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ENVIRONMENTAL STUDIES OF MACROZOOBENTHOS, AQUATIC MACROPHYTES, AND JUVENILE FISHES IN THE ST. CLAIR-DETROIT RIVER SYSTEM, 1983-1984

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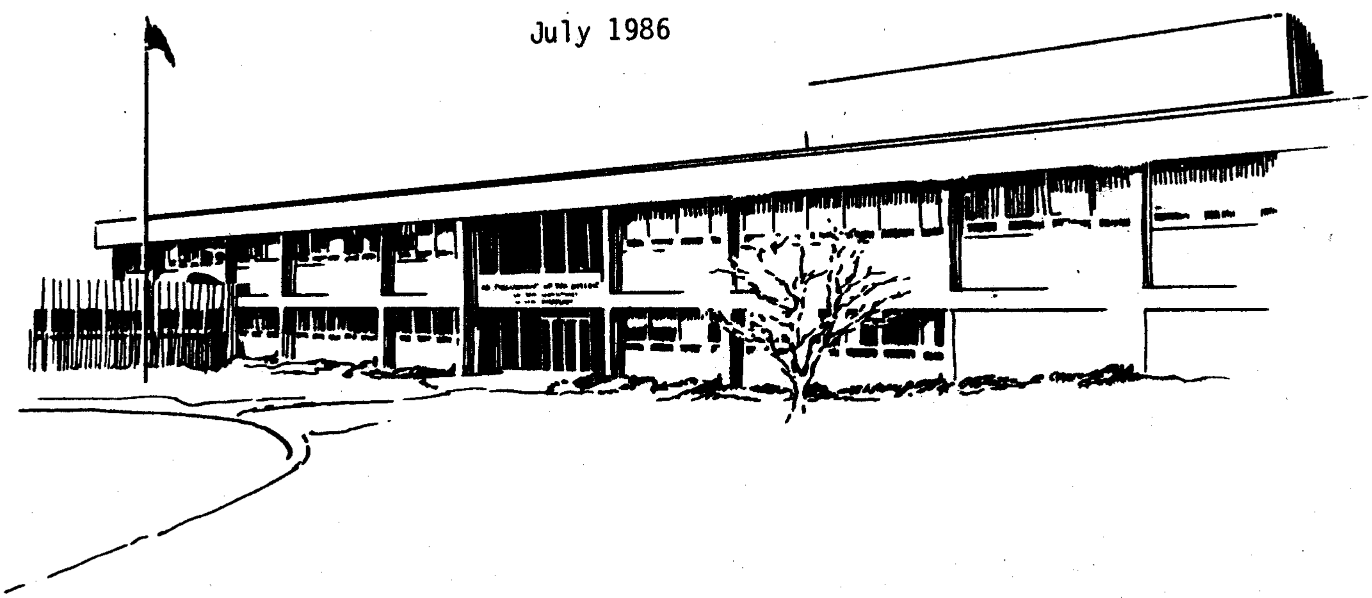

