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Aquatic Biological Survey, Oak Orchard Harbor: Final Report to the Army Corps of Engineers Buffalo District

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AQUATIC BIOLOGICAL SURVEY
OAK ORCHARD HARBOR, NEW YORK

FINAL REPORT

To The

Army Corps of Engineers

Buffalo District

by

Joseph C. Makarewicz, James M. Haynes, and Ronald C. Dilcher

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INTRODUCTION

This report evaluates the potential environmental impact of proposed maintenance dredging at Oak Orchard Harbor, New York, by the U.S. Army Corps of Engineers. Field samples were taken in the autumn of 1978 and in the spring and summer of 1979. Data reports for the autumn, spring and summer sampling trips were submitted earlier to the Buffalo District of the U.S. Army Corps of Engineers.

The impact of dredging was considered in relation to physical and chemical aspects, terrestrial vegetation/wetlands, aquatic macrophytes, macrobenthos, phytoplankton and zooplankton, fish, birds, endangered species, toxic chemicals and seiches. For each parameter considered, sections titled EXISTING CONDITIONS are followed by our ASSESSMENT OF IMPACT. The last section presents our recommendations concerning the general impact of dredging.

PHYSICAL ASPECTS

Existing Conditions

Sediment types at Oak Orchard Creek are variable in type. A cobble-gravel bottom is evident at the lake stations (Stations 1-5, Fig. 1) gradually changing to sand and gravel within the jetty (Station 6). Further southward in the creek, sand mixed with fine silt and organic debris is predominant at Station 7. From Station 7 southward, a coprogenous sediment mixture consisting of particulate matter remains, inorganic precipitations and minerogenic matter is evident (gyttja).

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 resuspended, creating a turbidity plume. This is the most visually obvious physical impact causing water discoloration and reduction in 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

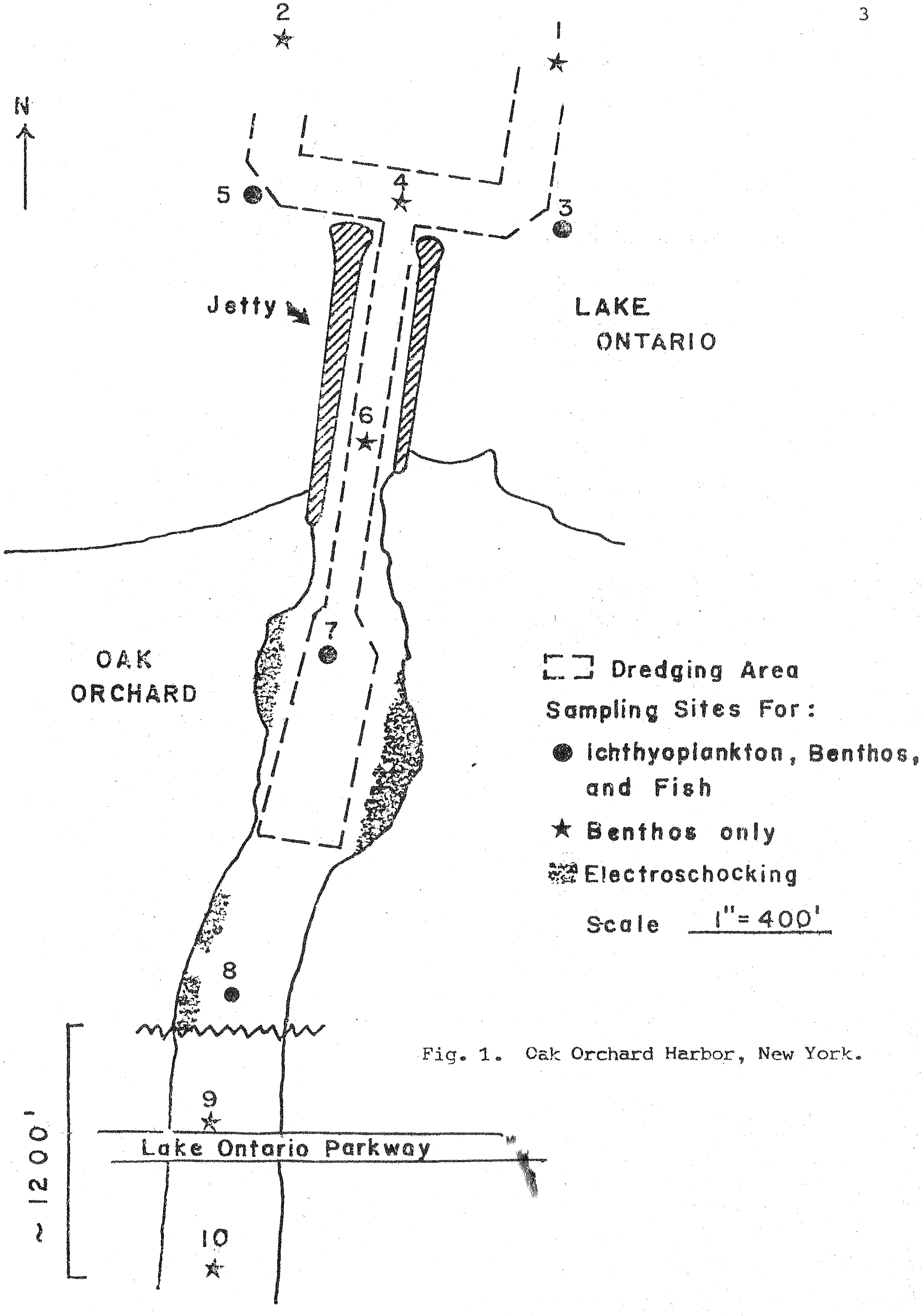


Fig. 1. Oak Orchard Harbor, New York.

suspended for longer periods of time. Fine silts and clays will be transported from the dredge site by currents into Lake Ontario. These changes in mechanical properties of sediments could affect the processes controlling the exchange of contaminants from polluted sediments to the water, the distribution of benthic organisms, fish reproduction, etc. The 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. Reduced inlet size (such as at Oak Orchard Creek) and long flushing times of small estuary bays will exaggerate these hydrodynamic effects (Kaplan et al. 1974). We are not professionally capable of predicting hydrodynamic effects of dredging at Oak Orchard Creek.

CHEMICAL ASPECTS

Existing Conditions

Within the project area, the waters of Oak Orchard Creek and adjacent Lake Ontario are oxygenated. Hydrogen sulfide was evident in benthos samples from Station 7 southward.

Assessment of Impact

Dredging operations are likely to produce changes in the chemistry of the water overlying the dredging site. First, 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 Oak Orchard Creek, the sediments of high organic content exist between Stations 6 and 10 (Fig. 1). However, dredging will occur only approximately half the distance between Stations 7 and 8. The sediments in this area can be expected to have a high biochemical oxygen demand.

