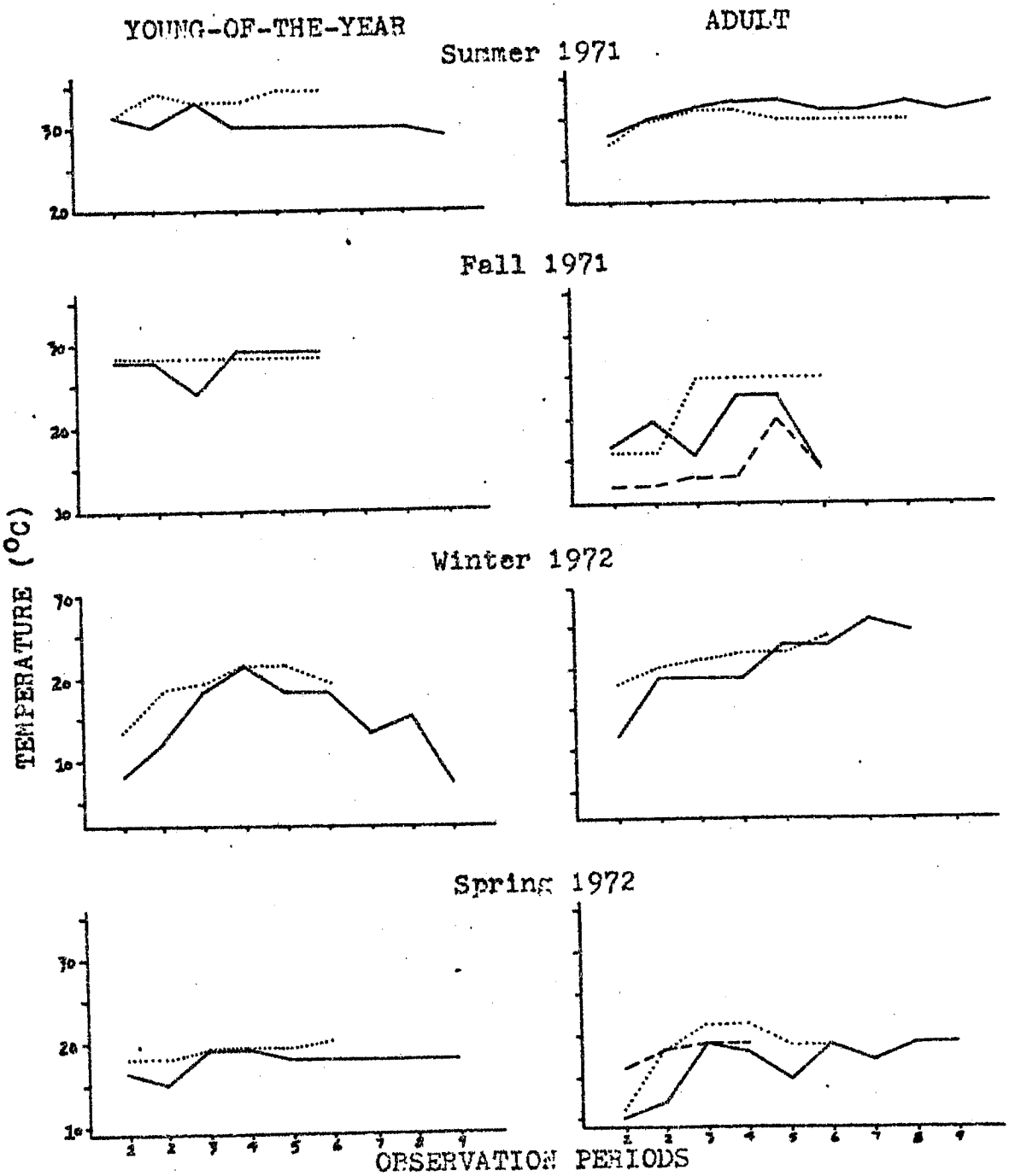


Fig. 1. Modal temperatures of white bass distribution in the thermal gradeint during successive observation periods from initiation of each test (3 observation periods equal one day).

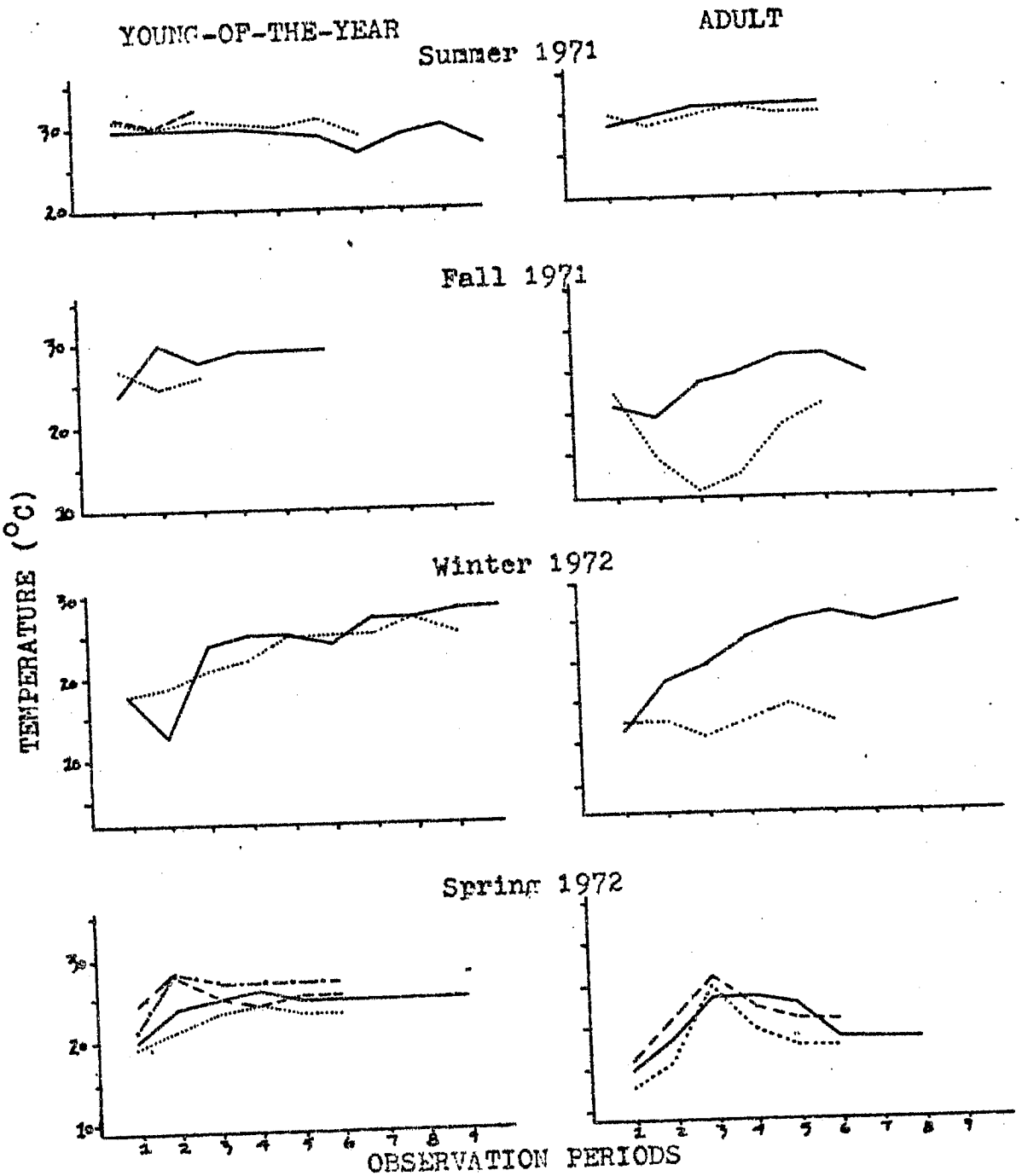


Fig. 2. Modal temperatures of smallmouth bass distribution in the thermal gradient during successive observation periods from initiation of each test (3 observation periods equal one day).

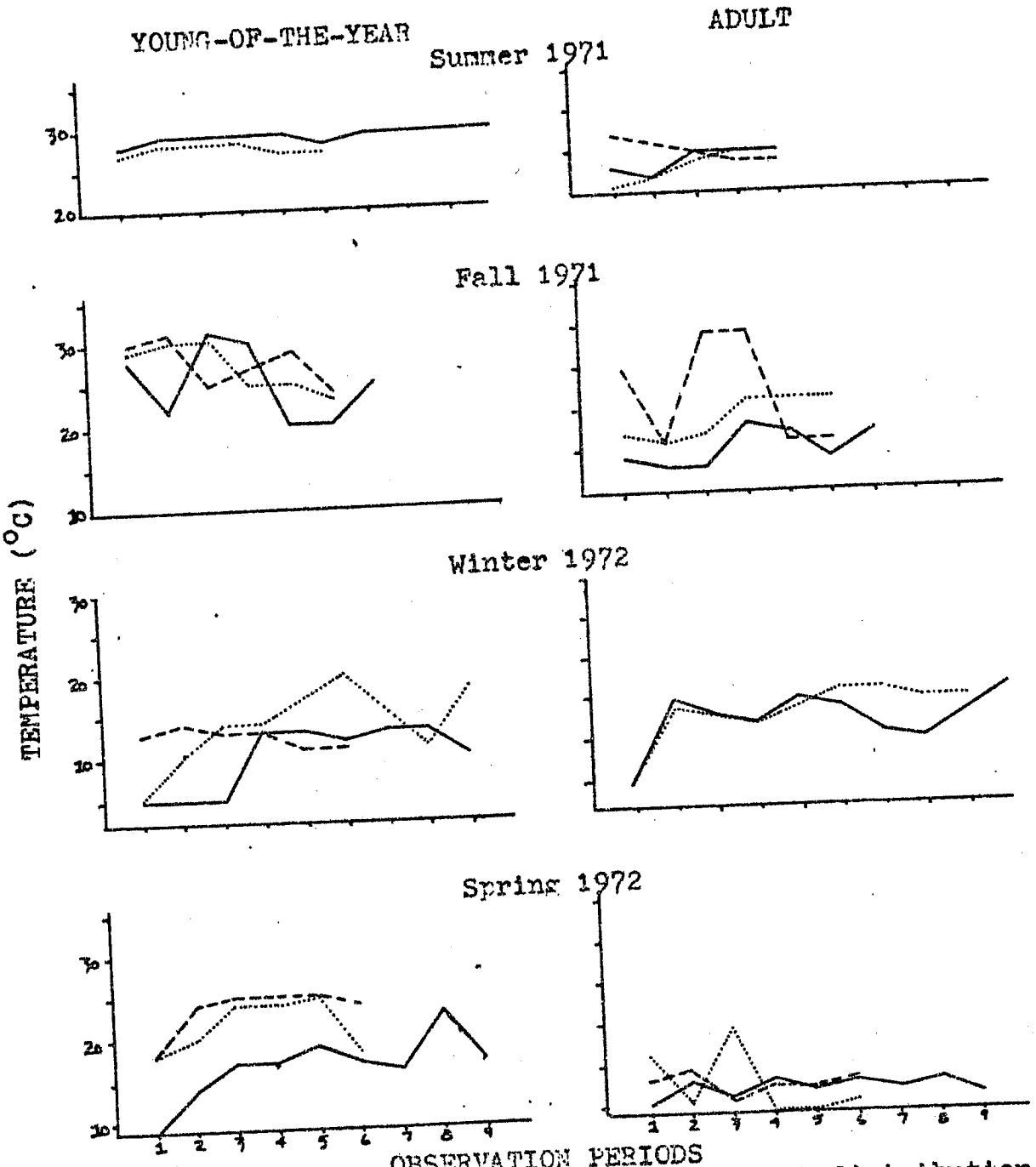


Fig. 3. Modal temperatures of yellow perch distribution in the thermal gradient during successive observation periods from initiation of each test (3 observation periods equal one day).

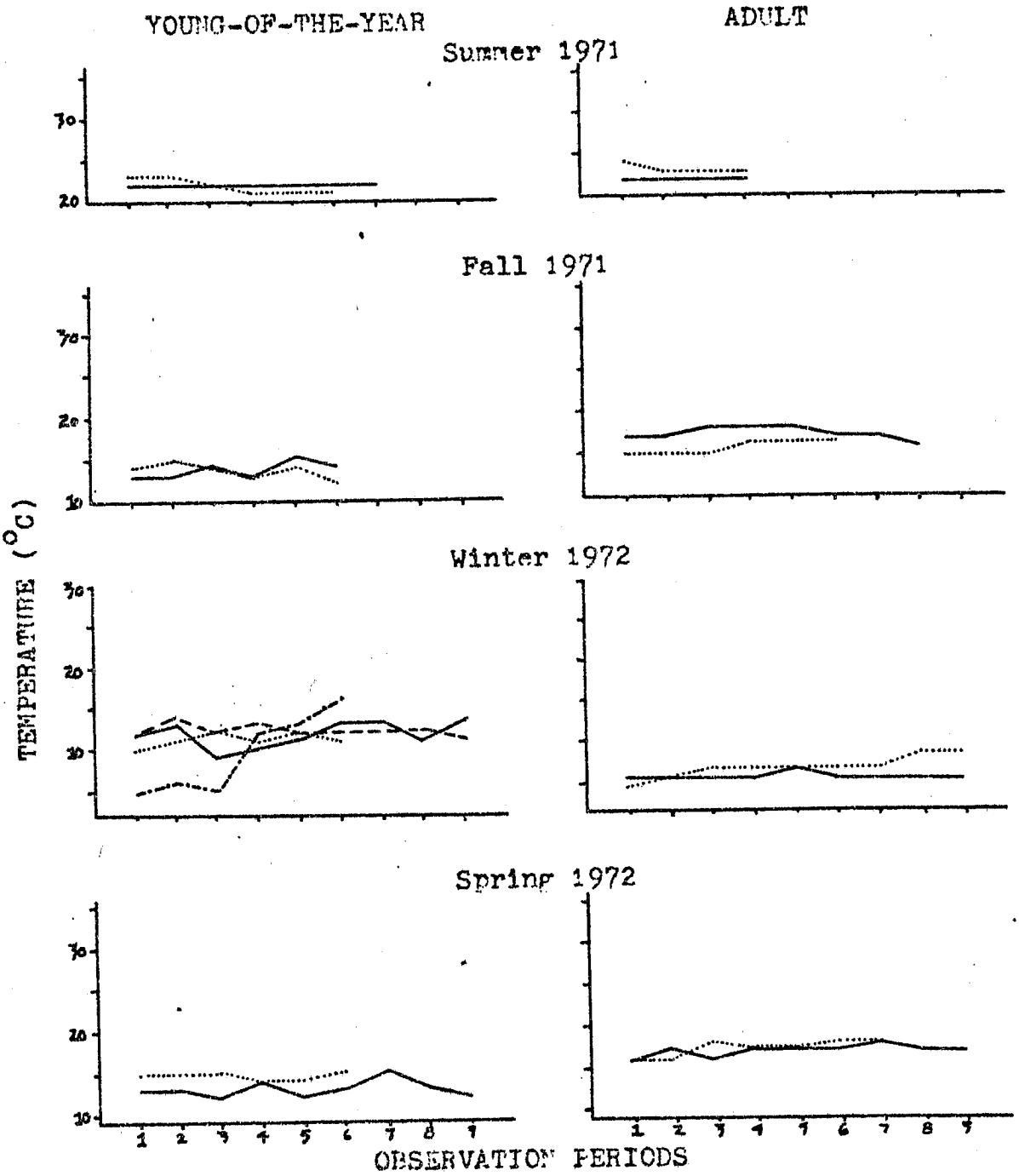


Fig. 4. Modal temperatures of emerald shiner distribution in the thermal gradient during successive observation periods from initiation of each test (3 observation periods equal one day).

JOB PROGRESS REPORT

RESEARCH PROGRESS SEGMENT

| | | | |
|---|---|---|---|
| State of: | Ohio | Date: | May 31, 1972 |
| Project No.: | F-41-R-3 | Name: | Environmental Evaluation of a Nuclear Power Plant |
| Job No.: | 2-B | Title: | Effects of Sudden Temperature Change |
| Period Covered: | June 1, 1971-May 31, 1972 | | |


## ABSTRACT

Adult and young-of-the-year white bass, smallmouth bass, yellow perch and emerald shiners were tested to determine temperatures actively avoided by fish in a thermal gradient and to describe rapid temperature changes resulting in stress symptoms. Upper avoidance temperatures indicated temperatures above which a species would not be found in the lake habitat. Stress temperatures indicated lethal temperatures. The same facilities and fish specimens were used in both preference and temperature change experiments.

Most species avoided different temperatures each season. Higher temperatures were avoided by fishes in summer and the lower temperatures avoided in winter or spring. Similar temperatures were avoided by adults and young of each species.

The upper stress temperature varied seasonally but appeared to be similar for all species in a given season. Rapid decreases in temperature of greater than 10C during winter usually caused stress to the species studied.

## RECOMMENDATIONS

The study of temperature avoidance behavior of fish and the affects of sudden temperature changes on fish species from the Locust Point area should continue. Tests to determine avoidance temperatures should be completed prior to temperature selection tests because avoidance tests may provide information on the upper lethal temperatures of each species. This information would be helpful in designing the upper limits of the gradient in temperature preference experiments.

## OBJECTIVE

The objective of this job is to determine the effects of sudden temperature changes on aquatic animals in the Locust Point region.

## TECHNIQUES USED

Information on the affects of sudden temperature changes on white bass, smallmouth bass, yellow perch and emerald shiners was obtained by behavioral observations before and after each thermal preference test. All equipment and facilities were those used in the preference experiments, and test temperatures were those available in the thermal gradient or holding tanks. The same fish species were used in both preference and temperature change experiments.

The temperature avoidance behavior of fish (acclimated to lake temperatures) was recorded during their initial period of exploration in the temperature gradient. This period usually extended from 1 to 4 hours after fish were placed into the gradient at ambient water temperatures. Higher temperatures consistently avoided by small groups of fish were schooling species, although individual fish sometimes penetrated warmer waters.

After a temperature preference test was terminated, fish were subjected to thermal changes by chasing them or transferring them from the compartment of their selected temperature to another of higher or lower temperature. Experimental fish were held in the compartment of a given test temperature for 5 to 10 minutes in tests of increased temperatures and one to several days in tests of decreased temperatures. The loss of swimming control and equilibrium which occurred at elevated temperatures were used as signs of "acute thermal stress" or "shock". The temperatures at which shock and death occurred were recorded. Fish were removed and measured immediately after a test.

## FINDINGS

With the exception of smallmouth bass, fish avoided different temperatures each season during their initial exposure to the thermal gradient. Avoidance temperatures at the upper limit of the experimental gradient were of questionable validity; gradient restrictions were necessary in some cases to insure survival of fish for preference tests. Smallmouth bass avoided similar temperatures (32-34C) during summer, fall and spring (winter tests were inconclusive) although they preferred different temperatures each season. Emerald shiners exhibited seasonal changes in upper avoidance temperatures, with a summer high (27-30C), intermediate fall and spring values and a winter low. White bass avoided high temperatures of 33-34C in summer and low temperature of about 20C during winter, while yellow perch avoided 29-32C in summer and 17-18C in winter.

Adult and young-of-the-year fish of each species appeared to avoid very similar temperatures each season. Although young, generally, avoided temperatures 1-2C higher than adults in summer and fall, the differences were small and this pattern did not continue through spring.

The loss of equilibrium and swimming control by fish at elevated temperatures were used as signs of "thermal stress". The temperature at which the above responses occur was considered to be lethal. Ecologically, the thermal stress temperature is as important as a temperature resulting in the physiological death of a fish.

The results of tests on the effects of rapid changes in temperature on white bass, smallmouth bass, yellow perch and emerald shiners indicated the immediate effects after short term exposure, and did not preclude the possibility that fish were affected in a way that did not become evident until beyond the observation period. Little information was available on stress temperatures during fall or winter, when most tests were eliminated to conserve healthy specimens for possible reuse in later preference tests. Although fish were not retested in later preference tests, the uncertainty of obtaining healthy individuals of various species and age groups justified the omission of many thermal stress tests which may have resulted in death or fish of questionable physiological state.

Although seasonal differences existed in the upper stress temperatures of each of the four species, these differences did not exceed 10C for the limited data available (perch and emerald shiners in winter). All species were stressed at similar upper temperatures (within 5C or less) in a given season. Smallmouth bass did not appear affected by temperatures that stressed other species in summer and spring (26 and 32C respectively). In summer emerald shiners were stressed at temperatures about 2C lower than white bass and yellow perch (both 35C), while during spring all three species were stressed at similar temperatures (28-30C).

During any season, only slight differences existed in the upper stress temperatures between young and adults of the same species.

Tests indicated a correlation between the stress response and one given upper temperature to which a species was exposed. This suggests that the rate of change of temperature (between 5-15C) over a very short period was less important, over the range tested, than a species specific upper stress temperature.

Tests to determine the effects of sudden decreases in water temperature on the four species were conducted primarily in spring and in winter when the difference between selected temperatures and ambient lake temperatures were greatest. In winter young fish of all species appeared slightly more sensitive to rapid temperature decreases than did adults. Temperature drops of greater than 10C usually caused fish to exhibit stress while temperature changes between -15 and -20C caused death. In spring most temperature decreases from preferred to ambient temperatures were of less than 11C. Fish exposed to an 11C temperature drop (or less) showed no visible stress during this season.

JOB COMPLETION REPORT

RESEARCH COMPLETION SEGMENT

State of: Ohio

Project No.: F-41-R-3

Job No.: 1-B

Period Covered: June 1, 1969-May 31, 1972

Date: May 31, 1972

Name: Environmental Evaluation of a Nuclear Power Plant

Title: Benthos Populations Prior to Discharge

## ABSTRACT

Benthos was sampled monthly in the Locust Point area during the ice-free months from June, 1969 through May, 1971. In 1969 and 1970, 21 stations along three transects were sampled; in 1971, the far-offshore stations were deleted and additional near-shore stations were added. In 1969 all samples were taken with a Petersen dredge; after that, the rocky substrates were sampled with a pump sampler, (Baker and Scholl, 1971).

Samples were taken in the reefs in April and May, 1967 through 1970 by the Lake Erie Research Unit, Ohio Division of Wildlife. Reef samples were analysed to provide supplemental information.

The most abundant organisms collected were Chironomidae larvae, Tubificidae and Gastropoda. The greatest diversity occurred on the gravel-small rock substrate. Diversity was least on silt-detritus substrate, where density was greatest. Clay supported only a few species and at low population densities.

## RECOMMENDATIONS

Sampling should be repeated after the power plant is in operation and results compared with this survey. Seasonal samples between 1972 and 1974 are desirable in order to detect any major changes that occur before the plant becomes operational.

## OBJECTIVES

The objective of this job was to determine the species distribution and density of benthic populations prior to discharge.

## TECHNIQUES USED

Twenty one stations in the Locust Point area were established in 1969 (Fig. 1). These varied in depth from 6 to 22 feet and included substrates of silt, sand, detritus, gravel, clay, small rocks, boulders and bedrock. The same 21 stations were sampled monthly from June through October, 1969, and from May through October, 1970.

Late in 1970, Toledo-Edison announced plans to build a cooling tower substantially reducing the area affected by the heated effluent. The sampling program for the spring of 1971 was modified accordingly by deleting the deeper, offshore stations and adding stations at the 6 and 10-foot contours (Fig. 2).

Samples were collected in 1969 with a Petersen dredge ($A=0.0833m^2$). In 1970, a pump-type sampler was used on the boulder and bedrock reef areas. This sampler consisted of a gasoline-powered centrifugal pump, 25 feet of 2-inch pressure hose and a 12-inch diameter head ($A=0.073m^2$). Mr. Russell Scholl and Mr. Ed Driscoll of the Ohio Division of Wildlife helped design the sampler and locate parts for it.

During 1969, each sample consisted of three dredge hauls which were analysed separately. However, the replicates proved to be very similar, and in 1970 and 1971 only one dredge haul was taken at each station.

All samples were sieved through a Number 35 U.S. Soil Series screen (0.5 mm mesh) and preserved in 10% formalin. Samples taken in 1970 and 1971 were stained with Rose Bengal. Samples were rough-sorted using a 10X dissecting microscope and the organisms identified to genus (species when possible) and counted.

Samples taken by the Ohio Division of Wildlife on the reefs in the Locust Point area were also examined. These were samples collected in April and May, 1967 through 1970 with the egg pump described by Manz (1964). The pump was towed over 0.024 hectares and the organisms sieved through standard brass screen (opening of 0.420mm) and preserved in 10% formalin.

## FINDINGS

Forty-five species were found in the benthos samples between June, 1969 and May, 1971 (Table 1). Thirteen species were oligochaetes and nine were chironomids. The greatest number of species collected in any month was 30 (September, 1969) and the fewest species (16) were taken in April and May, 1971.

Figure 2 shows graphically the mean numbers of organisms per square meter and the number of species collected each month is shown in Table 2. In this figure, all substrate types and water depths were pooled to show differences due only to season. The 1969 data does not show a seasonal pattern, but this was probably caused by inexperience on the part of the field crews. For example, the average number of organisms/$m^2$ in August was much lower than in July or September. However, in August, 1969 Transect 3 was not sampled because of the"firing schedule" at Camp Perry. Since the stations on Transect three were usually the most densely populated, the omission of the transect probably resulted in the lower average numbers.

A second factor probably affecting the 1969 samples was the method of sorting and counting, especially samples containing high amounts of detritus and silt. In 1969, samples were preserved in 10% formalin and sorted in white enamel pans. After 1969, samples were stained with Rose Bengal (100 mg/l) before sorting. Rose Bengal is a red dye with an affinity for lipids. Organisms were stained bright red and were much more easily seen. No doubt many small oligochaetes and chironomids in the 1969 samples were unnoticed.

The 1970 samples show a four-fold increase in numbers of organisms between May and September. This increase is due primarily to an increase in oligochaetes in late summer. There was little change in the numbers of species present over the summer. Apparently the total numbers of species in 1970 was less than in 1969, but this is probably because the reef samples were included in the 1969 figures. Several species were only found on the reefs.

In 1971, samples were taken in April and May. Samples were restricted to the six and 10-foot contours. The number of organsims per square meter was greater than in May, 1970, but the number of species was lower. At the six-foot contour stations the number of organisms was greater in April 1971 than in May 1971. Lower populations were probably caused by shifting sand bars in the area after heavy winds (Fig. 2).

The affect of water depth on species distribution and population density in 1970 is shown in figure 3. The 1970 data was chosen because 1970 was consistently sampled during all seasons. The distribution of organisms over the seasons did not appear to be dependent on depth. At the 6-foot stations there was considerable variation both in numbers of species and in percentage of the total organisms present. These fluctuations were probably caused by shifting sand bars and wave action. The greatest percentage of organisms was usually found between 10 and 15 feet where wave action was diminished but bottom conditions were suitable for high populations. The fewest organisms were usually taken at the 6-foot stations. The greatest numbers of species occurred at the 10 and 12-foot stations. The lowest species diversity was found at stations deeper than 15 feet.

Figure 4 and Tables 3-6 indicate how the distribution of species was related to substrate composition. The greatest diversity of species occurred

in gravel-small rock substrate and the greatest percentage of organisms was found in silt-detritus. Clay-gravel substrate supported the fewest organisms and the least diversity. The increase in percentage of organisms is silt-detritus in late summer corresponded with the increase in oligochaetes.

The most abundant taxa overall were Oligochaeta and Chironomidae. Gastropoda were fairly abundant at stations deeper than 10 feet. Aquatic insects other than chironomids were very scarce; Caenis was the only Ephemeropteran found and three genera of Trichoptera (Athripsodes, Oecetis and Polycentropus) occurred occasionally.

The four reef stations (D6-11, Niagara Reef; D6-10, Crib Reef; D6-9, Toussaint Reef; D6-8) have been treated separately because different sampling methods were used. In 1969, the Petersen dredge was used and gave very poor results, certainly underestimating the population. The pump sampler used in 1970 probably overestimated the population, though the samples are more representative of the reef environment. The pump head did not remain in one spot during sampling and the exact area sampled cannot be determined. The estimates showed the composition and relative abundance of species in the reef community. Table 7 shows the relative abundance of various species during the months sampled.

The reef data was supplemented by analyses of samples taken on the three reefs by the Ohio Division of Wildlife (Table 8). The additional pumped samples were sieved through a coarser screen than was used in our sampling and showed a different species composition. Very few chironomids or oligochaetes were retained by the screen, but some organisms not captured by the smaller pump (Orconectes, Asellus and some gastropods) were taken with the larger pump. The pump was towed over a known area and the results are expressed as mean number per hectare for the season (April and May).

## LITERATURE CITED

Baker, Carl T. and Russel L. Scholl. 1971. Walleye spawning area study in western Lake Erie, Ohio Division of Wildlife Dingell-Johnson Rept. F35 - R-10 Job 1. Mimeographed 24 p.

Manz, J. V. 1964. A pumping device used to collect walleye eggs from offshore spawning areas in western Lake Erie. Trans. Am. Fish Soc. 93(2):204-205.

Table 1. Benthic macroinvertebrates found in the Locust Point area June, 1969 through May, 1971.

Hydra

Planariidae

Hirudinea

Oligochaeta
- Limnodrilus hoffmeisteri
- Limnodrilus maumeensis
- Limnodrilus cervix
- Limnodrilus claparedeanus
- Limnodrilus claparedeanus-cervix
- Limnodrilus uderemianus
- Aulodrilus sp.
- Peloscolex ferox
- Potamothrix maldaviensis
- Potamothrix vejdovskyi
- Branchyura sowerbyi
- Nais sp.
- Stylaria sp.

Bryozoa

Isopoda
- Ascellus sp.

Amphipoda
- Gammarus sp.
- Hyalella azteca

Decapoda
- Orconectes virilis

Ephemeroptera
- Caenis sp.

Trichoptera
- Oecetis sp.
- Athripsodes sp.
- Polycentropus sp.

Chironomidae
- Chironomus (Chironomus) sp.
- C. (Cryptochironomus) sp.
- Polypedilum sp.
- Pseudochironomus sp.
- Tanytarus sp.
- Procladius sp.
- Coelotanypus sp.
- Cricotopus sp.
- Psectrocladius sp.