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ABSTRACT

This report provides information needed by the U.S. Army Corps of Engineers for preparation of a Supplemental Environmental Impact Statement addressing the winter operation of the lock facilities at Sault Ste. Marie, Michigan, and the subsequent extension of the navigation season in the St. Clair-Detroit River system (SCDRS) to January-February. We describe the distribution and abundance of macrozoobenthos, aquatic macrophytes and juvenile fishes during the 1983 and 1984 open water season, and attempt to predict or evaluate the potential environmental impact of an extended navigation season on the biota of SCDRS. Fauna and flora were diverse and abundant; we identified more than 300 taxa of macrozoobenthos, 30 taxa of submergent and emergent macrophytes, and 36 species of fish. The diversity and abundance of macrozoobenthos were generally highest in the St. Clair River. Abundance and diversity of submersed macrophytes were similar in the two rivers, but Chara dominated in the St. Clair River and Vallisneria americana in the Detroit River. We collected more total fish in the Detroit River but more species in the St. Clair River. Yellow perch and rock bass dominated most catches in both rivers. An ice jam in the St. Clair River in spring 1984 appeared to affect two of the three groups studied--macroinvertebrates and submersed macrophytes. Of the 24 abundant taxa of macroinvertebrates, 9 were seemingly less abundant in spring in 1984 than in 1983 in the St. Clair River; however the densities of 6 of these taxa had recovered by fall 1984 to levels equal to or exceeding those in fall 1983 and the other 3 were within 30% of those in 1983. Cover of the bottom with submersed macrophytes was somewhat reduced in spring of 1984--particularly in the St. Clair River--but recovered to 1983 levels by fall 1984. Plant biomass levels varied between years and locations; no consistent differences could be attributed to the ice jam. Catches of fish were lower in 1984 than in 1983 but differences between locations and months were inconsistent. Observed differences in the plant community could be attributed to reduced temperatures, and ice-scour may have reduced the density of several taxa of macrozoobenthos. Evaluation of the potential environmental impacts of an extended navigation season on the biota of SCDRS was not attempted.

PREFACE

This report provides information needed by the U.S. Army Corps of Engineers, Detroit District, for the preparation of a Supplemental Environmental Impact Statement describing the potential impacts on macrozoobenthos, aquatic macrophytes, and juvenile fish in the St. Clair-Detroit River system of an extension of the winter navigation season (from 8 January ± 1 week to 31 January ± 2 weeks). The work was done by the Ecology and Limnology Section of the Great Lakes Fishery Laboratory, U.S. Fish and Wildlife Service, under the general supervision of T. Edsall. T. Freitag and D. Williams served as contract monitors for this report under the general supervision of L. Weigum, Chief, Environmental Analysis Branch, U.S. Army Corps of Engineers, Detroit District.

The report was prepared by P. Hudson (and in alphabetical order, along with parenthetical listing of their major areas of responsibility), B. Davis (macrozoobenthos), S. Nichols (macrophytes) and C. Tomcko (juvenile fish). J. Oliver (currently employed by NUS Corporation) and J. Lamia (currently Graduate Student, University of Florida, Gainesville) contributed an integral part of the field and laboratory work during most of the study. C. Brown, J. French III, J. Hiltunen, R. Ogawa, D. Schloesser, and C. Wootke also assisted at various times in the field and laboratory. T. Edsall, A. Frank, and D. Schloesser reviewed the manuscript and made suggestions.

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers is considering the extension of operation of the Locks at Sault Ste. Marie, Michigan, from 8 January ± 1 week to 31 January ± 2 weeks. This study was undertaken to provide part of the information needed by the Corps for the preparation of a Supplemental Environmental Impact Statement addressing the winter operation of the lock facilities at Sault Ste. Marie, Michigan, and the subsequent extension of the navigation season in the St. Clair-Detroit River system (SCDRS) to mid-winter. The objectives of this study were (1) to describe the present distribution and abundance of macrozoobenthos, aquatic macrophytes, and juvenile fish that might adversely be affected by an extension of winter navigation and (2) to predict or evaluate the potential environmental impact of an extended navigation season on SCDRS. An extensive ice jam on the St. Clair River in spring 1984 and the associated ice breaking activities provided an opportunity to evaluate between-river and between-year variation in the abundance and distribution of biota relative to differences in ice cover and related shipping activities. The study area encompassed the region between Port Huron (at southern Lake Huron) on the north and the lower end of Grosse Ile (mouth of the Detroit River) on the south, including the St. Clair River, Lake St. Clair, and the Detroit River. The St. Clair River is 39.1 mi long and receives water from Lake Huron; mean annual discharge into Lake St. Clair during the study period was 212,000 ft^3/s. Lake St. Clair has a surface area of about 430 mi^2, a mean depth of 11 ft, and a maximum natural depth of 21 ft. Flushing time of the lake is 5 to 7 days. The Detroit River is 31.9 mi long and receives water from Lake St. Clair; and the mean annual discharge rate into Lake Erie was 216,000 ft^3/s. The shipping channel running through the system has a minimum statutory depth of 27 ft, which is maintained by dredging.