Second, 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). Disucssion on heavy metals is presented in the section TOXIC CHEMICALS.

Nutrients, especially ammonia, that stimulate plant growth may be released (Morton 1976). The sections on PHYTOPLANKTON AND ZOOPLANKTON and AQUATIC VEGETATION discuss possible impacts.

If toxic chemicals are present in the sediments, they may be released into the water column. Discussion on this potential impact is presented in the section on TOXIC CHEMICALS.

TERRESTRIAL VEGETATION/WETLANDS

Existing Conditions

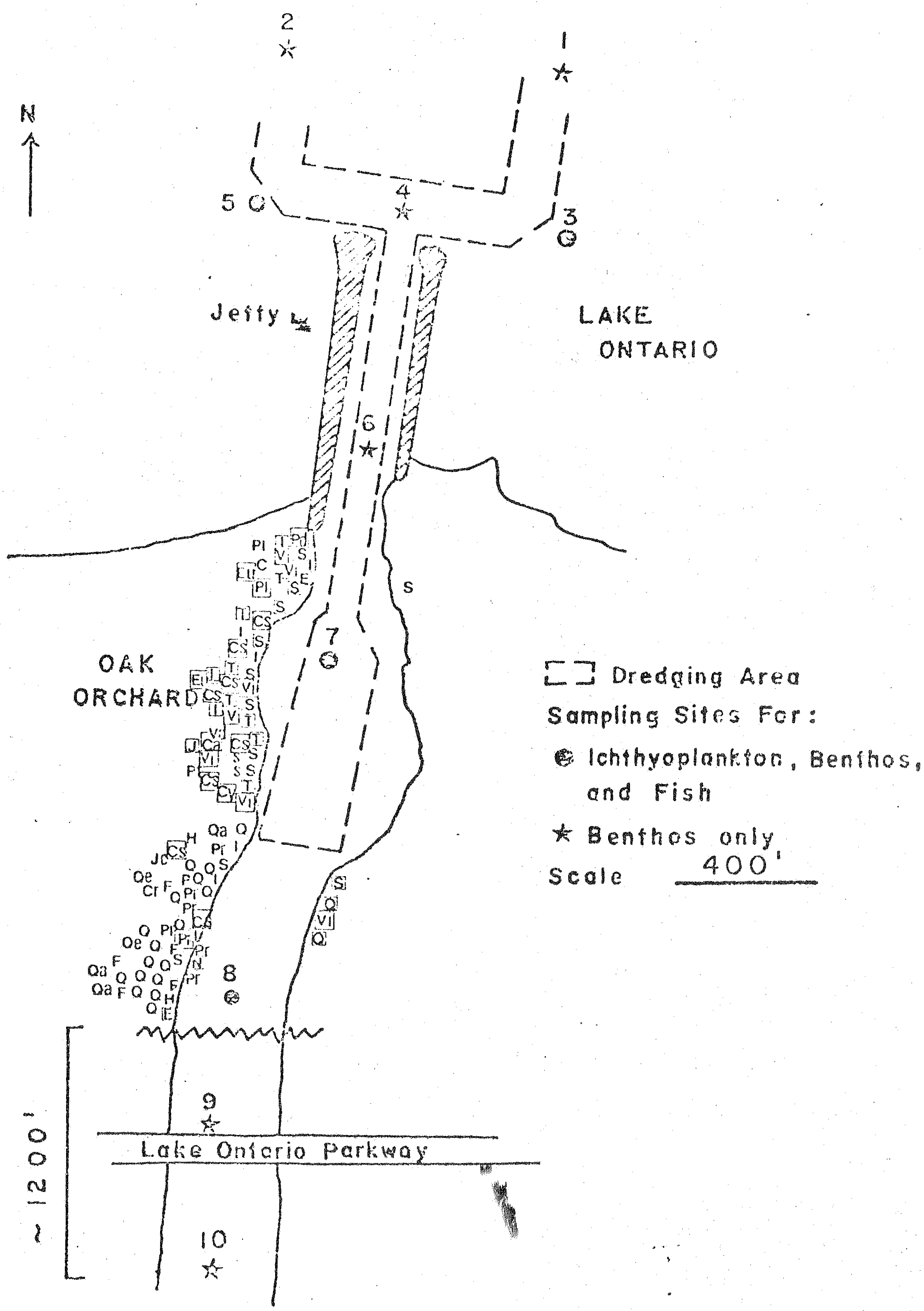
Toward the north end of the creek, the land on each side of the creek is a few feet above the lake level. Moving southward away from the lake, the altitude of the land is considerably higher with the creek contained in a steep-sided valley. The east side of Oak Orchard Creek is commercially developed with numerous marinas. Also, a few private homes still exist interspersed between the marinas. Landscape planting is common near residential structures and includes assorted biennial and annual flowering herbaceous garden and lawn plants.

Within 33 m of the creek's east shoreline, only a few terrestrial plants occur. A large white willow (Salix alba) exists near Station 7 while a mix of white willow, red oak (Quercus borealis) (40-60 ft. height range) and wild grape (Vitis sp.) occurs from approximately Station 8 southward on the hill above the creek (Fig. 2)

The west side of the creek toward the lake is characterized by species common to low-lying wet areas such as cottonwood (Populus deltoides) and white willow (Salix alba). Opposite Station 7 on the westside of the creek exists a wetland area containing typical wetland vegetation [e.g., red-osier dogwood (Cornus stolonifera), narrow-leaf cattail (Typha augustifoia) and bulrush (Scirpus sp.)]. Considerable wetland areas exist further upstream as part of the Iroquois Wildlife Refuge. Also, small, intermittent wetland areas exist along the creek south of the project area.

Continuing southward on the west side of the creek, steep-sided hills coming down to the water's edge are evident. Species more tolerant of drier conditions tend to prevail with red, white and pin oak being common. Some

Fig. 2. Location of terrestrial macrophytes and emergent aquatic macrophytes. Squares indicate more than one individual plant. Code for identifying organisms is located in Table 1.



of these trees reach $\sim$60 ft. in height. The understory, consisting of many species, is predominately herbaceous. Location of terrestrial plants can be found in Fig. 2.

Assessment of Impact

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

Table 1. Species list of terrestrial and wetland macrophytes at Oak Orchard Harbor, New York.

