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THE ENVIRONMENTAL EVALUATION WORK GROUP FY 1979 STUDIES OF THE WINTER NAVIGATION DEMONSTRATION PROGRAM

ST. LAWRENCE RIVER FISHERIES STUDY

Dennis J. Dunning

Bio Systems Research Inc.
455 Cayuga Road
Buffalo, New York 14225

July 31, 1979

This study was conducted as part of Project Number 5100 of the Great Lakes Basin Commission for the Environmental Evaluation Work Group of the Winter Navigation Board. Funding was provided by the U. S. Army Corps of Engineers - Detroit District through the Great Lakes Basin Commission.

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The objectives of this study were to (1) characterize the temporal and spatial distribution of adult fishes in the proposed Demonstration Corridor, (2) determine the population structure, relative growth and feeding ecology of northern pike, yellow perch, largemouth bass, smallmouth bass, and (3) characterize the diel and spatial distribution of larval fish in the proposed Demonstration Corridor, for the purpose of helping to identify fish spawning areas. Also included with this report, but bound separately in one volume, is the Appendices.

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ABSTRACT

Data were collected during the winter and spring of 1979 at Morristown, Chimney Bay and Tibbits Creek, to determine the character of the St. Lawrence River fisheries in these areas. Species abundance and distribution were found to vary by location, time of year and depth of sampling. The number and species of fish collected in gill nets were generally greater in shallow water as compared with deep water stations. Increased adult species abundance and diversity during the spring, relative to the winter, probably reflected increased fish movement associated with spawning and feeding. Ichthyoplankton abundance and species increased progressively throughout the spring. Mean lengths at age for northern pike and yellow perch generally indicated the existence of sexually dimorphic growth. Feeding appeared to be an important activity for northern pike and yellow perch during both winter and spring, as evidenced by stomach content analyses.

SUMMARY

1. The current study was developed to help evaluate the reasonably forseeable environmental effects of a proposed Winter Navigation Demonstration Program on the fisheries of the St. Lawrence River.

2. The study had two major segments; (1) adult fish sampling, which took place during the winter and spring, and (2) ichthyoplankton sampling, which took place only during the spring.

3. Adult fish sampling, centered at Morristown Point, Chimney Bay and Tibbits Creek, had a twofold objective; (1) to characterize the temporal and spatial distribution of adult fishes in the FY 1979 Winter Navigation Demonstration Corridor for the purpose of evaluating relative abundance and species composition of fishes, and determining the location of spawning grounds, and (2) to collect data on certain important species characteristics from northern pike and yellow perch.

4. The objective of the larval fish sampling conducted during the spring was to characterize the temporal and spatial distribution of fish larvae for the purpose of identifying fish spawning and nursery areas.

5. Gill nets, trap nets and seines were used to sample adult and juvenile fish.

6. Miller High-Speed Samplers were primarily used to sample larval fish; plankton nets (0.5m diameter) were briefly utilized for comparative purposes.

7. Relative species abundance and distribution of fishes collected during the current study varied by gear, location, depth and date of sampling.

8. In general, relatively fewer fishes were collected in gill nets during the winter in contrast to the spring.

9. Greater spring catches probably resulted from increased fish activity associated with feeding and spawning.

10. The average gill net catch in shallow water was over twice the adjusted catch for deep water at Chimney Bay, and over four times greater than the adjusted deep net catch at Morristown Point.

11. The relative distribution of fish between shallow and deep waters was species specific; some exhibited higher average catches near shore while others exhibited higher catches offshore.

12. Species diversity was higher at Chimney Bay and Tibbits Creek in comparison with Morristown Point, and appeared to reflect the greater diversity and abundance of productive habitats for fish at the former location.

13. The presence and abundance of yellow perch larvae at Morristown Point, Morristown Harbor and Chimney Bay seemed to indicate that these sites were yellow perch spawning and/or nursery areas. This was supported by the presence of large numbers of ripe and gravid adults at Chimney Bay-Tibbits Creek and Morristown Point sites.

