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Final Report: Aquatic Biological Survey, Cape Vincent Harbor

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FINAL REPORT

Aquatic Biological Survey

Cape Vincent Harbor

to the

Army Corps of Engineers

Buffalo District

by

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INTRODUCTION

This report evaluates the potential environmental impact of proposed maintenance dredging at Cape Vincent Harbor, New York, by the U.S. Army Corps of Engineers. Field samples were obtained in autumn 1978 and spring and summer 1979. Data reports based on these sampling efforts were submitted earlier to the Buffalo District of the U.S. Army Corps of Engineers.

Several consequences of dredging can adversely affect biological organisms (Sherk 1971). Habitats may be lost directly by destruction of benthos, macrophytes or wetlands or indirectly by altered bottom morphology and/or currents. Increased turbidity associated with dredging may impact organisms in several ways. Brown and Clark (1968) observed 16 to 83% declines in oxygen concentration on days when dredging occurred, while benthic sediment demand for oxygen was increased 8-fold after suspension (Isaac 1965). Both chemical and bacterial oxygen demands decrease oxygen levels in waters near dredging operations.

Increased turbidity associated with dredging can affect biological processes. Decreases in euphotic zone depths may severely limit total production in a dredging area (Stross and Stottlemeyer 1965). However, dredging also releases plant nutrients locked in the sediments, which may stimulate phytoplankton and macrophyte growth. Physical and chemical properties of the water, such as salinity and pH, where dredging occurs, often determine the types and proportions of nutrients and other chemicals that re-enter solution, adsorb to particles or precipitate out (Carritt and Goodgal 1954). Odum and Wilson (1962) observed that plant respiration increased with turbidity and found that once light penetration returned to normal levels, primary production was actually enhanced. Thus, dredged materials can harm or enhance plant populations depending on conditions unique to each situation.

Community disruption is a common result of dredging operations. Several studies have indicated that species diversity and abundance of fish, shellfish and benthic invertebrates decline after dredging (Sherk 1971). In some cases, recovery never occurs or requires years (Taylor and Salomon 1968, Flemer et al. 1967, Tuburon Marine Lab. 1970), while in others rapid immigrations replace most dredging losses (Harrison et al. 1964). Deposition of sediments tends to disrupt demersal spawning fish (Huet 1965). Finally, toxic chemicals are oftern present in dredged sediments and can adversely affect entire ecosystems through bio-accumulation and magnification effects (Tuburon Marine Lab. 1970).

A variety of dredging consequences affecting animal mortality and morbidity have been documented. Generally, egg and larval stages of fish and invertebrates are most sensitive to environmental changes. Increased mortality, reduced development and growth rates, and general physiological stress have been observed in a variety of mollusk species as a result of increased turbidity (David 1960, Loosanoff 1961). A number of authors (Sherk et al. 1972, Smith et al. 1965, Loosanoff 1961) have demonstrated altered physiological responses in mollusks and fish as a result of increased turbidity. Changes in ventilation, feeding and excretion are common in bioassay studies at turbidities encountered near dredging operations. Manning (1957) recorded complete mortality of oysters in a dredged channel, significant mortality within 8 m and no mortality beyond 23 m of the channel.

Interestingly, the mortality and morbidity of organisms observed in laboratory studies are rarely encountered in the field. Adult fish are able to leave affected areas, but for mollusks reasons are less apparent.

It appears that the behavior of dredged sediments in solution is involved. Typically, about 1% of hydraulically dredged sediments escape collection (Mackin 1961), and within about 300 m of a dredged site turbidities are at natural levels (May 1973, Mackin 1961). While impacts may be great in the immediate vicinity of dredging and recovery is often slow or incomplete, the area impacted is often relatively small compared to the area available to supply recolonizers. Of course, each ecosystem is unique and must be evaluated separately to determine dredging impacts.

In this report, the impact of dredging at Cape Vincent Harbor is considered in relation to physical and chemical conditions, terrestrial vegetation/wetlands, aquatic macrophytes, macrobenthos, phytoplankton and zooplankton, fish, birds, endangered species and toxic chemicals. For each factor considered, sections entitled Existing Conditions are followed by our Assessment of Impact. The last section presents our conclusions and recommendations concerning the general impact of dredging on the Cape Vincent-St. Lawrence ecosystem.

PHYSICAL ASPECTS

Existing Conditions

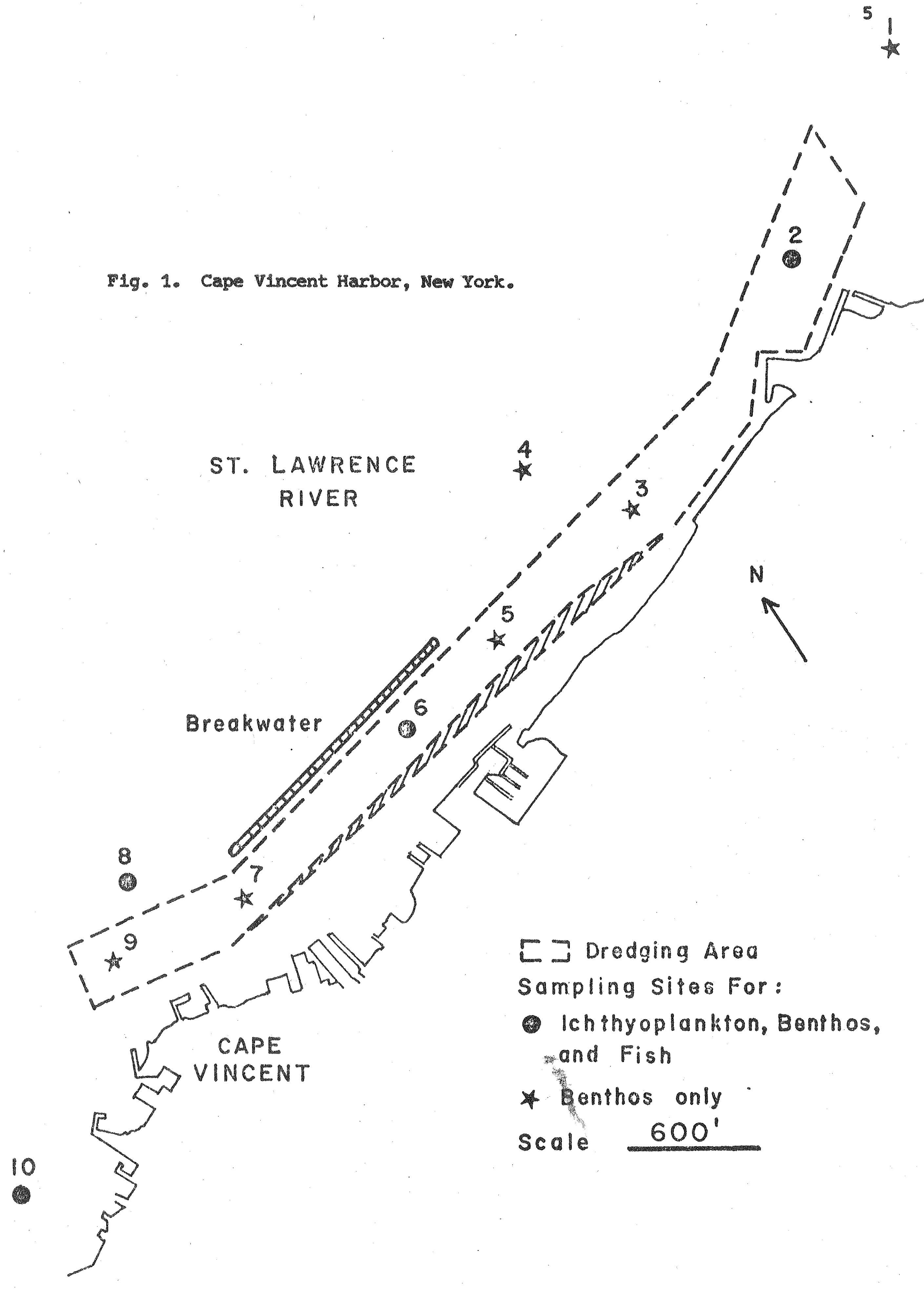
Sediments at Cape Vincent Harbor consisted of three basic types. A cobble-gravel-sand bottom was evident at Stations 8 to 10 (Fig. 1), which were generally outside previously dredged areas. Stations 2 to 7, generally within previously dredged areas, consisted mainly of grey and black muds rich in organic debris (gyttja). These stations also exhibited abundant freshwater clamshell fragments. Station 1, outside previously dredged sites and in a bay-like area, produced grey sand-silt sediments.