Gastropoda
- Amnicola sp.
- Bythinia sp.
- Physa sp.
- Pleurocera - Goniobasis
- Gyraulus sp.
- Volvata

Pelycepoda
- Sphaerium sp.
- Pisidium sp.
- Lampsilis sp.
- Proptera elata

Table 2. Numbers of organisms/$m^2$ and species at various depths.

1969 - Includes reef stations sampled by Petersen dredge.

| | June | | July | | Aug. | | Sept. | | Oct. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. |
| 6 ft. (5 sta) | 138 | 11 | 239 | 12 | 137 | 12 | 76 | 13 | 340 | 11 |
| 10 ft. (5 sta) | 167 | 14 | 469 | 17 | 159 | 9 | 208 | 18 | 761 | 19 |
| 12 ft. (4 sta) | 106 | 22 | 521 | 15 | 78 | 18 | 928 | 28 | 135 | 13 |
| 15 ft. (4 sta) | 933 | 20 | 1272 | 25 | 149 | 12 | 625 | 23 | 128 | 11 |
| >15 ft. (2 sta) | 748 | 16 | 1048 | 16 | 40 | 4 | 464 | 16 | 12 | 3 |
| Total species | | 27 | | 27 | | 23 | | 30 | | 26 |
| Total/$m^2$ | 2092÷5=418.4 | | 3549÷5=709.8 | | 563÷5=112.6 | | 2301÷5=460.2 | | 1376÷5=295.2 | |

1970 - Does not include reef stations.

| | May | | June | | July | | Aug. | | Sept. | | Oct. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 ft. (5 sta) | 164 | 9 | 1055 | 17 | 645 | 8 | 572 | 9 | 4552 | 16 | 3341 | 16 |
| 10 ft. (5 sta) | 1676 | 17 | 1761 | 17 | 2338 | 17 | 4000 | 17 | 8175 | 16 | 5882 | 15 |
| 12 ft. (3 sta) | 1320 | 7 | 2678 | 17 | 1670 | 16 | 2361 | 18 | 4220 | 22 | 6511 | 18 |
| 15 ft. (2 sta) | 854 | 12 | 2119 | 15 | 1906 | 12 | 2944 | 13 | 5342 | 14 | 3661 | 17 |
| >15 ft. (1 sta) | 1845 | 6 | 528 | 8 | 1703 | 10 | 2979 | 8 | 6044 | 8 | 5664 | 8 |
| Total species | | 20 | | 24 | | 23 | | 23 | | 24 | | 22 |
| Total/$m^2$ | 5909÷5=1181.8 | | 8141÷5=1628.2 | | 8262÷5=1652.4 | | 12856÷5=2571.2 | | 28333÷5=5666.6 | | 25059÷5=5011.8 | |

1971 - Ten nearshore stations.

| | April | | May | |
|---|---|---|---|---|
| 6 ft. (5 sta) | 427 | 10 | 186 | 8 |
| 10 ft. (5 sta) | 5045 | 16 | 5327 | 16 |
| Total species | | 16 | | 16 |
| Total/$m^2$ | 5472÷2=2736 | | 5513÷2=2756.5 | |

TABLE 3

Benthic macroinvertebrates from stations with a silt, sand and detrital substrate (D6-12,C6-1,D6-16,D6-17, D6-18,D6-19), May through October, 1969 & 1970, expressed as the mean number of organisms per square meter.

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Hydra | 7 | 0 | No Sample Taken | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| Hirudinea | 0 | 0 | | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 |
| Oligochaeta (immature) | 329 | 778 | | 25 | 2212 | 635 | 1307 | 1012 | 2836 | 6737 | 6489 |
| Limnodrilus Hoffmeisteri | 21 | 82 | | 0 | 12 | 56 | 34 | 42 | 52 | 132 | 172 |
| L. maumeensis | 45 | 72 | | 1 | 9 | 8 | 102 | 156 | 100 | 160 | 70 |
| L. claparedeanus-cervix | 17 | 23 | | 0 | 18 | 82 | 118 | 114 | 78 | 345 | 306 |
| Potamothrix Moldaviensis | 43 | 77 | | 0 | 10 | 12 | 50 | 108 | 190 | 26 | 108 |
| Branchyura sowerbyi | 10 | 3 | | 1 | 138 | 154 | 244 | 248 | 259 | 569 | 1192 |
| Chironomus (Chironomus) | 86 | 24 | | 10 | 126 | 345 | 126 | 291 | 499 | 1273 | 1124 |
| C.(Cryptochironomus) | 15 | 7 | | 3 | 63 | 12 | 2 | 8 | 4 | 4 | 52 |
| Polypedilum | 23 | 1 | | 0 | 15 | 0 | 2 | 6 | 4 | 8 | 2 |
| Tanytarsus | 3 | 92 | | 0 | 9 | 2 | 0 | 0 | 4 | 14 | 4 |
| Procladius | 45 | 10 | | 0 | 15 | 155 | 54 | 0 | 16 | 12 | 16 |
| Coelotanypus | 19 | 0 | | 9 | 9 | 8 | 6 | 12 | 14 | 108 | 86 |
| Caenis | 1 | 3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sphaerium | 0 | 4 | | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Gammarus | 0 | 5 | | 0 | 6 | 2 | 0 | 8 | 6 | 24 | 4 |

TABLE 4

Benthic macroinvertebrates from stations with a clay-gravel substrate (D6-13,D6-14,D6-15,D5-2), May through October, 1969 & 1970, expressed as the mean number of organisms per square meter.

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Hydra | 0 | 4 | 0 | 0 | 0 | 0 | 108 | 0 | 0 | 0 | 0 |
| Hirudinea | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 3 | 0 |
| Oligochaeta (immature) | 1 | 95 | 46 | 116 | 28 | 249 | 396 | 810 | 396 | 465 | 198 |
| Limnodrilus hoffmeisteri | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 9 |
| L. maumeensis | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| L. claparedeanus-cervix | 1 | 3 | 0 | 0 | 0 | 21 | 18 | 18 | 3 | 3 | 18 |
| Potamothrix moldaviensis | 0 | 15 | 47 | 1 | 0 | 21 | 3 | 30 | 6 | 18 | 18 |
| Branchyura sowerbyi | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 0 | 18 | 3 |
| Stylaria | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 12 | 9 | 12 | 0 |
| Gammarus | 15 | 9 | 0 | 0 | 3 | 3 | 6 | 9 | 9 | 6 | 15 |
| Chironomus (Chironomus) | 1 | 1 | 5 | 5 | 3 | 0 | 3 | 0 | 27 | 117 | 24 |
| C.(Cryptochironomus) | 6 | 14 | 7 | 3 | 4 | 24 | 6 | 9 | 0 | 9 | 21 |
| Pseudochironomus | 3 | 2 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 3 |
| Polypedilum | 0 | 11 | 9 | 2 | 0 | 15 | 66 | 9 | 12 | 12 | 24 |
| Tanytarsus | 0 | 12 | 2 | 14 | 0 | 27 | 6 | 6 | 48 | 192 | 9 |
| Procladius | 3 | 4 | 4 | 0 | 3 | 3 | 0 | 3 | 3 | 17 | 6 |
| Coelotanypus | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Caenis | 10 | 8 | 0 | 0 | 1 | 6 | 6 | 0 | 0 | 3 | 3 |
| Oecetis | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

TABLE 4
Cont'd

| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Amnicola | 0 | 0 | 0 | 1 | 0 | 0 | 12 | 0 | 0 | 0 | 0 |
| Bythinia | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| Sphaerium | 2 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 |
| Pisidium | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |

TABLE 5

m

Benthic macroinvertebrates from stations with a gravel and small rock substrate (D6-7,D6-6,D6-5,D6-4,D5-3,D5-4), May through October, 1969 & 1970, expressed as the mean number of organisms per square meter.

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Hydra | 21 | 198 | 1 | 3 | 0 | 0 | 500 | 92 | 2 | 0 | 36 |
| Planariidae | 7 | 35 | 0 | 11 | 20 | 0 | 4 | 16 | 0 | 30 | 26 |
| Hirudinea | 0 | 3 | 1 | 3 | 4 | 2 | 2 | 14 | 12 | 8 | 8 |
| Oligochaeta (immature) | 131 | 413 | 19 | 411 | 112 | 906 | 874 | 1214 | 1397 | 3393 | 4248 |
| Limnodrilus hoffmeisteri | 10 | 3 | 1 | 2 | 0 | 38 | 46 | 26 | 42 | 52 | 54 |
| L. maumeensis | 3 | 3 | 1 | 1 | 1 | 0 | 16 | 14 | 14 | 34 | 4 |
| L. claparedeanus-cervix | 1 | 1 | 0 | 1 | 0 | 24 | 10 | 26 | 10 | 118 | 14 |
| Potamothrix moldaviensis | 33 | 22 | 13 | 1 | 0 | 70 | 42 | 112 | 78 | 28 | 35 |
| Branchyura sowerbyi | 3 | 1 | 0 | 3 | 0 | 0 | 2 | 4 | 2 | 369 | 4 |
| Nais | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| Stylaria | 0 | 11 | 1 | 7 | 0 | 0 | 0 | 50 | 52 | 6 | 0 |
| Gammarus | 17 | 19 | 7 | 13 | 21 | 4 | 68 | 66 | 56 | 58 | 70 |
| Chironomus (Chironomus) | 28 | 0 | 5 | 11 | 3 | 0 | 407 | 2 | 160 | 602 | 92 |
| C.(Cryptochironomus) | 10 | 9 | 11 | 7 | 19 | 24 | 16 | 13 | 18 | 4 | 86 |
| Pseudochironomus | 1 | 0 | 3 | 2 | 3 | 7 | 8 | 2 | 0 | 0 | 6 |
| Polypedilum | 6 | 0 | 23 | 2 | 1 | 8 | 12 | 2 | 26 | 2 | 38 |
| Tanytarsus | 2 | 29 | 43 | 45 | 0 | 0 | 0 | 2 | 104 | 315 | 76 |
| Procladius | 5 | 3 | 6 | 28 | 4 | 0 | 0 | 4 | 2 | 38 | 82 |

TABLE 5
Cont'd

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Coelotanypus | 2 | 0 | 1 | 7 | 0 | 0 | 0 | 0 | 2 | 24 | 14 |
| Polycentropus | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Caenis | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| Oecetis | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amnicola | 0 | 0 | 0 | 9 | 0 | 2 | 10 | 6 | 8 | 8 | 0 |
| Bythinia | 3 | 3 | 1 | 4 | 4 | 0 | 4 | 0 | 0 | 0 | 0 |
| Pleurocere-Goniobasis* | 1 | 15 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 0 |
| Physa | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 2 | 2 | 0 |
| Sphaerium | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 1 | 6 | 8 | 0 |
| Pisidium | 5 | 1 | 0 | 19 | 0 | 6 | 6 | 0 | 10 | 28 | 16 |

* Cannot distinguish genera with certainty.

Table 6. Benthic macroinvertebrates, April & May, 1971, expressed as mean number of organisms per square meter.

| | April 17, 1971 | | | May 15, 1971 | | |
|---|---|---|---|---|---|---|
| | Silt, detritus substrate (A1, A2, B1, B2) | Clay, gravel substrate (D1, E1, E2) | Gravel, small rock substrate (C1, C2, D2) | Silt, detritus substrate (A1, A2, B1, B2) | Clay, gravel substrate (D1, E1, E2) | Gravel, small rock substrate (C1, C2, D2) |
| Hirudinea | 0 | 4 | 4 | 0 | 0 | 0 |
| Oligochaeta (imm.) | 4062 | 220 | 1176 | 2535 | 1220 | 1808 |
| Limnodrilus hoffmeisteri | 159 | 0 | 52 | 180 | 8 | 28 |
| L. maumeensis | 66 | 4 | 8 | 66 | 4 | 28 |
| L. cervix | 15 | 0 | 8 | 54 | 0 | 20 |
| L. claparedeanus | 195 | 0 | 12 | 117 | 0 | 4 |
| Potamothrix moldaviensis | 114 | 16 | 20 | 237 | 32 | 64 |
| Branchyura sowerbyi | 570 | 0 | 20 | 257 | 12 | 12 |
| Nais sp. | 18 | 4 | 4 | 21 | 12 | 20 |
| Gammarus sp. | 3 | 20 | 0 | 9 | 0 | 8 |
| Caenis sp. | 0 | 4 | 0 | 0 | 0 | 0 |
| Chironomus (Chironomus) | 171 | 4 | 100 | 171 | 0 | 0 |
| C. (Cryptochironomus) | 54 | 0 | 48 | 45 | 24 | 84 |
| Polypedilum | 0 | 0 | 0 | 0 | 12 | 8 |
| Tanytarsus | 0 | 0 | 0 | 12 | 8 | 8 |
| Procladius | 90 | 0 | 40 | 66 | 0 | 0 |
| Coelotanypus | 9 | 0 | 4 | 0 | 0 | 0 |

TABLE 7

Benthic macroinvertebrates from stations with a bedrock and large boulder substrate (D6-11,D6-10,D6-9,D6-8), May through October 1969 & 1970, expressed as percent of the total number of organisms (%).

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Hydra | 89 | 0 | 0 | 19 | 0 | 4 | 4 | 1* | 1* | No Sample Taken | 2 |
| Planariidae | 5 | 3 | 30 | 13 | 20 | 9 | 9 | 3 | 4 | | 23 |
| Oligochaeta (immature) | 1 | 30 | 18 | 27 | 22 | 65 | 2 | 10 | 5 | | 10 |
| Limnodrilus hoffmeisteri | 0 | 4 | 1 | 1 | 1 | 0 | 1* | 1* | 1* | | 0 |
| Nais | 0 | 1 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | | 1* |
| Gammarus | 1 | 39 | 26 | 10 | 2 | 1 | 44 | 62 | 48 | | 33 |
| Hyalella azteca | 0 | 3 | 2 | 3 | 0 | 0 | 5 | 2 | 1 | | 3 |
| Chironomus (Chironomus) | 0 | 1* | 1 | 2 | 1 | 0 | 16 | 1 | 2 | | 1* |
| C.(Cryptochironomus) | 0 | 2 | 1 | 1* | 0 | 1 | 0 | 1* | 1 | | 1* |
| Tanytarsus | 0 | 1* | 8 | 1* | 0 | 0 | 0 | 0 | 1* | | 1* |
| Procladius | 0 | 5 | 1 | 2 | 4 | 0 | 1 | 1 | 1 | | 1 |
| Coelotanypus | 0 | 1* | 1* | 1 | 8 | 0 | 0 | 0 | 0 | | 1* |
| Polycentropus | 1* | 0 | 2 | 1 | 5 | 1 | 1* | 1* | 1* | | 1* |
| Amnicola | 3 | 0 | 0 | 6 | 0 | 0 | 10 | 10 | 18 | | 16 |
| Bythinia | 0 | 0 | 4 | 3 | 18 | 0 | 0 | 0 | 1* | | 1* |
| Pleurocera-Goniobasis** | 2 | 1 | 0 | 1* | 0 | 0 | 0 | 0 | 2 | | 1 |
| Physa | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 2 | | 1 |
| Sphaerium | 0 | 2 | 0 | 5 | 1 | 0 | 1 | 1 | 2 | | 3 |
| Pisidium | 0 | 0 | 0 | 3 | 4 | 0 | 1 | 0 | 4 | | 2 |
| Valvata | 0 | 0 | 0 | 0 | 8 | 0 | 1 | 0 | 5 | | 0 |

*Indicates less than 1%
**Cannot distinguish genera with certainty

Table 8. Benthic macroinvertebrates collected at Niagara, Crib & Toussaint Reefs in April and May, 1967 through 1970 by Ohio Division of Wildlife egg pump, expressed as mean number of organisms per hectare.

| | 1967 | | | 1968 | | | 1969 | | | 1970 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Niagara | Crib (D6-10) | Toussaint (D6-9) | Niagara (D6-11) | Crib (D6-10) | Toussaint (D6-9) | Niagara (D6-11) | Crib (D6-10) | Toussaint D6-9) | Niagara | Crib (D6-10) | Toussaint (D6-9) |
| Planariidae | 2995 | 1789 | 62 | 1489 | 1269 | 811 | 104 | 166 | 0 | 21 | 62 | 69 |
| Hirudinea | 42 | 437 | 187 | 62 | 354 | 83 | 62 | 83 | 370 | 0 | 0 | 14 |
| Asellus sp. | 624 | 2766 | 187 | 2974 | 5886 | 208 | 229 | 728 | 42 | 0 | 104 | 14 |
| Gammarus sp. | 38750 | 105394 | 83824 | 74152 | 90979 | 54142 | 52000 | 28038 | 52083 | 12022 | 9818 | 10317 |
| Hyalella azteca | 1914 | 936 | 0 | 416 | 1102 | 0 | 0 | 0 | 0 | 42 | 146 | 111 |
| Orconectes sp. | 101 | 99 | 102 | 104 | 213 | 81 | 410 | 102 | 0 | 98 | 103 | 0 |
| Polycentropus sp. | 208 | 624 | 42 | 125 | 354 | 145 | 0 | 125 | 42 | 21 | 291 | 83 |
| Amnicola sp. | 15900 | 420 | 505 | 36100 | 39317 | 4400 | 200 | 34625 | 40 | 910 | 23412 | 4690 |
| Bythinia sp. | 1422 | 409 | 818 | 411 | 616 | 1211 | 101 | 529 | 2617 | 119 | 1108 | 1998 |
| Physa sp. | 917 | 1418 | 310 | 1903 | 1810 | 1120 | 1031 | 915 | 2921 | 207 | 533 | 114 |
| Pleurocera-Goniobasis* | 3821 | 1530 | 1239 | 2806 | 13419 | 4132 | 3211 | 10831 | 3033 | 3941 | 13399 | 4957 |
| Valvata sp. | 103 | 0 | 0 | 611 | 25 | 21 | 0 | 27 | 0 | 0 | 0 | 0 |
| Sphaerium sp. | 431 | 143 | 217 | 644 | 251 | 433 | 327 | 104 | 0 | 0 | 210 | 0 |
| Pisidium sp. | 0 | 122 | 432 | 217 | 473 | 316 | 0 | 0 | 0 | 0 | 119 | 0 |

*Cannot distinguish genera with certainty

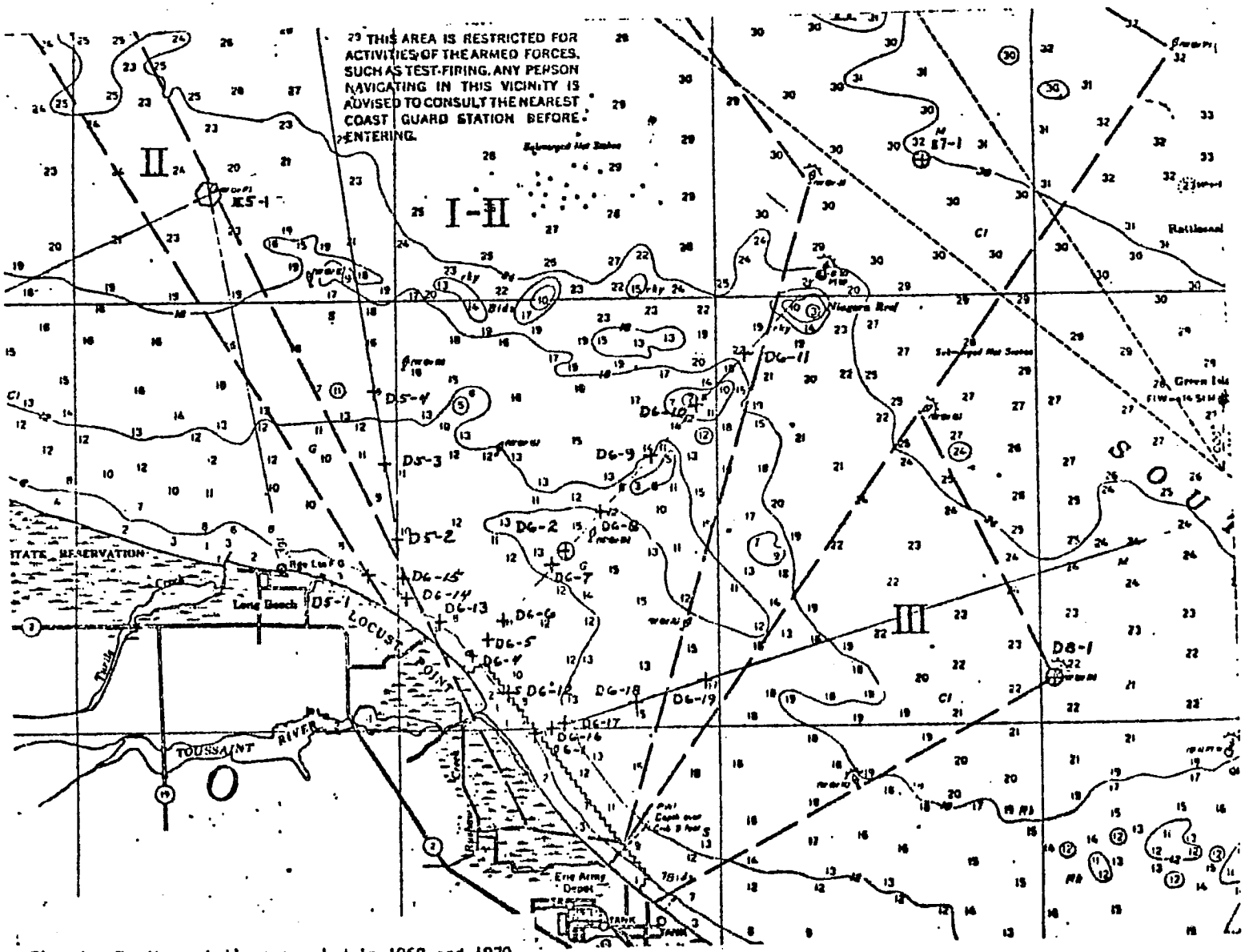


Fig. 1. Benthos stations sampled in 1969 and 1970.

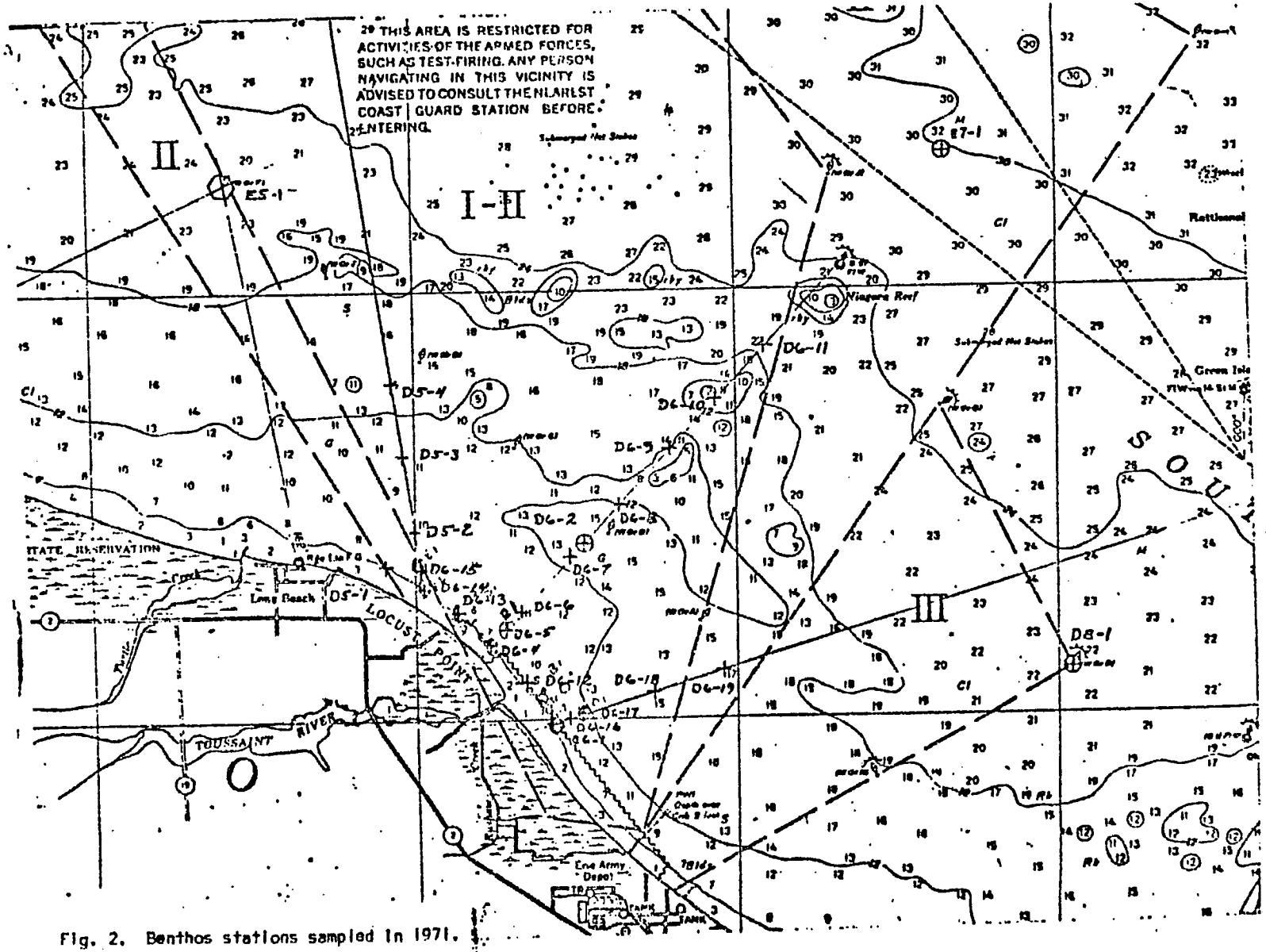


Fig. 2. Benthos stations sampled in 1971.

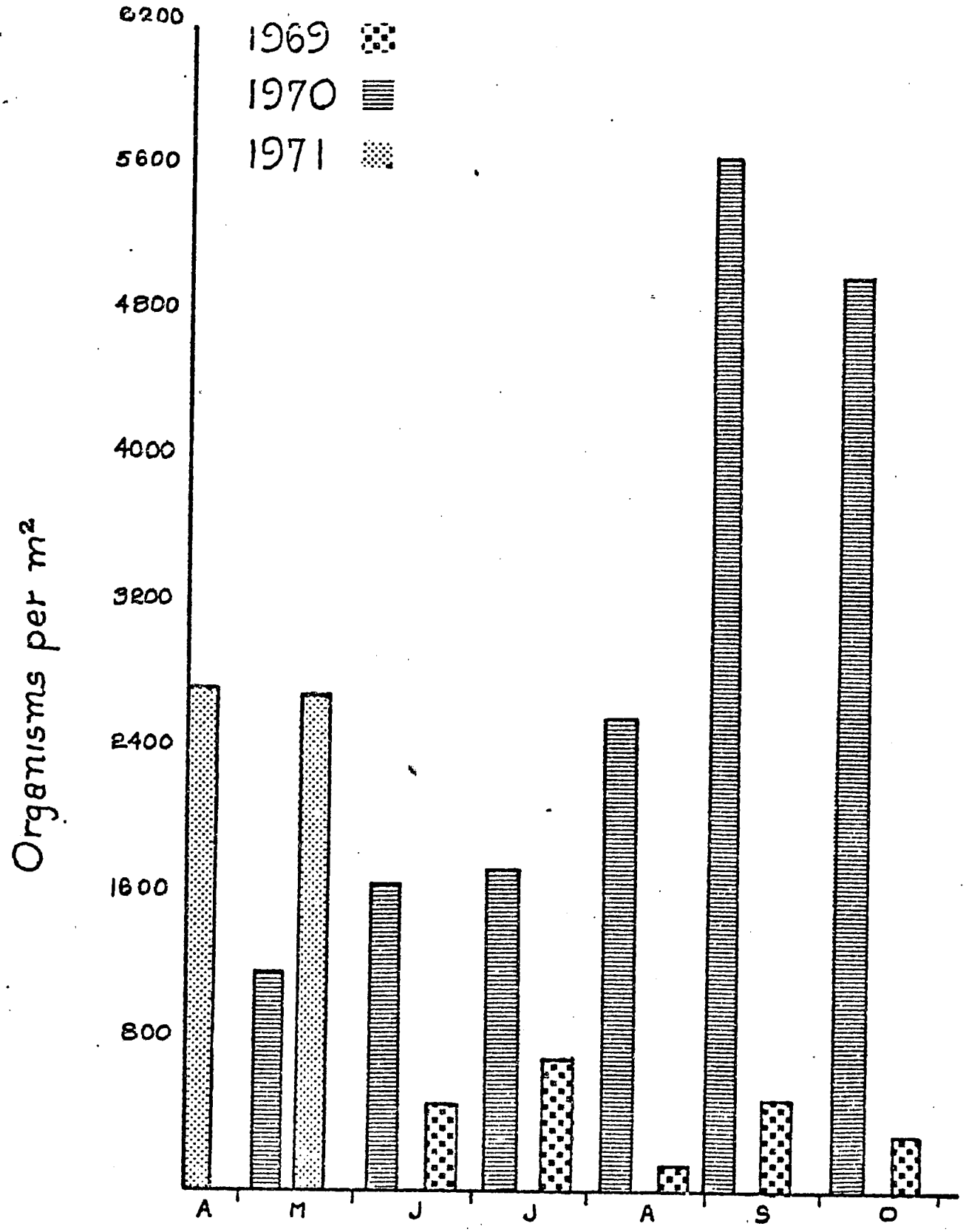


Figure 3. Mean number of organisms/m²/month from June 1969 to May 1971.