14. Differences in the mean length at age for northern pike captured by gill netting and trap netting were observed. However, a consistent pattern to these variations was not apparent.

15. Results indicated greater survival of northern pike for 1979 than for 1978. The underlying cause(s) of this annual variation is unclear.

16. Examination of food items found in the stomachs of northern pike revealed apparent differences in feeding behavior by area and season.

17. It appears that feeding is an important activity of northern pike during the winter and a disruption of this activity and/or its forage base might negatively affect the species.

18. The recapture of three northern pike during 1979 within the same general location at which they were tagged and released during 1978, appeared to indicate limited migrations either up or down the river.

19. Examination of food items found in the stomachs of yellow perch revealed apparent differences in feeding behavior by area, depth and season.

20. Further examination of the data will be necessary to determine whether changes in feeding, as noted above, accurately reflect actual seasonal changes, or if a significant bias, i.e. very different lengths of fish examined, was affecting the results.

21. The recapture of three yellow perch during 1979 at the same general location at which they were tagged and released during 1978, appeared to indicate limited migrations up or down the river.

22. Since 1931, only two studies of a comprehensive nature were conducted previous to this investigation, which attempted to characterize the nature of the fish resources of the St. Lawrence River (Dunning et al. 1978 and Eckert and Hanlon 1976).

23. Although the overall objective for all three studies was similar, a lack of uniformity and continuity between studies hampered data collection and analysis, thus reducing the overall efficiency of each succeeding program.

24. The current investigation answered some of the questions raised in the two previous studies on the St. Lawrence River, but also raised additional ones.

25. In order to collect baseline data in a manner which would be most useful and efficient in assessing the impacts of a proposed Winter Navigation Demonstration Program, a commitment to the collection of data over a period of years should be adopted.

26. To adequately examine the fisheries at the current study locations, the sampling season should be extended to include no less than the entire winter, and at least part of the summer. In addition, control sites outside the proposed Winter Navigation Demonstration Corridor should be selected and sampled.

27. Abundant evidence exists which demonstrates the importance of diet in determining the growth of fishes. Changes in the growth rate might influence reproductive rates either directly (via survival) or indirectly (via fecundity). As a result, examination of the feeding ecology for selected species should be continued.

28. Data collected during 1979 suggested that the distribution of fish in the St. Lawrence River varied depending on spatial and temporal factors. The extent and nature of this variability is not fully understood. Therefore, continued monitoring of the relative abundance and distribution of fishes in the St. Lawrence River is recommended.

29. Results from previous studies on the St. Lawrence River suggested the existence of local populations of certain species of fish (Dunning et al. 1978, Eckert and Hanlon 1976, Casselman 1967 and Stone et al. 1951). Since knowledge of the extent of local populations of fish is essential in studying their changes, tagging studies of fishes should be resumed and possibly expanded.

30. Since the fisheries of the St. Lawrence River are dependent upon a complex of additional physical, chemical, biological and sociological parameters, concurrent monitoring of additional parameters is necessary; in their absence, one can only hypothesize as to the causative factors effecting changes in the river fisheries.

31. A stable fishery is ultimately dependent upon continued strong recruitment. Modification of spawning habitat may result in lower reproductive success. As a result, fish spawning areas in the St. Lawrence River should be identified and evaluated as to their relative importance.

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INTRODUCTION

The proposed Winter Navigation Demonstration Program is part of an ongoing investigation to demonstrate the practicability of extending the commercial navigation season on the Great Lakes-St. Lawrence River System. As part of that program, the St. Lawrence Seaway Development Corporation proposes to modify existing ice booms at Ogdensburg-Prescott and Galop Island in the St. Lawrence River and conduct a limited number of vessel transits in a Demonstration Corridor. The Demonstration Corridor includes the ice boom sites and extends upstream and downstream in the channel for a total length of approximately 32.2 km (20 mi).