Assessment of Impact

Dredging is basically a process of artificially induced sediment erosion, transport and deposition. It differs from the natural process in that its occurrence is much more concentrated in time and space. During dredging operations, bottom sediments are mechanically disturbed and re-suspended, creating a turbidity plume. This most visually obvious physical impact causes water discoloration and reduces light penetration. The reduction in light penetration caused by turbidity plumes is temporary in nature and disappears within a few hours after dredging (Morton 1976). Effects of reduced light primary production of plants are discussed in the sections on PHYTOPLANKTON AND ZOOPLANKTON and AQUATIC VEGETATION.

Changes in median grain size, porosity and degree of sorting of dredged sediments are likely to occur as they are dredged, transported and re-deposited. The larger, heavier particles (sands, clumps of mud, etc.) will settle rapidly out of suspension while the fine silts and clays will remain suspended for longer periods of time. Fine silts and clays will be

Fig. 1. Cape Vincent Harbor, New York.



transported from the dredge site by currents into the St. Lawrence River. These changes in sediment properties could affect the processes controlling the exchange of contaminants from polluted sediments to the water, the distribution of benthic organisms, fish reproduction, etc. Potential effects on biota are discussed in the appropriate sections.

Newly dredged channels have been observed to cause significant hydrographic alterations such as rerouting river currents, changing flushing rates, inducing sediment deposition (shoaling) or erosion and creating deadwater and stagnant pockets. Relative significance of these impacts on a given ecosystem will be a function of the ratio of the dredged area to the total bottom area and contained water volume. Given the small size of the potential dredging area in comparison to the St. Lawrence River at Cape Vincent, it seems unlikely that significant hydrographic alterations will occur. However, as we are not professionally capable of predicting hydrographic effects of dredging, these possibilities should be evaluated by a professional engineer before dredging commences.

CHEMICAL ASPECTS

Existing Conditions

Within the project area, the waters of the St. Lawrence River were oxygenated. Although no water chemistry analyses were performed, hydrogen sulfide was evident in benthos samples from Stations 2, 3 and 6.

Assessment of Impact

Dredging operations are likely to produce changes in the chemistry of the water overlying the dredging site. Undisturbed sediments typically exhibit a gradient from oxidized surface deposits to increasingly reduced sediments in the deeper layers. The deeper, reduced sediments will create an oxygen demand (B.O.D. and C.O.D.) when they are exposed to the aerobic environment of the overlying body of water, thereby causing a decrease in dissolved oxygen (Mackin 1961, Army Corps of Engineers 1969, Slotta et al. 1973). Numerous authors (Marshall 1968, Chesapeake Bay Laboratory 1970, Saila et al. 1972) attribute the high organic content of the sediment as being the major cause of reduced oxygen concentrations in benthic systems. In Cape Vincent Harbor, the sediments of high organic content exist between Stations 1 and 7 (Fig. 1). The sediments in this area can be expected to have a high biochemical oxygen demand if dredged.

It is generally assumed that the chemical constituents associated with the surface sediment are in dynamic equilibrium with the overlying water, while those associated with the deeper sediments are not (Keeley and Engler 1974). As the deeper sediments are mixed with water during dredging, the potential for remobilization of their chemical constituents will increase. Dissolved concentrations in the vicinity of the dredging have an important effect on the chemical forms and on the solubility and mobility of chemicals. For example, as reduced sediments are oxidized during dredging, a decrease in interstitial hydrogen sulfide and an increase in sulfates might be expected. Oxidation of sulfides increases the mobility of heavy metals, such as silver, lead and zinc, that were found as sulfides (Gordon et al. 1972).

If heavy metals or other toxic chemicals are present in the sediments, they may be released into the water column. Discussion of this potential impact is presented in the TOXIC CHEMICALS section. Nutrients, especially ammonia, that stimulate plant growth may also be released (Morton 1976). The sections on PHYTOPLANKTON AND ZOOPLANKTON and AQUATIC MACROPHYTES address possible nutrient impacts.

TERRESTRIAL VEGETATION

Existing Conditions

The proposed dredging area at Cape Vincent Harbor lies just north of the village of Cape Vincent. Houses, marinas and boat docks continuously adjoin the water's edge in the southwestern half of the harbor. Terrestrial vegetation consists of planted lawns, flowers, shrubs and trees used for landscaping this residential-commercial area. The southeastern half of the southern shore is old field and park land. A few scattered trees exist, consisting mainly of willow (*Salix alba*), white ash (*Fraxinus americana*) and various poplars (*Populus* spp.) (Fig. 2). A number of scattered herbs and grasses are also present (Table 1). The shoreline itself is composed of heavy boulder and rubble rip-rap which serve to dampen wave action.

Assessment of Impact

No trees or vegetation will be removed by the proposed project. No impact from project implementation is anticipated if spoils are not dumped on dry land.

Fig. 2. Map of terrestrial macrophytes.