Ice cover is limited or absent from both the St. Clair and Detroit rivers during normal winters, but is usually well developed on Lake St. Clair. However, ice may enter the St. Clair River from Lake Huron mainly under the influence of northerly winds. The current carries the floes downstream until they meet the resistance of the solid ice cover in or upstream from Lake St. Clair. This ice cover increases as more ice enters the system and may extend upstream nearly to Lake Huron. During most of the winter, a large natural ice arch becomes lodged in the narrowing confines at the outlet of Lake Huron and prevents ice from entering the river. This condition usually lasts through the winter but may be disrupted by strong southerly winds, particularly in March and April, which break up the ice arch and push the ice field away from the river mouth. A wind change back to the north pushes the ice field back into the river and if no ice arch forms, floe ice may enter the river in large quantities to form a huge ice jam, as it did in 1984. Ice jams of roughly similar magnitude occurred in the St. Clair River in 1901, 1920, and 1942.

Concentration of toxic materials are elevated in the sediments in several areas in the SCDRS. No contaminant data were collected in the present study, but past work has demonstrated that the presence of contaminants affects the

health and abundance of fish, macrophytes, and particularly macrozoobenthos. In the St. Clair River levels of polychlorobiphenyls (PCBs) exceeded the Ontario guidelines (50 ppb) and International Joint Commission (IJC) objectives (100 ppb); certain areas can be classified as being heavily polluted with mercury (> 1 ppm), as judged by the U.S. Environmental Protection Agency (EPA) standards; oil and grease levels were within acceptable tolerances. In Lake St. Clair, cadmium levels (> 1 ppm) exceeded Ontario's guidelines and mercury levels exceeded EPA's guidelines. In the Detroit River, PCB, oil and grease, cyanide, chromium, cadmium, and mercury levels exceeded EPA's guidelines for heavily polluted sediments.

A total of 756 macrozoobenthos samples were collected with a Ponar grab along 21 transects in the St. Clair River, Lake St. Clair, and Detroit River in May and October in 1983 and 1984. Stations along the transects were at three locations: on the sloping side of the shipping channel (channel stations), immediately adjacent to the channel on the crest of the channel slope (near-channel stations), and between the crest of the channel slope and the adjacent shoreline (off-channel stations). Aquatic macrophytes were collected during late June, late July-early August, and early September at Stag, Fawn, and Russell islands in the St. Clair River, and at Belle Isle, Point Hennepin, and Stony Island in the Detroit River. A sampling grid composed of 500-ft-square blocks was used to distribute sampling effort. Grapnel hauls were made at the grid intersections and Ponar or hand-harvested samples were taken within individual blocks. Juvenile fish were sampled with hoop nets at the same locations at which macrophytes were collected, during late May, late June, late July-early August, early September, and early October in 1983 and 1984. At each location, two nets were set in submersed aquatic vegetation, and two others in nearby non-vegetated areas. A total of 40 net sets were made at each location during the two years of the study.

The diversity of macrozoobenthos within SCDRS was highest in the upper Detroit River, where we identified 101 taxa, and lowest in Lake St. Clair, where we recorded 65; we collected 98 taxa in the upper St. Clair River, 95 in the lower St. Clair River, and 80 in the lower Detroit River. Identifications usually were made only to genus, family or higher level; however, as judged by our species identification of adult aquatic insects, the list of taxa of macrozoobenthos in SCDRS might easily exceed 300 species.