Symbol	Genus and Species	Common Name
B	*Bidens coronata*	Tickseed sunflower
Cr	*Carya ovata*	Shagbark hickory
Ca	*Cornus amomum*	Silky dogwood
Cs	*Cornus stolonifera*	Red-osier dogwood
Cy	*Cyperus dentatus*	Sedge
E	*Epilobium* sp.	Willow herb
Eu	*Eupatorium perfoliatum*	Boneset
F	*Fraxinum americana*	White ash
H	*Hamamelis virginiana*	Witch-hazel
I	*Impatiens* sp.	Touch-me-not
Jc	*Juglans cinerea*	White walnut
J	*Juncus effusus*	Soft rush
O	*Ostrya virginiana*	Hop hornbeam
Pl	*Polygonum lapathifolium*	Smartweed
Pd	*Populus deltoides*	Cottonwood
Pt	*Populus tremuloides*	Trembling aspen
Pr	*Prunus serotina*	Wild black cherry
Qa	*Quercus alba*	White oak
Q	*Quercus borealis*	Red oak
Qe	*Quercus ellipsoidalis*	Pin oak
S	*Salix alba*	White willow
Sc	*Scirpus* sp.	Bulrush
T	*Typha augustifolia*	Narrow-leaf cattail
Vd	*Viburnum dentatum*	Arrow-wood
Vi	*Vitis* sp.	Wild grape

AQUATIC MACROPHYTES

Existing Conditions

Our collections included seven floating and eight submerged species (Table 1) of aquatic macrophytes (wetland vegetation is considered in the terrestrial vegetation). No rooted aquatic macrophytes occur below 3 m. This is a considerably greater depth than the 1 to 1.2 m reported for Irondequoit Bay (Ellis, Haines and Makarewicz 1976) and indicates a less turbid water that is relatively unpolluted compared to Irondequoit Bay.

Lemna minor (duckweed), a floating, non-rooted aquatic macrophyte, was prevalent everywhere but in the main channel where the currents carry this species out to the lake. No floating, rooted macrophytes were evident in April. However, such macrophyte growth was apparent by the end of May when macrophyte beds could be distinguished. A large aquatic macrophyte bed extends along the western edge of the project area and the creek (Fig. 3). In some places the bed extends at least 45.7 m into the creek, well into the proposed dredging area. Myriophyllum spp. is the predominant species in the beds with Potamogeton spp. also being abundant. This bed may serve to damp wave action from boat wakes and thus moderate erosion along the steep western bank of the creek.

On the east side of the creek, similar macrophyte development occurs each year; it is especially noticeable at the far north eastern side of the creek as it enters the jetty area. This bed continues southward on the east side of the creek but is not obvious because of extensive marina development. However, under the docks some macrophytes were evident. The bed on the east side does not extend as far up the creek as the one on the west side (Fig. 3). Again, Myriophyllum and Potamogeton spp. predominate.

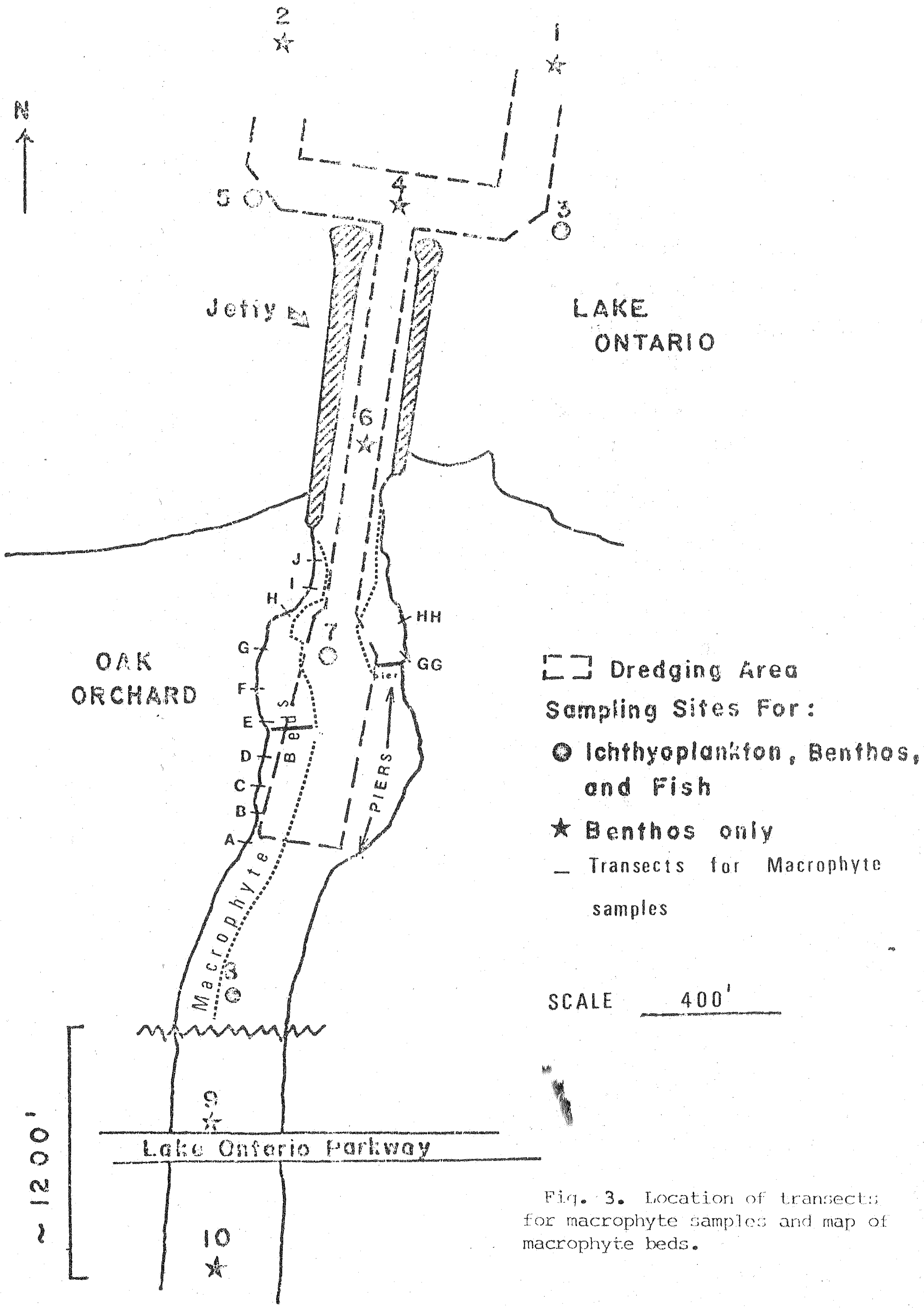


Fig. 3. Location of transects for macrophyte samples and map of macrophyte beds.