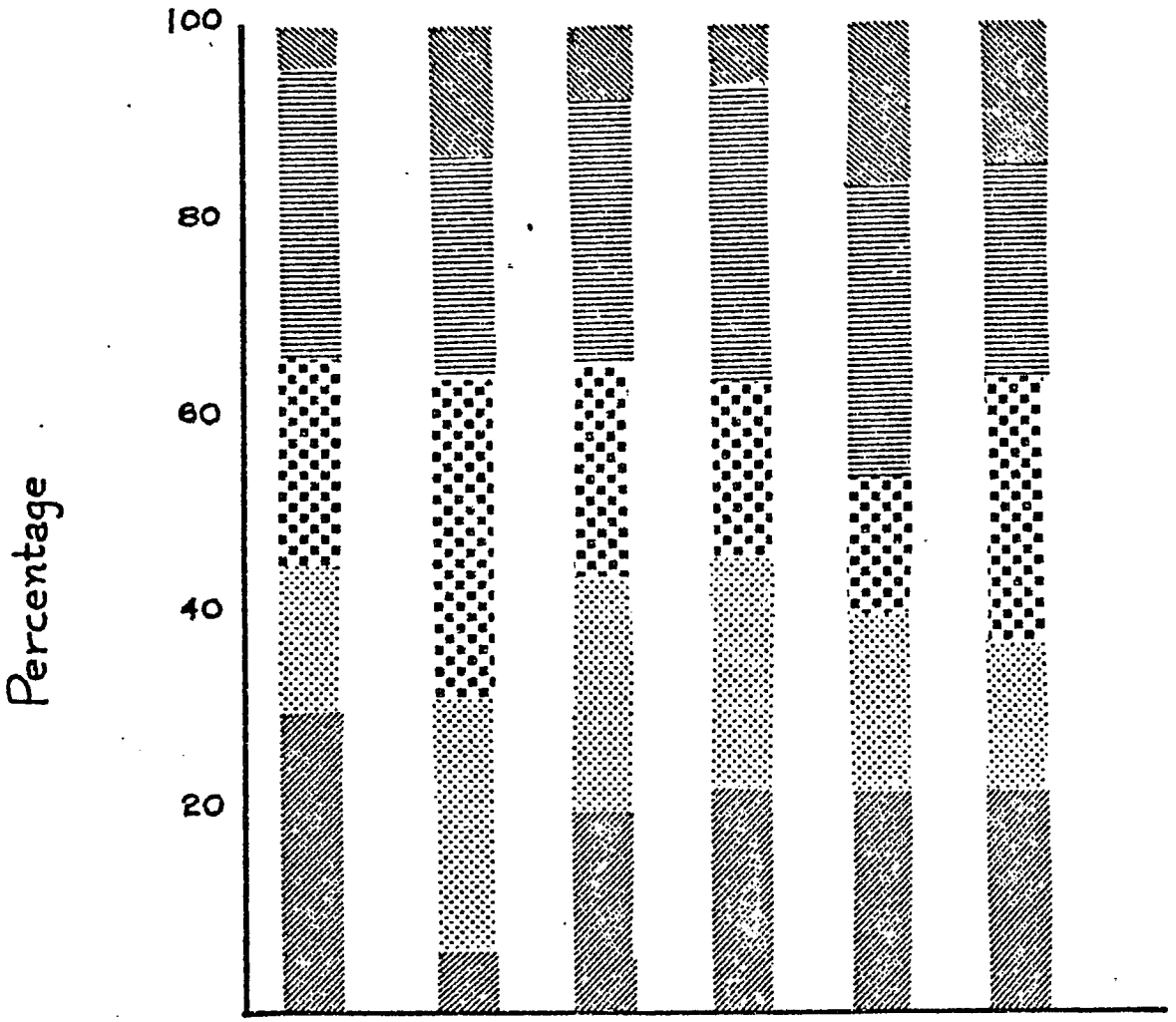


Figure 4. Percentage of benthos found at different water depths, no reef samples

6 feet, 10 feet, 12 feet, 15 feet, >15 feet

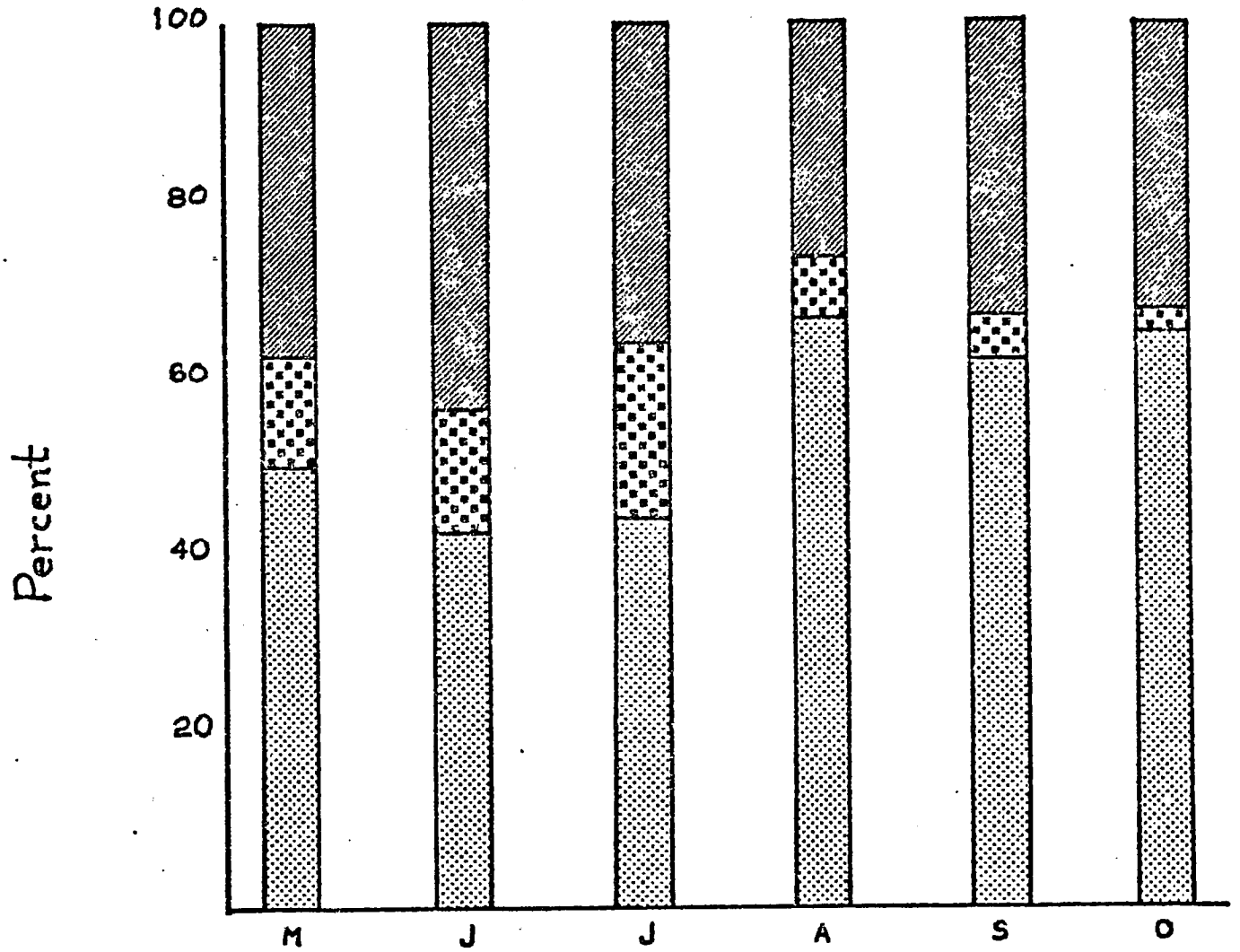


Figure 5. Percentage of organisms on different substrates.

Gravel and small rocks

Clay and gravel

Silt, sand and detritus

JOB COMPLETION REPORT

RESEARCH COMPLETION SEGMENT

State of: Ohio

Project No.: F-41-R-3

Job No.: 1-C

Period Covered: June 1, 1969-May 31, 1972

Date: May 31, 1972

Name: Environmental Evaluation of a Nuclear Power Plant

Title: Plankton Populations Prior to Discharge


## ABSTRACT

Zooplankton was sampled monthly in the Locust Point area from June, 1969 through May, 1971 during the ice free portion of the year. In 1969 and 1970 stations were distributed over a wide area of the lake. In 1971 the stations were located near shore, after the Toledo-Edison Company announced that a cooling tower was to be constructed.

Cyclopoid copepods were found in 97.2% of all samples and calanoid copepods found in 84.9% of the samples. Cladocerans were also abundant with Daphnia retrocurva occurring in 80.1% of the samples and Bosmina in 86.3%. Abundant rotifers included Keratella cochlearis and Polyarthra.

The highest densities of all zooplankton (all taxa) appeared in June, July and August. The copepod populations were greatest in June, July and August. Cladocerans and rotifers were most numerous in July and August.


## RECOMMENDATIONS

Zooplankton should be sampled in a more restricted area with more frequent samples until the power-plant is in operation. Phytoplankton should be sampled over all seasons before plant operation begins in 1974.

## OBJECTIVE

The objective of this research was to determine the character and composition of the zooplankton populations of the Locust Point area of Lake Erie prior to operation of the nuclear power-plant.

## TECHNIQUES USED

Plankton samples were taken at 23 stations along three transects radiating outward from the power plant (Figure 1). A summary of the stations and depths is shown in Table 1.

A 3-liter Kemmerer water bottle was used to collect samples at 1 and 3 meters. Samples were concentrated by passage through a No. 25 silk bolting cloth and zooplankters were then fixed in 5% formalin. The smaller nannoplankters were last with this procedure, but the larger zooplankters fed upon by fishes were retained and an overall estimate of the zooplankton was readily accomplished using this procedure. Zooplankters were counted in a Sedgewick-Rafter counting chamber at 100X magnification. Individual species were identified when necessary at 980X magnification.

## FINDINGS

The frequency of occurrence of individual zooplankters is shown in Table 2. The only protozoan found in the samples was Acinetz and it was found only in 1969. Rotifers were quite common in all samples. The ubiquitous Keratella cochlearis was found in 95.2% of all samples and Polyarthra was also abundant occurring in 93.7% of all samples. Brachinous, Keratella quadrula, Asplanchna and Filina were other prominent rotifers.

Copepods were idientified only as cyclopoid or calanoid types and the naupli were counted separately. Naupli were found in every sample taken and the widespread occurrence of calanoid cyclopoid copepods indicated a large number of copepods in the area.

Cladocerans were well represented in the zooplankton. The more numerous Cladocerans included Daphnia retrocurva (80.1% of all samples) and several species of Bosmina (86.3% of all samples) Chydorus and Daphnia galeata were found frequently in the samples.

Seasonally all zooplankton reached peak densities in June, July and August. Some of the stations with the highest numbers of zooplankters are shown in Table 3. Copepods were found in large numbers throughout the summer but Cladocerans reached peak populations in July and August.

The location and depth of all stations with the highest concentrations of zooplankters is shown in Table 3. No apparent relationship between density and depth is discernable from the data collected. At times zooplankton at 1-meter was most abundant and at other times samples at 3-meters had higher populations. There was no clear pattern when numbers of zooplankters near shore stations (less than 6 feet) were compared to off-shore stations. The number of species identified from offshore stations appeared to be greater than the diversity of the inshore stations. The increased diversity was probably a direct result of the emphasis placed on sampling offshore stations. As the samples were enumerated fewer species were identified in any one offshore station than in one inshore station. The greater diversity of zooplankton was probably an artifact of our sampling techniques.

A few notes were made on the phytoplankters found in the course of counting zooplankton. The spring diatom bloom consists largely of Melosira, Fragellaria, Asterionella, Tabellaria and small numbers of Pediastrum.

During summer algae were few in the samples. Green algae were more abundant than other species Pediastrum and Scinedesmus were fairly common, and Staurastrum and Ceratium were more common than in other seasons.

In the autumn representatives of the blue greens Aphanizomenon and Microcystis were abundant and the diatoms were again prominent. Pediastrum is probably the most common alga at all seasons. Ceratium and Staurastrum are also present throughout the year. (Table 4.)

Table 1. Stations sampled - Distance from shore and approximate depth.

| Stations | Distance from shore in ft. (approximate) | Approx. depth in ft. |
|---|---|---|
| D5-1 | 2000 | 6 |
| D5-2 = E1 | 7000 | 10 |
| D5-3 | 11000 | 11 |
| D5-4 | 17000 | 16 |
| D6-4 = C2 | 1000 | 6 |
| D6-5 | 3000 | 8 |
| D6-6 = C1 | 4000 | 11 |
| D6-7 | 9000 | 12 |
| D6-8 | 15000 | 12 |
| D6-9 | 21000 | 11 |
| D6-10 | 25000 | 8 |
| D6-11 | 30000 | 22 |
| D6-12 = B2 | 2000 | 6 |
| D6-13 = D2 | 1500 | 6 |
| D6-14 = E2 | 2000 | 6 |
| D6-15 | 5000 | 9 |
| D6-16 | 3500 | 12 |
| D6-17 = A1 | 5500 | 13 |
| D6-18 | 10000 | 15 |
| D6-19 | 15000 | 17 |
| C6-1 = A2 | 2000 | 6 |
| B1 | 4000 | 10 |
| D1 | 4000 | 9 |

____ = Inshore stations

Table 2. Frequency of occurrence of all plankters collected. (# of samples in which organism was identified)

| | June 69 | July 69 | Aug. 69 | Sept. 69 | Oct. 69 | May 70 | June 70 | July 70 | Aug. 70 | Sept. 70 | Oct. 70 | April 71 | May 71 | Total # samples in which plankter was collected | % of samples in which plankter occurs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Protozoan | | | | | | | | | | | | | | | |
| Acinetz | - | 3 | 3 | - | - | - | - | - | - | - | - | - | - | - | 1.7 |
| Rotifer | | | | | | | | | | | | | | | |
| K.quadrula | 15 | 25 | 4 | - | 8 | 31 | 32 | 12 | 11 | - | 5 | 8 | 15 | 166 | 47.3 |
| K.cochlearis | 15 | 28 | 23 | 30 | 32 | 30 | 33 | 32 | 30 | 27 | 33 | 6 | 15 | 334 | 95.2 |
| Polyarthra | 15 | 20 | 22 | 30 | 32 | 30 | 33 | 32 | 30 | 29 | 34 | 7 | 15 | 329 | 93.7 |
| Pompholyx | - | 7 | 7 | - | - | - | - | - | - | - | 10 | - | - | 24 | 6.8 |
| Asplanchna | 15 | - | 3 | 21 | 16 | 8 | 1 | - | 13 | 27 | 16 | - | - | 120 | 34.2 |
| Brachionus | 10 | 12 | 12 | 4 | - | 32 | 7 | 32 | 30 | 30 | 34 | 15 | 15 | 233 | 66.4 |
| Kellikotia | 10 | 11 | - | - | - | 13 | 8 | - | - | - | 1 | - | - | 43 | 12.3 |
| Philodina | 7 | 5 | - | - | - | - | - | - | - | - | - | - | - | 12 | 3.4 |
| Filinia | 7 | 1 | 2 | - | - | 23 | 4 | 8 | 9 | - | - | 3 | 15 | 72 | 20.5 |
| Trichoerca | 1 | 9 | 15 | - | - | - | - | - | - | - | 1 | - | - | 26 | 7.4 |
| Platyias | - | 5 | 2 | - | - | - | - | - | - | - | - | - | - | 7 | 2.0 |
| Testudinea | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | .3 |
| Notholca | - | - | - | - | - | 13 | - | - | - | - | - | - | - | 13 | 3.7 |
| Conchilus | - | - | - | - | - | - | - | 21 | - | - | - | - | - | 21 | 6.0 |
| Ascomorpha | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | .3 |
| Proales | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | .3 |
| Rotaria | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | .3 |
| Total # samples taken | 15 | 29 | 24 | 30 | 32 | 32 | 33 | 32 | 30 | 30 | 34 | 15 | 15 | 351 | |

Table 2. Continued

| | June 69 | July 69 | Aug. 69 | Sept. 69 | Oct. 69 | May 70 | June 70 | July 70 | Aug. 70 | Sept. 70 | Oct. 70 | April 71 | May 71 | Total # samples in which plankter was collected | % of samples in which plankter occurs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arthropods | | | | | | | | | | | | | | | |
| Copepods | | | | | | | | | | | | | | | |
| Cyclopoid | 15 | 29 | 24 | 30 | 32 | 30 | 32 | 32 | 30 | 30 | 33 | 12 | 12 | 341 | 97.2 |
| Calanoid | 15 | 29 | 24 | 30 | 28 | 27 | 15 | 26 | 28 | 29 | 28 | 9 | 10 | 298 | 84.9 |
| Naupli | 15 | 29 | 24 | 30 | 32 | 32 | 33 | 32 | 30 | 30 | 34 | 15 | 15 | 351 | 100.0 |
| Cladocerans | | | | | | | | | | | | | | | |
| D. retrocurva | 15 | 29 | 24 | 30 | 9 | 9 | 33 | 32 | 30 | 30 | 34 | 1 | 5 | 281 | 80.1 |
| D. galeata | 11 | 29 | 24 | 2 | - | - | 2 | 14 | 27 | 10 | 5 | - | 1 | 125 | 35.6 |
| D. parvula | 6 | 14 | 16 | - | - | - | 1 | - | - | - | - | 1 | - | 38 | 10.8 |
| Bosmina | 14 | 29 | 24 | 30 | 32 | 14 | 28 | 32 | 30 | 30 | 34 | 2 | 13 | 312 | 86.3 |
| Chydorus | 9 | 2 | - | 30 | 26 | 2 | 10 | 9 | 10 | 30 | 34 | 1 | - | 163 | 46.4 |
| Diphanisoma | 1 | 5 | 3 | 5 | - | - | 1 | - | 11 | 16 | 18 | - | - | 60 | 17.1 |
| Leptodora | 2 | 20 | 8 | 1 | - | - | 2 | 3 | 7 | 6 | 5 | - | - | 54 | 15.4 |
| Simocephalus | - | 9 | 7 | - | - | - | - | - | - | - | - | - | - | 16 | 4.6 |
| Ceriodaphnia | - | 2 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | 0.9 |
| Polyphemus | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.3 |
| Camptocerus | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | 0.3 |
| Other | | | | | | | | | | | | | | | |
| Lepidurus | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.3 |
| Total # samples taken | 15 | 29 | 24 | 30 | 32 | 32 | 33 | 32 | 30 | 30 | 34 | 15 | 15 | 351 | |

Table 3.

| | Average Density | Range of Densities | Location of Station of Greatest Concentration | | |
|---|---|---|---|---|---|
| | Average # zooplankters/l | Zooplankters/l | Station | Depth | Location of Station |
| June 1969 | 763 | 365-1454 | D6-12 | 1m | 2,000 ft. offshore; mouth of Toussaint |
| July 1969 | 207 | .78- 420 | D6-11 | 3m | 30,000 " " near Niagra reef |
| Aug. 1969 | 519 | 69-1832 | C6-1 | 1m | 2,000 " " south east mouth of Toussaint |
| Sept. 1969 | 463 | 212-1084 | D6-10 | 1m | 25,000 " " reef area |
| Oct. 1969 | 279 | 79- 767 | D6-13 | 1m | 1,500 " " north west of mouth of Toussaint |
| May 1970 | 256 | 142- 658 | D6-17 | 3m | 5,500 " " south east mouth of Toussaint |
| June 1970 | 408 | 121- 689 | D6-18 | 3m | 10,000 " " east of mouth of Toussaint |
| July 1970 | 1,722 | 439-3902 | D6-5 | 1m | 3,000 " " north of mouth of Toussaint |
| Aug. 1970 | 1,202 | 350-2769 | D6-16 | 1m | 3,500 " " south east of mouth of Toussaint |
| Sept. 1970 | 376 | 144- 748 | D5-2 | 1m | 7,000 " " north east of Long Beach |
| Oct. 1970 | 264 | 49 -700 | D5-3 | 3m | 11,000 " " north east of Long Beach |
| April 1971 | 37 | 13- 57 | D2 | 1m | 1,500 " " offshore at Locust Point |
| May 1971 | 571 | 369-1043 | A2 | 3m | 2,000 " " south east mouth of Toussaint |

Table 4. Phytoplankton
Predominant species noted in monthly samples.

| | |
|---|---|
| June 1969 | Nothing recorded |
| July 1969* | Microcystis noted once |
| Aug. 1969 | Pediastrum, Starastrum, Microcystis; Aphani heavy in some samples |
| Sept. 1969* | Aphanizomenon |
| Oct. 1969 | Melosira in many samples; Fragellaria, Pediastrum present |
| May 1970 | Much Melosira; Tabellaria, Fragellaria, Pediastrum present |
| June 1970* | Pediastrum |
| July 1970 | Aphanizomenon |
| Aug. 1970 | Much Anabaena in all samples; Ceratium also heavy |
| Sept. 1970 | Aphanizomenon in many samples; Pediastrum & Anabaena present |
| Oct. 1970 | Pediastrum, Melsira, Ceratium |
| April 1971 | Many Melosira, Tabellaria, Fragellaria & Asterionella |
| May 1971 | Many Melosira, Tabellaria, Fragellaria & Asterionella |

* very few phytoplankton notations in this month

Table 5. Average number of the most common zooplankters /l/ month.

| | May 1970 | June 1970 | July 1970 | Aug. 1970 | Sept. 1970 | Oct. 1970 | April 1971 | May 1971 |
|---|---|---|---|---|---|---|---|---|
| Copepoda | | | | | | | | |
| Calanoid | 50 | 55 | 110 | 40 | 15 | 15 | 5 | 10 |
| Cyclopoid | 5 | 5 | 10 | 10 | 20 | 10 | 5 | 5 |
| Naupli | 70 | 220 | 582 | 350 | 80 | 50 | 10 | 30 |
| Cladocera | | | | | | | | |
| Daphina | 2 | 37 | 106 | 94 | 24 | 14 | 0.3 | 1 |
| Bosmina | 2 | 8 | 91 | 150 | 26 | 21 | 0.3 | 3 |
| Chydorus | 0 | 2 | 2 | 4 | 131 | 40 | 0.2 | 0 |
| Rotifers | | | | | | | | |
| Keratella chochlearis | 15 | 20 | 310 | 330 | 10 | 40 | 5 | 70 |
| Polyarthra | 35 | 30 | 295 | 135 | 25 | 35 | 5 | 50 |
| Brachionus | 5 | 2 | 140 | 75 | 25 | 20 | 10 | 70 |

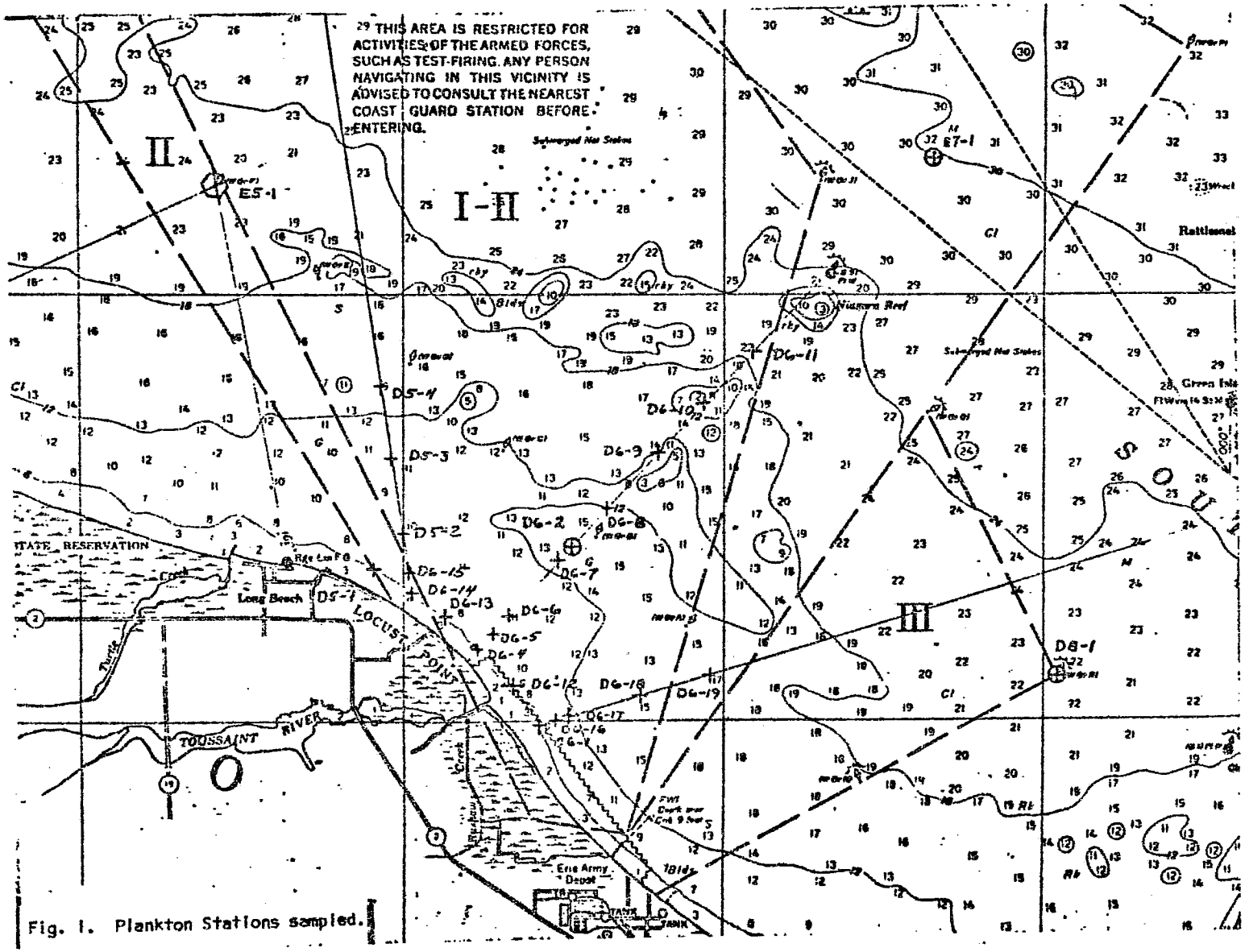


Fig. 1. Plankton Stations sampled.

JOB COMPLETION REPORT

RESEARCH COMPLETION SEGMENT

| | | | |
|---|---|---|---|
| State of: | Ohio | Date: | May 31, 1972 |
| Project No. | F-41-R-3 | Name: | Environmental Evaluation of a Nuclear Power Plant |
| Job No.: | I-A | Title: | Fish Population Prior to Discharge |
| Period Covered: | June 1, 1969-May 31, 1972 | | |


## ABSTRACT

Fish populations were sampled during ice-free months from June, 1969 through May, 1971 using a 150-ft. bag seine, 2750-ft. commercial seine, and three 150-ft. experimental gill nets.

Carp*, gizzard shad, freshwater drum and white bass were found during every sampling period. Carp were the most abundant over-all, normally comprising more than 80% of the sample. Drum and gizzard shad were next in abundance.

In general, the spring and early summer samples contained a greater percentage of adult fish, while the late summer and fall samples reflected the recruitment of young-of-the-year fish.

Chironomid larvae were the most frequently-found food items for most species in all months. There was little evidence of a seasonal change in food habits. Some species (drum, white bass) showed size-related changes in food habits.


* In this report, carp refers to carp, goldfish and/or carp-goldfish hybrids.

## RECOMMENDATIONS

Sampling of fish populations should be repeated after the nuclear power plant is in operation. Seasonal samples between now and then (1974) would be desirable in order to detect any major changes in the populations before discharge.

## OBJECTIVES

The objective of this job was to determine the composition and character of the fish populations in the area prior to discharge.

## TECHNIQUES USED

Sampling: Three transects in the Locust Point area were established in 1969 for sampling fish populations. The same three transects were used in 1970 and 1971 (Fig. 1). Transect 1 begins 1,000 ft. west of the Toussaint River and runs toward West Sister Island. Transect 2 runs from the mouth of the Toussaint River to Niagara Reef and Transect 3 starts 1,000 ft. east of the river and runs toward South Bass Island.

Mr. Virgil St. Clair, a commercial fisherman, operated his 2750-ft. seine east of the Toussaint River in the area of Transect 3. This net was from 12 to 16 ft. deep with 5" mesh at the outsides. The mesh gradually decreased in size toward the bat, which was 2-1/4" mesh. Fish were sampled with this gear once a month from June through October, 1969, May through October, 1970, and April and May, 1971.

The 150-ft. bag seine was fished at five locations; one haul was made at the base of each transect, one haul between Transects 1 and 2 and one haul between Transects 2 and 3. The net was 6 ft. deep with 3/4" mesh in the wings and 1/4" mesh in the bag. Fish were sampled by this method in July, August and October, 1969, May through October, 1970 and May, 1971.

Three experimental gill nets were set, one along each transect. They were fished overnight perpendicular to shore with the small mesh set closest to shore in about 8 feet of water. The nets were 6 ft. deep and 150 ft. long, consisting of contiguous 30-ft. panels of stretch mesh from 1/4" to 3". Gill nets were set once a month from August through October, 1969 and in May and August, 1970.

Species Composition: The catch of each species by each method was determined after every sampling period, as was the total catch for each gear. Except for carp all fish were weighed and measured and scales taken from representatives of each size group. When the commercial seine catch contained too many carp to process feasibly, Mr. St. Clair estimated the total catch. Catch per unit effort (CPE) was determined for each gear and a comparison was made between the relative numbers of individuals and species for each gill net and 150-ft. seine haul.

Age-Growth: Scales were read using a Bausch & Lomb microprojector and annular measurements made to enable back calculation of growth rate. Length-frequen plots were used for determining ages of shiners. Age data was compared with and supplemented by data from the Lake Erie Research Unit, Ohio Division of Wildlife, and Carlander's (1969) data for Lake Erie fishes.

Food Habits: Representatives of different size groups and species were weighed, measured and their stomachs preserved in 5% formalin as soon as possible after capture. Only live, seined fish were used for this study. Stomach contents were identified as far as possible and enumerated. Because of the small stomach volumes and diversity of food items, the numerical approach was used rather than the volumetric method.

Frequency of occurrence was calculated for each food item for each fish species. Differences from month to month were examined and food habits of different sized individuals of the same species were compared.

## FINDINGS

Species Composition: Appendix I is a list of scientific and common names of all fish taken. Table I shows the species present in each month of sampling. Altogether 33 species were found, although the greatest number for any one month was 21 (May, 1970). Fewest species (12) were taken in July and September, 1970.

Freshwater drum, carp (including goldfish and/or hybrids), gizzard shad and white bass were taken during every month sampled, while several species (spotted and white suckers, stonecat, rockbass, smallmouth and largemouth bass, green sunfish and logperch) occurred only once or twice. The number of species in part reflected the methods used, since not all sampling methods were used every month.

In every month except October, 1969 and August, 1970, carp and goldfish made up at least 60% by weight of the total sample. Next in abundance were gizzard shad and drum. In the two other months freshwater drum were most abundant. Total catches were greatest in the late spring and early fall samples and lowest in the summer months.

