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COMPARISON OF BENTHIC COMMUNITIES IN DREDGED AND UNDREDGED AREAS OF THE ST. LAWRENCE RIVER, CAPE VINCENT, N.Y.[1]

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ABSTRACT. Macroinvertebrate communities were compared in dredged and undredged areas of the St. Lawrence near Cape Vincent, N.Y., by sampling with a Ponar dredge in 3 seasons. No significant differences existed in numbers of *Gammarus* spp. and species of Oligochaeta between dredged and undredged areas. The chironomids *Pseudochironomus* and *Stictochironomus* spp. were significantly less abundant and *Clinotanypus* was significantly more abundant at previously dredged sites. Among mollusks, *Bithynia tentaculata* and *Sphaerium corneum* were found in significantly greater densities at undredged stations. Total macroinvertebrate abundance was greater in undredged areas. The differences in total abundance of invertebrates and abundance of individual species in dredged and undredged areas appear to be related to the presence of gyttja-type sediments caused by breakwater construction and dredging operations at least 40 years ago.

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INTRODUCTION

Dredging of sediments to deepen river channels has many short-term and long-term effects. Short-term changes produced by dredging include bottom disruption, increased turbidity, reduced oxygen availability in the water column, altered water chemistry and possible release of toxic wastes from the sediments (Sherk 1971). Although these short-term changes often result in morbidity or mortality of organisms (Loosanoff 1961, Odum and Wilson 1962), the overall impact on a community has often been considered minor because of the relatively small areas directly affected (Mackin 1962, May 1973) and the often rapid recolonization of dredged areas from nearby, unaffected communities (Harrison et al. 1964, Mackin 1962).

Dredging can also cause long-term community disruption and alteration. Several studies have indicated that species diversity and abundance of fish, shellfish and benthic invertebrates are reduced after dredging (Taylor and Salomon 1968, Flemer et al. 1967, U.S. Army Corps of Engineers 1970). In these cases, all marine, full recovery did not occur or required several years.

At Cape Vincent, N.Y., the harbor was built around the turn of the century and apparently has not been dredged for at least 40 years (Berkeley, P., U.S. Army Corps of Engineers, pers. comm.). An opportunity

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thus existed to investigate the long-term effect, if any, of dredging and harbor construction in a freshwater ecosystem. In a year-long study, benthic macroinvertebrate samples were taken in dredged and undredged areas in and near Cape Vincent Harbor on the St. Lawrence River.

STUDY SITE

Cape Vincent Harbor is located about 15 km downstream from Lake Ontario (fig. 1). The harbor was created by the construction of a breakwater and first dredged near the turn of this century to accommodate commercial cargo traffic in the Great Lakes-St. Lawrence system. The breakwater originally provided a sheltered unloading area for small cargo ships, but today the harbor is used by recreational craft and a ferry. Private homes, parkland and small businesses with little or no manufacturing now border the harbor and surrounding areas. Sediment composition does vary with dredged areas having gyttja-type sediments and undredged areas having either sand-cobble or gray-silt sediments (table 1).

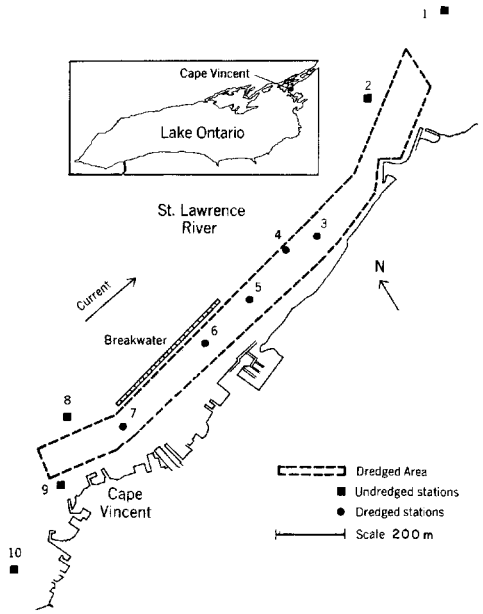

FIGURE 1. Location of Cape Vincent Harbor, New York, and the macrobenthos sampling location.

TABLE 1

Bottom composition and depth at macrobenthos sampling stations.