Numerous fish nesting sites and a number of juvenile and adult fish (cyprinids and centrarchids) were apparent in the macrophyte beds. These fish use the invertebrates associated with the beds for food and the beds themselves as cover from predators. Piscivorous predators (black bass, pike, gar and bowfin) also existed in and around the beds. The game fish *Esox lucius* (northern pike) probably spawns in the macrophyte beds in early spring. The aquatic macrophyte beds in Oak Orchard Creek also supply habitat for aquatic invertebrates and are important to spawning, hatching and feeding success of many fish species (see FISH section).

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.

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 possible at Oak Orchard Creek as the macrophyte beds "create" quiet areas that are relatively unaffected by the movement of the water in the main channel.

The dredging of the channel will destroy some macrophyte beds on the west side of the creek. The macrophyte beds to be destroyed supply habitat (i.e., cover) and food for invertebrates, fish fry, fingerlings and adult fish and are potential spawning sites for northern pike (Esox lucius). Removal of macrophyte cover will make the various minnows, basses and sunfishes vulnerable to predation by bass, pike, bowfin and gar. A decrease in forage fish abundance will ensue in the project area. If predaceous fish are not able to successfully move to another area, a decline in their numbers may also occur. The impact of dredging on fish and macrophytes is potentially severe. However, the area of macrophyte beds to be destroyed by dredging is small compared to the total area of macrophyte beds available in Oak Orchard Creek. We do not feel that a significant change in the warm water sport fishery will occur due to removal of this small portion of the macrophyte bed. However, this effect can be minimized even further by not dredging in the summer when larval fish are likely to be present.

The shoreline on portions of the west side of the creek is very steep and susceptible to erosion. The extensive macrophyte beds on the western side of the creek may serve to damp wave action from boat wakes and thus moderate erosion along the shoreline.

Table 2. Species list of aquatic macrophytes at Oak Orchard Harbor, New York.

Genus and Species	Common Name
Anacharis canadensis	Waterweed
Anacharis occidentalis	Waterweed
Ceratophyllum demersum	Coon-tail
Lemna minor	Lesser duckweed
Lemna trisulca	Star duckweed
Myriophyllum spp.	Water milfoil
Nuphar sp.	Yellow pond lily
Nuphar rubrodiscum	Yellow pond lily
Nymphaea sp.	Water lily
Numphaea odorata	Duckweed
Potamogeton spp.	Narrow-leaf pondweed
Potamogeton crispus	Pondweed
Spirodela polyrhiza	White pond lily
Vallesnaria americana	Tape grass
Wolffia sp.	White pond lily

MACROBENTHOS

Existing Conditions

The macrobenthic community of Oak Orchard Creek is presently dominated by species of midge larvae (chironomids) and oligochaets (tubificids) (Table 3). They account for ~70% of the total number of organisms sampled during the study period. Stations and seasonal differences in species composition and relative abundance of the chironomids and tubificids were found during the three sampling seasons.

In autumn, tubificids (54.6% of the total community) dominated the lake stations 1 to 6 on a substrate of mixed gravel, cobble and sand while chironomids accounted for less than 12% of the benthic community. At creek stations 7 to 10, tubificid standing crop decreased while chironomid standing crop increased slightly (Table 4). In the spring and summer, tubificid biomass was generally low at Stations 1 to 4 but increased by Stations 7 to 10. Chironomid biomass increased from the lake stations to the creek stations (Table 4).

Other organisms were occasionally abundant. For example, the autumn density of Gammarus, an amphipod, was 3553 and 605 individuals/m^2 at Stations 2 and 3, respectively. Mollusks observed included Pisidium, Ellipto, Physa, Musculium and Lymnacea. Although the distribution was variable and densities were low, mollusks were generally observed in the silty gyttja type sediments of the creek and not in the gravel-sand-cobble sediment of the lake stations.

The macroinvertebrate community of Oak Orchard Creek is similar to other shallow bays and drowned river mouths of Lake Ontario (Cook and Johnson 1974). In such bodies of water, large populations of chironomids (mainly Chironomus,

Table 3. Species list of benthic invertebrates at Oak Orchard Harbor, New York.

Annelida
- Oligochaeta
  - Haplotaxida
    - Naididae
      - *Stylaria lacustris*
    - Tubificidae
      - *Limnodrilus* spp. immatures
      - *L. claparedeianus*
      - *L. hoffmeisteri*
      - *Peloscolex ferox*
      - *Potamothrix moldaviensis*
      - *P. vejdovsky*
      - unidentifiable immature tubificids
  - Lumbriculida
    - Lumbriculidae
      - unidentifiable immature lumbriculids

Arthropoda
- Crustacea
  - Amphipoda
    - Gammaridae
      - *Crangonyx* ? *gracilis s.l.*
      - *Gammarus fasciatus*
  - Isopoda
    - Asellidae
      - *Asellus* sp.
  - Podocopa
    - Candonidae
      - *Candona scopulosa*
    - Cypridae
      - unidentifiable cyprinids
    - Limnocytheridae
      - *Limnocythere* ? *sancti-patrici*
- Insecta
  - Coleoptera
    - Elmidae
      - *Dubiraphia* sp.
  - Diptera
    - Ceratopogonidae
      - *Palpomyia* spp.
    - Chironomidae
      - *Chironomus* spp.
      - *Cricotopus* spp.
      - *Cryptochironomus* spp.
      - *Endochironomus* spp.

Table 3 (continued).

Arthropoda
- Insecta
  - Diptera
    - Chironomidae
      - *Glyptotendipes* sp.
      - *Micropsectra* sp.
      - *Microtendipes* spp.
      - *Parachironomus* spp.
      - *Paracladopelma* spp.
      - *Paralauterborniella* spp.
      - Pentaneurini
      - *Phaenopsectra* spp.
      - *Polypedilum* spp.
      - *Procladius* spp.
      - *Psectrocladius* sp.
      - *Psectrotanypus* spp.
      - *Pseudochironomus* spp.
      - *Rheotanytarsus* spp.
      - unidentifiable chironomids
  - Ephemeroptera
    - Caenidae
      - *Caenis* spp.
    - Ephemeridae
      - *Hexagenia limbata*
    - Heptageniidae
      - *Stenonema tripunctatum*
  - Lepidoptera
    - Pyralidae
      - (specimen unidentifiable)
  - Megaloptera
    - Sialidae
      - *Sialis* sp.
  - Trichoptera
    - Leptoceridae
      - *Ceraclea neffi*
    - Polycentropodidae
      - *Polycentropus* sp.

Coelenterata
- Hydrozoa
  - Hydroida
    - Hydridae
      - *Hydra* sp.

Table 3 (continued).