Tables 2, 3, and 4 show catch per unit effort (CPE) for the three sampling methods for each month. Data for the 2750-ft. seine is expressed as pounds per haul, for the 150-ft. seine as individuals per haul and for the gill nets as individuals per net. Since the 2750-ft. seine captured the large individuals of each species and too many individuals to count feasibly, the catch was expressed as pounds rather than numbers of individuals. The 150-ft. seine, on the other hand, took mostly young-of-the-year fish and shiners; thus it was more practical to express these catches as numbers of individuals.

Tables 5 and 6 are comparisons of the numbers of individuals each month at each sampling location for the gill net and 150-ft. seine catches. Since the 2750-ft. seine was pulled at only one location each month, there is no similar data for it.

The greatest numbers of individuals were taken most often West of the Toulssaint River and the fewest individuals were most often taken East of the river. No seasonal trend in numbers of species or individuals at a given location was detected, but numbers seemed lower in August and September, 1970 than the same months of 1969.

Age-Growth: Data from several sources was combined to give a view of the age structure of fishes in the Locust Point area. Table 7 shows the mean length for each age class of most species collected. The figures are from work done in this study, from the Lake Erie Research Unit of the Ohio Division of Wildlife and from Carlander's (1969) information on Lake Erie fishes.

Samples in early spring were comprised mostly of adult individuals. As the summer progressed, young-of-the-year individuals, as well as yearlings, became more abundant. Young-of-the-year white bass, shiners, drum, gizzard shad and alewife were taken only in the 150-ft. bag seine. Young-of-the-year carp and goldfish were never taken and only a few young-of-the-year channel catfish were captured.

Table 8 shows the size composition of the species frequently captured, using all three methods. This table reflects type of gear used as well as population changes, since not all sizes of fish were equally susceptible to all types of gear.

Food Habits: From June, 1969 through May, 1971, 1919 stomachs were examined, 71.8% of which contained food. The number of stomachs examined each month and the number containing food is shown in Table 9. A seasonal pattern

was evident, with a greater percentage of stomachs containing food in the summer months than in the spring and fall (Fig. 2). All the percentages may be lower than in actuality since it is common for fish to regurgitate when they are caught and handled.

Table 10 shows the frequency of occurrence of various food items in Locust Point fish stomachs from June, 1969 through May, 1971. The percent frequency of occurrence is based on the number of stomachs containing food. "Unidentifiable debris" included material too digested to be identified as well as sand, silt and gravel. Results are probably biased toward hard-to-digest organisms, since they would remain in the stomach longer.

Stomach contents of carp and goldfish were the most difficult to identify, but almost always included copepods and cladocerans. In addition, insects and amphipod remains were frequently found, as was plant material.

Gizzard shad stomach contents were predominantly zooplankton and phytoplankton, but most contained significant amounts of silt or sand grains.

Freshwater drum under 6 inches long ate no fish; their major food items were chironomid larvae (mostly Chironomus (Chironomus), C. (Cryptochironomus) and Glyptotendipes. Other insects and cladocerans occurred occasionally. The three species of chironomids found were the most abundant ones found in benthos samples from the area. The species were plentiful in all open-lake samples, from all substrate types and seldom occur in emergent vegetation along the shore.

Drum between 6 and 12 inches long ate primarily Chironomidae, but contained a wider variety of other insects, including Hemiptera and Odonata, than those shorter than six inches. Drum larger than 12-inches contained fish

almost exclusively. The apparent seasonal trend toward a greater occurrence of Chironomidae in late summer and fall is probably due to recruitment of young-of-the-year drum into the population rather than an actual change in food habits.

White bass showed a similar size-related pattern, the small individuals utilizing zooplankton and Chironomidae and the larger ones feeding almost entirely on fish. No such pattern was evident for yellow perch. All sizes fed about equally on Chironomidae and fish.

Emerald and spottail shiners fed mainly on insects. The large individuals utilized Cladocera and Copepoda extensively, but diets of young-of-the-year individuals (less than 2.8 inches) were not so restricted. The diversity of insects eaten (Chironomidae and other Diptera, Odonata, Trichoptera, Hemiptera and Coleoptera) indicated the shiners were feeding on the surface and in emergent vegetation, perhaps into the Toussaint River, as well as in the open lake.

Both bullheads and channel catfish were omnivorous, feeding on everything from cladocerans to fish. The occurrence of the midge Cricotopus, dipterans other than Chironomidae, and Coleoptera indicates considerable shallow-water or upstream feeding as well as open-water feeding suggested by the presence of C. (Cryptochironomus), amphipods, and Gastropoda.

Amphipods were utilized by all species of fish except gizzard shad. They occurred especially frequently in the spring, perhaps before many small fish were available as food.

All species of fish utilized food organisms found in the Locust Point area, both in the open lake and along the shore or in the river. Food items found included benthic invertebrates from all substitutes in the area (silt and sand bottom, gravel and clay bottom and the reefs). The plankters utilized corresponded with those predominant in most of the plankton samples (Daphnia retrocurva, Bosmina sp., Chydorus sp. and cyclopoid copepods).

## LITERATURE CITED

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Carlander, K. D. 1969. Handbook of Freshwater Fishery Biology. Vol. I. Iowa State Univ. Press, Ames, Iowa. 752 pp.

Table 1. Species compositon of Locust Point fish populations in the months sampled from 1969 to 1971. The presence of a species during a given month is indicated by an X.

| | 1969 | | | | | 1970 | | | | | | 1971 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J[a*] | J[ac*] | A[abc*] | S[ab] | O[abc] | M[abc] | J[ac] | J[ac] | A[abc] | S[ac] | O[ac] | A[a] | M[ac] |
| longnose gar | | | X | | | | X | | | | | | |
| bowfin | X | X | | | | | X | | | | | | X |
| alewife | | X | X | X | | X | X | | | | | | |
| gizzard shad | X | X | X | X | X | X | X | X | X | X | X | X | X |
| coho salmon | | | | X | | | | | X | | | X | |
| American smelt | | X | | | X | X | | | X | | | | X |
| northern pike | | | | X | | X | | | X | | | | |
| carp | X | X | X | X | X | X | X | X | X | | X | X | |
| goldfish | X | X | X | X | X | X | X | X | | X | X | | X |
| carp X goldfish | X | X | X | X | X | X | X | X | X | X | X | X | X |
| silver chub | | | | | | X | X | | | | | | |
| emerald shiner | | X | X | X | X | X | X | X | X | X | X | | X |
| spottail shiner | | X | X | X | X | X | X | X | X | X | X | | X |
| spotfin shiner | | X | | | | | X | | | | | | |
| quill back | X | X | X | X | | X | | | | X | X | X | X |
| golden redhorse | X | | | X | | X | | | | | X | X | X |
| white sucker | | | | | | X | | | | | | X | |
| spotted sucker | | | | | | X | | | | | | | |
| channel catfish | X | X | X | X | | X | X | X | X | X | X | X | |
| brown bullhead | X | X | X | X | | X | X | X | X | X | X | X | X |
| stonecat | | | | | | | | | X | | | | |
| white bass | X | X | X | X | X | X | X | X | X | X | X | X | X |
| white crappie | X | X | X | X | X | X | X | X | X | | X | | X |
| black crappie | | X | X | | | X | | | | X | | X | X |
| rock bass | | | | | | | X | | | | | | |
| smallmouth bass | | | | | X | | | | | | | | |
| largemouth bass | | | | X | | X | | | | | | | |
| green sunfish | | X | | | | | | | | | | | |
| orange spotted sunfish | | X | | | | | | | | X | X | | |
| walleye | | | | | | X | | X | X | | | X | |
| yellow perch | X | X | X | X | X | X | X | X | X | X | | X | X |
| log perch | | | | | | | | X | | | X | | |
| freshwater drum | X | X | X | X | X | X | X | X | X | X | X | X | X |
| TOTAL SPECIES | 13 | 20 | 16 | 18 | 11 | 21 | 17 | 12 | 15 | 12 | 14 | 13 | 14 |

* a=commercial seine
* b=gill nets
* c=150-ft. bag seine

Table 2. Catch per unit effort (lbs/haul), using the 2750-ft. shore seine.

| | 1969 | | | | | 1970 | | | | | | 1971 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | May | June | July | Aug. | Sept. | Oct. | Apr. | May |
| Alewife | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0.6 |
| Gizzard shad | unknown | | unknown | | 58 | 17 | 23 | 8.1 | 0 | 7.2 | 207 | 6.0 | 10.1 |
| Carp | unknown | | unknown | 526 | 55 | 2055 | 1405 | 270 | 1.9 | 502 | 1026 | 14,000 | 1000 |
| Quillback | 21 | 2.8 | unknown | 1.9 | 0 | 18 | 0 | 0 | 0 | 1.8 | 2.8 | 28 | 68 |
| Channel catfish | 21 | 9.6 | unknown | 15 | 0 | 1.2 | 8.2 | 6.5 | 3.0 | 11 | 1.4 | 7.9 | 0 |
| Brown bullheads | 9.9 | 0.8 | unknown | 1.3 | 0 | 2.3 | 2.3 | 8.3 | 0.9 | 3.4 | 0.5 | 5.8 | 7.4 |
| Golden redhorse | 0.4 | 0 | 0 | 0 | 0 | 1.7 | 0 | 0 | 0 | 0 | 0.9 | 5.3 | 0.4 |
| White sucker | 0 | 0 | 0 | 0 | 0 | 7.8 | 0 | 0 | 0 | 0 | 0 | 26 | 0 |
| White bass | 4.1 | 3.3 | 4.0 | 30 | 0 | 0 | 11 | 7.0 | 0.4 | 1.5 | 0 | 9.5 | 17 |
| Crappie | 0.4 | 0 | unknown | 0.3 | 0 | 2 | 0.5 | 1.8 | 0.8 | 0.2 | 0 | 1 | 0.4 |
| Walleye | 0 | 0 | 0 | 0 | 0 | 9.4 | 0 | 0 | 0 | 0 | 0 | 2.5 | 0 |
| Yellow perch | 0.8 | 0.3 | unknown | 2.3 | 0.2 | 3.3 | 2.1 | 0.5 | 0.8 | 0.2 | 0 | 15 | 2 |
| Freshwater drum | 44 | 19 | unknown | 8.2 | 0 | 42 | 16 | 114 | 7.5 | 16.0 | 0 | 75 | 64 |
| Coho salmon | 0 | 0 | 0 | 1.6 | 0 | 0 | 0 | 0 | 1.2 | 0 | 0 | 6.8 | 0 |
| TOTAL LBS. | 101.6 | 35.8 | total unknown | 586.6 | 113.2 | 2159.8 | 1468.4 | 416.2 | 16.5 | 543.3 | 1238.6 | 14,188.8 | 1169.9 |

*excluding gizzard shad and carp

**excluding gizzard shad

Table 3. Catch per unit effort (numbers per haul), using the 150-ft. bag seine.

| | 1969 | | | | | 1970 | | | | | | 1971 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | May | June | July | Aug. | Sept. | Oct. | Apr. | May |
| Alewife | No Sample | 20 | 9.7 | No Sample | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | No Sample | 0 |
| Gizzard shad | " | 141.2 | 71.3 | " | 237 | 0 | 0 | 2519 | 33 | 13.4 | 118.6 | " | 0 |
| Carp & Goldfish | " | 4.2 | 1 | " | 0.2 | 4.6 | 1 | 0 | 0 | 0.2 | 0.2 | " | 0 |
| Emerald shiner | " | 33.4 | 24 | " | 2 | 11.8 | 53.6 | 34.8 | 3.3 | 10.6 | 0.2 | " | 264.3 |
| Spottail shiner | " | 9.6 | 3.3 | " | 6.6 | 136.2 | 22.4 | 5.2 | 3.3 | 2.8 | 0.8 | " | 11.3 |
| Channel catfish | " | 0.2 | | " | 0 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | " | 0 |
| Brown bullhead | " | 0.6 | 0.3 | " | 0 | 0 | 0 | 0 | 0 | 0 | 0 | " | 0 |
| White bass | " | 32.2 | 9.7 | " | 2.6 | 2.6 | 0 | 89 | .3 | 9 | 0 | " | 0 |
| Crappie | " | 6.8 | 0.3 | " | 0.2 | 0.8 | 0 | 0.4 | .3 | 0 | 0.8 | " | 0.3 |
| Yellow perch | " | 0.6 | 0.3 | " | 0.2 | 0.4 | 0 | 0 | 0 | 0 | 0 | " | 0 |
| Drum | " | 0.2 | 0 | " | 0 | 0.2 | 0 | 0.2 | 0 | 0.4 | 0.2 | " | 0 |
| Sunfish | " | 0.8 | 0 | " | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | " | 0 |
| Black bass | " | 0 | 0 | " | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | " | 0 |
| Smelt | " | 0.1 | 0 | " | 0 | 0 | 0 | 0 | .7 | 0 | 0 | " | 1 |
| Walleye | " | 0 | 0 | " | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | " | 0 |
| TOTAL NUMBER | | 249.9 | 119.9 | | 249.0 | 156.8 | 75.6 | 2698.8 | 40.9 | 56.6 | 121.0 | | 276.9 |

Table 4. Catch per unit effort (numbers per net), using experimental gill nets.

| | 1969 | | | | | 1970 | | | | | | 1971 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | May | June | July | Aug. | Sept. | Oct. | Apr. | May |
| Alewife | No Sample | No Sample | 102 | 386 | 129 | 0.3 | No Sample | No Sample | 0 | No Sample | No Sample | No Sample | No Sample |
| Gizzard shad | " | " | 64.3 | 7.3 | 36 | 1.3 | " | " | 194.7 | " | " | " | " |
| Carp & Goldfish | " | " | 19.3 | 8.7 | 0.3 | 8.7 | " | " | 25 | " | " | " | " |
| Emerald shiners | " | " | 12.3 | 62 | 0 | 0.7 | " | " | 10.3 | " | " | " | " |
| Spottail shiners | " | " | 0 | | 101 | 227.7 | " | " | 0 | " | " | " | " |
| Channel catfish | " | " | 5 | 0.3 | 0 | 4.3 | " | " | 6.7 | " | " | " | " |
| Brown bullheads | " | " | 0 | 0 | 0 | 0 | " | " | 2.7 | " | " | " | " |
| White bass | " | " | 4.7 | 2.3 | 1 | 6.7 | " | " | 12.7 | " | " | " | " |
| Yellow perch | " | " | 207.7 | 85 | 29.3 | 3.7 | " | " | 50 | " | " | " | " |
| Freshwater drum | " | " | 1 | 12.3 | 2.7 | 0.7 | " | " | 6 | " | " | " | " |
| Crappie | " | " | 1.3 | 0 | 0.7 | 0 | " | " | 1 | " | " | " | " |
| Golden redhorse | " | " | 0 | 0.7 | 0 | 0 | " | " | 0 | " | " | " | " |
| Smelt | " | " | 0 | 0 | 0.3 | 0.3 | " | " | 0 | " | " | " | " |
| Walleye | " | " | 0 | 0 | 0 | 2 | " | " | 2 | " | " | " | " |
| TOTAL NUMBER | | | 417.6 | 564.6 | 300.3 | 256.4 | | | 311.1 | | | | |

Table 5. Numbers of individuals and species taken at each gill net location.

| | Transect 1 (West of river) | | Transect 2 (at river mouth) | | Transect 3 (East of river) | |
|---|---|---|---|---|---|---|
| | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. |
| 8/22/69 | 569 | 8 | 197 | 7 | 488 | 11 |
| 9/24/69 | 659 | 9 | 561 | 8 | 773 | 10 |
| 10/28/69 | 452 | 8 | 251 | 5 | 300 | 5 |
| 5/6/70 | 368 | 7 | 176 | 9 | 225 | 7 |
| 8/12/70 | 113 | 4 | 346 | 9 | 437 | 11 |

Table 6. Numbers of individuals and species taken at each 150-ft. bag seine haul location.

| | Transect 1 (West of river) | | Transect 1-2 (West of river) | | Transect 2 (river mouth) | | Transect 2-3 (East of river) | | Transect 3 (East of river) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. sp |
| 7/30/69 | 236 | 3 | 412 | 10 | - | - | - | - | 230 | 7 |
| 8/29/69 | 169 | 9 | - | - | 122 | 6 | - | - | 71 | 5 |
| 10/29/69 | 365 | 7 | 349 | 3 | 295 | 3 | 63 | 5 | 265 | 5 |
| 5/6/70 | 100 | 5 | 287 | 7 | 335 | 8 | 43 | 6 | 21 | 3 |
| 6/12/70 | 166 | 5 | 27 | 2 | 90 | 3 | 16 | 4 | 97 | 8 |
| 7/18/70 | 30 | 5 | 208 | 3 | 275 | 4 | 4113 | 3 | 3518 | 7 |
| 8/22/70 | 58 | 2 | 14 | 4 | 51 | 5 | - | - | - | - |
| 9/21/70 | 31 | 4 | 31 | 5 | 86 | 4 | 19 | 6 | 17 | 4 |
| 10/24/70 | 242 | 5 | 219 | 5 | 117 | 2 | 8 | 2 | 19 | 4 |
| 5/15/71 | 657 | 1 | - | - | 123 | 3 | - | - | 51 | 4 |

Table 7. Mean total length and range (in inches), where available, of indicated age class for some species captured in the Locust Point area.

| | 0 | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|---|
| Alewife [b] | 1.5-5.9 $\bar{x}$=4.4 | | | | | | |
| Gizzard shad [b] | $\bar{x}$=6.4 | $\bar{x}$=10.9 | $\bar{x}$=12.8 | $\bar{x}$=13.6 | $\bar{x}$=14.3 | | |
| Carp [c] | 0.7-8.0 $\bar{x}$=6.0 | $\bar{x}$=6.5 | $\bar{x}$=8.7 | $\bar{x}$=9.6 | $\bar{x}$=13.9 | $\bar{x}$=13.9 | $\bar{x}$=15.7 |
| Goldfish [c] | | x=3.5 | 5.0-6.0 | | | | |
| Quillback [c] | 1.5-2.2 | 9.5-9.7 | 10.9-15.4 | 14.9-16.5 | | | |
| Emerald shiner [ab] | 1.7-3.1[b] $\bar{x}$=2.6[b] | 2.2-3.4[a] | 3.0-3.8[a] | | | | |
| Spottail shiner [ab] | 1.8-3.5[b] $\bar{x}$=2.8[b] | 3.4-4.6[a] | 4.5-5.1[a] | 4.9-5.5[a] | | | |
| Channel catfish [b] | $\bar{x}$=4.8 | $\bar{x}$=7.9 | $\bar{x}$=10.1 | $\bar{x}$=12.2 | $\bar{x}$=13.2 | $\bar{x}$=15.3 | $\bar{x}$=15.9 |
| Brown bullhead [c] | 2.0-4.9 | 2.7-6.0 | | | | | |
| White bass [b] | 2.0-6.0 $\bar{x}$=4.1 | $\bar{x}$=10.1 | $\bar{x}$=11.8 | $\bar{x}$=12.6 | $\bar{x}$=13.4 | $\bar{x}$=14.6 | |
| Yellow perch [b] | 2.2-4.7 $\bar{x}$=2.6 | 5.1-6.9 $\bar{x}$=6.5 | 6.2-7.9 $\bar{x}$=7.2 | 6.5-9.8 $\bar{x}$=8.3 | 7.9-10.1 $\bar{x}$=9.0 | 8.6-10.6 $\bar{x}$=9.6 | |
| Walleye [b] | $\bar{x}$=9.6 | $\bar{x}$=15.2 | $\bar{x}$=16.8 | $\bar{x}$=18.4 | $\bar{x}$=19.5 | $\bar{x}$=19.9 | |
| Freshwater drum [a] | 1.5-5.6 $\bar{x}$=3.9 | 5.1-7.5 $\bar{x}$=6.4 | 6.4-9.4 $\bar{x}$=8.5 | 8.9-14.0 $\bar{x}$=11.7 | 10.2-15.4 $\bar{x}$=12.3 | 12.2-16.5 $\bar{x}$=14.6 | 12.3-16.[illegible] $\bar{x}$=15.1 |
| American smelt [bc] | 1.6-3.6[b] $\bar{x}$=2.4[b] | 5.6-6.2[c] | $\bar{x}$=9.5[c] | | | | |

[a]=age determined in the present study
[b]= age determined by Lake Erie Research Unit, Ohio Division of Wildlife
[c]=data from Carlander, Freshwater Fishery Biology, for Lake Erie fish

Table 8. Size range (inches) of fish captured in the Locust Point area by all three methods of capture.

| | 1969 | | | | |
|---|---|---|---|---|---|
| | June[a] | July[ac] | Aug.[abc] | Sept.[ab] | Oct.[abc] |
| Gizzard shad | 7.0-16.5 | 1.5-15.8 | 1.2-12.0 | 4.9-14.6 | 2.4-16.6 |
| Alewife | 0 | 1.3- 2.2 | 1.4- 4.1 | 4.1- 5.1 | 3.6- 5.4 |
| Carp & Goldfish | 6.2-29.4 | 9.5-23.2 | 5.9-19.7 | 4.1-19.8 | 4.3-24.6 |
| Quillback | 9.6-16.3 | 12.4-13.3 | 9.3-13.0 | 9.3-13.0 | 14.9 |
| Emerald shiners | 0 | 2.4- 4.4 | 1.9- 4.8 | 4.1- 5.3 | 2.4- 3.7 |
| Spottail shiners | 0 | 1.8- 5.4 | 1.9- 4.7 | | 2.6- 5.5 |
| Channel catfish | 7.2-16.3 | 2.9-16.1 | 5.5-18.0 | 13.6-19.7 | 0 |
| Brown bullheads | 7.3-11.6 | 4.1-10.4 | 6.7 | 6.1- 9.4 | 0 |
| Golden redhorse | 9.5 | 0 | 0 | 13.2-13.9 | 0 |
| White sucker | 0 | 0 | 0 | 0 | 0 |
| White bass | 5.4-9.9 | 1.5- 7.9 | 1.8-10.6 | 3.6-12.4 | 2.7- 6.0 |
| Yellow perch | 6.5- 8.3 | 5.0- 8.9 | 5.8-11.5 | 5.6- 9.4 | 5.2-11.5 |
| Black bass | 0 | 0 | 0 | 13.0 | 3.2 |
| Sunfish | 0 | 2.6- 3.0 | 0 | 0 | 0 |
| Crappie | 8.3 | 4.1- 8.9 | 6.0-10.3 | 7.5 | 2.8- 3.5 |
| Walleye | 0 | 0 | 0 | 0 | 0 |
| Freshwater drum | 9.3-21.3 | 6.3-20.9 | 5.5-18.5 | 2.6-16.1 | 3.3-15.0 |
| Coho salmon | 0 | 0 | 0 | 16.3 | 0 |
| Smelt | 0 | 3.3 | 0 | 0 | 7.6 |

=commercial seine
=gill net
=150-ft. bag seine

Table 8. Size range (inches) of fish captured in the Locust Point area by all three methods of capture.

| | 1970 | | | | | |
|---|---|---|---|---|---|---|
| | May[abc] | June[ac] | July[ac] | Aug.[abc] | Sept.[ac] | Oct.[ac] |
| Gizzard shad | 6.7-14.9 | 6.9-15.5 | 1.2-11.0 | 1.0-15.1 | 1.4-13.1 | 2.1-13.4 |
| Alewife | 6.7 | 6.6- 7.4 | 0 | 0 | 0 | 0 |
| Carp & Goldfish | 6.5-27.3 | 8.8-16.3 | 6.2-23.1 | 7.4-18.1 | 6.7- 8.6 | 6.9-16.3 |
| Quillback | 9.8-16.6 | 0 | 0 | 0 | 5.6-13.9 | 13.1-13.3 |
| Emerald shiners | 1.8- 4.7 | 1.8- 4.2 | 2.0- 5.2 | 3.0- 5.1 | 1.4- 4.3 | 3.6 |
| Spottail shiners | 3.2- 5.3 | 3.0- 4.8 | 1.3- 3.7 | 1.0- 4.6 | 2.6- 4.9 | 3.4- 4.4 |
| Channel catfish | 2.9-18.9 | 2.3-16.5 | 13.4-17.4 | 4.8-17.9 | 14.0-17.7 | 16.2 |
| Brown bullheads | 8.5-11.5 | 7.5-10.6 | 5.1-10.9 | 6.1-11.4 | 6.7-10.7 | 8.3- 8.4 |
| Golden redhorse | 16.6 | 0 | 0 | 0 | 0 | 14.7 |
| White sucker | 9.2-17.0 | 0 | 0 | 0 | 0 | 0 |
| White bass | 4.4-15.6 | 5.1-11.6 | 1.5- 7.5 | 1.6-11.1 | 2.0-11.7 | 2.4-10.6 |
| Yellow perch | 6.2- 9.3 | 6.8- 9.0 | 6.8- 7.3 | 5.6- 9.2 | 7.4 | 0 |
| Black bass | 10.4 | 0 | 0 | 0 | 0 | 0 |
| Sunfish | 0 | 0 | 0 | 0 | 1.6 | 3.7 |
| Crappie | 3.3-14.2 | 6.3- 7.9 | 1.3- 7.6 | 3.3- 7.8 | 7.8 | 2.9- 4.1 |
| Walleye | 9.4-12.5 | 0 | 4.1 | 6.2-12.8 | 0 | 0 |
| Freshwater drum | 6.1-17.9 | 6.6-15.9 | 3.7-14.0 | 3.9-17.4 | 1.1-15.8 | 0 |
| Coho salmon | 0 | 0 | 0 | 14.1 | 0 | 0 |
| Smelt | 6.6- 7.3 | 0 | 0 | 1.9- 2.3 | 0 | 0 |

=commercial seine
=gill net
=150-ft. bag seine

Table 8. Size range (inches) of fish captured in the Locust Point area by all three methods of capture.

| | 1971 | |
|---|---|---|
| | Apr.[a] | May[ac] |
| Gizzard shad | 13.0-13.2 | 8.1-16.1 |
| Alewife | 0 | 6.7- 7.3 |
| Carp & Goldfish | 8.0-19.1 | 8.3-12.3 |
| Quillback | 16.0-20.6 | 5.2-18.3 |
| Emerald shiners | 0 | 1.9- 4.3 |
| Spottail shiners | 0 | 3.1- 4.8 |
| Channel catfish | 11.7-19.1 | 0 |
| Brown bullheads | 8.7-11.7 | 7.5-11.4 |
| Golden redhorse | 13.8-16.2 | 7.8- 8.1 |
| White sucker | 13.3-18.9 | 0 |
| White bass | 6.5-12.2 | 5.6-14.6 |
| Yellow perch | 6.6-12.4 | 7.1- 9.3 |
| Black bass | 0 | 0 |
| Sunfish | 0 | 0 |
| Crappie | 9.0- 9.3 | 7.5- 8.1 |
| Walleye | 9.1-14.6 | 0 |
| Freshwater drum | 7.5-17.6 | 5.3-20.7 |
| Coho salmon | 18.3-20.4 | 0 |
| Smelt | 0 | 5.0- 5.9 |

=commercial seine .
=gill net
=150-ft. bag seine

Table 9. Number of fish stomachs examined each month and number containing food, June, 1969 - May, 1971.