The densities of most taxa of macrozoobenthos were significantly higher in 1983 than in 1984, in October than in other months, and at the off-channel stations than at other stations. Densities of most taxa were highest in the St. Clair River. Of particular interest were the taxa with significantly higher populations in 1983 than in 1984. If the low densities occurred mainly in spring 1984 in the St. Clair River and no recovery occurred by fall 1984, we might postulate that the ice jam in May 1984 caused long-term damage. Densities of nine taxa were lower in the spring in 1984 than in 1983: Amnicola, Chironomidae, Gammarus, Harpacticoida, Hyalella, Isopoda, Nematoda, Oecetis, and Turbellaria. The lower density were restricted to the St. Clair River, particularly in the lower section. Among these taxa, the densities of

Nematoda, Isopoda, Gammarus, Chironomidae, and Oecetis had recovered in fall 1984 to levels equalling or exceeding those in fall 1983; the densities of Turbellaria, Harpacticoida, Hyalella, and Amnicola were still low in fall 1984. Mean biomass ranged from 0.03 to 4.84 g/m² over the 21 transects. Biomass was highest in the Russell Island and Belle Isle areas and lowest near lower Lake Huron. Average total densities ranged from 976 to 96,684/m² over the 21 transects in 1983-1984, and the average number of taxa at each transect ranged from 9 to 38.

Twenty taxa of submersed macrophytes were collected in the St. Clair and Detroit rivers in 1983 and 1984; the most common, in order of frequency of occurrence, were Chara spp., narrow-leaf forms of Potamogeton spp., Vallisneria americana, Potamogeton gramineus, P. richardsonii, Myriophyllum spicatum, and Elodea canadensis. Other taxa occurred in less than 13% of the samples. Chara spp. was the most commonly collected taxon in the St. Clair River and V. americana was the most common in the Detroit River. The total number of taxa at each location ranged from 7 to 14 and was highest in September. Percent occurrence of individual taxa during each sampling period between 1983 and 1984 varied less than 10% at each location.

In the St. Clair River in June, most submersed macrophyte taxa were less abundant in 1984 than in 1983. However, a paired comparison of all taxa showed significant differences only at Russell Island. A similar decline in biomass of dominant taxa occurred in the Detroit River, but was significant only at Belle Isle. Biomass of most taxa in September was similar in 1983 and 1984. Changes in the areal extent of the submersed macrophyte beds also showed similar trends between years, months, and locations.

Emergent macrophyte taxa were present in only two of the sampling grids at the six locations. A small bed of Scirpus acutus was at the tip of Fawn Island. Stony Island had extensive beds of Typha latifolia and Sparganium eurycarpum, usually in monotypic stands, and the species of Eleocharis, Phalaris, Sagittaria, and Scirpus occurred together in mixed stands. Mean dry weight biomass of individual taxa varied from 10 to more than 2000 g/m².

We captured 1,771 fish of 36 species in 1983 and 1,038 fish of 26 species in 1984. Of the total of 39 species represented, only 7 were common (> 50 fish collected in each year); yellow perch, rock bass, hornyhead chub, spottail shiner, striped shiner, rainbow smelt, and white sucker collectively made up 86% of the total for both years combined. Only yellow perch and rock bass were common to both rivers in both years. An average of 2.4 species was collected per net set in 1983 and 1984. The number of species collected was higher in the Detroit River than in the St. Clair River. The mean catch of all species combined was nominally larger in 1983 than in 1984, increased from May to October, was larger in the St. Clair River than the Detroit River, and was larger in nets set in vegetation than in those set in non-vegetated areas. However, most of these differences were not significant at the 0.05 level. The mean catches of yellow perch and rock bass were nominally higher in 1983 than 1984, but were significantly higher only at Russell Island and Belle

Isle. Significantly more yellow perch were caught in nets set in vegetation than in those set in non-vegetated areas at Fawn Island. A statistically significant relation between catch and vegetation was not observed for other species or at other locations. Most of the fish caught were adults.