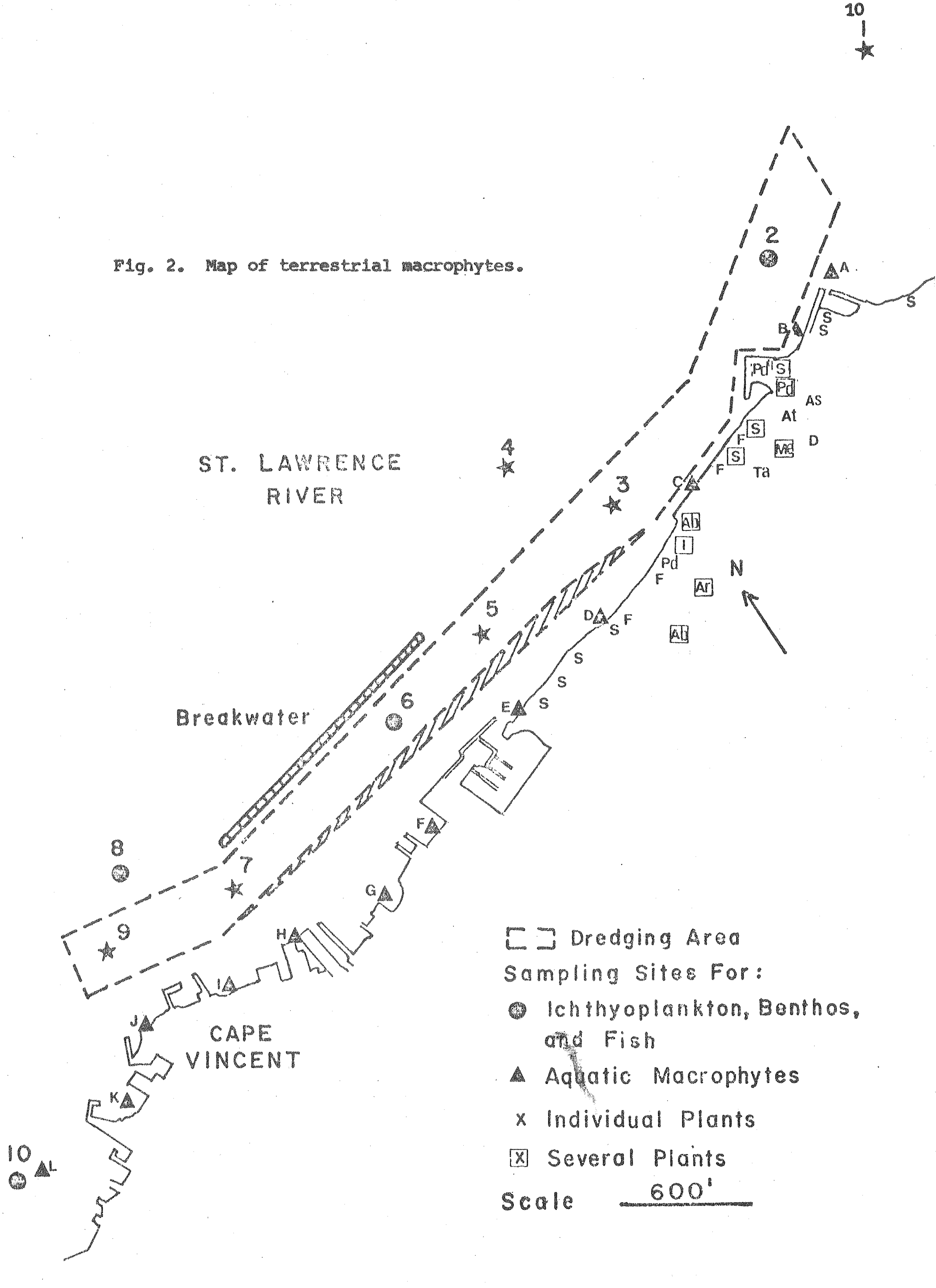


Table 1. Species list of terrestrial macrophytes at Cape Vincent Harbor, New York (See Figure 2).

Code	Genus and Species	Common Name
A	*Acer saccharinum*	Silver maple
Ar	*Amaranthus* sp.	Pigweed
Ab	*Ambrosia* sp.	Ragweed
At	*Arctium minus*	Common burdock
Al	*Asclepias* sp.	Milkweed
As	*Aster* sp.	Aster
D	*Daucus carota*	Queen Anne's Lace
F	*Fraxinus americana*	White ash
I	*Impatiens* sp.	Touch-me-not
Lo	*Lonicera* sp.	Honeysuckle
Me	*Melilotus* sp.	Sweet clover
Pl	*Polygonum lapathifolium*	Smartweed
Pa	*Populus alba*	White poplar
Pd	*Populus deltoides*	Cottonwood
Pt	*Populus tremuloides*	Trembling aspen
S	*Salix alba*	White willow
Ta	*Tanacetum* sp.	Tansy
Vc	*Vicia* sp.	Vetch

AQUATIC MACROPHYTES

Existing Conditions

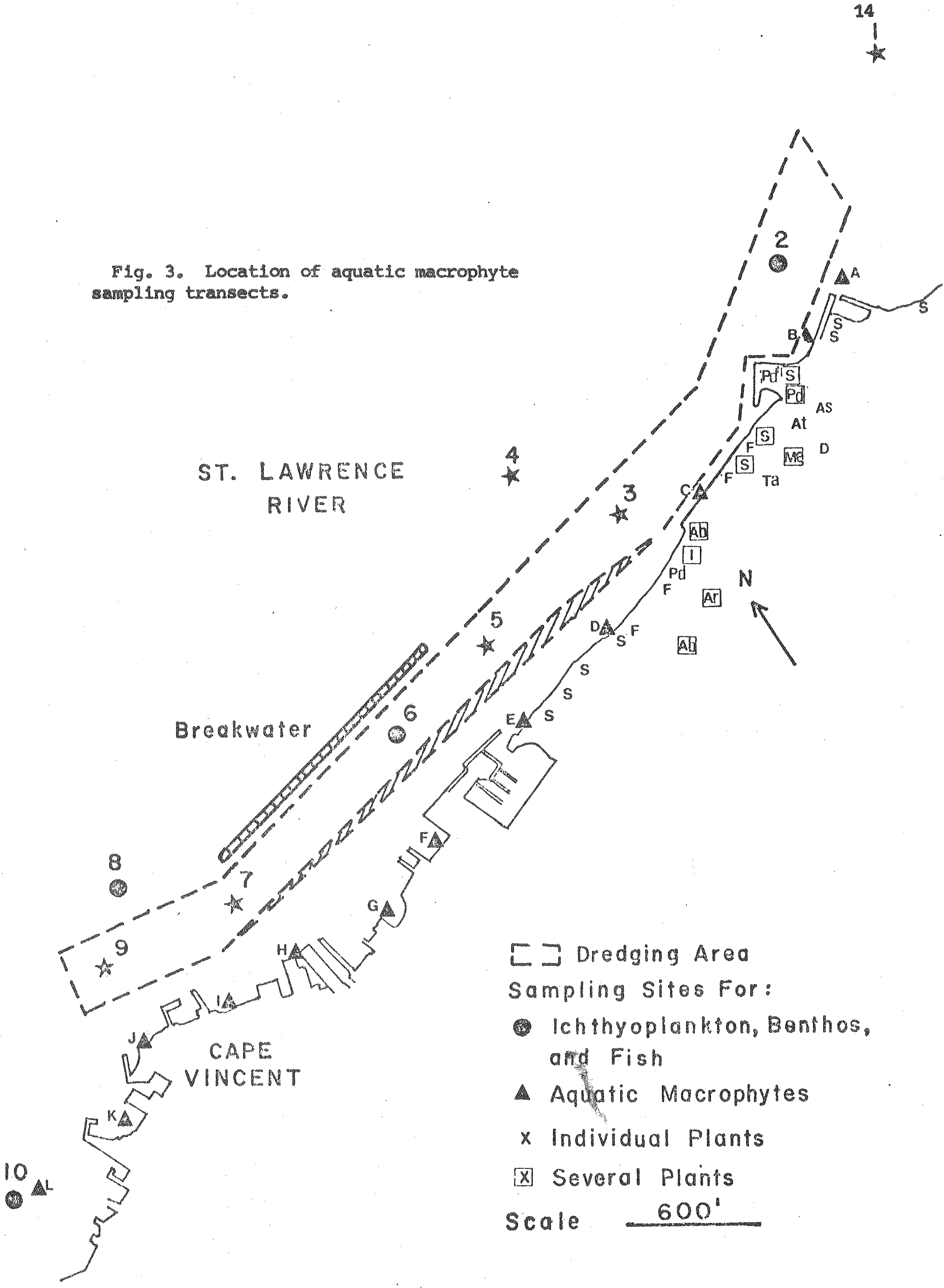
Our collections included one floating and seven submerged and rooted aquatic macrophytes (Table 2). Compared to harbors and rivers on the southern shore of Lake Ontario, the clarity of the river water at Cape Vincent is high as indicated by the great depth to which rooted macrophytes occur (10 m). Macrophytes were sampled in 4 or 5 places along northerly transects from shore at 11 stations (Fig. 3). Beds are distributed in small patches throughout the project area, but because of the large area to be sampled, we were unable to determine their exact dimensions within the current scope of work. Very little aquatic vegetation occurs on the wave-swept, rip-rapped shoreline.