| Sample Date | Stomachs examined | Stomachs containing food | Percent containing food |
|---|---|---|---|
| 1969 | | | |
| June 26 | 140 | 120 | 85.7 |
| July 4 | 149 | 127 | 85.0 |
| July 26 | 92 | 72 | 78.0 |
| July 30 | 130 | 107 | 82.0 |
| Aug. 24 | 0 | - | - |
| Sept.24 | 80 | 51 | 63.8 |
| Oct. 29 | 140 | 88 | 62.9 |
| 1970 | | | |
| May 8 | 298 | 172 | 57.7 |
| June 22 | 255 | 181 | 71.0 |
| July 18 | 208 | 178 | 85.6 |
| Aug. 22 | 72 | 60 | 83.3 |
| Sept.12 | 89 | 71 | 79.8 |
| Oct. 10 | 33 | 23 | 69.7 |
| 1971 | | | |
| April 17 | 83 | 51 | 61.4 |
| May 15 | 150 | 76 | 50.7 |
| TOTAL | 1919 | 1377 | 71.8 |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 197

| Fish species Date sampled & number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Carp | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 17 | 22 | 22 | | | | | | | | | | | | | | | 67 | 11 | | | | | 100 |
| 7/4/69 - 3 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/26/69 - 4 | | | | | | | | | | | | | | | | | | 100 | | | | | 100 |
| 7/30/69 - 1 | 100 | 100 | | | | | | | | | | | | | | | | | | | | | 100 |
| 9/27/69 - 2 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 10/18/69 - 6 | | | | | | | | | | | | | | | | | | 17 | | | | | 83 |
| 5/8/70 - 12 | | | | | | | | | | | | | | | | | | | | | | | 67 |
| 6/12/70 - 3 | 33 | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/18/70 - 3 | | | | | 100 | | 100 | | | | | | | | | | | | | | | | |
| 8/22/70 - 1 | | | | | | | | | | | | | | | | | | | | | | | |
| 9/12/70 - 0 | | | | | | | | | | | | 100 | | | | | | | | | | | |
| 10/10/70 - 1 | | | | | | | | | | | | | | | | | | | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/15/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Goldfish | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 21 | 67 | 48 | | | | | | | | | | | | | | | 20 | 14 | | | | | 100 |
| 7/4/69 - 5 | 20 | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/26/69 - 14 | 15 | 7 | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/30/69 - 2 | | | | | | | | | | | | | | | | | | | | | | | |
| 9/27/69 - 1 | 100 | | | | | | | | | | | | | | | | 33 | | | | | | 33 |
| 10/18/69 - 3 | 67 | 33 | | | | | | | | | | | | | | | | | | | | | 100 |
| 5/8/70 - 8 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 6/12/70 - 2 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/18/70 - 4 | | | | | | | | | | | | | | | | | | | | | | | |
| 8/22/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 9/12/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 10/10/70 - 1 | 100 | 100 | | | | | | | | | | | | | | | | | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/15/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 19

continued

| Fish species<br>Date sampled &<br>number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gizzard shad | | | | | | | | | | | | | | | | | | | | | | | |
| 6/25/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/4/69 - 9 | 89 | 56 | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/26/69 - 16 | 94 | 94 | | | | | | | | | | | | | | | | | | | | | 83 |
| 7/30/69 - 52 | 46 | 19 | | | | | | | | | | | | | | | | | | | | | 100 |
| 9/27/69 - 10 | 90 | 50 | | | | | | | | | | | | | | | | | | | | | 100 |
| 10/18/69 - 42 | 64 | 56 | | | | | | | | | | | | | | | | | | | | | 100 |
| 5/8/70 - 10 | | | | | | | | | | | | | | | | | | | | | | | |
| 6/12/70 - 2 | 100 | 100 | | | | | | | | | | | | | | | | | | | | | 50 |
| 7/18/70 - 2 | 100 | 50 | | | | | | | | | | | | | | | | | | | | | |
| 8/22/70 - 1 | | 100 | | | | | | | | | | | | | | | | | | | | | |
| 9/12/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 10/10/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/15/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Freshwater drum | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 10 | | | | | | 10 | | | | | | | | | | | | | 10 | | | 90 | |
| 7/4/69 - 1 | 100 | 100 | | | | | | | | | | | | | | | | | 100 | | | | 100 |
| 7/26/69 - 12 | 38 | | | | | | | | | | | | | | | | 16 | | | | | 33 | |
| 7/30/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 9/27/69 - 7 | 14 | | | | | 86 | | | | | | | | | | | 28 | | | | | 14 | |
| 10/18/69 - 0 | | | | | | | | | | | | | | | | | | | | | | 100 | |
| 5/8/70 - 1 | | | | | | | | | | | | | | | | | | | 7 | | | 50 | 29 |
| 6/12/70 - 14 | | | | | 21 | | 21 | | | | | | | | | | | | 20 | | | 5 | |
| 7/18/70 - 20 | 20 | | 5 | | | | 85 | 10 | | 5 | 5 | | | | | | 10 | | 10 | | | 20 | |
| 8/22/70 - 10 | | | | | 10 | | 90 | 40 | 20 | 10 | | | | | | | | | | | | 56 | |
| 9/12/70 - 9 | 11 | | | | 33 | | 56 | 33 | 22 | 11 | 11 | 11 | 11 | | 33 | | | | 100 | | | | |
| 10/10/70 - 1 | | | | | | | 100 | | | | | | | | | | | | 86 | | | | 14 |
| 4/17/71 - 7 | | | | | | | | | | | | | | | | | | | 50 | | | | |
| 5/15/71 - 6 | | | 17 | | | | 67 | 50 | | | | | | | | | | | | | | | |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 19

continued

| Fish species<br>Date sampled &<br>number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **White bass** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 18 | | | | | | 6 | | | | | | | | | | | | | 31 | | | 94<br>15 | 46 |
| 7/4/69 - 13 | 54 | 8 | | | | | | | | | | | | | | | 13 | | | | | 63 | 6 |
| 7/26/69 - 16 | 75 | | | | | 6 | | | | | | | | | | | | 5 | | | | 58 | 10 |
| 7/30/69 - 19 | 42 | 16 | | | | 5 | | | | | | | | | | | | | | | | 100 | |
| 9/27/69 - 14 | | | | | | | | | | | | | | | | | 20 | 10 | | | | | 70 |
| 10/18/69 - 10 | 20 | 20 | | | | 30 | | | | | | | | | | | 8 | 8 | | | | 25 | 25 |
| 5/8/70 - 12 | 8 | | | | | | 25 | | | | 17 | | | | | | | | | | | 92 | 5 |
| 6/12/70 - 37 | | | | | 5 | | | | | | | | | | | | | | | | | 21 | |
| 7/18/70 - 68 | 72 | 79 | | | 3 | | | | | | | | | | | | | | | | | 100 | |
| 8/22/70 - 18 | 6 | | | | 83 | | 83 | | 6 | | | 6 | | | | | | | | | | 6 | 6 |
| 9/12/70 - 17 | 29 | 24 | | | 29 | | 24 | | 12 | | | | 12 | | 29 | 12 | | | | | | 50 | |
| 10/10/70 - 4 | 25 | | | | | | | | | | | | | | | | 25 | | | | | | |
| 4/17/71 - 7 | | | | | | 14 | | 14 | | | | | | | | | | 86 | | | | 90 | 20 |
| 5/15/71 - 20 | | 5 | | | | 10 | | | | | | | | | | | | | | | | | |
| **Yellow perch** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/4/69 - 3 | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 7/26/69 - 1 | | | | | | | | | | | | | | | | | | | | | | | |
| 7/30/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 9/27/69 - 3 | | | | | | | | | | | | | | | | | | | | | | 100 | |
| 10/18/69 - 2 | | | | | | 50 | | | | | | | | | | | | 50 | | | | | 50 |
| 5/8/70 - 4 | | | | | | | | | | | | | | | | | | | | | | 25 | 75 |
| 6/12/70 - 9 | 11 | | | | 78 | | | | | | | | | | | | | | | | | 11 | 11 |
| 7/18/70 - 3 | | | 33 | | | | | 33 | | | | | | | | | 33 | | | | 33 | 33 | 33 |
| 8/22/70 - 4 | | | | 25 | 25 | | 50 | | 25 | | | | | | | | | | | | | 75 | |
| 9/12/70 - 1 | | | | | | | 100 | 100 | | | | | | | | | | | | | | 100 | |
| 10/10/70 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 4/17/71 - 8 | | | | | | 25 | 25 | | | | | | | | | | | 75 | | | | 13 | |
| 5/15/71 - 3 | | | | | | | | | | | | | | | | | | 33 | | | | 67 | |

*Mostly identified to genus

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 197

continued

| Fish species<br>Date sampled &<br>number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Channel catfish** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 24 | | | | | 17 | 25 | | | | | | | | | | | 21 | 4 | | | | 46 | 100 |
| 7/4/69 - 2 | 50 | | | | | | | | | | | | | | | | 100 | | | | | | 50 |
| 7/26/69 - 10 | | | 10 | | 10 | | | | | | | | | | | | | | | | | 60 | 50 |
| 7/30/69 - 1 | | | | | | 100 | | | | | | | | | | | | | | | | | |
| 9/27/69 - 7 | | | | 29 | 43 | | | | | | | | | | | | 14 | | | | | 71 | |
| 10/18/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/8/70 - 2 | | | | | | | | | | | | | | | | | | | | | | 50 | 50 |
| 6/12/70 - 18 | 11 | 6 | 6 | 6 | 28 | | 11 | 11 | | | 6 | 6 | | | | | | | | | | 50 | |
| 7/18/70 - 4 | | 25 | 25 | | | | 25 | | | | | | | | | | 25 | | | | | 100 | |
| 8/22/70 - 1 | | | | | | | 100 | | 100 | | | | 100 | | | | 100 | 100 | | | | | |
| 9/12/70 - 6 | | | | | 83 | | 67 | 17 | 17 | | | 33 | 17 | | | | 17 | | | | | 83 | |
| 10/10/70 - 1 | | | | | | | 100 | 100 | | | | 100 | | | | | | | | | | | |
| 4/17/71 - 2 | | | | | | | 50 | 50 | | | | | | | | | | | | | | 50 | |
| 5/15/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| **Brown bullhead** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 14 | | | | | | 14 | | | | | | | | | | | 7 | | | | | | 100 |
| 7/4/69 - 6 | | | | | | | | | | | | | | | | | 33 | 17 | | | | | 100 |
| 7/26/69 - 2 | | | | | | | | | | | | | | | | | | | | | | 50 | 50 |
| 9/27/69 - 2 | | | | | | | | | | | | | | | | | 50 | 50 | | | | 50 | 50 |
| 10/18/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/8/70 - 3 | | | | | 33 | | 100 | 67 | | | 100 | 100 | | | | | 100 | 67 | 33 | | | | |
| 6/12/70 - 5 | 20 | | 20 | 20 | 80 | | 60 | | | | 20 | | | | | | | 20 | | | | | 20 |
| 7/18/70 - 29 | 100 | 62 | 7 | | 3 | | | | | | | | | | | | | 3 | | | | 7 | |
| 8/22/70 - 1 | | | | 100 | 100 | | 100 | 100 | 100 | | | | 100 | | 100 | | 100 | 100 | | | | | |
| 9/12/70 - 3 | | | | | 67 | | | | | | | | | | | | | | | | | | 33 |
| 10/10/70 - 1 | | | | | | | 100 | | | | | 100 | | | | | | | | | | | |
| 4/17/71 - 10 | | | | | | 20 | 60 | | | | | 10 | | | | | | 90 | 10 | | | 30 | |
| 5/15/71 - 13 | | | | | | 8 | 69 | 69 | | 8 | 69 | 23 | | | | | | 38 | | | | | 38 |

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 197

continued

| Fish species<br>Date sampled & number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera (not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Emerald shiner** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/23/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | 78 |
| 7/4/69 - 27 | 63 | 11 | | | | | | | | | | | | | | | | | | | | | |
| 7/26/69 - 0 | | | | | | | | | | | | | | | | | 13 | | | | | | 47 |
| 7/30/69 - 15 | 13 | 7 | | | | 53 | | | | | | | | | | | | | | | | | |
| 9/27/69 - 0 | | | | | | | | | | | | | | | | | 33 | | | | | | 17 |
| 10/18/69 - 6 | 33 | 17 | | | | 17 | | | | | | | | | | | | | | | | | |
| 5/8/70 - 18 | 6 | 6 | | | | 6 | 11 | | | | 6 | | | | | 6 | 11 | | | | | | 50 |
| 6/12/70 - 27 | 4 | | | | 15 | | | | | | | | | | | | 7 | 4 | | | | | 67 |
| 7/18/70 - 21 | | | | | | | | | | | | | | | | | 10 | | | | | | 90 |
| 9/22/70 - 8 | | | | | 75 | 25 | 13 | | | | | | | | | | | | | | | | 25 |
| 9/12/70 - 6 | | | | | 33 | | 17 | | | | | | | | | | 17 | | | | | | 50 |
| 10/10/70 - 1 | | | | 100 | | 100 | | | 100 | | | | | | | | | | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | 17 |
| 5/15/71 - 6 | 50 | | | 17 | | 33 | | | | | | | | | | | | | | | | | |
| **Spottail shiner** | | | | | | | | | | | | | | | | | | | | | | | |
| 6/23/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 7/4/69 - 38 | 26 | | | | | 3 | | | | | | | | | | | 11 | | | | | | 95 |
| 7/26/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 7/30/69 - 3 | | | | | | 67 | | | | | | | | | | | | | | | | | 33 |
| 9/27/69 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 10/18/69 - 19 | 26 | 37 | | | | 32 | | | | | | | | | | | 37 | | | | | | 64 |
| 5/8/70 - 64 | | | 2 | 13 | 16 | 3 | 21 | 21 | 2 | | 11 | | | 2 | 2 | | 5 | 6 | | | | | 47 |
| 6/12/70 - 52 | 8 | 4 | 2 | | 4 | | | | | | | | | | | | 2 | 4 | | | | | 37 |
| 7/18/70 - 11 | 9 | | | | | | | | | | | | | | | | | | | | | | 91 |
| 8/22/70 - 8 | | | | 13 | 100 | | 75 | 13 | 25 | | | 13 | 13 | | | | 25 | | | | | | |
| 9/12/70 - 9 | | | | 22 | 67 | | 56 | 22 | 11 | | | | | | | | | | | | | 11 | |
| 10/10/70 - 4 | 25 | | 25 | 50 | 50 | | 50 | 25 | | | | | | | | | 25 | 25 | | | | | |
| 4/17/71 - 0 | | | | | | | | | | | | | | | | | | | | | | | |
| 5/15/71 - 10 | | | | | | | 30 | | | | | | | | | | | 10 | | | | | 80 |

* not identified to genus

Table 10. Frequency of occurrence (%) of food items in some Locust Point fishes, June, 1969 through May, 1971.(cor

| Fish species Date sampled & number of stomachs | Cladocera | Copepoda | Trichoptera | Coleoptera | Diptera(not Chironomidae) | Chironomidae* | C. (Chironomus) | C. (Cryptochironomus) | Glyptotendipes | Polypedilum | Procladius | Coelotanypus | Cricotopus | Pseudochironomus | Tanytarsus | Psectrocladius | Insecta (unidentifiable) | Amphipoda | Decapoda | Gastropoda | Pelecypoda | Fish | Unidentifiable Debris |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crappie | | | | | | | | | | | | | | | | | | | | | | | |
| 6/28/69 - 0 | | | | | | | | | | | | | | | | | 5 | 5 | | | | 10 | 29 |
| 7/4/69 - 21 | 90 | 38 | | | | | | | | | | | | | | | | | | | | 100 | |
| 7/26/69 - 1 | | | | | | | | | | | | | | | | | | | 8 | | | 25 | 50 |
| 7/30/69 - 12 | 67 | 8 | | | | | | | | | | | | | | | | | | | | 100 | |
| 9/27/69 - 1 | | | | | | 100 | | | | | | | | | | | | | | | | | |
| 10/18/69 - 0 | | | | | | | | | | | | | | | | | 10 | | | | | 80 | 10 |
| 5/8/70 - 10 | | | | 10 | | | 10 | | 10 | | | | | | | | | | | | | 100 | |
| 6/12/70 - 3 | | | | | 33 | | | | | | | | | | | | 8 | 8 | | | | 92 | |
| 7/18/70 - 12 | 67 | 42 | | | 25 | | 25 | | | | | | | | | | | | | | | | |
| 8/22/70 - 5 | | | | | 60 | | 100 | | 20 | | | 20 | | | | | | | | | | 100 | |
| 9/12/70 - 1 | | | | | | | | | | | | | | | | | 25 | | | | | | 25 |
| 10/10/70 - 4 | 75 | 75 | | | | | 25 | | | | | | | | | | | | | | | 100 | |
| 4/17/71 - 1 | | | | | | | | | | | | | | | | | | | | | | 100 | |
| 5/15/71 - 2 | | | | | | | | | | | | | | | | | | | | | | | |

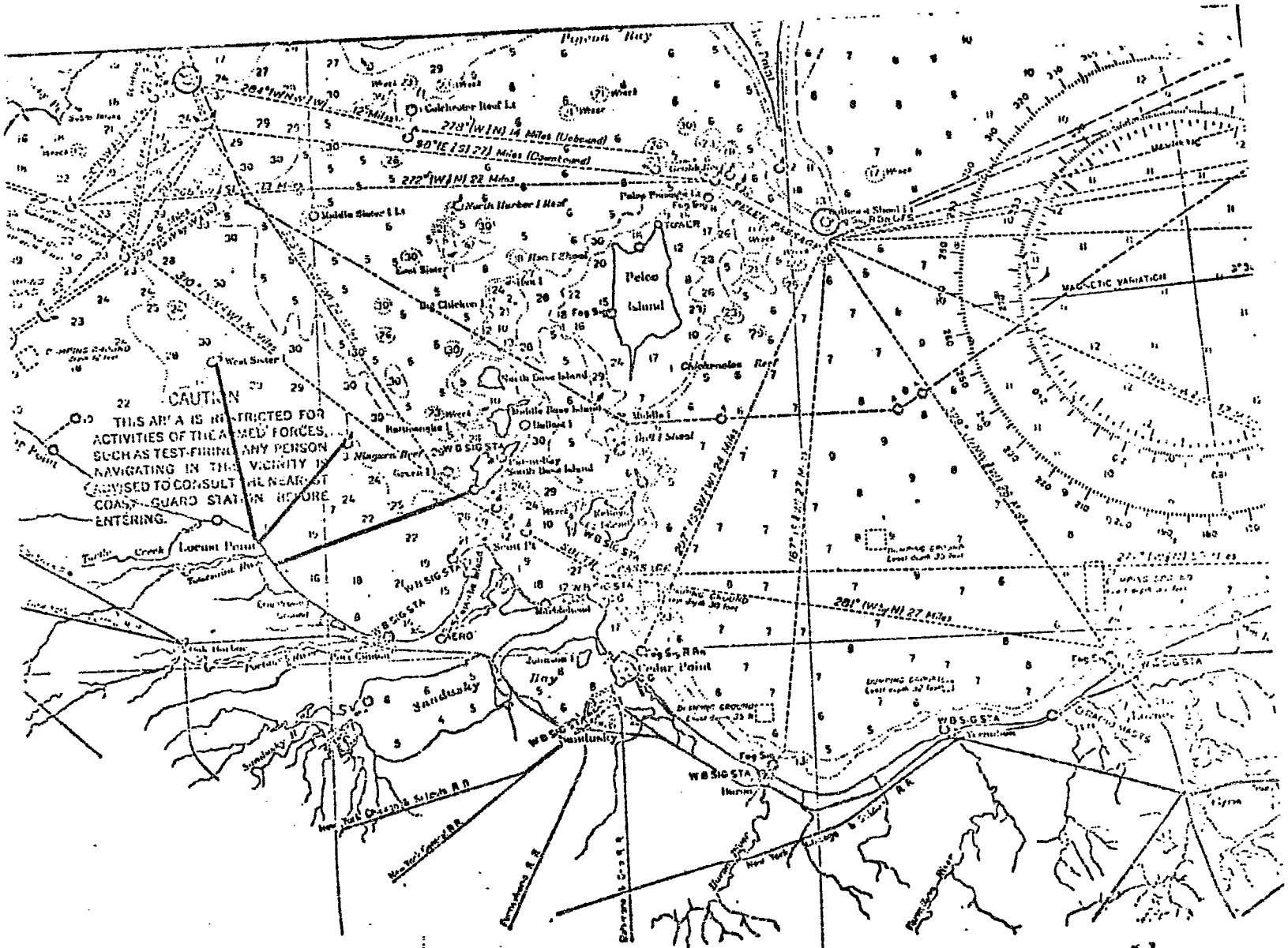


Fig. 1. Three transects established in
the Locust Point area.

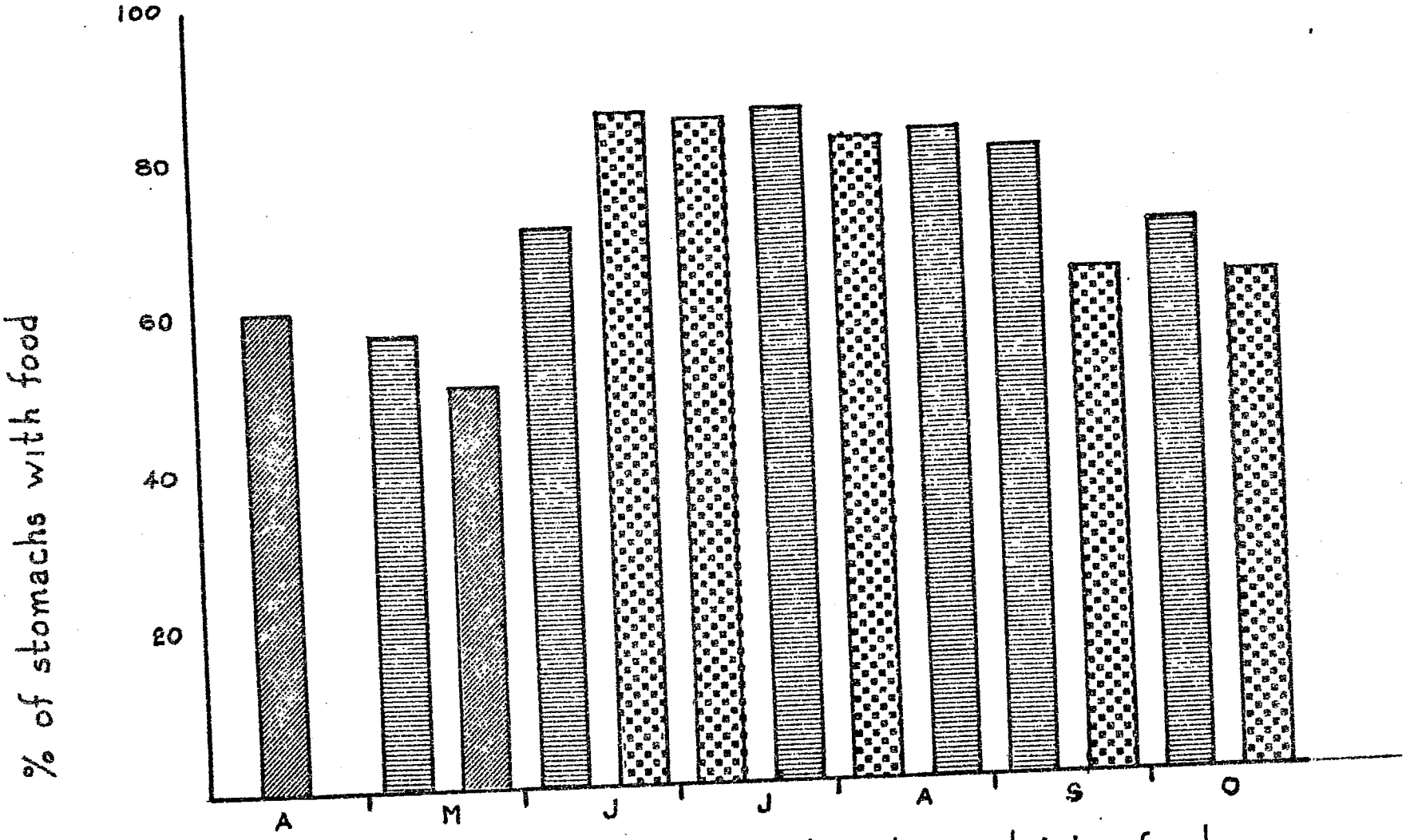


Figure 2. Percent of examined stomachs containing food

1969, 1970, 1971

Appendix 1. Scientific names of fishes found in the Locust Point area, June, 1969 - May, 1971.

| | |
|---|---|
| Alewife | Alosa pseudoharengus |
| American smelt | Osmerus eperlanus mordax |
| Black crappie | Pomoxis nigromaculatus |
| Bowfin | Amia calva |
| Brown bullhead | Ictalurus nebulosus |
| Carp | Cyprinus carpio |
| Channel catfish | Ictalurus punctatus |
| Coho salmon | Oncorhynchus kisutch |
| Common emerald shiner | Notropis atherinoides |
| Common white sucker | Catostomus commersoni |
| Freshwater drum | Aplodinotus grunniens |
| Gizzard shad | Dorosoma cepedianum |
| Golden redhorse | Moxostoma erythrurum |
| Goldfish | Carassius auratus |
| Green sunfish | Lepomis cyanellus |
| Largemouth bass | Micropterus s. salmoides |
| Logperch | Percina caprodes |
| Longnose gar | Lepisosteus osseus |
| Northern pike | Esox lucius |
| Orangespotted sunfish | Lepomis humilis |
| Quillback | Carpiodes cyprinus |
| Rock bass | Ambloplites rupestris |
| Silver chub | Hybopsis storeriana |
| Smallmouth bass | Micropterus d. dolomieui |

Appendix I. (cont'd)

| | |
|---|---|
| Spotted sucker | *Minytrema melanops* |
| Spotfin shiner | *Notropis spilopterus* |
| Spottail shiner | *Notropis hudsonius* |
| Stonecat | *Noturus flavus* |
| Walleye | *Stizostedion v. vitreum* |
| White bass | *Morone chrysops* |
| White crappie | *Pomoxis annularis* |
| Yellow perch | *Perca flavescens* |

JOB COMPLETION REPORT

RESEARCH PROGRESS SEGMENT

| | | | |
|---|---|---|---|
| State of: | Ohio | Date: | May 31, 1972 |
| Project No.: | F-41-R-3 | Name: | Environmental Evaluation of a Nuclear Power Plant |
| Job No.: | 2-A | Title: | Temperature Preferences of Locust Point Fishes |
| Period Covered: | June 1, 1971-May 31, 1972 | | |


## ABSTRACT

Temperature preferences were determined for adult and young-of-the-year white bass, smallmouth bass, yellow perch and emerald shiners during four seasons from July, 1971 through May, 1972.

Fish specimens for experiments were collected from local areas by shore seining, trap netting, hook-and-line fishing and from commercial fishermen. Most fish were held in the laboratory at or near ambient lake temperatures for only short periods prior to testing. Fish tested in winter were caught during late fall and held at ambient temperatures until they were tested.

Seasonal differences in temperature selection existed for all four species within the 2-3 day testing periods. With the exception of emerald shiners in summer, all species preferred above ambient lake temperatures each season. In general, white bass and smallmouth bass selected similar high temperatures, yellow perch preferred intermediate temperatures while emerald shiners selected low water temperatures. Fish were distributed about a narrow range of temperatures in the summer and were widely distributed over a large range of temperatures during fall. A relatively constant temperature preference was reached within several hours in summer, but required 2-3 days of progressive acclimation in the temperature gradient during winter. Young

yellow perch and emerald shiners selected temperatures differing from those selected by the adults during the same season, while the young and adults of white bass and smallmouth bass preferred very similar temperatures.

## RECOMMENDATIONS

The study of the seasonal temperature preferences of fishes should continue with emphasis on species from the bottom habitat of the Locust Point area. Effort should be expended to obtain healthy test specimens and any differences in temperature selection between healthy and unhealthy individuals should be clearly defined.

## OBJECTIVE

The objective of this job is to determine the temperature preferences of Locust Point fishes.

## TECHNIQUES USED

A horizontal temperature gradient approximately 24 m in length and 25 cm in depth was established for testing the temperature preferences of fish during four seasons of the year. Within a wooden tank 8.72 m long, 79.0 cm wide and 50 cm high, a system of alternating transverse baffles formed a series of 28 compartments without greatly restricting the movements of fish. Filtered lake water (1-2 l/min) passed through 1/4" Tygon tubing within a cooling reservoir and into the low temperature end of the gradient; the water was then heated progressively higher by immersion heaters as it flowed to a standpipe at the opposite end of the trough.

A Vicore 500 watt heater, ARC static switch relay and corresponding Juno thermoregulator maintained a constant water temperature $\pm$ 0.15C in the center

of each compartment. Each season a different gradient was established by controlling the temperature at the thermoregulator of each compartment 0.5-1.0C above that of the previous compartment. The gradient ranged from a low of several degrees below ambient lake temperature (summer, fall and spring), or slightly above ambient (winter), to high of 15-26C above ambient.

Aeration from three air stones in each compartment greatly reduced vertical temperature stratification of the water column (Table 1) and created saturated, or nearly saturated, $O_2$ levels during all seasons (Table 2). Oxygen measurements were made each season using a model 54 YSI oxygen meter and probe.

Most fish were caught by trapping, shore seining and hook-and-line fishing near the F. T. Stone Laboratory on South Bass Island. Adult fish were sexually mature. Young fish were primarily young-of-the-year, although some immature (1+ year old) perch and smallmouth were tested in spring. Fish for winter experiments were caught during November and held at ambient lake temperatures until they were tested. During other seasons fish were held only for short periods of time at lake temperatures. Fish were maintained and tested under normal seasonal photoperiods. Natural lighting from windows in north and west walls was adequate for almost all observations.

Prior, to testing, each fish or group of fish was held in an acclimation tank similar to the gradient apparatus for 24-48 hrs. The acclimation tank was half the length of the gradient tank, identical to it in compartmentation (without heaters and thermoregulators) and maintained at ambient lake temperatures. In the acclimation tank fish were observed for visible signs of poor condition, aggressive behavior and randomness of distribution.

Fish were then transferred from the behavioral acclimation tank to the compartment of the gradient with a temperature nearest the ambient lake temperature. The number of fish tested at one time varied with the species and size of individual fish. Large smallmouth bass were tested singly, while

young-of-the-year emerald shiners were run in groups of 20-25 fish. After the transfer, fish moved freely about the thermal gradient for 4-6 hours before the first observation period. In summer, the gradient ranged from below ambient to 36C. During fall and winter, the testing procedure was modified because many fish moved into temperatures beyond their upper lethal limits while exploring the gradient trough. Fish were screened within a limited gradient with a maximum temperature below the suspected upper lethal temperature of each species, and were allowed into progressively higher temperatures as their selected temperatures increased.

Observations of fish distribution within the test apparatus were initiated approximately 4-6 hours after fish had been introduced into the temperature gradient. Fish were observed from behind a blind during three periods each day. The number of fish in each compartment was recorded every 10 min. for 80-100 min. in the morning, at mid-day and just before sunset. The water temperatures at the center of every other compartment were measured with a YSI multi-channel telothermometer (with fixed probes) and were recorded before and after each observation period. The water temperatures in compartments without temperature probes were interpolated from adjacent water temperatures and periodically confirmed by actual measurement.

During the summer and fall most preference tests lasted 48-hours (6 observation periods). Spring tests for each species group consisted of one 72 hr. test followed by one or more test of 48 hrs. Winter tests were 72 hours long. Five day (120 hr.) tests were conducted for three of the four species in summer and occasionally during the remaining seasons.

## FINDINGS

Temperatures selected by each species during the 2-3 day tests changed progressively through the four seasons. Seasonal thermal preferences are represented by the modes in the distributions of each species about temperatures in the laboratory gradient (Figures 1,2,3,4). Although white bass, smallmouth bass and yellow perch preferred temperatures above ambient lake temperatures during the four seasons, the interval between the selected temperature and ambient varied from season to season. The smallest difference between the seasonal preferred temperatures and ambient temperatures occurred in summer. The largest difference was during winter when the preference was not considered stable until fish had been in the gradient for 2 to 3 days. The difference between temperatures selected during summer and winter was greatest (11-17C) for emerald shiner, about 10C for white bass and yellow perch and least (5C) for smallmouth bass. Temperatures selected by most fish during the fall (falling field temperatures) were similar to those preferred in summer. However, temperatures selected in spring (rising field temperatures) were nearest winter preference values. Emerald shiners, the exception, selected very similar temperatures during fall and spring.

Although variation existed between temperatures selected during a given test and those selected in replicate tests, each species appeared to prefer a relatively precise zone of temperatures in the thermal gradient. Figures 2,3,4 and 5 show the variability of modal temperatures selected within given tests, between replicate tests and between species. Temperature selection appeared most consistent during summer and least definite in fall when wide differences existed within tests and between replicate tests. During all seasons, most emerald shiners selected a narrow range of temperatures ($\pm$ 2C about their preference temperatures) with little differences between

tests or over successive observation periods within a test. White bass and smallmouth bass, also, were fairly precise in thermal selection, although preferences of these species changed over successive observation periods, especially during winter. Yellow perch were the least precise species in selecting a temperature. Yellow perch formed tight schools at ambient temperatures in the behavioral acclimation tank, but were widely spaced in the temperature gradient and moved as a group back and forth between high and low temperature areas. This behavior usually resulted in fairly reliable modal temperature values (with a wide range in observed distribution), but periodically produced erratic modal values.