Mollusca
- Gastropoda
  - Basomatophora
    - Lymnaeidae
      - unidentifiable immature *Lymnacea* spp.
    - Physidae
      - *Physa heterostropha*
- Pelecypoda
  - Heterodonta
    - Sphaeriidae
      - *Musculium transversum*
      - *Pisidium* sp.
      - *P. (Cyclocalyx) castertanum*
      - *P. (C.) henslowanum*
      - *P. (C.) supinum*
      - *P. lilljeborgi*
  - Schizodonta
    - Unionidae
      - *Ellipto complanata*
      - *Froptera alata*

Platyhelminthes
- Turbellaria
  - Tricladida
    - Planariidae
      - ? *Cura formanii*

Table 4. Summary of macroinvertebrate data for Oak Orchard Creek, New York (1978-1979). Original data can be found in the autumn, spring and summer data reports.

AUTUMN

Stations	Tubificids #/m²	Tubificids % of Total	Chironomids #/m²	Chironomids % of Total	Community Standing Crop #/m²	Species Number
1	300	88.8	38	11.2	338	2
2	0	0.0	0	0.0	3572*	2
3	69	3.6	19	1.0	692	3
4	1568	97.6	38	2.4	1606	2
5	46	100.0	0	0.0	46	1
6	507	87.9	69	12.0	577	3
7	15	3.3	38	8.4	454	9
8	100	48.3	95	45.9	207	4
9	192	68.5	68	23.2	293	8
10	77	50.7	25	16.4	152	5

* mostly Gammarus

SPRING

Stations	Tubificids #/m²	Tubificids % of Total	Chironomids #/m²	Chironomids % of Total	Community Standing Crop #/m²	Species Number
1	0	0.0	40	29.4	136	9
2	8.6	9.1	32	23.5	95	7
3	0	0.0	23	45.1	51	3
4	26	81.0	0	0.0	32.1	3
5	129	56.8	17	20.7	227	9
6	16	70.0	167	22.1	737	10
7	679	42.8	730	46.1	1585	14
8	275	29.2	572	60.9	939	17
9	120	23.7	231	45.7	506	13
10	181	52.8	135	39.4	343	9

Table 4 (continued).

SUMMER

Stations	Tubificids #/m^2	Tubificids % of Total	Chironomids #/m^2	Chironomids % of Total	Community Standing Crop #/m^2	Species Number
1	42	16.5	91	36.0	254	10
2	0	0.0	85	65.9	129	4
3	0	0.0	93	24.2	384	7
4	1282	54.3	936	39.6	2362	13
5	0	0.0	149	52.8	282	9
6	10	22.7	21	47.7	44	5
7	970	70.5	224	16.3	1376	12
8	1049	76.9	138	10.1	1364	12
9	797	67.8	321	27.3	1175	12
10	917	59.7	464	30.2	1536	16

Procladius and *Cryptochironomus* spp.) often develop. With few exceptions, these three genera comprise the bulk of the chironomids taken at Stations 7 to 10 during each season of the year. *Chironomus* spp. were more widely distributed and relatively more abundant than *Procladius* or *Cryptochironomus* spp. *Phaenospectra* spp. was very abundant within the creek in May while *Polypedilum* spp. became more prevalent in the July samples.

At the lake stations 1 to 6, *Rheotanytarsus* and *Cricotupus* spp. predominated. *Micropsecta* spp., considered intolerant of pollution (Resh and Unzicker 1975), was observed at the lake stations in July. The dominant tubificids at both lake and creek stations were *Limnodrilus hoffmeisteri* and *Potamothrix moldaviensis*.

For each sampling date, a relatively uniform pattern of standing crops was observed for the lake and creek stations. Generally, standing crop increased from the lake to the creek stations. Average standing crops at the lake stations were 1139, 426 and 576 individuals/m^2 for the autumn, spring and summer, respectively. These values are somewhat higher than invertebrate densities (29 to 620/m^2) in Lake Ontario off Irondequoit Bay, New York (Ellis, Haines and Makarewicz 1976).

Average standing crops at the creek stations were 276, 843 and 1362 individuals/m^2 for the autumn, spring and summer, respectively. In comparison to other river mouths/bays of Lake Ontario, Oak Orchard Creek has densities similar to the northern end of Irondequoit Bay, New York (Ellis, Haines and Makarewicz 1976). However, these values are much lower than most reports for other bay and harbor sediments in Lake Ontario; for example, about 2000 to 52,000 individuals/m^2 in Hamilton Bay (Johnson and Matheson 1968), 50,000 commonly and up to 200,000/m^2 in Toronto Bay (Brinkhurst 1970) and 21,000/m^2 in Oswego Harbor and River (Kinney 1972).

In comparing the lake and creek stations seasonally at Oak Orchard, species diversity and standing crop increased from the lake stations to the creek stations. This indicates that the creek is a more productive and diverse area than the lake, providing a relatively abundant variable food source for consumer organisms.

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.

Dredging will completely eliminate the macroinvertebrate population in the area being excavated. Outside of the excavation area, settling of re-suspended 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 above will be limited to areas north of the southern terminus of the proposed dredging area and into Lake Ontario following 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. However, as the total area to be dredged is small compared to the entire creek ecosystem, we anticipate that recolonization from upstream areas will occur relatively rapidly.

PHYTOPLANKTON AND ZOOPLANKTON

Existing Conditions

Phytoplankton and zooplankton samples were not taken. However, the section of Oak Orchard Creek within the project area is a drowned river mouth of Lake Ontario. Thus, phytoplankton and zooplankton populations similar to those of the inshore areas of Lake Ontario would be expected as would some epiphytic and periphytic phytoplankton associated with the macrophyte community. Littoral species of zooplankton would probably be more predominant within the creek than outside the creek.

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 result in a short-term stimulatory effect on phytoplankton production due to the possible release of limiting nutrients into the ecosystem. This effect may be greater in Lake Ontario where nutrients are more likely to be in short supply. Localized phytoplankton blooms could occur in Lake Ontario in the plume of nutrient waters from the creek 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 fish and many juvenile fish. Many members of the zooplankton community are "filter feeders." They strain the water for small food particles. Preliminary 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

Oak Orchard Creek is a productive fish nursery area characterized by slow current, variable depths and substrates and by abundant aquatic vegetation. These factors, in association with a productive surrounding watershed, combine to provide abundant food sources for a diverse fish assemblage. Bottom sediments are rich in organic debris in various states of decay. Large quantities of leaf and stick fragments indicate substantial detrital input from the watershed. These materials and abundant aquatic vegetation form a base for benthic invertebrate production which supports a large juvenile and adult fish community. High fish production is strongly suggested by early maturity (mature pumpkinseed at <10 cm) and abundant body fat found in most species.