The number of taxa of macrozoobenthos collected in this study (160) exceeded that in any previous work on the SCDRS. Comparison with other large river systems indicated that the diversity and density of macrozoobenthos is much greater in SCDRS than in most other rivers of the world. Sediment particle size and contaminant distribution basically determined the benthic community in the SCDRS. The St. Clair River, with its wider range of sediment size and diverse macrophyte community, was dominated by pollution intolerant aquatic insects, amphipods, and snails. Diversity was similar in the area around Belle Isle in the Detroit River. Low diversity of macrozoobenthos in the lower Detroit River reflected a moderate effect of contaminants. The constant flow, low turbidity, and luxuriant macrophyte growth in SCDRS were major factors in stabilization and in the incorporation of fine deposits into the sediments of the off-channel areas. As a result, densities and biomass of macrozoobenthos were much higher than in the shifting sand habitat characteristic of most rivers.

Community diversity, biomass, and percent coverage of macrophytes has remained stable in SCDRS since at least 1978. The taxonomic composition and abundance of aquatic macrophytes probably reflects the stability of flow more than any other environmental variable. The lack of spates provides long-term stability to the system. Narrow-leaf forms of Potamogeton spp. were more common at shoal areas at the head and side of islands in SCDRS than along the shores of both mainlands. The maximum biomass estimates for the SCDRS were on the low side of the range reported for aquatic macrophyte stands in rivers at temperate latitudes (110-520 g/m^2). We found the highest biomass in September at every island, although biomass values for September were not significantly different from those for July-August at Belle Isle and Pt. Hennepin. Turbidity may be high enough in the Detroit River to prevent development of certain species of submersed macrophytes in the deeper littoral areas.

This was the first study of the juvenile fish community in the near-channel areas of SCDRS. Most species in the vicinity of these island shoals were either rare, transient species, or preferred other areas of the river. It is also possible that we were not adequately sampling this community. We found that the tendency for catches of fish to be higher in plant beds than in non-vegetated areas, may be species-specific, and depend on location; the tendency was also stronger in 1983 than 1984, and was correlated with season. Three of the four common species inhabiting the island shoals were more abundant in vegetated than in non-vegetated areas.

The ice jam in spring 1984 appeared to affect at least two of the three groups studied. Nine of the 24 most abundant taxa of macroinvertebrates declined in abundance in spring 1984, but only in the St. Clair River. Six of these taxa had recovered in fall 1984 to levels equalling or exceeding those in fall 1983 and the densities of the other taxa were within 30% of those in 1983. Areal coverage by submersed macrophytes was somewhat less in spring in 1984 than in 1983, particularly in the St. Clair River, but recovered to 1983 levels by fall 1984. Plant biomass varied between years and locations, and no consistent differences could be attributed to the ice jam. Catches of fish were lower in 1984 than in 1983, but differences in numbers between location and month were inconsistent. Observed differences in the plant community could be attributed to lower temperatures, and ice-scour may have reduced the density of several taxa of macrozoobenthos.

This study was conducted to describe the distribution and abundance of macrozoobenthos, aquatic macrophytes, and juvenile fishes in SCDRS in 1983-84. We believe that we have addressed this objective for the open water season on SCDRS within the constraints imposed by our data set, and that our study provides a baseline data set that can be used to evaluate the major effects of any future extension of the navigation season. We do not believe that the results of our study can be used now to answer the question of whether increased winter vessel traffic will have a measurable effect on the biota of SCDRS. Although some adverse effects may have been associated with the ice jam in April 1984, we cannot provide evidence to show that the ice jam was caused or exacerbated by navigation, or that the jam simulated conditions that might result from vessel operation in January or February. We believe that an adequate evaluation of the potential impacts of winter navigation on SCDRS will require the development of an energy flow model plus an age-structured fishery model. Research funded by the U.S. Army Corps of Engineers on SCDRS has provided a substantial base for development of a model of this kind. Additional data are needed on phytoplankton, periphyton, zooplankton standing crop and production, and terrestrial inputs to complete the energy budget. This information would permit quantification of the simultaneous effects of all components, according to their interrelationships in the ecosystem, and avoid the problem associated with a piecemeal evaluation of the individual components. Such a model would be useful in partitioning impacts, so that rational remedial strategies and mitigation could be attempted.

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