The time required for fish to select a relatively constant zone of temperatures varied seasonally. Although most groups of fish demonstrated a precise temperature preference within several hours during summer months, a few groups (especially yellow perch) remained inactive at ambient or near-ambient temperatures for almost a day before initiating exploratory behavior in the gradient and then making a temperature selection. Temperature frequency distribution of fish within the gradient of temperatures were pooled at 2C temperature intervals. The data were analyzed by Spearman's rank correlation coeficients to determine differences between temperatures selected during successive days from the initiation of each test. Results indicated that no significant difference existed for any species between temperatures selected the first day and those selected the second day during the summer. A standard 2-day test period was established during summer to insure adequate time for selection of temperatures and to allow time for changes in temperature preference. Tests of 5-days duration were conducted once during summer on most species age groups. Only slight fluctuations (1-4C) occurred in thermal preferences made by fish through the 5th or 6th day in the gradient (where data was available).

During fall, selected temperatures fluctuated widely with successive observations but definite upper and lower preference limits were evident for each species within the 2-day test period. Preferendum temperatures were below those of the same species during the summer period. During winter, higher temperatures were preferred during the first day and, generally, the fish moved toward a temperature below the summer selected temperatures, with the exception of young white bass and smallmouth bass. Young-of-the-year white bass appeared to select decreasing temperatures after the 2nd day. Young and adult smallmouth bass (small sample sizes) selected temperatures after 3-days near temperatures preferred in summer. In spring, smallmouth bass, young yellow perch and adult white bass preferred increasing temperatures during the first day, as in winter. However, other species and age groups made relatively stable selections shortly after their introduction.

Differences between temperatures selected by young and adults were largest in yellow perch and emerald shiners. During all seasons young perch selected temperatures 4C or more above temperatures preferred by adults. Adult emerald shiners chose temperatures higher than young in summer, fall and spring, but preferred waters about 5C lower than young in winter. Very similar temperatures were selected by the young and adults of both white bass and smallmouth bass.

Table 1. Seasonal temperatures (°C) of surface (S) and bottom (B) waters of the temperature gradient apparatus.

| Compartment No. | SUMMER | | FALL | | WINTER | | SPRING | |
|---|---|---|---|---|---|---|---|---|
| | S | B | S | B | S | B | S | B |
| 1 | 20.8 | 20.5 | 11.0 | 10.7 | 2.0 | 2.0 | 9.9 | 9.8 |
| 2 | 21.0 | 20.8 | 13.5 | 13.3 | 5.0 | 5.0 | 12.2 | 12.0 |
| 3 | 21.2 | 21.0 | 14.0 | 14.0 | 6.0 | 6.0 | 12.5 | 12.5 |
| 4 | 21.8 | 21.6 | 15.5 | 15.5 | 6.8 | 6.8 | 13.1 | 3.0 |
| 5 | 22.2 | 22.0 | 16.2 | 16.0 | 7.5 | 7.5 | 14.1 | 14.1 |
| 6 | 22.5 | 22.3 | 17.0 | 17.0 | 8.4 | 8.4 | 15.0 | 15.0 |
| 7 | 22.7 | 22.6 | 17.2 | 17.2 | 9.8 | 9.8 | 15.3 | 15.2 |
| 8 | 23.0 | 23.0 | 18.0 | 18.0 | 10.2 | 10.2 | 16.1 | 16.0 |
| 9 | 23.8 | 23.6 | 18.5 | 18.5 | 11.2 | 11.2 | 17.2 | 17.2 |
| 10 | 24.0 | 24.0 | 19.3 | 19.2 | 12.2 | 12.2 | 18.0 | 18.0 |
| 11 | 24.7 | 24.6 | 20.0 | 20.0 | 13.5 | 13.2 | 19.0 | 19.0 |
| 12 | 25.5 | 25.2 | 20.5 | 20.5 | 14.2 | 14.2 | 20.2 | 20.0 |
| 13 | 25.5 | 25.4 | 21.6 | 21.5 | 15.2 | 15.2 | 20.5 | 20.5 |
| 14 | 25.9 | 25.6 | 22.3 | 22.1 | 16.0 | 16.0 | 22.1 | 22.1 |
| 15 | 26.6 | 26.5 | 23.0 | 23.0 | 17.0 | 17.0 | 23.6 | 23.5 |
| 16 | 27.2 | 27.2 | 24.2 | 24.2 | 18.0 | 18.0 | 24.2 | 24.2 |
| 17 | 28.0 | 28.0 | 25.0 | 25.0 | 18.9 | 18.8 | 25.7 | 25.5 |
| 18 | 28.8 | 28.8 | 26.0 | 26.0 | 19.8 | 19.8 | 26.0 | 26.0 |
| 19 | 2918 | 29.8 | 27.7 | 27.5 | 21.0 | 21.0 | 27.1 | 27.0 |
| 20 | 30.8 | 30.6 | 29.0 | 29.0 | 22.1 | 22.1 | 28.3 | 28.0 |
| 21 | 31.6 | 3.15 | 30.0 | 30.0 | 23.0 | 23.0 | 29.2 | 29.0 |
| 22 | 32.5 | 32.5 | 32.2 | 32.2 | 23.9 | 23.9 | 30.2 | 30.2 |
| 23 | 33.3 | 33.4 | 33.0 | 33.0 | 25.0 | 25.0 | 31.2 | 31.1 |
| 24 | 34.5 | 34.3 | 34.1 | 34.0 | 26.1 | 26.0 | 32.7 | 32.5 |
| 25 | 35.6 | 35.5 | 35.4 | 35.3 | 27.5 | 27.4 | 33.7 | 33.5 |
| 26 | 36.1 | 36.0 | 35.9 | 35.8 | 28.1 | 28.1 | 34.1 | 34.0 |
| 27 | 36.0 | 35.9 | 36.0 | 36.0 | 29.1 | 29.1 | 34.3 | 34.2 |
| 28 | 35.9 | 35.8 | 35.8 | 35.8 | 29.5 | 29.5 | 35.0 | 34.8 |

Table 2. Seasonal oxygen concentrations (mg/l) in surface (S) and bottom (B) waters of the temperature gradient apparatus.

| Compartment No. | SUMMER | | FALL | | WINTER | | SPRING | |
|---|---|---|---|---|---|---|---|---|
| | S | B | S | B | S | B | S | B |
| 1 | 8.1 | 8.1 | | | 11.2 | 11.2 | 10.4 | 10.4 |
| 2 | 8.2 | 8.2 | 10.0 | 9.9 | 11.0 | 11.0 | 10.4 | 10.4 |
| 3 | 8.2 | 8.2 | 10.0 | 9.8 | 10.9 | 10.9 | 10.4 | 10.4 |
| 4 | 8.2 | 8.2 | 9.8 | 9.7 | 10.8 | 10.8 | 10.4 | 10.4 |
| 5 | 8.1 | 8.1 | 9.8 | 9.6 | 10.6 | 10.6 | 10.2 | 10.2 |
| 6 | 8.1 | 8.1 | 9.8 | 9.6 | 10.4 | 10.4 | 10.2 | 10.2 |
| 7 | 8.1 | 8.1 | 10.0 | 9.6 | 10.2 | 10.2 | 10.1 | 10.0 |
| 8 | 8.0 | 8.0 | 10.0 | 9.4 | 10.0 | 10.0 | 10.0 | 10.0 |
| 9 | 8.0 | 8.0 | 9.6 | 9.4 | 9.8 | 9.7 | 9.9 | 9.9 |
| 10 | 8.0 | 8.0 | 9.6 | 9.2 | 9.6 | 9.6 | 9.7 | 9.7 |
| 11 | 7.9 | 7.9 | 9.7 | 9.2 | 9.5 | 9.5 | 9.7 | 9.7 |
| 12 | 7.9 | 7.9 | 9.8 | 8.9 | 9.2 | 9.2 | 9.6 | 9.5 |
| 13 | 7.8 | 7.8 | 9.4 | 8.9 | 8.8 | 8.8 | 9.5 | 9.5 |
| 14 | 7.7 | 7.7 | 9.3 | 8.7 | 8.6 | 8.6 | 9.1 | 9.1 |
| 15 | 7.7 | 7.6 | 9.1 | 8.6 | 8.5 | 8.5 | 8.8 | 8.8 |
| 16 | 7.6 | 7.5 | 9.6 | 8.4 | 8.4 | 8.4 | 8.7 | 8.7 |
| 17 | 7.4 | 7.3 | 9.0 | 8.3 | 8.2 | 8.2 | 8.6 | 8.6 |
| 18 | 7.3 | 7.3 | 9.5 | 8.2 | 8.0 | 8.0 | 8.6 | 8.5 |
| 19 | 7.2 | 7.1 | 9.0 | 8.0 | 7.9 | 7.9 | 8.4 | 8.4 |
| 20 | 7.0 | 7.0 | 9.5 | 7.8 | 7.8 | 7.7 | 8.3 | 8.3 |
| 21 | 7.0 | 6.9 | 9.5 | 7.6 | 7.6 | 7.6 | 8.2 | 8.1 |
| 22 | 6.8 | 6.8 | 9.9 | 7.5 | 7.5 | 7.5 | 8.0 | 8.0 |
| 23 | 6.7 | 6.7 | 9.3 | 7.4 | 7.4 | 7.4 | 7.8 | 7.8 |
| 24 | 6.6 | 6.6 | 9.4 | 7.2 | 7.3 | 7.3 | 7.5 | 7.5 |
| 25 | 6.6 | 6.5 | 9.4 | 7.2 | 7.2 | 7.2 | 7.4 | 7.4 |
| 26 | 6.6 | 6.6 | 9.4 | 7.2 | 7.0 | 7.0 | 7.4 | 7.4 |
| 27 | 6.6 | 6.6 | 9.5 | 7.1 | 7.0 | 7.0 | 7.5 | 7.5 |
| 28 | 6.6 | 6.6 | 9.1 | 7.1 | 6.9 | 6.9 | 7.4 | 7.5 |

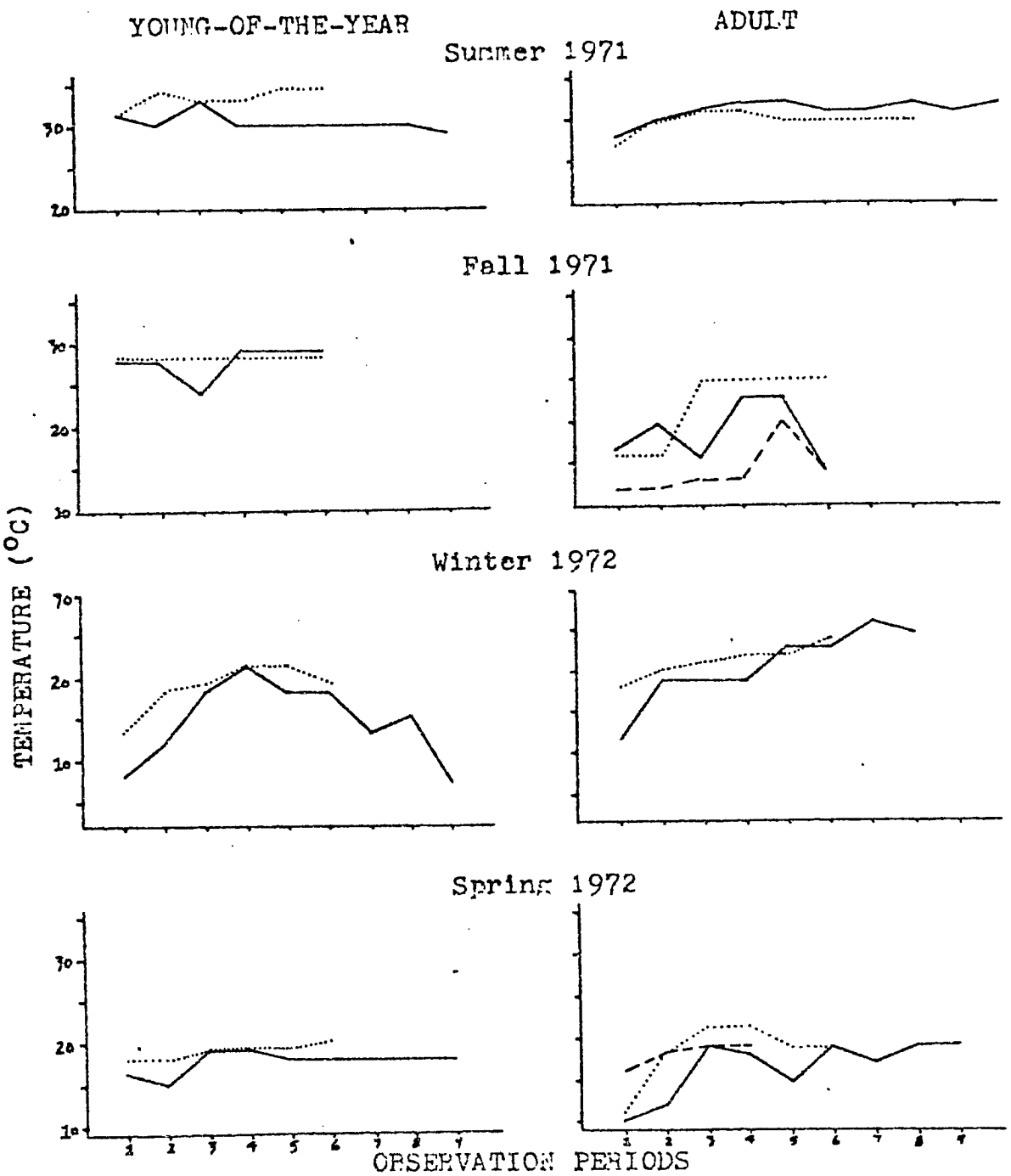


Fig. 1. Modal temperatures of white bass distribution in the thermal gradeint during successive observation periods from initiation of each test (3 observation periods equal one day).

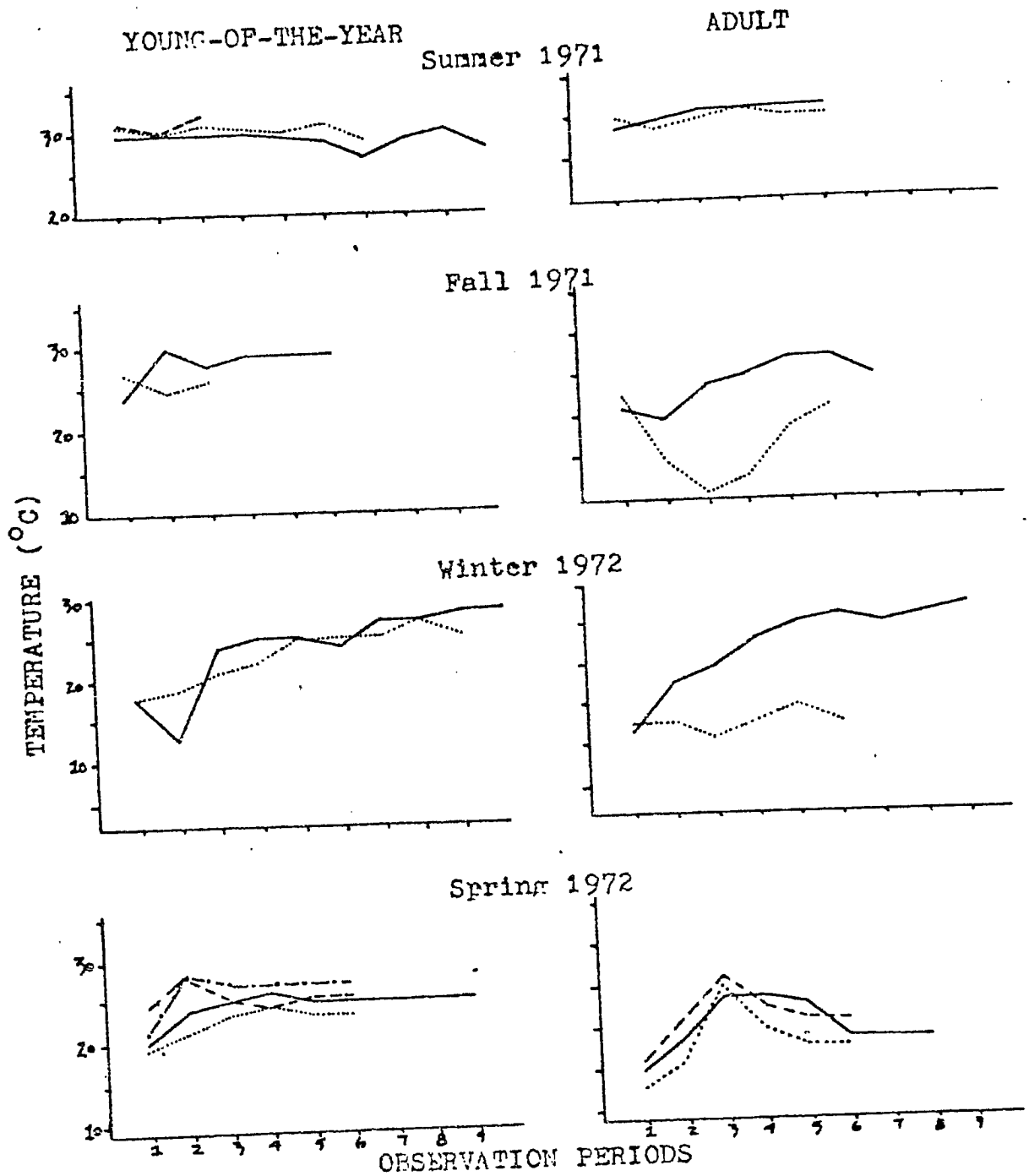


Fig. 2. Modal temperatures of smallmouth bass distribution in the thermal gradient during successive observation periods from initiation of each test (3 observation periods equal one day).

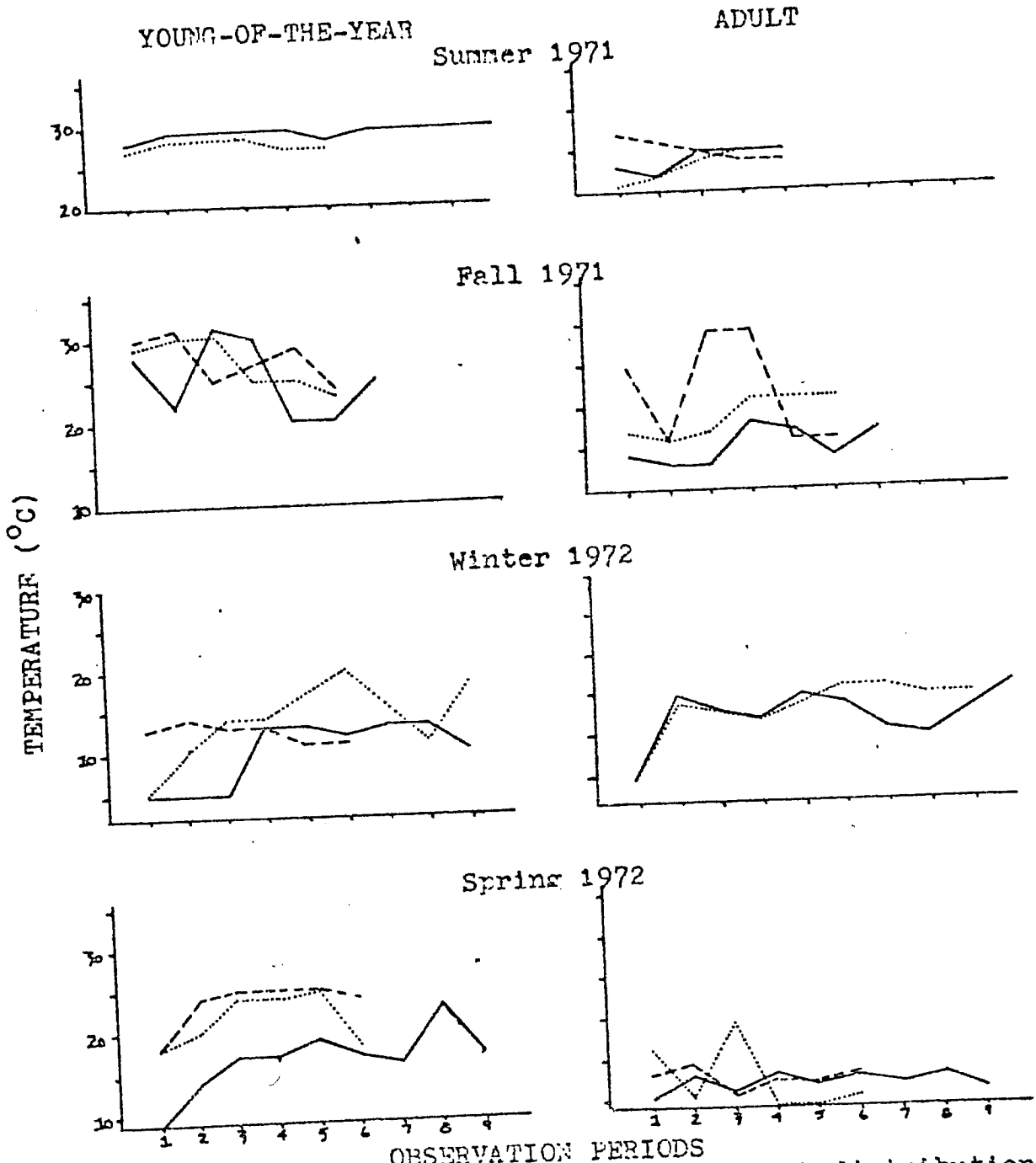


Fig. 3. Modal temperatures of yellow perch distribution in the thermal gradient during successive observation periods from initiation of each test (3 observation periods equal one day).

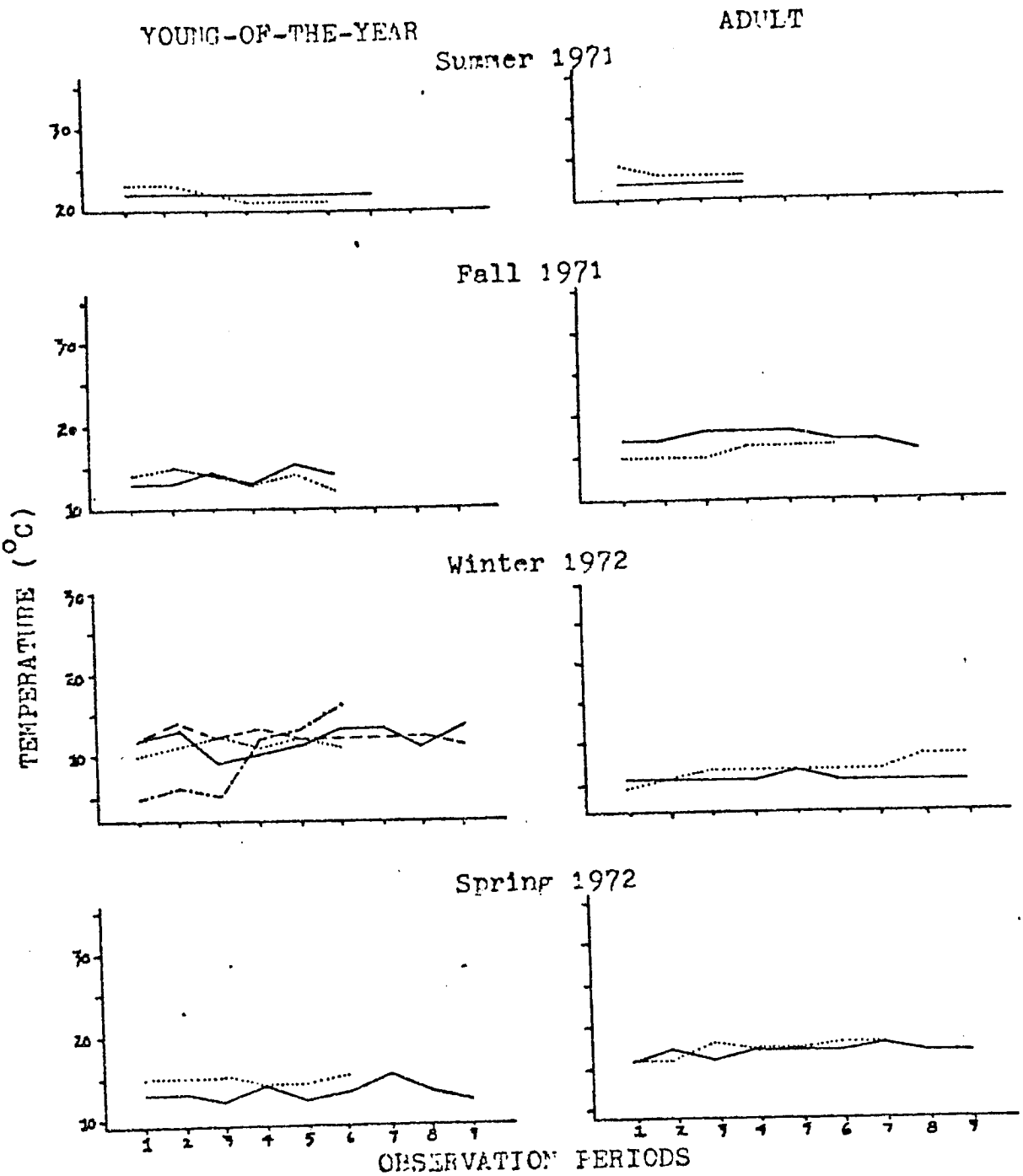


Fig. 4. Modal temperatures of emerald shiner distribution in the thermal gradient during successive observation periods from initiation of each test (3 observation periods equal one day).

PREPARED BY: L. S. Putnam
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DATE: August 25, 1972

DATE: September 15, 1972

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DATE: August 25, 1972

DATE: September 22, 1972

JOB COMPLETION REPORT

RESEARCH COMPLETION SEGMENT

| | | | |
|---|---|---|---|
| State of: | Ohio | Date: | May 31, 1972 |
| Project No.: | F-41-R-3 | Name: | Environmental Evaluation of a Nuclear Power Plant |
| Job No.: | I-B | Title: | Benthos Populations Prior to Discharge |
| Period Covered: | June 1, 1969-May 31, 1972 | | |

## ABSTRACT

Benthos was sampled monthly in the Locust Point area during the ice-free months from June, 1969 through May, 1971. In 1969 and 1970, 21 stations along three transects were sampled; in 1971, the far-offshore stations were deleted and additional near-shore stations were added. In 1969 all samples were taken with a Petersen dredge; after that, the rocky substrates were sampled with a pump sampler, (Baker and Scholl, 1971).

Samples were taken in the reefs in April and May, 1967 through 1970 by the Lake Erie Research Unit, Ohio Division of Wildlife. Reef samples were analysed to provide supplemental information.

The most abundant organisms collected were Chironomidae larvae, Tubificidae and Gastropoda. The greatest diversity occurred on the gravel-small rock substrate. Diversity was least on silt-detritus substrate, where density was greatest. Clay supported only a few species and at low population densities.

## RECOMMENDATIONS

Sampling should be repeated after the power plant is in operation and results compared with this survey. Seasonal samples between 1972 and 1974 are desirable in order to detect any major changes that occur before the plant becomes operational.

## OBJECTIVES

The objective of this job was to determine the species distribution and density of benthic populations prior to discharge.

## TECHNIQUES USED

Twenty one stations in the Locust Point area were established in 1969 (Fig. 1). These varied in depth from 6 to 22 feet and included substrates of silt, sand, detritus, gravel, clay, small rocks, boulders and bedrock. The same 21 stations were sampled monthly from June through October, 1969, and from May through October, 1970.

Late in 1970, Toledo-Edison announced plans to build a cooling tower substantially reducing the area affected by the heated effluent. The sampling program for the spring of 1971 was modified accordingly by deleting the deeper, offshore stations and adding stations at the 6 and 10-foot contours (Fig. 2).

Samples were collected in 1969 with a Petersen dredge ($A=0.0833m^2$). In 1970, a pump-type sampler was used on the boulder and bedrock reef areas. This sampler consisted of a gasoline-powered centrifugal pump, 25 feet of 2-inch pressure hose and a 12-inch diameter head ($A=0.073m^2$). Mr. Russell Scholl and Mr. Ed Driscoll of the Ohio Division of Wildlife helped design the sampler and locate parts for it.

During 1969, each sample consisted of three dredge hauls which were analysed separately. However, the replicates proved to be very similar, and in 1970 and 1971 only one dredge haul was taken at each station.

All samples were sieved through a Number 35 U.S. Soil Series screen (0.5 mm mesh) and preserved in 10% formalin. Samples taken in 1970 and 1971 were stained with Rose Bengal. Samples were rough-sorted using a 10X dissecting microscope and the organisms identified to genus (species when possible) and counted.

Samples taken by the Ohio Division of Wildlife on the reefs in the Locust Point area were also examined. These were samples collected in April and May, 1967 through 1970 with the egg pump described by Manz (1964). The pump was towed over 0.024 hectares and the organisms sieved through standard brass screen (opening of 0.420mm) and preserved in 10% formalin.

## FINDINGS

Forty-five species were found in the benthos samples between June, 1969 and May, 1971 (Table 1). Thirteen species were oligochaetes and nine were chironomids. The greatest number of species collected in any month was 30 (September, 1969) and the fewest species (16) were taken in April and May, 1971.

Figure 2 shows graphically the mean numbers of organisms per square meter and the number of species collected each month is shown in Table 2. In this figure, all substrate types and water depths were pooled to show differences due only to season. The 1969 data does not show a seasonal pattern, but this was probably caused by inexperience on the part of the field crews. For example, the average number of organisms/$m^2$ in August was much lower than in July or September. However, in August, 1969 Transect 3 was not sampled because of the"firing schedule" at Camp Perry. Since the stations on Transect three were usually the most densely populated, the omission of the transect probably resulted in the lower average numbers.

A second factor probably affecting the 1969 samples was the method of sorting and counting, especially samples containing high amounts of detritus and silt. In 1969, samples were preserved in 10% formalin and sorted in white enamel pans. After 1969, samples were stained with Rose Bengal (100 mg/l) before sorting. Rose Bengal is a red dye with an affinity for lipids. Organisms were stained bright red and were much more easily seen. No doubt many small oligochaetes and chironomids in the 1969 samples were unnoticed.