In terms of percent occurrence by station, star duckweed (*Lemna trisulca*), the only non-rooted aquatic macrophyte, was the least abundant species found. Given the currents and wave action along shore in the St. Lawrence, it is not surprising that floating, non-rooted macrophytes are rare. Water milfoil (*Myriophyllum* spp.) dominate the macrophyte community overall, but seasonal variations in species abundance were apparent. Water milfoil was found at all sampling stations in autumn, while in spring and summer it occurred at 63% of the stations. Tape grass (*Vallesnaria americana*) was also more abundant in autumn as opposed to spring and summer (54% vs. 17% of stations). Coontail (*Ceratophyllum demersum*) and waterweed (*Anacharis canadensis*) were equally abundant in all seasons (43% and 49% occurrence, respectively), while the pondweeds (*Potamogeton* spp.) became more abundant in spring and summer (50% vs. 15% in autumn). It is likely that sub-bottom root stock and rhizomes were

Table 2. Species list of aquatic macrophytes at Cape Vincent Harbor, New York.

Genus and Species	Common Name
Anacharis canadensis	Waterweed
Ceratophyllum demersum	Coontail
Lemna trisulca	Star duckweed
Myriophyllum sp.	Water milfoil
Potamogeton sp.	Narrow-leaf pondweed
Potamogeton crispus	Pondweed
Potamogeton richardsonii	Pondweed
Vallesnaria americana	Tape grass

Fig. 3. Location of aquatic macrophyte sampling transects.



present in all seasons but were not recoverable by the sampling technique used.

Numerous invertebrate species, especially the abundant amphipod Gammarus, were associated with the macrophyte beds. Abundant yellow perch and rock bass populations in the area utilize the macrophyte beds for protective cover and as a food reservoir. These forage fish, in turn, support the black bass and pike populations which make Cape Vincent a sport fishery site of international repute. The beds undoubtedly function to protect fish fry and fingerlings of all species, as well as providing spawning habitat for adults.

Assessment of Impact

The disruption of the sediments by dredging may release primary plant nutrients into the water. Such an event would probably benefit phytoplankton more than macrophytes. An increase in phytoplankton would probably reduce submerged macrophytes by shading. However, this effect would be temporary. When dredging operations are concluded, turbidity of the water should return to normal levels quickly as a result of river currents. Wind could also influence sediment transport patterns.

Besides light shading and release of nutrients, sediment resuspension during dredging can mechanically trap phytoplankton and carry them to the bottom. This can cause a reduction in macrophyte production if it settles out in shallow "quiet areas" and blankets the leaves of rooted macrophytes (Kaplan et al. 1974, Ingle 1952). Such a situation is unlikely at Cape Vincent as the macrophyte beds exist within areas of the currents.

The dredging of the channel will destroy some macrophyte beds, although most beds are located outside the previously dredged area. The macrophyte beds to be destroyed supply habitat, cover and food for invertebrates, fish fry, fingerlings and adults and are potential spawning sites for several species (e.g., northern pike, muskellunge). Removal of macrophyte cover will make the various minnows, centrarchids, percids and esocids vulnerable to predation by bass, pike and other species. The impact of dredging on aquatic macrophytes and the organisms associated with them is potentially severe. A decrease in fish abundance in the project area may ensue, but replacement of fish populations should be rapid due to recolonization from large nearby habitats. Macrophytes may not return as quickly, as evidenced by their frequent absence in previously dredged areas. As long as new dredging does not extend beyond old boundaries, we do not believe a significant long-term change in the sport fishery will occur.

MACROBENTHOS

Existing Conditions

The macrobenthic community (Table 3) at Cape Vincent Harbor is dominated by three major groups: Crustacea (42%), Mollusca (26%) and Chironomids (22%). Combined with planarians (3%) and tubificids (5%), these groups accounted for 97% of the organisms sampled (Table 4). Two organisms in particular dominated the Cape Vincent assemblage: the amphipod *Gammarus fasciatus* and the snail *Bithynia tentaculata*. Station and seasonal differences in species composition and abundance were evident.

In concentrations greater than $100/m^2$, both *Bithynia* and *Gammarus* were present at a majority of stations in all seasons (67 and 93% of the stations, respectively). Other species present in all seasons in concentrations greater than $100/m^2$ or 25 g shell-less weight at a minority of stations included the planarian *Dugesia tigrina* (20% of stations) and the mollusks *Sphaerium corneum* (27%), *Elliptio complanata* (30%) and *Lampsilis r. radiata* (30%). In densities greater than $100/m^2$, tubificid oligochaetes and chironomids were found almost exclusively in the spring (45 and 33% of the stations, respectively), but small numbers were present in all seasons at most stations.

The harbor can be divided into two distinct biotic areas based on past dredging history. Among the chironomids, *Chironomus*, *Procladius* and *Clinotanypus* spp. were most frequent and abundant at previously dredged stations (2, 3, 5, 6, 7 and 9); *Microtendipes*, *Paratendipes* and *Phaenopsectra* spp. were found frequently and abundantly at undredged (1, 4, 8 and 10) and previously dredged stations; and *Pseudochironomus*, *Stictochironomus* and *Cryptochironomus* spp. were most frequent and abundant at previously un-

Table 3. Species list of benthic invertebrates of Cape Vincent Harbor, New York.

Phylum
    Class
        Order
            Family
                Genus and species

Annelida
    Hirudinea
        Phryngobdellida
            Erpobdellidae
                Erpobdella punctata
        Rhynchobdellida
            Glossiphoniidae
                Glossiphonia complanata
                Helobdella elongata
                H. fusca
                H. stagnalis
    Oligochaeta
        Haplotaxida
            Tubificidae
                Aulodrilus americanus
                A. piqueti
                Limnodrilus spp.
                L. claparedeianus
                L. hoffmeisteri
                L. profundicola
                Peloscolex ferox
                Potamothrix moldaviensis
                P. vejdovsky
                unidentifiable immature *Limnodrilus*
                unidentifiable immature Tubificidae
        Lumbriculida
            Lumbriculidae
                unidentifiable immature Lumbriculidae

Arthropoda
    Crustacea
        Amphipoda
            Gammaridae
                Gammarus fasciatus
        Decapoda
            Cambaridae
                unidentifiable female Cambarinae
        Isopoda
            Asellidae
                Asellus racovitzai racovitzai

Table 3 (continued).