Twenty-nine species of fish were observed in the project area with rock bass (Ambloplites rupestris), pumpkinseed (Lepomis gibbosus), bluegill (Lepomis macrochirus), white perch (Morone americana) and johnny darter (Etheostoma nigrum) being the most common (Table 5). The most common species of angling interest found in the project area were lake trout (Salvelinus namaycush), brown trout (Salmo trutta), chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch), northern pike (Esox lucius), largemouth bass (Micropterus salmoides), smallmouth bass (Micropterus dolomieui) and brown bullhead (Ictalurus nebulosus).

During the study period, 3 of 29 fish species did not possess developed gonads or ripe sex products. This indicates that potential spawning activity in the project area is high (i.e., the project area is a nursery). Rock bass, white perch and pumpkinseed were the most common species in

Table 5. Species list of fish at Oak Orchard Harbor, New York.

Amiidae	
Amia calva	Bowfin
Catostomidae	
Moxostoma spp.	Redhorse sucker
Centrarchidae	
Ambloplites rupestris	Rock bass
Lepomis gibbosus	Pumpkinseed
Lepomis macrochirus	Bluegill
Micropterus dolomieui	Smallmouth bass
Micropterus salmoides	Largemouth bass
Pomoxis nigromaculatus	Black crappie
Clupeidae	
Dorosoma cepedianum	Gizzard shad
Cyprinidae	
Campostoma anomalum	Stoneroller minnow
Carassius auratus	Gold fish
Cyprinus carpio	Carp
Nocomis micropogon	River chub
Notemigonus crysoleucas	Golden shiner
Notropis atherinoides	Emerald shiner
Notropis bifrenatus	Bridle shiner
Pimephales promelas	Fathead shiner
Cyprinodontidae	
Fundulus diaphanus	Eastern banded killifish
Esocidae	
Esox lucius	Northern pike
Ictaluridae	
Ictalurus nebulosus	Brown bullhead
Noturus flavus	Stonecat madtom
Lepisosteidae	
Lepisosteus osseus	Longnose gar
Percidae	
Etheostoma nigrum	Johnny darter

Table 5 (continued).

Salmonidae	
Oncorhynchus kisutch	Coho salmon
Oncorhynchus tschawytscha	Chinook salmon
Salmo gairdneri	Rainbow trout
Salmo trutta	Brown trout
Salvelinus namaycush	Lake trout
Serranidae	
Morone americana	White perch
Morone chrysops	White bass

spawning condition. However, all the sport fishes were observed at some time possessing developed gonads or ripe sex products.

Species of Most Interest to Sport Fishermen

There appears to be a substantial interaction between the Oak Orchard Creek and Lake Ontario fish communities. For example, northern pike live in the creek but may forage in the lake at night while salmonids live in the lake but generally enter the creek in the autumn to spawn. In the following section, we discuss the life histories (Scott and Crossman 1973) of abundant fish and fish of angling interest observed in the project area. Two major catagories will be considered: (1) predominately lake species which may utilize the creek; and (2) predominately creek species which may utilize the lake.

I. Predominately Lake Species

A. Family Salmonidae - Lake, brown and rainbow trout and chinook and coho salmon were caught.

1. Mature brown trout, probably engaged in fall spawning migrations, were caught in Lake Ontario and Oak Orchard Creek in the autumn of 1978. A few were also captured in the lake in the spring of 1979.

2. Mature chinook salmon, probably engaged in fall spawning runs, were captured in the lake and creek only in the autumn of 1978.

3. Although coho salmon are known to spawn in Great Lakes tributaries in September and October, we caught coho in the lake only in the spring of 1979.

4. Lake trout were netted only in the lake in the autumn of 1978 and in the spring of 1979.

5. One rainbow trout was caught in the creek during the autumn of 1978.

No salmonids were caught in the summer of 1979 probably because of high nearshore water temperatures (> 16°C). Salmonids prefer waters near 10°C and probably had moved to the deeper, cooler waters of Lake Ontario.

B. Lake Centrarchidae - Only rock bass and smallmouth bass were caught in Lake Ontario.

1. Although adult smallmouth bass were netted in each season, they are extremely net wary. This probably accounts for the small numbers caught despite large populations known to exist in the lake. The Oak Orchard area is a suitable smallmouth habitat, consisting of rocky or sandy shallows with nearby deep, cool areas. Smallmouth congregate in spring and spawn over sand, gravel or rock bottoms in lakes or rivers. We found juveniles and spent adults in the creek, indicating that reproduction occurs there.

2. Rock bass also spawn in the spring and early summer after building nests in gravelly, vegetated areas. They are often associated with smallmouth bass and pumpkinseed, as we found at Oak Orchard. Most rock bass caught in the creek were immature while those in the lake were mature. This indicates that adults primarily inhabit the lake. Juvenile rock bass were the most abundant species caught in the shallow aquatic creek vegetation, indicating the importance of these areas as a nursery.

C. Family Serranidae - White perch were the most abundant species of the study. They were generally absent from the Oak Orchard area in the autumn of 1978 but numerous in the spring and summer of 1979. White perch employ open water, mass fertilization while spawning from mid-May through July in almost any type of water. Although primarily lake residents, they enter Oak Orchard Creek to spawn as indicated by the presence of immature fish in the lake and gravid fish in the creek in the spring of 1979. In the summer of 1979, most perch caught in the creek and lake were spent but were already regenerating new reproductive products. Since white perch were also gravid during the autumn of 1978, we suspect that this species may be breeding twice annually. White perch have high fecundity, are voracious feeders and often quickly displace established, competing species.

D. Family Catostomidae - Mature redhorse suckers were found every season in the lake, indicating that adults are lake residents which engage in spring spawning movements to the creek. However, no redhorse were caught in the creek, except in the autumn of 1978.

Other predominately lake species caught in small numbers included gizzard shad and white bass.

II. Predominantly Creek Species

A. Family Centrarchidae - Pumpkinseed, bluegill, largemouth bass and black crappie were caught in Oak Orchard Creek.

1. After rock bass, pumpkinseed were the most numerous juveniles in the creek. For both bluegill and pumpkinseed, the creek appears to be a major nursery area. Both species use the aquatic vegetation for shelter, invertebrate food supplies and nesting. Many nests were observed in the spring and summer of 1979, some with adults guarding them. Unlike rock bass, adult bluegill and pumpkinseed were caught in the creek in most seasons.

2. Largemouth bass adults and juveniles were also caught in most seasons. Also spring spawners, largemouth bass build nests over sand and gravel near aquatic vegetation. Two gravid females were caught in the spring of 1979.

B. Family Cyprinidae - As expected, a number of cyprinid species were found at Oak Orchard, including carp, goldfish, stoneroller and fathead minnows and golden, bridle and emerald shiners.