The 1970 samples show a four-fold increase in numbers of organisms between May and September. This increase is due primarily to an increase in oligochaetes in late summer. There was little change in the numbers of species present over the summer. Apparently the total numbers of species in 1970 was less than in 1969, but this is probably because the reef samples were included in the 1969 figures. Several species were only found on the reefs.

In 1971, samples were taken in April and May. Samples were restricted to the six and 10-foot contours. The number of organsims per square meter was greater than in May, 1970, but the number of species was lower. At the six-foot contour stations the number of organisms was greater in April 1971 than in May 1971. Lower populations were probably caused by shifting sand bars in the area after heavy winds (Fig. 2).

The affect of water depth on species distribution and population density in 1970 is shown in figure 3. The 1970 data was chosen because 1970 was consistently sampled during all seasons. The distribution of organisms over the seasons did not appear to be dependent on depth. At the 6-foot stations there was considerable variation both in numbers of species and in percentage of the total organisms present. These fluctuations were probably caused by shifting sand bars and wave action. The greatest percentage of organisms was usually found between 10 and 15 feet where wave action was diminished but bottom conditions were suitable for high populations. The fewest organisms were usually taken at the 6-foot stations. The greatest numbers of species occurred at the 10 and 12-foot stations. The lowest species diversity was found at stations deeper than 15 feet.

Figure 4 and Tables 3-6 indicate how the distribution of species was related to substrate composition. The greatest diversity of species occurred

in gravel-small rock substrate and the greatest percentage of organisms was found in silt-detritus. Clay-gravel substrate supported the fewest organisms and the least diversity. The increase in percentage of organisms is silt-detritus in late summer corresponded with the increase in oligochaetes.

The most abundant taxa overall were Oligochaeta and Chironomidae. Gastropoda were fairly abundant at stations deeper than 10 feet. Aquatic insects other than chironomids were very scarce; Caenis was the only Ephemeropteran found and three genera of Trichoptera (Athripsodes, Oecetis and Polycentropus) occurred occasionally.

The four reef stations (D6-11, Niagara Reef; D6-10, Crib Reef; D6-9, Toussaint Reef; D6-8) have been treated separately because different sampling methods were used. In 1969, the Petersen dredge was used and gave very poor results, certainly underestimating the population. The pump sampler used in 1970 probably overestimated the population, though the samples are more representative of the reef environment. The pump head did not remain in one spot during sampling and the exact area sampled cannot be determined. The estimates showed the composition and relative abundance of species in the reef community. Table 7 shows the relative abundance of various species during the months sampled.

The reef data was supplemented by analyses of samples taken on the three reefs by the Ohio Division of Wildlife (Table 8). The additional pumped samples were sieved through a coarser screen than was used in our sampling and showed a different species composition. Very few chironomids or oligochaetes were retained by the screen, but some organisms not captured by the smaller pump (Orconectes, Asellus and some gastropods) were taken with the larger pump. The pump was towed over a known area and the results are expressed as mean number per hectare for the season (April and May).

## LITERATURE CITED

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Manz, J. V. 1964. A pumping device used to collect walleye eggs from offshore spawning areas in western Lake Erie. Trans. Am. Fish Soc. 93(2):204-205.

Table 1. Benthic macroinvertebrates found in the Locust Point area June, 1969 through May, 1971.

Hydra

Planariidae

Hirudinea

Oligochaeta
- *Limnodrilus hoffmeisteri*
- *Limnodrilus maumeensis*
- *Limnodrilus cervix*
- *Limnodrilus claparedeanus*
- *Limnodrilus claparedeanus-cervix*
- *Limnodrilus uderemianus*
- *Aulodrilus* sp.
- *Peloscolex ferox*
- *Potamothrix maldaviensis*
- *Potamothrix vejdovskyi*
- *Branchyura sowerbyi*
- *Nais* sp.
- *Stylaria* sp.

Bryozoa

Isopoda
- *Asellus* sp.

Amphipoda
- *Gammarus* sp.
- *Hyalella azteca*

Decapoda
- *Orconectes virilis*

Ephemeroptera
- *Caenis* sp.

Trichoptera
- *Oecetis* sp.
- *Athripsodes* sp.
- *Polycentropus* sp.

Chironomidae
- *Chironomus (Chironomus)* sp.
- *C. (Cryptochironomus)* sp.
- *Polypedilum* sp.
- *Pseudochironomus* sp.
- *Tanytarus* sp.
- *Procladius* sp.
- *Coelotanypus* sp.
- *Cricotopus* sp.
- *Psectrocladius* sp.

Gastropoda
- *Amnicola* sp.
- *Bythinia* sp.
- *Physa* sp.
- *Pleurocera - Goniobasis*
- *Gyraulus* sp.
- *Volvata*

Pelycepoda
- *Sphaerium* sp.
- *Pisidium* sp.
- *Lampsilis* sp.
- *Proptera alata*

Table 2. Numbers of organisms/$m^2$ and species at various depths.

1969 - Includes reef stations sampled by Petersen dredge.

| | June | | July | | Aug. | | Sept. | | Oct. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. | No. indiv. | No. spp. |
| 6 ft. (5 sta) | 138 | 11 | 239 | 12 | 137 | 12 | 76 | 13 | 340 | 11 |
| 10 ft. (5 sta) | 167 | 14 | 469 | 17 | 159 | 9 | 208 | 18 | 761 | 19 |
| 12 ft. (4 sta) | 106 | 22 | 521 | 15 | 78 | 18 | 928 | 28 | 135 | 13 |
| 15 ft. (4 sta) | 933 | 20 | 1272 | 25 | 149 | 12 | 625 | 23 | 128 | 11 |
| >15 ft. (2 sta) | 748 | 16 | 1048 | 16 | 40 | 4 | 464 | 16 | 12 | 3 |
| Total species | | 27 | | 27 | | 23 | | 30 | | 26 |
| Total/$m^2$ | 2092÷5=418.4 | | 3549÷5=709.8 | | 563÷5=112.6 | | 2301÷5=460.2 | | 1376÷5=295.2 | |

1970 - Does not include reef stations.

| | May | | June | | July | | Aug. | | Sept. | | Oct. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 ft. (5 sta) | 164 | 9 | 1055 | 17 | 645 | 8 | 572 | 9 | 4552 | 16 | 3341 | 16 |
| 10 ft. (5 sta) | 1676 | 17 | 1761 | 17 | 2338 | 17 | 4000 | 17 | 8175 | 16 | 5882 | 15 |
| 12 ft. (3 sta) | 1320 | 7 | 2678 | 17 | 1670 | 16 | 2361 | 18 | 4220 | 22 | 6511 | 18 |
| 15 ft. (2 sta) | 854 | 12 | 2119 | 15 | 1906 | 12 | 2944 | 13 | 5342 | 14 | 3661 | 17 |
| >15 ft. (1 sta) | 1845 | 6 | 528 | 8 | 1703 | 10 | 2979 | 8 | 6044 | 8 | 5664 | 8 |
| Total species | | 20 | | 24 | | 23 | | 23 | | 24 | | 22 |
| Total/$m^2$ | 5909÷5=1181.8 | | 8141÷5=1628.2 | | 8262÷5=1652.4 | | 12856÷5=2571.2 | | 28333÷5=5666.6 | | 25059÷5=5011.8 | |

1971 - Ten nearshore stations.

| | April | | May | |
|---|---|---|---|---|
| 6 ft. (5 sta) | 427 | 10 | 186 | 8 |
| 10 ft. (5 sta) | 5045 | 16 | 5327 | 16 |
| Total species | | 16 | | 16 |
| Total/$m^2$ | 5472÷2=2736 | | 5513÷2=2756.5 | |

TABLE 3

Benthic macroinvertebrates from stations with a silt, sand and detrital substrate (D6-12,C6-1,D6-16,D6-17, D6-18,D6-19), May through October, 1969 & 1970, expressed as the mean number of organisms per square meter.

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Hydra | 7 | 0 | No Sample Taken | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| Hirudinea | 0 | 0 | | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 |
| Oligochaeta (immature) | 329 | 778 | | 25 | 2212 | 635 | 1307 | 1012 | 2836 | 6737 | 6489 |
| Limnodrilus Hoffmeisteri | 21 | 82 | | 0 | 12 | 56 | 34 | 42 | 52 | 132 | 172 |
| L. maumeensis | 45 | 72 | | 1 | 9 | 8 | 102 | 156 | 100 | 160 | 70 |
| L. claparedeanus-cervix | 17 | 23 | | 0 | 18 | 82 | 118 | 114 | 78 | 345 | 306 |
| Potamothrix Moldaviensis | 43 | 77 | | 0 | 10 | 12 | 50 | 108 | 190 | 26 | 108 |
| Branchyura sowerbyi | 10 | 3 | | 1 | 138 | 154 | 244 | 248 | 259 | 569 | 1192 |
| Chironomus (Chironomus) | 86 | 24 | | 10 | 126 | 345 | 126 | 291 | 499 | 1273 | 1124 |
| C.(Cryptochironomus) | 15 | 7 | | 3 | 63 | 12 | 2 | 8 | 4 | 4 | 52 |
| Polypedilum | 23 | 1 | | 0 | 15 | 0 | 2 | 6 | 4 | 8 | 2 |
| Tanytarsus | 3 | 92 | | 0 | 9 | 2 | 0 | 0 | 4 | 14 | 4 |
| Procladius | 45 | 10 | | 0 | 15 | 155 | 54 | 0 | 16 | 12 | 16 |
| Coelotanypus | 19 | 0 | | 9 | 9 | 8 | 6 | 12 | 14 | 108 | 86 |
| Caenis | 1 | 3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sphaerium | 0 | 4 | | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Gammarus | 0 | 5 | | 0 | 6 | 2 | 0 | 8 | 6 | 24 | 4 |

TABLE 4

Benthic macroinvertebrates from stations with a clay-gravel substrate (D6-13,D6-14,D6-15,D5-2), May through October, 1969 & 1970, expressed as the mean number of organisms per square meter.

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Hydra | 0 | 4 | 0 | 0 | 0 | 0 | 108 | 0 | 0 | 0 | 0 |
| Hirudinea | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 3 | 0 |
| Oligochaeta (immature) | 1 | 95 | 46 | 116 | 28 | 249 | 396 | 810 | 396 | 465 | 198 |
| Limnodrilus hoffmeisteri | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 9 |
| L. maumeensis | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| L. claparedeanus-cervix | 1 | 3 | 0 | 0 | 0 | 21 | 18 | 18 | 3 | 3 | 18 |
| Potamothrix moldaviensis | 0 | 15 | 47 | 1 | 0 | 21 | 3 | 30 | 6 | 18 | 18 |
| Branchyura sowerbyi | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 0 | 18 | 3 |
| Stylaria | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 12 | 9 | 12 | 0 |
| Gammarus | 15 | 9 | 0 | 0 | 3 | 3 | 6 | 9 | 9 | 6 | 15 |
| Chironomus (Chironomus) | 1 | 1 | 5 | 5 | 3 | 0 | 3 | 0 | 27 | 117 | 24 |
| C.(Cryptochironomus) | 6 | 14 | 7 | 3 | 4 | 24 | 6 | 9 | 0 | 9 | 21 |
| Pseudochironomus | 3 | 2 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 3 |
| Polypedilum | 0 | 11 | 9 | 2 | 0 | 15 | 66 | 9 | 12 | 12 | 24 |
| Tanytarsus | 0 | 12 | 2 | 14 | 0 | 27 | 6 | 6 | 48 | 192 | 9 |
| Procladius | 3 | 4 | 4 | 0 | 3 | 3 | 0 | 3 | 3 | 17 | 6 |
| Coelotanypus | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Caenis | 10 | 8 | 0 | 0 | 1 | 6 | 6 | 0 | 0 | 3 | 3 |
| Oecetis | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

TABLE 4
Cont'd

| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Amnicola | 0 | 0 | 0 | 1 | 0 | 0 | 12 | 0 | 0 | 0 | 0 |
| Bythinia | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| Sphaerium | 2 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 |
| Pisidium | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |

TABLE 5

m

Benthic macroinvertebrates from stations with a gravel and small rock substrate (D6-7,D6-6,D6-5,D6-4,D5-3,D5-4), May through October, 1969 & 1970, expressed as the mean number of organisms per square meter.

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Hydra | 21 | 198 | 1 | 3 | 0 | 0 | 500 | 92 | 2 | 0 | 36 |
| Planariidae | 7 | 35 | 0 | 11 | 20 | 0 | 4 | 16 | 0 | 30 | 26 |
| Hirudinea | 0 | 3 | 1 | 3 | 4 | 2 | 2 | 14 | 12 | 8 | 8 |
| Oligochaeta (immature) | 131 | 413 | 19 | 411 | 112 | 906 | 874 | 1214 | 1397 | 3393 | 4248 |
| Limnodrilus hoffmeisteri | 10 | 3 | 1 | 2 | 0 | 38 | 46 | 26 | 42 | 52 | 54 |
| L. maumeensis | 3 | 3 | 1 | 1 | 1 | 0 | 16 | 14 | 14 | 34 | 4 |
| L. claparedeanus-cervix | 1 | 1 | 0 | 1 | 0 | 24 | 10 | 26 | 10 | 118 | 14 |
| Potamothrix moldaviensis | 33 | 22 | 13 | 1 | 0 | 70 | 42 | 112 | 78 | 28 | 35 |
| Branchyura sowerbyi | 3 | 1 | 0 | 3 | 0 | 0 | 2 | 4 | 2 | 369 | 4 |
| Nais | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| Stylaria | 0 | 11 | 1 | 7 | 0 | 0 | 0 | 50 | 52 | 6 | 0 |
| Gammarus | 17 | 19 | 7 | 13 | 21 | 4 | 68 | 66 | 56 | 58 | 70 |
| Chironomus (Chironomus) | 28 | 0 | 5 | 11 | 3 | 0 | 407 | 2 | 160 | 602 | 92 |
| C.(Cryptochironomus) | 10 | 9 | 11 | 7 | 19 | 24 | 16 | 13 | 18 | 4 | 86 |
| Pseudochironomus | 1 | 0 | 3 | 2 | 3 | 7 | 8 | 2 | 0 | 0 | 6 |
| Polypedilum | 6 | 0 | 23 | 2 | 1 | 8 | 12 | 2 | 26 | 2 | 38 |
| Tanytarsus | 2 | 29 | 43 | 45 | 0 | 0 | 0 | 2 | 104 | 315 | 76 |
| Procladius | 5 | 3 | 6 | 28 | 4 | 0 | 0 | 4 | 2 | 38 | 82 |

TABLE 5
Cont'd

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Coelotanypus | 2 | 0 | 1 | 7 | 0 | 0 | 0 | 0 | 2 | 24 | 14 |
| Polycentropus | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Caenis | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| Oecetis | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amnicola | 0 | 0 | 0 | 9 | 0 | 2 | 10 | 6 | 8 | 8 | 0 |
| Bythinia | 3 | 3 | 1 | 4 | 4 | 0 | 4 | 0 | 0 | 0 | 0 |
| Pleurocere-Goniobasis* | 1 | 15 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 0 |
| Physa | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 2 | 2 | 0 |
| Sphaerium | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 1 | 6 | 8 | 0 |
| Pisidium | 5 | 1 | 0 | 19 | 0 | 6 | 6 | 0 | 10 | 28 | 16 |

* Cannot distinguish genera with certainty.

Table 6. Benthic macroinvertebrates, April & May, 1971, expressed as mean number of organisms per square meter.

| | April 17, 1971 | | | May 15, 1971 | | |
|---|---|---|---|---|---|---|
| | Silt, detritus substrate (A1,A2,B1,B2) | Clay, gravel substrate (D1,E1,E2) | Gravel, small rock substrate (C1,C2,D2) | Silt, detritus substrate (A1,A2,B1,B2) | Clay, gravel substrate (D1,E1,E2) | Gravel, small rock substrate (C1,C2,D2) |
| Hirudinea | 0 | 4 | 4 | 0 | 0 | 0 |
| Oligochaeta (imm.) | 4062 | 220 | 1176 | 2535 | 1220 | 1808 |
| Limnodrilus hoffmeisteri | 159 | 0 | 52 | 180 | 8 | 28 |
| L. maumeensis | 66 | 4 | 8 | 66 | 4 | 28 |
| L. cervix | 15 | 0 | 8 | 54 | 0 | 20 |
| L. claparedeanus | 195 | 0 | 12 | 117 | 0 | 4 |
| Potamothrix moldaviensis | 114 | 16 | 20 | 237 | 32 | 64 |
| Branchyura sowerbyi | 570 | 0 | 20 | 257 | 12 | 12 |
| Nais sp. | 18 | 4 | 4 | 21 | 12 | 20 |
| Gammarus sp. | 3 | 20 | 0 | 9 | 0 | 8 |
| Caenis sp. | 0 | 4 | 0 | 0 | 0 | 0 |
| Chironomus(Chironomus) | 171 | 4 | 100 | 171 | 0 | 0 |
| C.(Cryptochironomus) | 54 | 0 | 48 | 45 | 24 | 84 |
| Polypedilum | 0 | 0 | 0 | 0 | 12 | 8 |
| Tanytarsus | 0 | 0 | 0 | 12 | 8 | 8 |
| Procladius | 90 | 0 | 40 | 66 | 0 | 0 |
| Coelotanypus | 9 | 0 | 4 | 0 | 0 | 0 |

TABLE 7

Benthic macroinvertebrates from stations with a bedrock and large boulder substrate (D6-11,D6-10,D6-9,D6-8), May through October 1969 & 1970, expressed as percent of the total number of organisms (%).

| | 1969 | | | | | 1970 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6/17 | 7/17 | 8/15 | 9/23 | 10/29 | 5/8 | 6/8 | 7/7 | 8/6 | 9/16 | 10/7 |
| Hydra | 89 | 0 | 0 | 19 | 0 | 4 | 4 | 1* | 1* | No Sample | 2 |
| Planariidae | 5 | 3 | 30 | 13 | 20 | 9 | 9 | 3 | 4 | Taken | 23 |
| Oligochaeta (immature) | 1 | 30 | 18 | 27 | 22 | 65 | 2 | 10 | 5 | | 10 |
| Limnodrilus hoffmeisteri | 0 | 4 | 1 | 1 | 1 | 0 | 1* | 1* | 1* | | 0 |
| Nais | 0 | 1 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | | 1* |
| Gammarus | 1 | 39 | 26 | 10 | 2 | 1 | 44 | 62 | 48 | | 33 |
| Hyalella azteca | 0 | 3 | 2 | 3 | 0 | 0 | 5 | 2 | 1 | | 3 |
| Chironomus (Chironomus) | 0 | 1* | 1 | 2 | 1 | 0 | 16 | 1 | 2 | | 1* |
| C.(Cryptochironomus) | 0 | 2 | 1 | 1* | 0 | 1 | 0 | 1* | 1 | | 1* |
| Tanytarsus | 0 | 1* | 8 | 1* | 0 | 0 | 0 | 0 | 1* | | 1* |
| Procladius | 0 | 5 | 1 | 2 | 4 | 0 | 1 | 1 | 1 | | 1 |
| Coelotanypus | 0 | 1* | 1* | 1 | 8 | 0 | 0 | 0 | 0 | | 1* |
| Polycentropus | 1* | 0 | 2 | 1 | 5 | 1 | 1* | 1* | 1* | | 1* |
| Amnicola | 3 | 0 | 0 | 6 | 0 | 0 | 10 | 10 | 18 | | 16 |
| Bythinia | 0 | 0 | 4 | 3 | 18 | 0 | 0 | 0 | 1* | | 1* |
| Pleurocera-Goniobasis** | 2 | 1 | 0 | 1* | 0 | 0 | 0 | 0 | 2 | | 1 |
| Physa | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 2 | | 1 |
| Sphaerium | 0 | 2 | 0 | 5 | 1 | 0 | 1 | 1 | 2 | | 3 |
| Pisidium | 0 | 0 | 0 | 3 | 4 | 0 | 1 | 0 | 4 | | 2 |
| Valvata | 0 | 0 | 0 | 0 | 8 | 0 | 1 | 0 | 5 | | 0 |

*Indicates less than 1%
**Cannot distinguish genera with certainty

Table 8. Benthic macroinvertebrates collected at Niagara, Crib & Toussaint Reefs in April and May, 1967 through 1970 by Ohio Division of Wildlife egg pump, expressed as mean number of organisms per hectare.

| | 1967 | | | 1968 | | | 1969 | | | 1970 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Niagara | Crib (D6-10) | Toussaint (D6-9) | Niagara (D6-11) | Crib (D6-10) | Toussaint (D6-9) | Niagara (D6-11) | Crib (D6-10) | Toussaint D6-9) | Niagara | Crib (D6-10) | Toussaint (D6-9) |
| Planariidae | 2995 | 1789 | 62 | 1489 | 1269 | 811 | 104 | 166 | 0 | 21 | 62 | 69 |
| Hirudinea | 42 | 437 | 187 | 62 | 354 | 83 | 62 | 83 | 370 | 0 | 0 | 14 |
| Asellus sp. | 624 | 2766 | 187 | 2974 | 5886 | 208 | 229 | 728 | 42 | 0 | 104 | 14 |
| Gammarus sp. | 38750 | 105394 | 83824 | 74152 | 90979 | 54142 | 52000 | 28038 | 52083 | 12022 | 9818 | 10317 |
| Hyalella azteca | 1914 | 936 | 0 | 416 | 1102 | 0 | 0 | 0 | 0 | 42 | 146 | 111 |
| Orconectes sp. | 101 | 99 | 102 | 104 | 213 | 81 | 410 | 102 | 0 | 98 | 103 | 0 |
| Polycentropus sp. | 208 | 624 | 42 | 125 | 354 | 145 | 0 | 125 | 42 | 21 | 291 | 83 |
| Amnicola sp. | 15900 | 420 | 505 | 36100 | 39317 | 4400 | 200 | 34625 | 40 | 910 | 23412 | 4690 |
| Bythinia sp. | 1422 | 409 | 818 | 411 | 616 | 1211 | 101 | 529 | 2617 | 119 | 1108 | 1998 |
| Physa sp. | 917 | 1418 | 310 | 1903 | 1810 | 1120 | 1031 | 915 | 2921 | 207 | 533 | 114 |
| Pleurocera-Goniobasis* | 3821 | 1530 | 1239 | 2806 | 13419 | 4132 | 3211 | 10831 | 3033 | 3941 | 13399 | 4957 |
| Valvata sp. | 103 | 0 | 0 | 611 | 25 | 21 | 0 | 27 | 0 | 0 | 0 | 0 |
| Sphaerium sp. | 431 | 143 | 217 | 644 | 251 | 433 | 327 | 104 | 0 | 0 | 210 | 0 |
| Pisidium sp. | 0 | 122 | 432 | 217 | 473 | 316 | 0 | 0 | 0 | 0 | 119 | 0 |

*Cannot distinguish genera with certainty

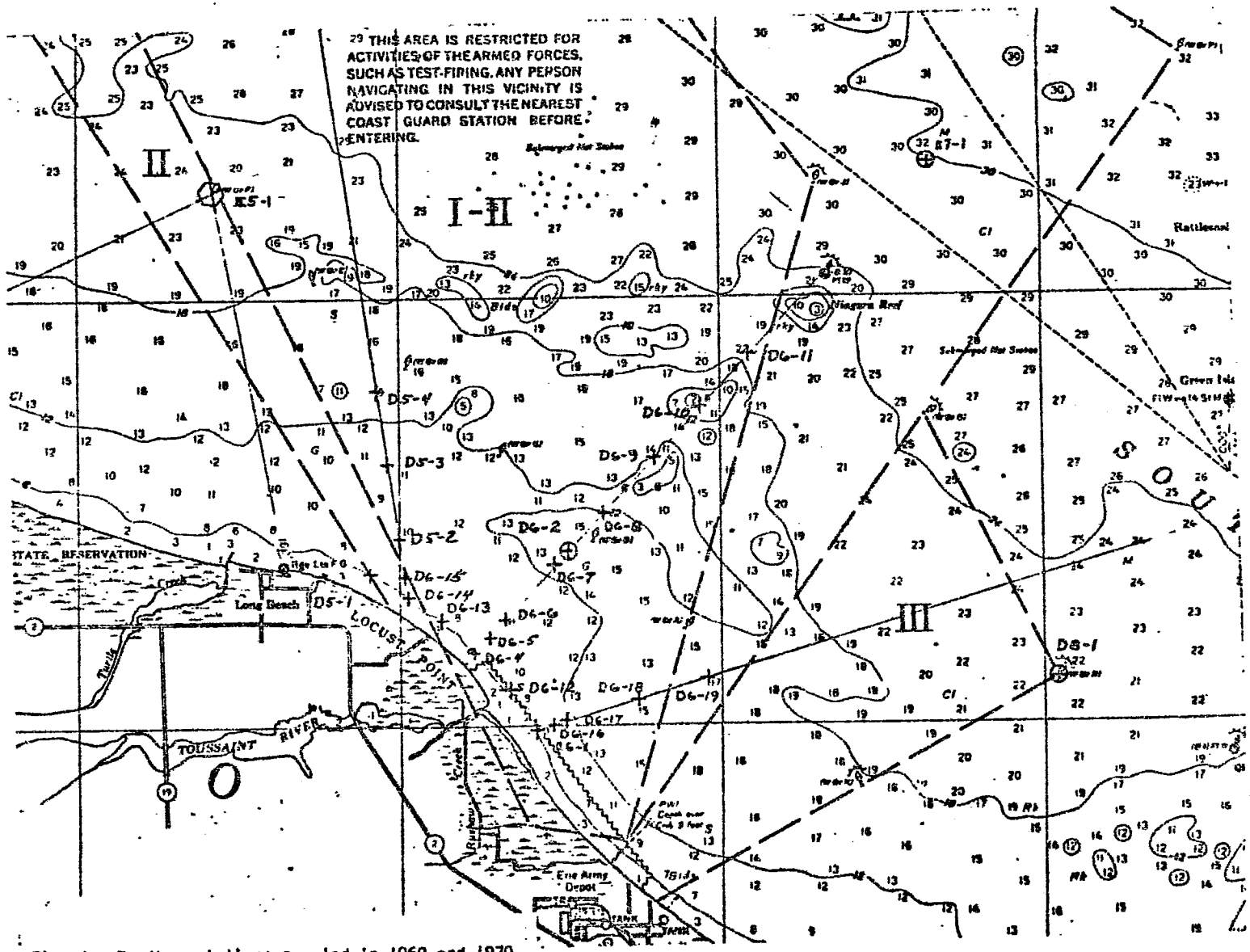


Fig. 1. Benthos stations sampled in 1969 and 1970.

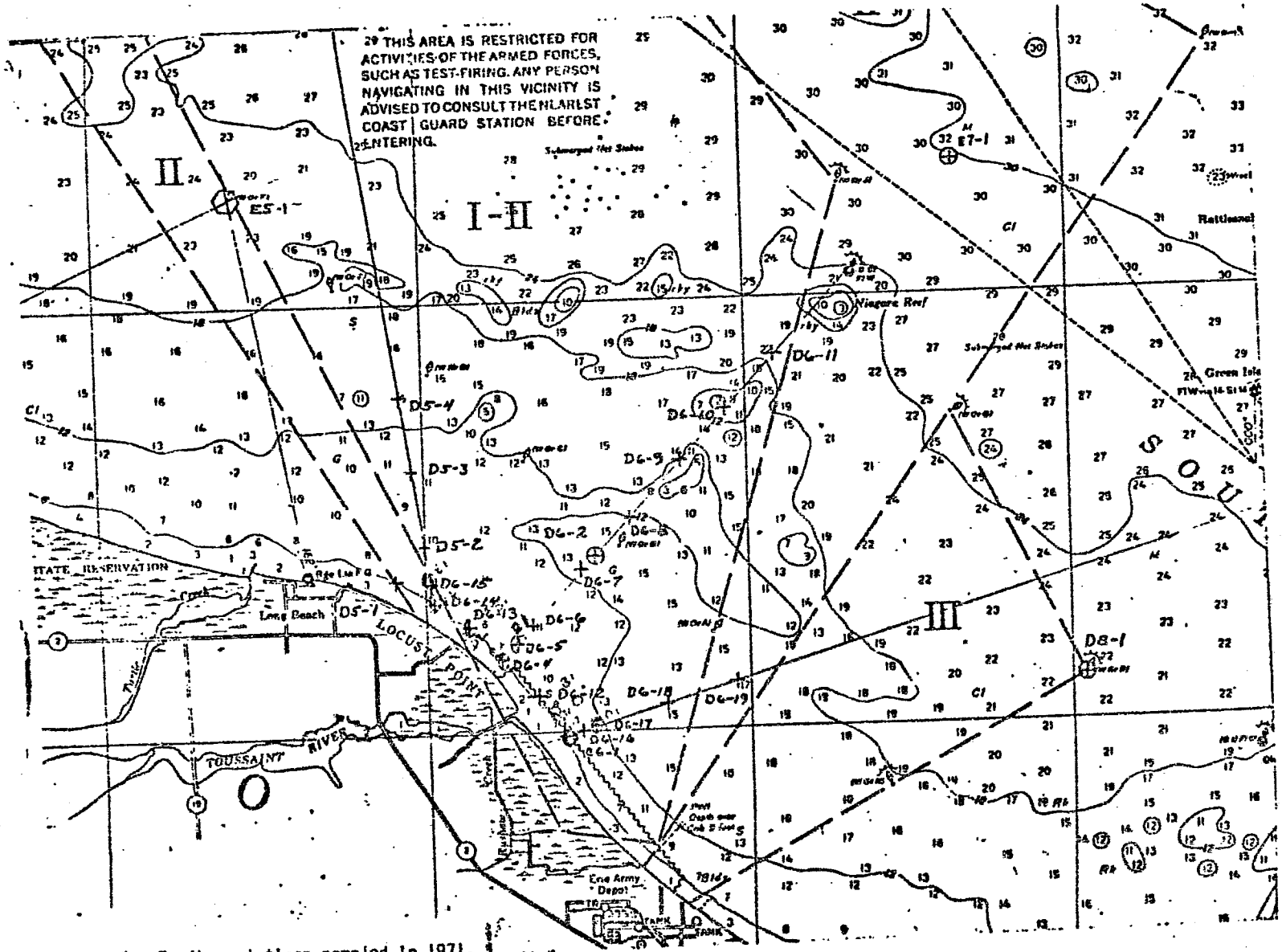


Fig. 2. Benthos stations sampled in 1971.