Arthropoda (cont.)
- Insecta
  - Coleoptera
    - Elmidae
      - *Macronychus glabratus*
      - *Stenelmis* sp.
  - Diptera
    - Ceratopogonidae
      - unidentifiable ceratopogonid larvae
    - Chironomidae
      - *Chironomus* spp.
      - *Clinotanypus* spp.
      - *Coelotanypus* spp.
      - *Cricotopus* spp.
      - *Cryptochironomus* spp.
      - *Micropsectra* spp.
      - *Microtendipes* spp.
      - *Parachironomus* spp.
      - *Paralauterborniella* sp.
      - *Paratendipes* spp.
      - *Phaenopsectra* spp. (includes *Tribelos*)
      - *Polypedilum* spp.
      - *Procladius* spp.
      - *Pseudochironomus* spp.
      - *Rheotanytarsus* spp.
      - *Strictochironomus* spp.
      - unidentifiable chironomid larvae
      - unidentifiable chironomid pupae
  - Ephemeroptera
    - Ephemeridae
      - *Hexagenia limbata*
  - Lepidoptera
    - Pyralidae
      - unidentifiable pyralid
  - Trichoptera
    - Lepidostomatidae
      - *Lepidostoma* spp.
    - Leptoceridae
      - *Ceraclea excisa*
      - *Oecetis* spp.
    - Limnophilidae
      - unidentifiable pupae of Limnophilidae
    - Molannidae
      - *Molanna* sp.
      - *M. flavicornis*
    - Polycentropodidae
      - *Phylocentropus* spp.

Mollusca
- Gastropoda
  - Basomatophora
    - Lymnaeidae
      - unidentifiable immature *Lymnaea* spp.

Table 3 (continued).

Mollusca (cont.)
    Gastropoda (cont.)
        Basomatophora (cont.)
            Planorbidae
                Promenetus exacuous
        Prosobranchia
            Hydrobiidae
                Amnicola lustrica
                Bithynia tentaculata
            Pleuroceridae
                Goniobasis livescens
            Valvatidae
                Valvata lewisi
                V. tricarinata tricarinata
        Pulmonata
            Physidae
                Physa sp.
    Pelecypoda
        Heterodonta
            Sphaeriidae
                Pisidium compressum
                Pisidium (Cyclocalyx) casertanum
                P. (C.) henslowanum
                P. (C.) nitidum
                P. (C.) ventricosum
                P. (C.) walkeri
                Pisidium (Pisidium) amnicum
                P. (P.) dubium
                Musculium lacustre
                Sphaerium (Sphaerium) corneum
                S. (S.) striatinum
        Schizodonta
            Unionidae
                Elliptio complanata
                Lampsilis radiata radiata

Platyhelminthes
    Turbellaria
        Tricladida
            Planariidae
                Cura formanii
                Dugesia tigrina
                ? *Phagocata morgani morgani*
                P. woodworthi

Table 4. Frequency, abundance and percent importance of macroinvertebrates[1] by season averaged over stations.

Taxon	Autumn		Spring		Summer			
	No. of Station[2]	Number/m^2	No. of Station	Number/m^2	No. of Station	Number/m^2	Total	Percent
Planaridae	2	74.6	3	73.1	1	40.3	178.0	3
Tubificidae	0	16.2	9	294.8	-	-	311.0	5
Crustacea	9	1131.2	10	747.0	9	753.9	2632.1	42
Chironomidae	8	89.0	10	787.1	1	482.4	1357.5	22
Mollusca	9	781.5	9	527.0	5	303.4	1611.9	26
TOTAL		2092.5		2429.0		1580.0	6081.5	97

[1] Total number collected = 62,956

[2] Number of stations where single species abundance within taxa exceeded 100 organisms/m^2 or 25 g shell-less weight

dredged stations. Among bivalves, *Elliptio complanata*, *Lampsilis r. radiata*, *Pisidium casertanum* and *P. nitidum* were frequent and abundant at previously dredged and undredged stations, while *Sphaerium corneum*, *S. striatum*, *Physa* sp. and *Musculinium lacustre* were most frequent and abundant in previously undredged areas. No molluscan species appeared to exclusively prefer previously dredged areas. Among planarians, a group known to be sensitive to hydrogen sulfide, the dominant forms *Dugesia tigrina* and *Cura formanii* were most frequent and abundant in previously undredged areas where no hydrogen sulfide was detected. Among tubificids, *Limnodrilus* spp. dominated and were frequent and abundant throughout the harbor. Interestingly, immature *Limnodrilus* were most abundant in previously dredged areas (Stations 2-7).

The relative unimportance of tubificids (5%) indicates that the harbor area is unpolluted (Ellis *et al.* 1976). Certain chironomids (*Chironomus* and *Procladius* spp.) are often associated with polluted conditions (Cook and Johnson 1974). *Chironomus* and *Procladius* spp. were among the most abundant chironomids species at Cape Vincent. They were found predominately in previously dredged areas, indicating that previous dredging may have affected species distributions. However, the presence of *Micropsectra* spp., a pollution intolerant chironomid (Resh and Unzicker 1975), at previously dredged sites indicates that dredging did not pollute the area. The abundance of other pollution intolerant organisms like *Gammarus* and the mollusks also strongly suggests that the macrobenthic community at Cape Vincent has not been disturbed by pollution.

Macrobenthos standing crops averaged 2100 organisms/m^2 and are much lower than sites studied on Lake Ontario. Invertebrate densities ranged from 2000 to 52,000/m^2 in Hamilton Bay (Johnson and Matheson 1968), 50,000 to 200,000/m^2 in Toronto Bay (Brinkhurst 1970) and averaged 21,000/m^2 in Oswego Harbor and River (Kinney 1972). There were major differences in standing crop among stations (range 846 to 3013 organisms/m^2), with undredged stations averaging 2616 organisms/m^2 and previously dredged stations averaging 1851/m^2 (Table 5). Not surprisingly, standing crops were highest in the spring (Table 4).

The benthic community is particularly rich in mollusks and crustaceans which are important food sources for fish populations. In addition to live mollusks, most samples contained abundant shells and shell fragments. In summer samples, we found many shells with rock bass eggs attached to them. Not only does the macrobenthic community form the base of the aquatic food chain, but also elements of it apparently provide necessary spawning substrates for one of the two most abundant fish in the region.

Assessment of Impact

Benthic organisms are important in aquatic ecosystems in that they function as the crucial link in a detritus-based food chain. They utilize organic matter and recycle nutrients that otherwise would collect and remain trapped in the sediments. Benthic organisms supply food to many species of fish and to other predatory aquatic organisms. Impacts of dredging on the benthic community vary widely, ranging from no significant impact to the virtual elimination of most benthic organisms. Environmental factors that tend to influence impacts are flushing rates, size of the dredging operations relative to the size of the estuary, physical and chemical properties of the sediment, duration of the dredging project, the relative tolerance of the species occurring at the dredging and disposal site to environmental stress, and the relative ability of species to repopulate the site.

Table 5. Abundance and percent of macroinvertebrates by station averaged over seasons.