1. Emerald and golden shiners are primarily schooling lake residents which serve as forage fish for a number of predators. Emerald shiners spawn in the lake, but juveniles often enter creeks, as we found at Oak Orchard. Golden shiners spawn from June to August by depositing their eggs in aquatic macrophytes and algae. We found immature individuals in the spring of 1979 and mature fish in the summer of 1979.

2. Carp are spring and early summer spawners that lay eggs *en masse* in shallow, weedy areas. The large size of many adults suggested that they also inhabit the lake. We observed spawning activities in the creek in the spring of 1979.

3. Bridle shiners spawn from May to August and are characteristic of quiet streams with vegetated shallows. They are an important forage fish for centrarchids and white perch in the Lake Ontario region. Adverse impacts of dredging on bridle shiners could dramatically alter the Oak Orchard Creek food webs.

C. Family Ictaluridae - Brown bullheads and stonecat madtoms were collected.

1. Brown bullheads spawn in warm, shallow, weedy, mud-bottom areas from late spring to September. We found both immature and mature individuals in the creek.

D. Families Amiidae and Lepisosteidae - Bowfins and longnose gars were abundant in Oak Orchard Creek. These primitive predators are voracious piscivores and spawn in late spring and early summer. Both prefer quiet, weedy shallows and spawn there. Bowfins spawn in nests and gars directly in the weeds.

E. Family Esocidae - Northern pike, also voracious piscivores, inhabit Oak Orchard Creek and occassionally forage in the lake. Pike usually spawn in flooded terrestrial vegetation immediately after ice-out in April and May while juveniles and adults frequent macrophyte beds.

F. Family Cyprinodontidae - Eastern banded killifish are creek residents often found in small schools in shallows. They spawn in quiet, shallow, weedy areas over sand and detritus. Killifish at Oak Orchard displayed these characteristics.

G. Family Percidae - Johnny darters are creek residents which spawn under rocks in shallow regions each spring. This habit may explain why we found darters abundant in the autumn of 1978 and the summer of 1979 but found none while electroshocking in the spring of 1979. Johnny darters prefer sand-silt-gravel substrates in weedy shallows and should be unaffected if suitable habitat remains after dredging.

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). Brown trout and coho and chinook salmon move into the tributaries of Lake Ontario between August and November while lake trout move to cobble shoal areas of the lake. Evidence is accumulating which suggests a 10-20% success rate for natural reproduction of these salmonids on the south shore of Lake Ontario tributaries (Abraham 1979). The populations of these fish are of local economic interest in thay they support a growing recreational industry - the sport fishery.

Project implementation may affect fish migration. Some species are known to avoid turbid waters; thus some fish movements into or out of the creek could be temporarily halted by dredging operations. Some species of fish (e.g., the salmonids), however, use olfactory cues during migration and would not be deterred from a normal migration by just the occurrence of turbid waters (EIFAC 1965). However, as the sediments in Oak Orchard are high in organic matter and would be expected to exert an oxygen demand on the water if disturbed, interruption of migration by fall dredging is likely.

Dredging activity could create an area of water with chemical conditions unsuitable for fish life. Adult fish would be expected to avoid an area of low dissolved oxygen concentrations. The extent of this area (also see section on SEICHES) would stretch from at least the southern terminus of the project area northward into Lake Ontario, where it would be mixed with the highly oxygenated waters of Lake Ontario. Duration would be a function of the length of the dredging operations and B.O.D. of sediments.

Thus, dredging operations may affect the spawning behavior of salmonids. Dredging operations should not take place during the salmonid spawning season (mainly in the autumn) if future year classes are to remain strong. Discussion on effects of dredging on warm water species is given in the AQUATIC VEGETATION section.

High concentrations of suspended solids resulting from a dredging operation could result in direct damage to adult and larval fish which have not avoided 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 operations, but adult fish would have ample opportunity to avoid such concentrations in an open system. The only filter feeders in Oak Orchard Creek as adults are the alewife and the gizzard shad, both of which are considered to be nuisance species in Lake Ontario. 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 be reduced in the area. The 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 game fish (salmonids 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, as they may be caught in the wash water processing of dredged materials (Herdendorf 1978) and be physically destroyed.

The brown and lake trout and the coho and chinook salmon are autumn spawners. This means that juveniles migrate downstream during the spring feed on aquatic invertebrates and zooplankton. Although salmonids will not spawn in the proposed dredging area, juveniles of this family and other families may be especially sensitive to excessive turbidity. 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 a high mean hatch of striped bass eggs on coarse sands (58.9%) and in a plain plastic pan (60.3%) than on silty sand (21%), silt-clay sand (4%) or detritus (0%). With sedimentation of resuspended matter, sandy-gravelly areas on the western and eastern sides of the north end of the creek may change in bottom composition. We observed spawning of rock bass and pumpkinseed in this area.

The creation of a muddy bottom could have a beneficial impact on certain fish populations. For example, carp which utilizes the bottom sediment for food would have enhanced growth. However, this species is generally considered to be of no value in this area.

Ricker (1945) does note 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 propsed action is so limited in relation to the entire creek/drowned river mouth ecosystem that a negligible impact is probable.

BIRDS

Existing Conditions

In six days of observations during the autumn, summer and spring, 54 species of birds were observed at Oak Orchard Creek (Table 6). This compares favorably to the 232 species recorded over a number of years by numerous bird watchers for Irondequoit Bay (Genesee Ornithological Society), a bay ~40 miles east of Oak Orchard Creek. Of the 232 species found in Irondequoit Bay, 153 species are known to breed in the area. Because habitat composition for the entire Oak Orchard Creek watershed is similar to the Irondequoit Bay area, similar breeding populations would be expected in Oak Orchard Creek.

The most abundant birds seen at Oak Orchard Creek include the Canada goose (*Branta canadensis*), the ringed-bill gull (*Larus delawarensis*) and the blue jay (*Cyanocitta cristata*). Other abundant species include the red-winged blackbird (*Agelaius phoeniceus*), house sparrow (*Passer domesticus*), common grackly (*Quiscalus quiscula*) and starling (*Sturnis vulgaris*).

Some of the more rare or unusual birds observed at Oak Orchard Creek include the osprey (*Pandion haliactus*), great blue heron (*Ardea herodias*) and the great horned owl (*Bubo virginianus*).

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. However, it is difficult to imagine that the noise of machinery and human activity associated with dredging would be significantly greater than the noise and human activity currently occurring at the creek on weekends by the constant parade of motor boats and sailboats. Nevertheless, no significant long-term effects on bird populations should occur with project implementation.

Table 6. Species list and relative abundance of birds at Oak Orchard Harbor, New York.