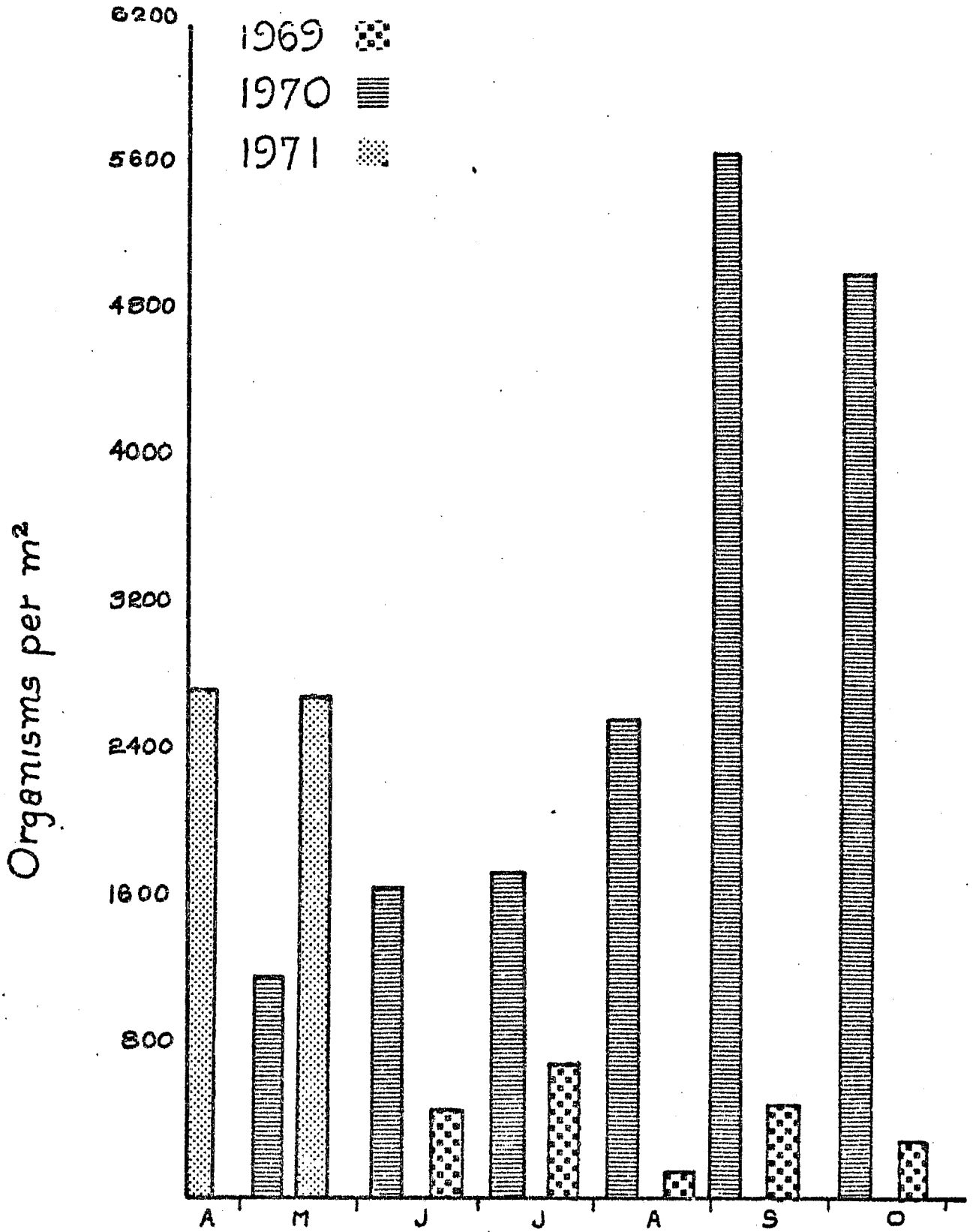


Figure 3. Mean number of organisms/m²/month from June 1969 to May 1971.

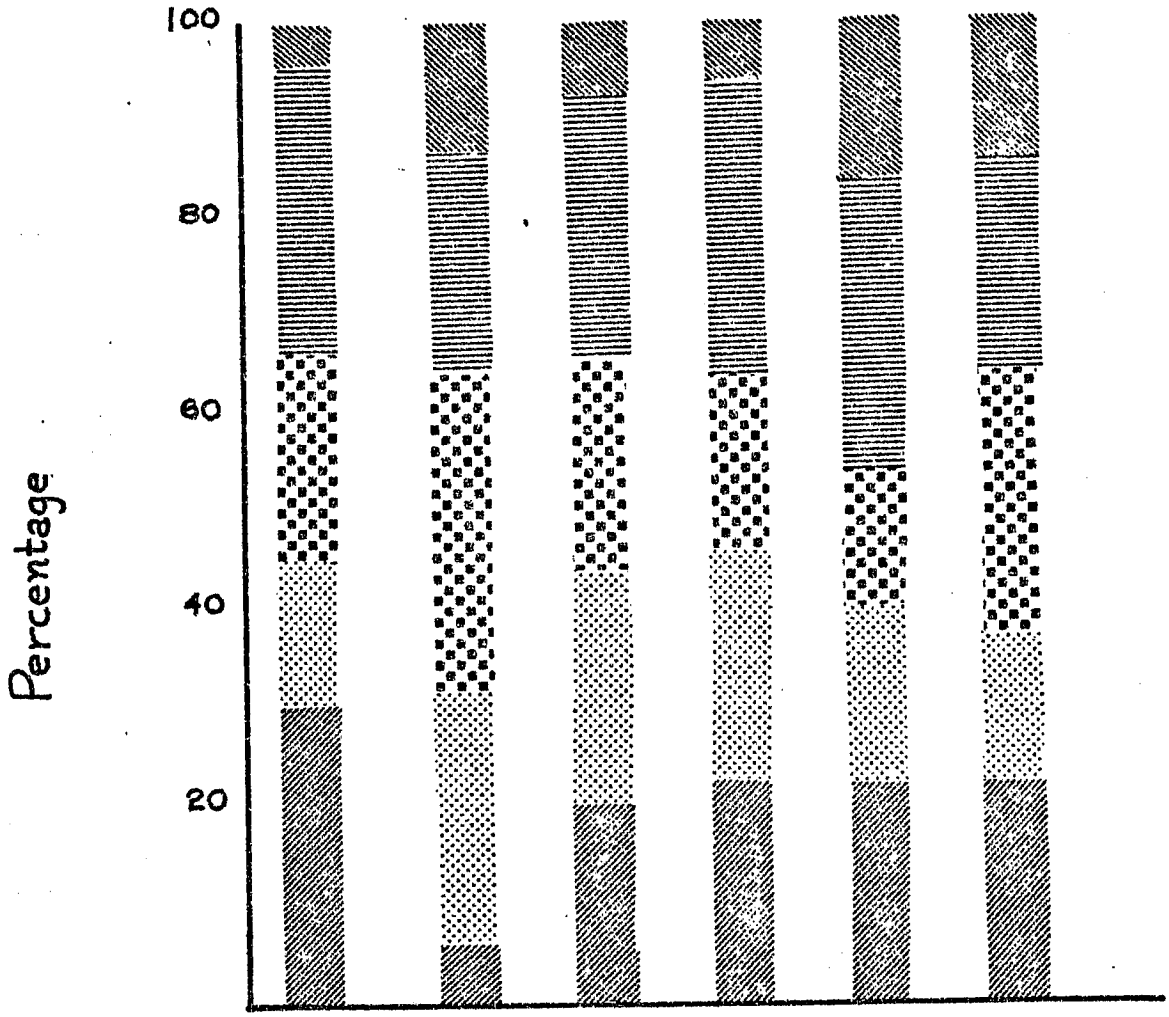


Figure 4. Percentage of benthos found at different water depths, no reef samples

6 feet, 10 feet, 12 feet, 15 feet, >15 feet

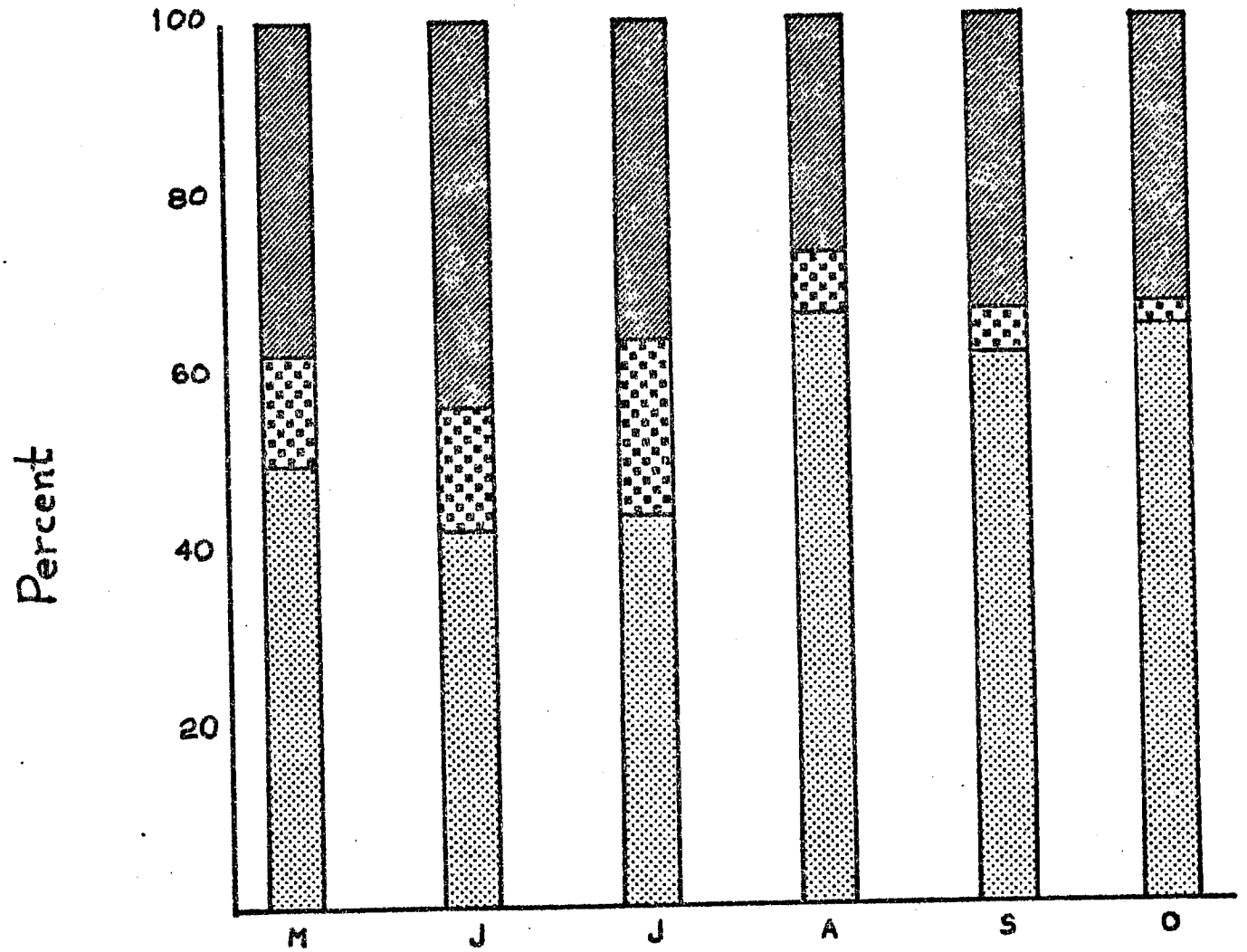


Figure 5. Percentage of organisms on different substrates.

Gravel and small rocks

Clay and gravel

Silt, sand and detritus

JOB COMPLETION REPORT

RESEARCH COMPLETION SEGMENT

State of: Ohio

Project No.: F-41-R-3

Job No.: I-C

Period Covered: June 1, 1969-May 31, 1972

Date: May 31, 1972

Name: Environmental Evaluation of a Nuclear Power Plant

Title: Plankton Populations Prior to Discharge


## ABSTRACT

Zooplankton was sampled monthly in the Locust Point area from June, 1969 through May, 1971 during the ice free portion of the year. In 1969 and 1970 stations were distributed over a wide area of the lake. In 1971 the stations were located near shore, after the Toledo-Edison Company announced that a cooling tower was to be constructed.

Cyclopoid copepods were found in 97.2% of all samples and calanoid copepods found in 84.9% of the samples. Cladocerans were also abundant with Daphnia retrocurva occurring in 80.1% of the samples and Bosmina in 86.3%. Abundant rotifers included Keratella cochlearis and Polyarthra.

The highest densities of all zooplankton (all taxa) appeared in June, July and August. The copepod populations were greatest in June, July and August. Cladocerans and rotifers were most numerous in July and August.


## RECOMMENDATIONS

Zooplankton should be sampled in a more restricted area with more frequent samples until the power-plant is in operation. Phytoplankton should be sampled over all seasons before plant operation begins in 1974.

## OBJECTIVE

The objective of this research was to determine the character and composition of the zooplankton populations of the Locust Point area of Lake Erie prior to operation of the nuclear power-plant.

## TECHNIQUES USED

Plankton samples were taken at 23 stations along three transects radiating outward from the power plant (Figure 1). A summary of the stations and depths is shown in Table 1.

A 3-liter Kemmerer water bottle was used to collect samples at 1 and 3 meters. Samples were concentrated by passage through a No. 25 silk bolting cloth and zooplankters were then fixed in 5% formalin. The smaller nannoplankters were last with this procedure, but the larger zooplankters fed upon by fishes were retained and an overall estimate of the zooplankton was readily accomplished using this procedure. Zooplankters were counted in a Sedgewick-Rafter counting chamber at 100X magnification. Individual species were identified when necessary at 980X magnification.

## FINDINGS

The frequency of occurrence of individual zooplankters is shown in Table 2. The only protozoan found in the samples was Acinetz and it was found only in 1969. Rotifers were quite common in all samples. The ubiquitous Keratella cochlearis was found in 95.2% of all samples and Polyarthra was also abundant occurring in 93.7% of all samples. Brachinous, Keratella quadrula, Asplanchna and Filina were other prominent rotifers.

Copepods were idientified only as cyclopoid or calanoid types and the naupli were counted separately. Naupli were found in every sample taken and the widespread occurrence of calanoid cyclopoid copepods indicated a large number of copepods in the area.

Cladocerans were well represented in the zooplankton. The more numerous Cladocerans included Daphnia retrocurva (80.1% of all samples) and several species of Bosmina (86.3% of all samples) Chydorus and Daphnia galeata were found frequently in the samples.

Seasonally all zooplankton reached peak densities in June, July and August. Some of the stations with the highest numbers of zooplankters are shown in Table 3. Copepods were found in large numbers throughout the summer but Cladocerans reached peak populations in July and August.

The location and depth of all stations with the highest concentrations of zooplankters is shown in Table 3. No apparent relationship between density and depth is discernable from the data collected. At times zooplankton at 1-meter was most abundant and at other times samples at 3-meters had higher populations. There was no clear pattern when numbers of zooplankters near shore stations (less than 6 feet) were compared to off-shore stations. The number of species identified from offshore stations appeared to be greater than the diversity of the inshore stations. The increased diversity was probably a direct result of the emphasis placed on sampling offshore stations. As the samples were enumerated fewer species were identified in any one offshore station than in one inshore station. The greater diversity of zooplankton was probably an artifact of our sampling techniques.

A few notes were made on the phytoplankters found in the course of counting zooplankton. The spring diatom bloom consists largely of Melosira, Fragellaria, Asterionella, Tabellaria and small numbers of Pediastrum.

During summer algae were few in the samples. Green algae were more abundant than other species Pediastrum and Scinedesmus were fairly common, and Staurastrum and Ceratium were more common than in other seasons.

In the autumn representatives of the blue greens Aphanizomenon and Microcystis were abundant and the diatoms were again prominent. Pediastrum is probably the most common alga at all seasons. Ceratium and Staurastrum are also present throughout the year. (Table 4.)

Table 1. Stations sampled - Distance from shore and approximate depth.

| Stations | Distance from shore in ft. (approximate) | Approx. depth in ft. |
|---|---|---|
| D5-1 | 2000 | 6 |
| D5-2 = E1 | 7000 | 10 |
| D5-3 | 11000 | 11 |
| D5-4 | 17000 | 16 |
| D6-4 = C2 | 1000 | 6 |
| D6-5 | 3000 | 8 |
| D6-6 = C1 | 4000 | 11 |
| D6-7 | 9000 | 12 |
| D6-8 | 15000 | 12 |
| D6-9 | 21000 | 11 |
| D6-10 | 25000 | 8 |
| D6-11 | 30000 | 22 |
| D6-12 = B2 | 2000 | 6 |
| D6-13 = D2 | 1500 | 6 |
| D6-14 = E2 | 2000 | 6 |
| D6-15 | 5000 | 9 |
| D6-16 | 3500 | 12 |
| D6-17 = A1 | 5500 | 13 |
| D6-18 | 10000 | 15 |
| D6-19 | 15000 | 17 |
| C6-1 = A2 | 2000 | 6 |
| B1 | 4000 | 10 |
| D1 | 4000 | 9 |

____ = inshore stations

Table 2. Frequency of occurrence of all plankters collected.
(# of samples in which organism was identified)

| | June 69 | July 69 | Aug. 69 | Sept. 69 | Oct. 69 | May 70 | June 70 | July 70 | Aug. 70 | Sept. 70 | Oct. 70 | April 71 | May 71 | Total # samples in which plankter was collected | % of samples in which plankter occurs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Protozoan Acinetz | - | 3 | 3 | - | - | - | - | - | - | - | - | - | - | - | 1.7 |
| Rotifer K.quadrula | 15 | 25 | 4 | - | 8 | 31 | 32 | 12 | 11 | - | 5 | 8 | 15 | 166 | 47.3 |
| K.cochlearis | 15 | 28 | 23 | 30 | 32 | 30 | 33 | 32 | 30 | 27 | 33 | 6 | 15 | 334 | 95.2 |
| Polyarthra | 15 | 20 | 22 | 30 | 32 | 30 | 33 | 32 | 30 | 29 | 34 | 7 | 15 | 329 | 93.7 |
| Pompholyx | - | 7 | 7 | - | - | - | - | - | - | - | 10 | - | - | 24 | 6.8 |
| Asplanchna | 15 | - | 3 | 21 | 16 | 8 | 1 | - | 13 | 27 | 16 | - | - | 120 | 34.2 |
| Brachionus | 10 | 12 | 12 | 4 | - | 32 | 7 | 32 | 30 | 30 | 34 | 15 | 15 | 233 | 66.4 |
| Kellikotia | 10 | 11 | - | - | - | 13 | 8 | - | - | - | 1 | - | - | 43 | 12.3 |
| Philodina | 7 | 5 | - | - | - | - | - | - | - | - | - | - | - | 12 | 3.4 |
| Filinia | 7 | 1 | 2 | - | - | 23 | 4 | 8 | 9 | - | - | 3 | 15 | 72 | 20.5 |
| Trichoerca | 1 | 9 | 15 | - | - | - | - | - | - | - | 1 | - | - | 26 | 7.4 |
| Platyias | - | 5 | 2 | - | - | - | - | - | - | - | - | - | - | 7 | 2.0 |
| Testudinea | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | .3 |
| Notholca | - | - | - | - | - | 13 | - | - | - | - | - | - | - | 13 | 3.7 |
| Conchilus | - | - | - | - | - | - | - | 21 | - | - | - | - | - | 21 | 6.0 |
| Ascomorpha | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | .3 |
| Proales | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | .3 |
| Rotaria | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | .3 |
| Total # samples taken | 15 | 29 | 24 | 30 | 32 | 32 | 33 | 32 | 30 | 30 | 34 | 15 | 15 | 351 | |

Table 2. Continued

| | June 69 | July 69 | Aug. 69 | Sept. 69 | Oct. 69 | May 70 | June 70 | July 70 | Aug. 70 | Sept. 70 | Oct. 70 | April 71 | May 71 | Total # samples in which plankter was collected | % of samples in which plankter occurs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arthropods | | | | | | | | | | | | | | | |
| Copepods | | | | | | | | | | | | | | | |
| Cyclopoid | 15 | 29 | 24 | 30 | 32 | 30 | 32 | 32 | 30 | 30 | 33 | 12 | 12 | 341 | 97.2 |
| Calanoid | 15 | 29 | 24 | 30 | 28 | 27 | 15 | 26 | 28 | 29 | 28 | 9 | 10 | 298 | 84.9 |
| Naupli | 15 | 29 | 24 | 30 | 32 | 32 | 33 | 32 | 30 | 30 | 34 | 15 | 15 | 351 | 100.0 |
| Cladocerans | | | | | | | | | | | | | | | |
| D. retrocurva | 15 | 29 | 24 | 30 | 9 | 9 | 33 | 32 | 30 | 30 | 34 | 1 | 5 | 281 | 80.1 |
| D. galeata | 11 | 29 | 24 | 2 | - | - | 2 | 14 | 27 | 10 | 5 | - | 1 | 125 | 35.6 |
| D. parvula | 6 | 14 | 16 | - | - | - | 1 | - | - | - | - | 1 | - | 38 | 10.8 |
| Bosmina | 14 | 29 | 24 | 30 | 32 | 14 | 28 | 32 | 30 | 30 | 34 | 2 | 13 | 312 | 86.3 |
| Chydorus | 9 | 2 | - | 30 | 26 | 2 | 10 | 9 | 10 | 30 | 34 | 1 | - | 163 | 46.4 |
| Diphanisoma | 1 | 5 | 3 | 5 | - | - | 1 | - | 11 | 16 | 18 | - | - | 60 | 17.1 |
| Leptodora | 2 | 20 | 8 | 1 | - | - | 2 | 3 | 7 | 6 | 5 | - | - | 54 | 15.4 |
| Simocephalus | - | 9 | 7 | - | - | - | - | - | - | - | - | - | - | 16 | 4.6 |
| Ceriodaphnia | - | 2 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | 0.9 |
| Polyphemus | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.3 |
| Camptocerus | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | 0.3 |
| Other | | | | | | | | | | | | | | | |
| Lepidurus | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.3 |
| Total # samples taken | 15 | 29 | 24 | 30 | 32 | 32 | 33 | 32 | 30 | 30 | 34 | 15 | 15 | 351 | |

Table 3.

| | Average Density | Range of Densities | Location of Station of Greatest Concentration | | |
|---|---|---|---|---|---|
| | Average # zooplankters/l | Zooplankters/l | Station | Depth | Location of Station |
| June 1969 | 763 | 365-1454 | D6-12 | 1m | 2,000 ft. offshore; mouth of Toussaint |
| July 1969 | 207 | 78- 420 | D6-11 | 3m | 30,000 " " near Niagra reef |
| Aug. 1969 | 519 | 69-1832 | C6-1 | 1m | 2,000 " " south east mouth of Toussaint |
| Sept. 1969 | 463 | 212-1084 | D6-10 | 1m | 25,000 " " reef area |
| Oct. 1969 | 279 | 79- 767 | D6-13 | 1m | 1,500 " " north west of mouth of Toussaint |
| May 1970 | 256 | 142- 658 | D6-17 | 3m | 5,500 " " South east mouth of Toussaint |
| June 1970 | 408 | 121- 689 | D6-18 | 3m | 10,000 " " east of mouth of Toussaint |
| July 1970 | 1,722 | 439-3902 | D6-5 | 1m | 3,000 " " north of mouth of Toussaint |
| Aug. 1970 | 1,202 | 350-2769 | D6-16 | 1m | 3,500 " " south east of mouth of Toussaint |
| Sept. 1970 | 376 | 144- 748 | D5-2 | 1m | 7,000 " " north east of Long Beach |
| Oct. 1970 | 264 | 49 -700 | D5-3 | 3m | 11,000 " " north east of Long Beach |
| April 1971 | 37 | 13- 57 | D2 | 1m | 1,500 " " offshore at Locust Point |
| May 1971 | 571 | 369-1043 | A2 | 3m | 2,000 " " south east mouth of Toussaint |

Table 4. Phytoplankton
Predominant species noted in monthly samples.

| | |
|---|---|
| June 1969 | Nothing recorded |
| July 1969* | Microcystis noted once |
| Aug. 1969 | Pediastrum, Starastrum, Microcystis; Aphani heavy in some samples |
| Sept. 1969* | Aphanizomenon |
| Oct. 1969 | Melosira in many samples; Fragellaria, Pediastrum present |
| May 1970 | Much Melosira; Tabellaria, Fragellaria, Pediastrum present |
| June 1970* | Pediastrum |
| July 1970 | Aphanizomenon |
| Aug. 1970 | Much Anabaena in all samples; Ceratium also heavy |
| Sept. 1970 | Aphanizomenon in many samples; Pediastrum & Anabaena present |
| Oct. 1970 | Pediastrum, Melsira, Ceratium |
| April 1971 | Many Melosira, Tabellaria, Fragellaria & Asterionella |
| May 1971 | Many Melosira, Tabellaria, Fragellaria & Asterionella |

* very few phytoplankton notations in this month

Table 5. Average number of the most common zooplankters /l/ month.

| | May 1970 | June 1970 | July 1970 | Aug. 1970 | Sept. 1970 | Oct. 1970 | April 1971 | May 1971 |
|---|---|---|---|---|---|---|---|---|
| Copepoda | | | | | | | | |
| Calanoid | 50 | 55 | 110 | 40 | 15 | 15 | 5 | 10 |
| Cyclopoid | 5 | 5 | 10 | 10 | 20 | 10 | 5 | 5 |
| Naupli | 70 | 220 | 582 | 350 | 80 | 50 | 10 | 30 |
| Cladocera | | | | | | | | |
| Daphina | 2 | 37 | 106 | 94 | 24 | 14 | 0.3 | 1 |
| Bosmina | 2 | 8 | 91 | 150 | 26 | 21 | 0.3 | 3 |
| Chydorus | 0 | 2 | 2 | 4 | 131 | 40 | 0.2 | 0 |
| Rotifers | | | | | | | | |
| Keratella chochlearis | 15 | 20 | 310 | 330 | 10 | 40 | 5 | 70 |
| Polyarthra | 35 | 30 | 295 | 135 | 25 | 35 | 5 | 50 |
| Brachionus | 5 | 2 | 140 | 75 | 25 | 20 | 10 | 70 |

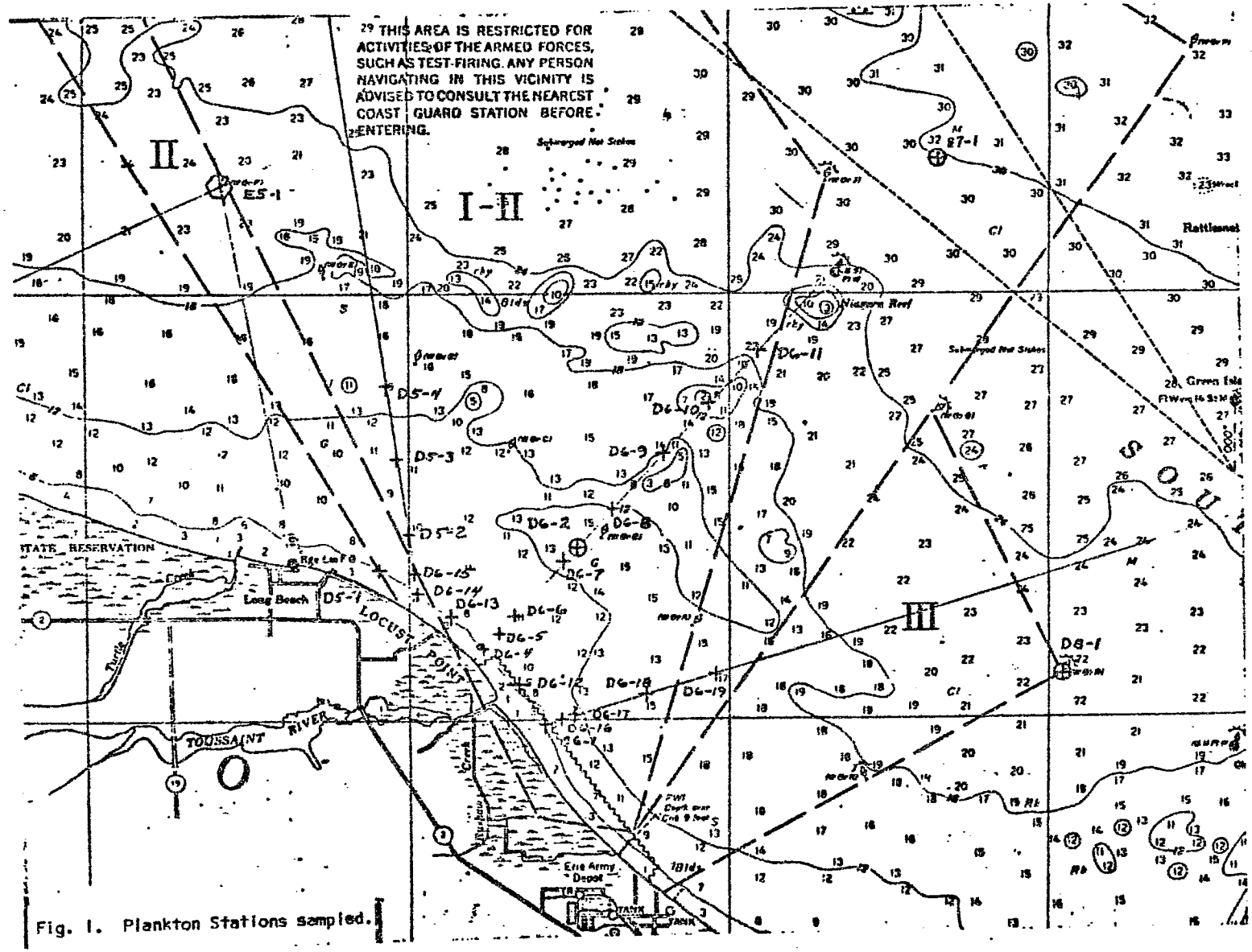


Fig. 1. Plankton Stations sampled.