Station	Individuals/m^2	Percent
1	2850	13.6
2	2394	11.4
3	1343	6.4
4	1827	8.7
5	1957	9.3
6	846	4.0
7	2055	9.8
8	3013	14.3
9	1972	9.4
10	2773	13.2
TOTAL	21030	100.1

Dredging will completely eliminate the macroinvertebrate population in the area being excavated. Outside of the excavation area, settling of resuspended sediments will occur. This will result in a smothering effect on some of the benthic invertebrates, thus reducing standing crop and altering species composition in areas affected by the turbidity plume. In general, if the sediments are anoxic, smaller animals are more vulnerable to burial because of their inability to reach the surface before they suffocate (Morton 1976). Some marine bivalve mollusks, however, can incur an oxygen debt, thus providing themselves a long time period for escape (Nichol 1960).

Concern about the effects of sediments resuspended during dredging on the benthic organisms generated studies as early as 1938. Filter-feeding organisms, like freshwater clams that collect food by filtering particles suspended in the water, are the groups of benthic organisms most likely to suffer disorders caused by the abrasive action of silt and clay. According to Sherk (1971), the imposition of suspended load stress on filter feeders affects their rate of water transport, the efficiency of their filtering mechanisms and the energy needed for maintenance. Specific physiological disorders observed in filter feeders exposed to heavy suspended sediment loads include: abrasion of the gill filaments, clogging of gills, impaired respiration, impaired feeding, reduced pumping rates, retarded egg development and reduced growth and survival of the larvae (Yonge 1953, Loosanoff and Tommers 1948, Loosanoff 1961, Davis 1960, Cairns 1968, Smith and Brown 1971, Gordon et al. 1972). The overall productivity of benthic populations whose individual members are experiencing any of these disorders will decrease. These changes in productivity could have detrimental ramifications at higher trophic levels.

The effects outlined will be limited to the harbor area and areas downstream along the turbidity plume. However, the effects should be of short duration and not long term because recolonization of affected areas should begin shortly after dredging ceases. The rate of recolonization is difficult to estimate. However, Slotta et al. (1973) observed benthic infauna to return to former abundance levels within two weeks at Coos Bay, Oregon, a marine system. On the other hand, Kaplan et al. (1974) observed no recovery of the benthic community within eleven months after dredging at Goose Creek, New York.

The data suggest that previous dredging operations may have altered species distributions and abundances at Cape Vincent Harbor. In view of past effects and the importance of the benthic community to the ecosystem, the extent of new dredging should be carefully considered. However, because the benthic community has been altered already and because the total area to be dredged is so small compared to the St. Lawrence ecosystem, we anticipate no further damage to the system as a result of dredging, especially if new dredging activities are confined to previously dredged channels.

PHYTOPLANKTON AND ZOOPLANKTON

Existing Conditions

Phytoplankton and zooplankton samples were not taken, but populations similar to those of Lake Ontario would be expected as would some epiphytic and periphytic phytoplankton associated with the macrophyte community.

Assessment of Impact

An increase in turbidity will reduce light penetration which may decrease phytoplankton production (Sherk et al. 1972, Odum and Wilson 1962). However, the turbidity effects will be of relatively short duration and should produce no long-term changes in the phytoplankton community.

Dredging operations may have a short-term stimulating effect on phytoplankton production due to the possible release of limiting nutrients into the ecosystem. Localized phytoplankton blooms could occur in the plume of nutrient enriched waters from dredging as the turbidity decreases and light becomes more available. No long-term effects on the phytoplankton community are expected to result from the proposed dredging operations. Recolonization of the dredging zone by upstream phytoplankton should occur immediately after the dredging operations have ended.

Zooplankton populations are responsible for providing food for many organisms in the aquatic ecosystem including some adult and many juvenile fish. Many members of the zooplankton community are "filter feeders." They strain the water for small food particles. Studies by Corner (1961) suggest that resuspended sediment particles may interfere with normal ability to obtain food by reducing the effectiveness of feeding appendages. Resuspended sediments may adhere to eggs or animals, thereby causing cellular damage or abnormal settling rates to the bottom (Sullivan and Hancock 1973). Hydrogen sulfide concentrations in the water may increase as a result of dredging anaerobic sediments laden with hydrogen sulfide. Low concentrations of hydrogen sulfide will kill zooplankton. However, no long-term effects on the zooplankton community are expected to result from dredging. Recolonization of the dredged zone by zooplankton carried in by the currents should occur immediately.

FISH

Existing Conditions

Cape Vincent Harbor is located on the St. Lawrence River about 16 km from the river's origin in Lake Ontario. As such, it is not surprising that the groups of fish collected at Cape Vincent represent a transition between lake and river assemblages (Table 6). Rock bass (*Ambloplites rupestris*) and yellow perch (*Perca flavescens*), primarily lake species, dominate the fishes, but a number of cyprinids, primarily stream species, were found along shore. Although the fish assemblage is diverse, numbers are generally small compared to other sites on Lake Ontario. Reasons for low densities may include rapid depth increases offshore and the boulder substrate along shore. Although macrophytes and their associated invertebrates, as well as benthic invertebrates, are abundant throughout the sampling area, shallow-protected habitat for fish appears to be minimal. Wave action along shore is considerable and may prohibit large numbers of fish from living on the rocky substrates. Depths of 6 to 12 m immediately offshore, combined with gyttja substrates (often rich in hydrogen sulfide) may also contribute to reduced fish abundance.

Twenty-seven species of fish were observed in the project area with rock bass, yellow perch, smallmouth bass (*Micropterus dolomieui*), longnose dace (*Rhinichthyes cataractae*) and Johnny darter (*Etheostoma nigrum*) being the most common (Table 6). The most common species of angling interest found in the project areas were smallmouth bass, northern pike (*Esox lucius*), yellow perch, brown bullhead (*Ictalurus nebulosus*) and lake trout (*Salvelinus namaycush*). During the study period, 5 of the 27 species were not observed to possess developed gonads or ripe sex products. This indicates that potential spawning activity in the project area is substantial.

Table 6. Species list of fish at Cape Vincent, New York.

Anguillidae	
Anguilla rostrata	American eel
Catostomidae	
Catostomus commersoni	White sucker
Centrarchidae	
Ambloplites rupestris	Rock bass
Lepomis gibbosus	Pumpkinseed
Lepomis macrochirus	Bluegill
Micropterus dolomieui	Smallmouth bass
Clupeidae	
Alosa pseudoharengus	Alewife
Dorosoma cepedianum	Gizzard shad
Cyprinidae	
Couesius plumbeus	Lake chub
Nocomis micropogon	River chub
Notropis bifrenatus	Bridle shiner
Notropis hudsonius	Spottail shiner
Pimephales notatus	Bluntnose minnow
Rhinichthyes atratulus	Blacknose dace
Rhinichthyes cataractae	Longnose dace
Semotilus atromaculatus	Creek chub
Semotilus corporalis	Fallfish
Cyprinodontidae	
Fundulus diaphanus	Eastern banded killifish
Esocidae	
Esox lucius	Northern pike
Ictaluridae	
Ictalurus nebulosus	Brown bullhead
Noturus flavus	Stonecat
Osmeridae	
Osmerus mordax	Rainbow smelt
Percichthyidae	
Morone americana	White perch

Table 6 (continued).