Genus and Species	Common Name	Fall	Spring	Summer
Branta canadensis	Ganada goose	65		
Bubo virginianus	Great horned owl	1		
Dendrocopos villosus	Hairy woodpecker	1		
Falco tinnunculus	Kestrel	1		
Larus marinus	Great black-backed gull	1		
Melanitta deglandi	White-winged scoter	1		
Pandion haliaetus	Osprey	1		
Regulus calendula	Ringed-crowned kinglet	2		
Melospiza georgiana	Swamp sparrow	1	1	
Dendroica coronata	Myrtle warbler	7	1	
Sitta carolinensis	White-breasted nuthatch	2	1	
Charadrius vociferus	Killdeer	6	9	11
Agelaius phoeniceus	Red-winged blackbird	30	20	15
Melospiza melodia	Song sparrow	2	2	6
Turdus migratorius	Robin	4	6	14
Sturnus vulgaris	Starling	20	11	34
Dendrocopos pubescens	Downy woodpecker	11	2	2
Cyanocitta cristata	Blue jay	3	50	2
Larus delawarensis	Ringed-bill gull	10	10	250
Megaceryle aleyon	Belted kingfish	1	2	2
Larus argentatus	Herring gull	3	2	10
Spinus tristis	American goldfinch	2	2	2
Parus atricapillus	Black-capped chickadee	4	4	3
Zenaidura macroura	Mourning dove	1	6	4
Bombycilla cedrorum	Cedar waxwing	3		3
Molothrus ater	Brown-headed cowbird		1	
Empidonax trallii	Willow flycatcher		1	
Ardea herodias	Great blue heron		1	
Cardinalis cardinalis	Cardinal		2	
Dendroica petechis	Yellow warbler		4	

Table 6 (continued).

Genus and Species	Common Name	Fall	Spring	Summer
Empidonax minimus	Least flycatcher		2	
Vireo sp.	Unidentified vireo		1	
Troglodytes aedon	House wren		1	
Colaptes auratus	Common flicker		1	3
Quiscalus quiscula	Common grackle		16	26
Progne subis	Purple martin		10	6
Icterus galbula	Northern oriole		1	1
Passer domesticus	House sparrow		20	9
Dumetella carolinensis	Grey catbird		1	4
Hirundo rustica	Barn swallo		7	8
Myiarchus crinitus	Great crested flycatcher			1
Riparia riparia	Bank swallow			5
Butorides virescens	Green heron			1
Coccyzus erythropthalmus	Black-billed cuckoo			1
Sturnella magna	Eastern meadowlark			2
Spizella passerina	Chipping sparrow			1
Anas platyrhynchos	Mallard			7
Iridoprocne bicolor	Tree swallow			2
Columba livia	Rock dove			2
Falco sparverius	American kestrel			2
Tyrannus tyrannus	Eastern kingbird			1
Contopus virens	Eastern wood pewee			2
Geothlypis trichas	Common yellowthroat			2
Actitus macularia	Spotted sandpiper			1

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 to 6) 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. Several species protected by State and/or Federal Law have existing or historical ranges that encompass the Oak Orchard area. Of these, only the Peregrine Falcon and Bald Eagle might be seen in the Oak Orchard region today.

Assessment of Impact

The dredging project proposed for Oak Orchard Creek should not have any adverse effect on habitat of value to endangered species or any individuals of an endangered species.

TOXIC CHEMICALS

Existing Conditions

Analysis 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 the intensive agriculture occurring within the watershed of Oak Orchard Creek, 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 and 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 marsh grass, from water via phytoplankton, from ingestion of contaminated particulate matter by filter faders 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.

SEICHES

Existing Conditions

Currents in Oak Orchard Creek normally move northward to Lake Ontario. Thus, the area to be affected by dredging operations would extend north of Station 8 (Fig. 1), a relatively small portion of the river ecosystem. This northward flow of water is reversed periodically by seiches. Seiches or standing waves were evident within the project area of Oak Orchard Creek during every sampling period. The seiches in Oak Orchard Creek are a manifestation of seiches occurring on Lake Ontario commonly due to wind-induced tilting of the water surface and the thermocline (Wetzel 1975). During a seiche event, water moves periodically in and out of Oak Orchard Creek from Lake Ontario; that is, there are times when the creek's water moves southward rather than northward to the lake. The period of inflow and outflow into the creek are dependent on events in Lake Ontario. However, periods of seiches as short as 30 minutes were observed at Oak Orchard Creek.

Assessment of Impact

In the preceding sections, all impacts were based on the creek flowing northward. Only a small portion of this biologically productive creek, a nursery area for many fish, would be affected by resuspension of sediments and silting. With the current moving southward, extensive areas of the creek not in the project area, areas including spawning sites for fish, the macrophyte community which shelters warm water sport fishes, and the benthic community may be smothered by sedimenting particles. Also, the area of high biochemical oxygen demand and low dissolved concentration will move not into the large, relatively unproductive waters of the inshore zone of

Lake Ontario but into the biologically productive upstream waters of the creek, which contain large numbers of fish and invertebrates. These organisms would probably not be able to withstand the low oxygen concentrations which would develop. In fact, many of the factors mentioned in previous sections would occur but potentially over a much greater area of the creek.

The duration of seiches and the extent of the southerly movement are not known. Because a much greater area of the creek could be affected, their occurrence during dredging operations could have a significant effect on fish, benthic invertebrates and on the macrophyte community in Oak Orchard Creek. The duration of seiches and the extent of their movement southward into Oak Orchard Creek warrant further field studies, before dredging commences.

RECOMMENDATIONS

1. Studies of the toxic chemical contents of the sediments of Oak Orchard Creek should be initiated (if they have not already begun).
2. The occurrence and duration of seiches and the extent of movement of water south into the Oak Orchard Creek should be evaluated. If sediments suspended by the dredging operations are carried southward rather than northward into Lake Ontario by a seiche, significant adverse effects on the biological community of Oak Orchard Creek south of the project area are possible.
3. To minimize adverse effects on the salmonid and warm water sport fisheries, dredging should be restricted to a period of time after autumn salmonid spawning runs but before the spring spawning of warm water species. Potential toxic effects will also be minimized by cold winter water temperatures which slow the metabolic and feeding rates of fish, thus reducing potential toxicant uptake.
4. If parts 1, 2 and 3 are adequately accounted for, we anticipate that the destruction of the benthos populations and the removal of aquatic macrophyte beds with their associated warm water fishes, and the destruction of phytoplankton and zooplankton in the dredging area northward following the turbidity plume will have a negligible environmental impact on the entire creek-drowned river mouth ecosystem. This conclusion is based on the fact that the scope of the proposed action is limited in relation to the entire creek and lake ecosystem and our assumption that recolonization will occur rapidly from nearby undisturbed areas.

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