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Project Summary

Distribution, Abundance and Entrainment of Larval Fishes in the Western and Central Basins of Lake Erie

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As part of a multi-agency effort to assess the impact of entrainment of larval fishes at steam-generating electrical power plants, personnel from The Ohio State University collected samples of larval fishes from waters of the Western and Central Basins of Lake Erie. Samples were collected in the Western Basin in 1975, 1976 and 1977. Samples were collected along the southshore of the Central Basin in 1978.

A total of 19 taxa of larval fish were collected with metered plankton nets in Ohio and adjacent Ontario waters of the Western Basin of Lake Erie in 1975 and 1976. Analysis of yellow perch collections indicates that shallow inshore areas serve as important nursery areas for this species. Collection of larvae provides evidence of relict breeding populations of lake whitefish and sculpin in the Western Basin. Sufficient data were gathered from 1975 and 1976 collections to permit calculation of an estimate of the impact of entrainment on adult yellow perch and emerald shiner populations using the equivalent adult approach.

A total of 17 taxa were collected in the Maumee River estuary during sampling periods in 1975, 1976 and 1977. A total of 11 taxa were collected from the Sandusky River estuary in 1976. Gizzard shad/alewife, white bass/white perch and freshwater drum constituted 98 percent of the larvae collected in the Maumee River estuary proper and 91 percent of the larvae collected in the Sandusky River estuary.

Gizzard shad/alewife, emerald shiners, white bass/white perch, and yellow perch, constituted over 97 percent of the larval fish collected in Ohio and Michigan waters of the Western Basin of Lake Erie in 1977. Significantly greater numbers of gizzard shad/alewife and spottail shiner larvae were captured immediately adjacent to the shore than at a depth of five meters offshore while greater numbers of smelt larvae were captured at points further offshore at a depth of five meters than at points immediately adjacent to the shore. Significantly greater numbers of walleye larvae were collected along the Ohio shoreline portion of the study area than in Maumee Bay or along the Michigan shoreline. Significantly greater numbers of freshwater drum larvae were collected in Maumee Bay.

A total of 25 taxa of larval fish were collected in Ohio waters of the Central Basin portion of Lake Erie in 1978. Gizzard shad/alewives, emerald shiners and spottail shiners constituted 82.4 percent of the larval fish collected. Larval gizzard shad, carp/goldfish, spottail shiners, troutperch and yellow perch densities were significantly higher in shallow (1-2 m deep) nearshore areas than offshore in areas five and ten meters deep. Significant differences were found between entrainment estimates derived from field samples and in-plant samples from the Central Basin for gizzard shad, rainbow smelt, carp and freshwater drum. All estimates of entrainment from field collections

were higher than those for in-plant collections.

This Project Summary was developed by EPA's Environmental Research Laboratory, Duluth, MN, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The Great Lakes provide a freshwater supply for 70 to 75 percent of the basin's 29 million residents, attractive recreational boating and sport fishing areas, and water for industrial processes and electrical generation. These conflicting uses have diminished the prospect of the lakes as an inexhaustible resource. The purpose of this report is to summarize a series of studies conducted to assess the abundance, distribution and entrainment of larval fishes in the Ohio and Michigan waters of Lake Erie. The imapct of electrical generating facilities on larval fish populations is potentially large. Electrical generation is the largest user of Great Lakes water. The 89 electrical generating stations in the coastal areas of the Great Lakes are responsible for over 70 percent of the total water use in the Great Lakes Basin. With the United States relying more heavily on domestic energy supplies, the role of the Great Lakes will become even more important in energy production; an additional 17 power plants are planned for the basin by the mid-1980's.

Steam generating plants have three major types of adverse effects upon the aquatic environment when they use large amounts of cooling water: 1. the intake of cooling water by the facility can cause the entrapment and impingement of fishes upon the plants' intake structures; 2. entrainment can have a damaging effect upon smaller aquatic organisms such as plankton, fish eggs, fish larvae, and shellfish larvae; and 3. the discharge of heated cooling water into the aquatic environment can disrupt the function of complex and highly productive natural systems. The effect of entrainment on larval fish numbers is the focal point of this study.

It has been shown that the nearshore zone of Lake Erie is a valuable fish spawning and nursery area. The movement of larval fishes is often controlled more by water movement than by swimming ability. Thus, larval fishes and bouyant fish eggs, occurring in high density in nearshore areas, are highly susceptible to the hazards posed by high-volume cooling water intakes.

A number of larval fish investigations have been conducted in Lake Erie. Unfortunately, these studies tend to report efforts concentrated in limited areas and have a very limited circulation. The most complete study of larval fishes in Lake Erie is the overall program, of which the present study is a part, designed to assess the impact of cooling water intakes in Michigan and Ohio. It included sampling in Ohio, Michigan and Canadian waters of Lake Erie.

Environmental studies in the vicinity of Detroit Edison's Monroe, Michigan site began in 1970. Larval fish studies began in 1973. Larval fish distribution studies were initiated in 1975. This study makes independent entrainment estimates for selected power plants in the Western and Central Basins. In addition, the distribution and abundance of selected larval fish species are described for the study period extending from May, 1975 to August, 1978. An open lake portion of Lake Erie (1740 km^2) was subdivided into six depth zones. A two-meter contour interval was used to delineate each depth zone. Sampling stations were established in a stratified random pattern with 56 stations sampled in 1975 and 60 in 1976. Nine cruises were made between May 12 and September 3 during 1975, and fourteen between April 12 and September 3 in 1976. All collections were made during daylight hours.

In 1977, numerous transects perpendicular to the shoreline were made in the nearshore portions of the Western Basin of Lake Erie, and samples were taken during the midsummer months. This was done in the Central Basin in 1978.