Percidae	
Etheostoma nigrum	Johnny darter
Perca flavescens	Yellow perch
Percopsidae	
Percopsis omiscomaycus	Trout-perch
Salmonidae	
Salvelinus namaycush	Lake trout

Rock and smallmouth bass and yellow perch were the most common species observed in spawning condition. However, all the sport fishes were observed possessing developed gonads or ripe sex products at some time during the study.

Several fish species appear characteristic of the Cape Vincent area. Among the centrarchids rock and smallmouth bass predominate, but we also found several pumpkinseed (Lepomis gibbosus). Rock and smallmouth bass were found along the rocky shore (juveniles) and captured in deep water with gill nets (adults). Spawning appeared to take place throughout the project area in June and July, frequently on clamshells by rock bass.

Juvenile American eels (Anguilla rostrata) were numerous along the shore at Cape Vincent. They are voracious predators whose favorite prey in the Lake Ontario region are longnose dace, the most abundant cyprinid we found. Eels do not spawn in freshwater.

Alewives (Alosa pseudoharengus) are one of the most abundant species in the Lake Ontario region. Capture of several alewife larvae in July indicates adult spawning activities along shore.

We found a number of cyprinids inhabiting the shallow, rocky shores at Cape Vincent. Although they are thought to spawn from May through July, we found mature longnose dace in each season. This species is common along Lake Ontario beaches from June through August (Scott and Crossman 1973), and we found the greatest number in July, probably spawning. The bluntnose minnow (Pimephales notatus) was the next most abundant cyprinid, followed by river chubs (Nocomis micropogon) and two shiner species. All were inshore during the spring and summer seasons, apparently spawning. Bluntnose minnows build nests under stones in shallow waters, while river chubs most frequently spawn in shallow streams. Bridle (Notropis bifrenatus) and spottail (*N. hudsonius*) shiners spawn inshore in spring and summer and are major forage fish in the Lake Ontario region. We also found single specimens of blacknose dace (*Rhinichthyes atratulus*), creek chub (*Nocomis micropogon*), lake chub (*Couesius plumbeus*) and fallfish (*Semotilus corporalis*).

Northern pike specimens caught included adults, juveniles and a larva. Two juveniles, electroshocked in May 1979, were mistakenly identified as muskellunge initially, and the error was not caught before inclusion in the spring data report. The harbor is not a good, marshy pike spawning area. Most reproduction probably occurs on the Canadian side of the St. Lawrence, where abundant shallow macrophyte beds exist.

Several brown bullhead, mostly juveniles, were found among the rocks along shore. Apparently, some spawning does occur even though the habitat is not considered typical for bullheads.

Adult white perch (*Morone americana*) were netted in the harbor. Major white perch populations already exist in Lake Ontario, and this species may be establishing itself in the St. Lawrence as well.

Yellow perch were the second most abundant species found. The presence of juveniles near shore and adults offshore indicates that indigenous, reproducing populations exist in the harbor area. Johnny darters were the other percid species found. Reproduction occurs under rocks along shore, and gravid individuals were found in spring samples.

One or two representatives of other species were also found at Cape Vincent: white sucker (*Catostomus commersoni*), eastern banded killifish (*Fundulus diaphanus*), gizzard shad (*Dorosoma cepedianum*), stonecat (*Noturus flavus*), rainbow smelt (*Osmerus mordax*), trout-perch (*Percopsis omiscomaycus*) and lake trout (NYSDEC personnel at Cape Vincent said this species is rarely found in the area).

Assessment of Impact

I. Adults

Because of their mobility, adult fish are less likely to experience the chemical and physical impacts of dredging. In fact, Herdendorf (1978) states that dredging activities have little direct impact on adult fish. The adults simply move away from the disturbance.

There are periods in their life history when fish concentrate in large numbers in a small area (i.e., spawning and nursery areas). Dredging activity could create an area of water with chemical conditions unsuitable for fish life. Adult fish would be expected to avoid low dissolved oxygen concentrations in turbidity plumes which would extend an undetermined distance downstream. Eventually, the plume would mix completely with the St. Lawrence waters. Duration of the lowered oxygen levels would be a function of the length of dredging operations and the oxygen demand of the sediments.

High concentrations of suspended solids resulting from a dredging operation could result in direct damage to adult and larval fish which do not avoid the dredging area. Suspended particles in the water damage gills and filter-feeding apparatus by cutting and abrasion. Such damage can increase individual susceptibility to fungal and bacterial disease. However, only very high concentrations of suspended solids (several thousand ppm) cause damage in adult fish (EIFAC 1965). High turbidity levels will reduce light penetration, thereby impairing underwater vision and thus feeding in visually feeding fish. Concentrations of suspended solids this high could be reached in the dredging operation, but adult fish would have ample opportunity to avoid such concentrations in an open system. The only filter feeders in the Cape Vincent area as adults are alewife and the gizzard shad, both of which are considered to be nuisance species. Effects on larval fishes are given under ICHTHYOPLANKTON.

Dredging may have an indirect effect on fish via reduction in food resources or in reduced ability to find food. Populations of zooplankton and benthic invertebrates (important as potential food items) may be temporarily reduced in the dredged areas (see appropriate sections for details). Small fish (used as food by large fish) may also be reduced in the area. Such effects, if they occur at all, are expected to be localized and temporary, and any such impairment would not be expected to have any long-term adverse impact on fish population.

II. Ichthyoplankton

The most critical period of fish life history occurs from the time eggs are laid until juveniles mature enough to forage and to escape predators effectively. During this time, young fish are most vulnerable to outside disturbances. Dredging should not take place during the spawning and growing season of important fish (percids and centrarchids especially) if year classes are to remain strong.

Dredging activities would reduce ichthyoplankton numbers in the immediate vicinity of the operations. Most fish larvae are planktonic feeders for several weeks after hatching. It is during this period, usually the spring and early summer, when larvae unable to freely move in the water column are vulnerable to dredges. They may be caught in the wash water processing of dredged materials (Herdendorf 1978) and be physically destroyed. Juveniles may be especially sensitive to excessive turbidity since damage to gills and other tissues of juveniles is more likely to occur than to those of adult fish (Morton 1976).

III. Eggs

Silting of spawning beds is one of the most critical impacts on fish populations (Morton 1976). The sedimentation of resuspended solids could smother eggs of nest building fish or adhesive eggs of mass spawners at and near the dredging site. Also, some species of fish will not spawn if turbidities exceed about 100 ppm (McDonald and Thomas 1970). The change in sediment composition and particle distribution that may occur near the dredging site could interfere or prevent fish reproduction in the future. For example, in a marine fish (striped bass) Bayliss (1968) observed higher mean hatches of striped bass eggs on coarse sands (58.9%) and in plain plastic pans (60.3%) than on silty sand (21%), silt-clay sand (4%) or detritus (0%). With sedimentation of resuspended matter, sandy cobble areas on the western and eastern ends of the harbor may suffer changes in bottom composition.

Ricker (1945) notes that a significant reduction in the reproductive capacity of a species due to spawning bed damage could endanger species survival more than the effect of the loss of part of the existing adult fish population. However, the scope of the proposed action is so limited in relation to the entire harbor-river ecosystem that a negligible impact is probable.