Station	Depth (m)	Bottom Composition
Dredged		
3	5.5	Gray-black gyttja
4	7.0	Gray-black gyttja
5	5.8	Gray-black gyttja
6	5.5	Black gyttja
7	5.5	Gray-black gyttja
Undredged		
1	4.6	Gray silt
2	7.0	Gray silt
8	8.2	Sand, cobble
9	3.1	Sand, cobble
10	2.4	Sand, cobble

METHODS AND MATERIALS

We used a Ponar dredge (.053 m^2) to collect 3 replicate samples at each of 10 stations within a 5-hr period during autumn, spring and summer of 1978–1979 for a total of 90 samples (fig. 1). Stations 3, 4, 5, 6 and 7 were in dredged areas whereas Stations 1, 2, 8, 9 and 10 were in areas outside of the harbor not dredged. In the field, samples were carefully washed through a 0.47-mm mesh screen bucket with the residue preserved in 10% formalin. Invertebrates were hand sorted to taxonomic order and stored in 95% ethanol. Because efficiency of recovering invertebrates from samples varied among sorters, debris from 10 randomly selected picked samples were repicked and a correction applied to counts before being converted to number/m^2. Oligochaeta were temporarily mounted in Amman's lactophenol (Brinkhurst 1970); head capsules of chironomid larvae were boiled in KOH for about 5 min and mounted in CMC-10^R

RESULTS

All species exhibited a contagious distribution by the variance to mean ratio test (Elliott 1971) indicating that parametric statistical tests were inappropriate for data analysis. Significant differences between stations were determined by the Mann Whitney U-test (Elliott 1971) on the total number of macroinvertebrates or of a given species for the combined 3 seasonal samples. Total macroinvertebrate abundance of

all species was significantly greater in undredged stations ($P < 0.05$) (fig. 2). Mann-Whitney U-tests were also used to compare individual species abundances between dredged and undredged stations. No significant differences existed in numbers of *Gammarus* spp. and species of Oligochaeta between dredged and undredged stations. However, the chironomids *Pseudochironomus* and *Stictochironomus* spp. were significantly more abundant in undredged areas whereas *Clinotanypus* spp. was significantly more abundant at previously dredged sites (fig. 3). Among mollusks, *Bithynia tentaculata* (Gastropoda) and *Sphaerium corneum* (Pelecypoda) were found in significantly greater densities at undredged stations (fig. 3).

Because of the large variation in replicate samples due to the contagious distribution of each organism, several species had distinctly, but not significantly, different densities between dredged and undredged areas (table 2). For example, chironomids and immature tubificids were more abundant in dredged areas, whereas mollusks and the tubificids *Potamothrix*

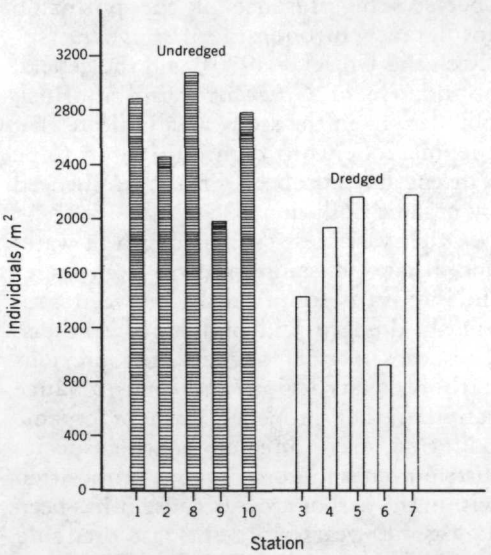

FIGURE 2. Abundance of macroinvertebrates in undredged and dredged sampling sites. Values represent the mean of the replicated seasonal samples.

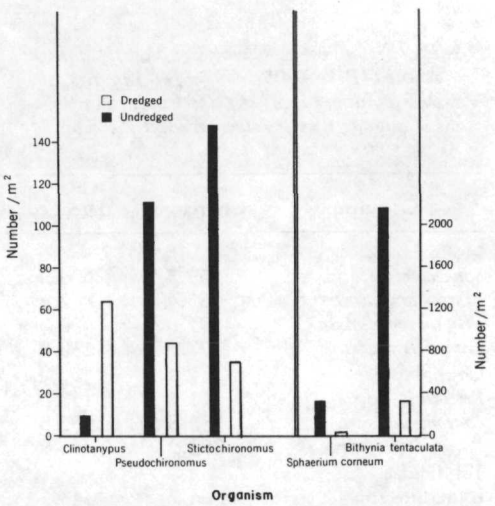

FIGURE 3. Abundance for selected Chironomidae and Mollusca at dredged and undredged sites (abundances are significantly different at $P < 0.05\%$).

vejdovskyi, *P. moldaviensis* and *Aulodrilus pigueti* were more abundant in undredged areas.

DISCUSSION

Gammarus spp. (41%), Mollusca (25%), Chironomidae (21%) and Oligochaeta (8%) comprised 95% of the organisms collected. Compared to most other Lake Ontario-St. Lawrence River studies (Johnson and Matheson 1968, Brinkhurst 1970, Kinney 1972, Ellis et al. 1976, Makarewicz et al. 1979), Oligochaeta abundance was considerably lower at Cape Vincent Harbor, although species composition (table 2) was similar to that reported by Brinkhurst (1974). Overall benthic invertebrate abundance and species composition observed at Cape Vincent were similar to the Lake Ontario and St. Lawrence River collections of Kinney (1972). However, significant differences in macroinvertebrate abundance between dredged and undredged areas caused by harbor construction and maintenance, pollution or boat traffic are apparent in our data.