Field collections were preserved in buffered 5 percent formaldehyde solution. Larvae from each sample were identified to the lowest taxon possible, counted, measured for total length, and transferred to a 70 percent ethanol solution. Data were analysed with either an IBM 360 or an Amdahl 470 computer. Volume weighted estimates of the total number of larvae in each depth zone were calculated.

Open lake samples were used to estimate the number of larvae entrained at each power plant along the shoreline. These were calculated by multiplying the density of larvae at the collecting station closest to the power plant intake by the average flow rate for that power plant per day. At power plants along the shoreline, in-plant ichthyoplankton samples were collected weekly and used to estimate the impact of power generation on fish populations in the lake.

Conclusions

1. Sampling procedures employed were selective for species inhabiting limnetic areas and may not adequately represent species which inhabit littoral regions.
2. Abundance estimates were made. The resultant standard deviations and standard errors of the mean were large but decreased when mean densities exceeded 100 fish/100 m^3.
3. The capture of whitefish larvae on reefs and along the Michigan and Ohio shorelines indicated that a remnant spawning population of whitefish was inhabiting the Western Basin.
4. The capture of sculpin larvae on reefs in the island area indicated that a remnant spawning population of sculpins was inhabiting the Western Basin.
5. The Maumee River estuary contained higher densities and greater estimated numbers of larvae than the Sandusky River estuary. Production estimates of gizzard shad and freshwater drum in the two estuaries often approached or matched the production estimates of these species in the Western Basin study areas.
6. Both the Maumee and Sandusky River estuaries are important spawning and nursery sites for gizzard shad, white bass, walleye and freshwater drum.
7. Higher densities of gizzard shad, white bass and freshwater drum were captured in Maumee Bay and in Sandusky Bay than along either the Ohio or Michigan shorelines. This would indicate that these areas provide valuable nurseries for these species. The high densities of larvae in these areas may result from spawning in the bay as well as from larvae carried into the bay areas by river currents.
8. Rainbow smelt and yellow perch larvae were almost entirely restricted to the lake proper.
9. In the Western Basin in 1975 and 1976, larval yellow perch were found predominantly in nearshore areas associated with sandy and/or gravel substrate. Perch larvae were concentrated near the bottom. Walleye larvae were collected in the same areas as perch larvae in the nearshore zone as well as offshore on the reefs.
10. Higher densities of rainbow smelt and emerald shiner were collected at stations in deeper open water than at stations located adjacent to the shoreline.
11. In the Western Basin in 1977, larval yellow perch densities were highest in the area along the Michigan shoreline north of Woodtick Peninsula and south of the River Raisin. The larvae found here may have been carried into and retained in this area by the eddying effects of the Maumee and Detroit Rivers, as suggested by the fact that spawning habitat in the area is not ideal for yellow perch.
12. In the Western Basin, yellow perch anc

walleye larvae densities were generally highest along the Ohio shoreline, particularly in the Locus Point area. The sandy, gravel bottom and offshore islands and shoals provide the best spawning habitat for these species remaining in Lake Erie.

13. Higher densities of pro-larval smelt captured along Cedar Point in the Central Basin indicated that the area probably is being used as a spawning site for rainbow smelt. If so, this would be the first record of smelt spawning that far west along the United States shoreline.
14. The capture of larval freshwater drum was limited to the western half of the Central Basin study area. Freshwater drum prefer water less than 12 meters deep. East of Cleveland, water less than 12 meters deep is limited to a very narrow band along the shoreline, limiting spawning habitat.
15. In 1978, highest densities of larval yellow perch sampled were found in the eastern third of the Central Basin study area. Perch in the area are believed to be using the harbor breakwalls and sand collected in the quiet areas of these structures as spawning habitat.
16. Because fish densities were highest in the Maumee estuary and Bay, and since Toledo Edison's Bayshore Plant is located at the month of the Maumee River, entrainment is likely to be higher at the Bayshore Plant than at any other power plant studied.
17. Significant differences were found between entrainment estimates derived from field collections and in-plant collections at Central Basin power plants.
18. In-plant estimates of entrainment, when samples are collected with submersible pumps, are believed to give a better estimate of entrainment than field collections made with metered nets Avoidance of the gear is not as much a problem for pump samples as it is for nets.
19. Based on in-plant collections, entrainment estimates were highest at the Avon Lake power station. A total of 231,543,500 larvae or 60.1% of total entrainment in the study area of the Central Basin occurred there. Cyprinids accounted for 53% of the Avon Lake entrainment total.
20. Yellow perch entrainment was calculated to be highest at the Avon Lake and Ashtabula A and B plants. An estimated 1,340,500 yellow perch larvae were estimated to have been entrained at Avon Lake and 1,315,417 at the Ashtabula A and B Plant.
21. Estimates of entrainment at the Ashtabula A and B Plant and the Ashtabula C Plant represent a comparison of entrainment losses due to inshore and offshore intakes. The Ashtabula C Plant, where the water intake is located 1200 meters offshore, has 78% of the water requirement of the Ashtabula A and B Plant with an intake located 425 meters offshore. Estimates of entrainment were found to be much lower for the C Plant in all cases except rainbow smelt, which was 10 times higher. Yellow perch entrainment at the C Plant was found to be 20% of that at the A and B Plant.
22. Central Basin entrainment estimates generally represented between 2 and 4% of total estimated nearshore production. Yellow perch entrainment represented 3% of total yellow perch production. The highest percentage of any species entrained was carp, as 36% of the total nearshore carp production was entrained.

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The complete report, entitled "Distribution, Abundance and Entrainment of Larval Fishes in the Western and Central Basins of Lake Erie," (Order No. PB 84-141 522; Cost: $16.00, subject to change) will be available only from:
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