BIRDS

Existing Conditions

In six days of observations during the autumn, spring and summer, 36 species of birds were observed at Cape Vincent Harbor (Table 7). The most abundant birds seen included Canada geese (*Branta canadensis*), ring-billed gulls (*Larus delawarensis*), house sparrows (*Passer domesticus*), starlings (*Sturnus vulgaris*) and purple martins (*Progne subis*). The only birds observed in all seasons were song sparrows (*Melospiza melodia*) and ring-billed gulls. The majority of birds were observed in spring and summer and appear to migrate in autumn. Other common species observed included red-winged blackbirds (*Agelaius phoeniceus*), common grackles (*Quiscalus quiscula*) and tree swallows (*Iridoprocne bicolor*). Some of the less common birds observed at Cape Vincent included common egrets (*Casmerodius albus*), black scoters (*Melanitta nigra*) and great black-backed gulls (*Larus marinus*).

Assessment of Impact

No outright destruction of nesting habitat or birds would result from dredging activities. Most species of birds would tend to avoid the noise and human activity associated with dredging operations. No significant long-term effects on bird population should occur with project implementation.

Table 7. Species list of birds in the Cape Vincent Harbor area.

Genus and Species	Common Name
Actitis macularia	Spotted sandpiper
Agelaius phoeniceus	Red-winged blackbird
Anas platyrhynchos	Mallard
Anas rubripes	Black duck
Bombycilla cedrorum	Cedar waxwing
Branta canadensis	Canada goose
Casmerodius albus	Common egret
Chaetura pelagica	Chimney swift
Charadrius vociferus	Killdeer
Chlidonias niger	Black tern
Columba livia	Rock dove
Corvus brachyrhynchos	Common crow
Dendroica coronata	Yellow-rumped warbler
Dendroica petechia	Yellow warbler
Hirundo rustica	Barn swallow
Icterus galbula	Northern oriole
Iridoprocne bicolor	Tree swallow
Larus argentatus	Herring gull
Larus delawarensis	Ring-billed gull
Larus marinus	Great black-backed gull
Melanitta nigra	Black scoter
Melospiza melodia	Song sparrow
Molothrus ater	Brown-headed cowbird
Parus atricapillus	Chickadee
Passer domesticus	House sparrow
Progne subis	Purple martin
Quiscalus quiscula	Common grackle
Spinus tristis	American goldfinch
Spizella passerina	Chipping sparrow
Sterna hirundo	Common tern

Table 7 (continued).

Genus and Species	Common Name
Sturnella magna	Eastern meadowlark
Sturnus vulgaris	Starling
Troglodytes aedon	House wren
Turdus migratorius	American robin
Vireo gilvus	Warbling vireo
Zenaida macroura	Mourning dove

ENDANGERED SPECIES

Existing Conditions

The Endangered Species Act of 1973 (16 USC 1531-1543, 87 Stat. 884) provides Federal protection of certain species whose existence is considered to be threatened or endangered. New York State, under jurisdiction of Section 11-0535 of the Environmental Conservation Law, also protects species considered to be endangered within the State. The Federal Register of 17 January 1979, Vol. 44, No. 12, pages 3636-3654, presents the most current list of species protected under the Endangered Species Act. The Act essentially makes it a violation of Federal Law to take any species that are listed as endangered except by permit for scientific purposes or for enhancing the propagation of survival of the species. Threatened species are considered to be in less peril of survival but could possibly become endangered in all or part of their range in the foreseeable future. Regulations concerning them are less rigorous.

No plants or animals (Tables 1, 2, 3, 5, 6 and 7) observed in the project area are currently protected by the Endangered Species Act. Additionally, no plants protected by State Law are known to occur in the study area. No endangered species of birds were observed or are known to nest in the Cape Vincent area.

Assessment of Impact

The dredging project proposed for Cape Vincent Harbor should not have any adverse effect on habitat of value to endangered species or any individuals of an endangered species.

TOXIC CHEMICALS

Existing Conditions

Analyses for toxic chemicals in the sediments were not performed by us. Our conclusions on the effects of dredging are based on the assumption that sediments disturbed by dredging will not contain toxic substances (e.g., heavy metals or substances that may be concentrated in the food web such as pesticides). Because of contamination problems in Lake Ontario and the Northeast generally, this may not be a good assumption.

Assessment of Impact

Dredging of contaminated sediments can cause the redistribution and remobilization of toxicants sorbed to the sediments. Contaminants seldom occur in the surface sediments or in water columns at concentrations high enough to have lethal effects on aquatic organisms. The danger with toxic contaminants lies in the fact that persistant pesticides are concentrated, cycled and magnified in the food web. This accumulation of toxic chemicals in the tissues of organisms is referred to as bioconcentration. Important pathways by which contaminants can enter the food web are from sediment via macrophytes, from water via phytoplankton, from ingestion of contaminated particulate matter by filter and deposit feeding organisms, and from ingestion of food organisms that have already concentrated contaminants.

Toxic chemicals cause a variety of physiological, behavioral and genetic disorders in aquatic food chains, which would include birds and man. If sediment analyses reveal the presence of toxic chemicals, further evaluation of impacts on aquatic food webs ending in man would be required to assess the impact on the biota and human health. Information on the types of pesticides present would be required to make effective evaluations. This evaluation should consider not only the disposal of spoils but also the impact of the release of toxic contaminants on the biota during the dredging operations. The contaminant issue in the Lake Ontario watershed is of special concern in the public's mind after the Love Canal "incident" and the Mirex contamination of salmonids in Lake Ontario.

CONCLUSIONS

Potential adverse impacts of dredging in the Cape Vincent area are few. Silting-in of protective habitat and reproductive areas along shore would appear to be of most concern. A large amount of fish spawning occurs in the late spring and summer months, and dredging at this time would be ill-advised.

Between the previously dredged channel and shore lies a patchy macrophyte community which hosts an abundant assemblage of invertebrates. Were dredging to extend outside the current channel, invertebrate production would be reduced, and a ripple effect up the food web might result. Evidence of previous invertebrate reduction in the dredged area was discussed in the MACROBENTHOS section.

However, the potential dredging area is so small compared to the size of the river that environmental impacts on the ecosystem as a whole should be minimal, especially if dredging operations are confined to previous project areas. Recolonization from nearby unaffected areas after dredging by macrophytes, invertebrates and fish should occur relatively rapidly. The maximum impact of dredging would probably result in the loss of invertebrate and fish year classes in the harbor area. Appropriate seasonal timing of dredging and recolonization should minimize this impact.

The question can be raised as to whether dredging should be conducted at all. The existing channel is 6 to 15 m deep, has a smooth bottom and presents navigational hazards to only the largest of ships.

RECOMMENDATIONS

1. Studies of possible toxic chemical content in Cape Vincent Harbor sediments should be initiated and completed before dredging begins.
2. To minimize adverse impacts on the biota, especially the reproductive and developmental phases, dredging should be restricted to the original channel.
3. If part 1 and 2 are adequately accounted for, we anticipate that the destruction of benthic, aquatic macrophyte and fish populations in the dredging area will have a neglible impact in the St. Lawrence ecosystem as a whole. This conclusion is based on the fact that the scope of the propsed action is limited in relation to the river ecosystem, the assumption that recolonization from nearby undisturbed areas will occur, and the assumption that toxic chemicals are not present in the sediments.

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