The possibility exists that propeller wash and/or organic pollution produced

TABLE 2

Selected organisms not having significantly different densities ($P > 0.05$, number/m^2) in dredged and undredged areas of Cape Vincent Harbor, St. Lawrence River. Values represent the means of the replicated seasonal samples.

Organism	Undredged	Dredged
Mollusca		
Sphaerium striatinum	59.8	0.0
Musculium lacustre	85.4	2.8
Elliptio complanata	195.0	98.0
Lampsilis radiata	227.8	130.8
Chironomidae		
Procladius spp.	71.2	152.0
Chironomus spp.	33.8	502.8
Paratendipes spp.	281.2	441.8
Tubificidae*		
Immature spp.	64.7	143.5
Potamothrix vedjdovski	25.1	8.5
Potamothrix moldaviensis	5.0	1.1
Aulodrilus pigueti	27.3	1.4

**Aulodrilus americanus, Peloscolex ferox, Limnodrilus profundicola* and *L. claparedianus* were also found in small numbers at Cape Vincent.

the macrobenthos community observed in the dredged area at Cape Vincent. Cashin (1956) remarked that tugs and ships operating in shallow waters can cause considerable sediment disruption. However, the large ocean going vessels, typical of the St. Lawrence, stay in the main river channel far to the west of the harbor. The only consistent large-craft user of the harbor is the Cape Vincent-Kingston ferry which makes 4–6 round trips/day near Stations 7 and 8. However, disturbances of harbor area sediments by passing boats were never observed. If propeller wash were causing the lower abundance and changes in species composition observed in the dredged area, we would expect similar species abundance and composition patterns at Station 7 and 8. This was not observed. Abundance and composition at Station 8 were similar to the undredged areas.

The slightly lower total abundance of invertebrates at undredged Station 9 compared to dredged Stations 5 and 7 is perplexing. Perhaps the close proximity of this station to a group of marinas and the lower invertebrate abundance are related. In fact, evidence of past construction (i.e., a sunken jetty) in this area exists, and the possibility of some other perturbation (i.e., dredging) of the area can not be totally dismissed.

Chironomus and *Procladius* spp. are often associated with polluted or disturbed conditions (Cook and Johnson 1974). *Chironomus* and *Procladius* spp. were among the most abundant chironomids at Cape Vincent and were found predominately in previously dredged areas. However, the absence of *Tubifex tubifex*, the low abundance of *Limnodrilus hoffmeisteri*, and the presence of other benthic organisms, including other tubificid species (table 2), indicate that gross organic pollution (e.g., residential runoff and sewage) is minimal at Cape Vincent. Furthermore, the existence of species of *Aulodrilus* and *Potamothrix* suggests that conditions at Cape Vincent are best described as eutrophic rather than organically polluted (Brinkhurst and Cook 1974). The relative unimportance of the pollution tolerant tubificids, the overall diversity of tubificid species, the presence of the pollution intolerant chironomid *Microspectra* sp. (Resh and Unzicker 1975), and the general abundance of *Gammarus* and mollusk populations in the study area indicate that the macrobenthic community at Cape Vincent has not been greatly influenced by organic pollution.

Other variables, such as depth of water and distance of sampling sites from shore, did not vary significantly between previously dredged and undredged stations. These observations suggest that previous harbor construction and maintenance activities, not propeller wash or organic pollution, have affected benthic species distribution and community composition within the harbor area. Because it has been at least 40 years since the last dredging occurred in the harbor, the lower abundance of invertebrates in the dredged area can not be considered to be due to short-term

effects (e.g., sedimentation, bottom disruption, increased turbidity, reduced oxygen availability).

With dredging and breakwater construction, stripping of the sand-cobble substrate common to the undredged area occurred. The irregular shoreline, the numerous extensions of docks and, most of all, the breakwater serve to reduce currents in the harbor area allowing the formation of the gyttja-type sediments common in the dredged area. The difference in total abundance of all invertebrate species combined and abundance of individual species in dredged and undredged areas appears to be related to the presence of the gyttja-type sediments. Numerous studies have shown that the type of sediment can be very important in determining the distribution of macroinvertebrate bottom fauna (Hynes 1970).

Unfortunately, no pre-harbor information on species distribution and abundance exists for Cape Vincent, and such a lack required us to employ *a posteriori* techniques of analysis. Nevertheless, periodic maintenance dredging until 40 years ago and the presence of the breakwater have altered sediment composition sufficiently to produce the macrobenthic abundance and distribution differences observed. Had an artificial harbor not been constructed in the early 1900s and subsequently maintained, macrobenthic abundance and composition would probably not differ significantly throughout the 6-km section of the St. Lawrence River shoreline studied. The long-term effect of a perturbation (i.e., dredging/breakwater construction) on the ecosystem appears to be a decrease in total abundance and differences in species composition of benthic invertebrates between disturbed and undisturbed areas.

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