Several important criteria have been adopted to either halt or modify the Demonstration Program and include environmental considerations. This study was developed to help evaluate the reasonably forseeable environmental effects of a demonstration project on the fishery resources in the Corridor, before the demonstration actually begins. Then, during demonstration activities, similar studies will be undertaken to quantify actual effects. This study is only the first phase being undertaken during non-demonstration conditions. The study was split into two major segments; (1) adult fish sampling, which took place during the winter and spring, and (2) ichthyoplankton sampling, which took place only during the spring.

Adult fish sampling had a twofold objective: (1) to characterize the temporal and spatial distribution of adult fishes in the FY 1979 Winter Navigation Demonstration Corridor, for the purpose of evaluating relative abundance and species composition of fishes and determining the location of spawning grounds; and (2) to collect certain species characteristics from northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieui*). These species data included length, weight, age, sex and stomach contents, for the purpose of examining population structure, relative growth and feeding ecology.

Adult fish sampling activities were concentrated at Morristown Point, Chimney Bay and Tibbits Creek. Morristown Point was selected because: (1) it is thought to be a spawning area for several species of fish (Dunning, Evans and Tarby 1978), (2) it lies adjacent to the navigation channel and (3) it is relatively unprotected from wave action resulting from commercial vessel transits in the navigation channel. The Chimney Bay-Tibbits Creek area was selected because of its association with the Tibbits Creek marsh, which probably serves as an important spawning ground and nursery area for fishes of the St. Lawrence River (Dunning et al. 1978 and Werner and Ford 1972), and because of its proximity to the navigation channel. Data were previously collected at Morristown Point and Chimney Bay-Tibbits Creek by Dunning et al. (1978) and Eckert and Hanlon (1976).

The objective of the larval fish sampling conducted during the spring of 1979 was to characterize the temporal and spatial distribution of fish larvae in the FY 1979 Winter Navigation Demonstration Corridor, for the purpose of helping to identify fish spawning and nursery areas.

MATERIALS AND METHODS

STUDY AREA

The Winter Navigation Demonstration Corridor encompasses a section of the St. Lawrence River extending from Morristown on the American shore 32.2 km (20 mi) downriver to Cardinal on the Canadian shore. The 1979 Fisheries Study was centered around Morristown Harbor, Morristown Point, Chimney Bay and Tibbits Creek. All of these areas lie within the Demonstration Corridor (Figures 1, 2, and 3).

The Morristown Harbor area has extensively developed shorelines for boat services. The shoreline at the mouth of the harbor is characterized by limestone rock ledges and rubble. Associated with the harbor is a small marsh system fed by Louce Creek.

The shore and shelf around Morristown Point, when examined in a downriver direction, are characterized by limestone rock ledges and rubble which grade into a sand and rubble and then back to limestone rock ledges and rubble. The transition from channel to shore is abrupt and littoral areas are limited in extent.

The Chimney Bay area, especially in the vicinity of Tibbits Creek, has a more extensive littoral zone than that found at Morristown. The banks are composed of clay with some areas having rock and sand. Bottom composition typically includes sand, rock and organic debris. Aquatic macrophytes are abundant in the littoral zone.

The Tibbits Creek marsh, which empties into Chimney Bay, is about 16.2 ha (40 acres), of which 55% is open water and 45% is open cattail (*Typha*) marsh (Werner and Ford 1972). Extensive stands of aquatic macrophytes characterize the open water area.

DATA ACQUISITION

Fisheries data were collected weekly during the winter and spring of 1979. Winter sampling, defined as that sampling conducted through the ice cover on the river, was accomplished from the week of February 12 through the week of March 12 at Chimney Bay, from the week of February 12 through the week of March 19 at Morristown Point and from the week of March 5 through the week of March 19 at Morristown Harbor. Spring sampling for adult fishes was conducted weekly at Chimney Bay, Tibbits Creek and Morristown Point from the week of March 26 through the week of May 7 and was initiated as soon after ice-out on the river as possible. Spring sampling for larval fishes was conducted weekly at Chimney Bay, Morristown Point and Morristown Harbor from the week of April 2 through the week of May 14.

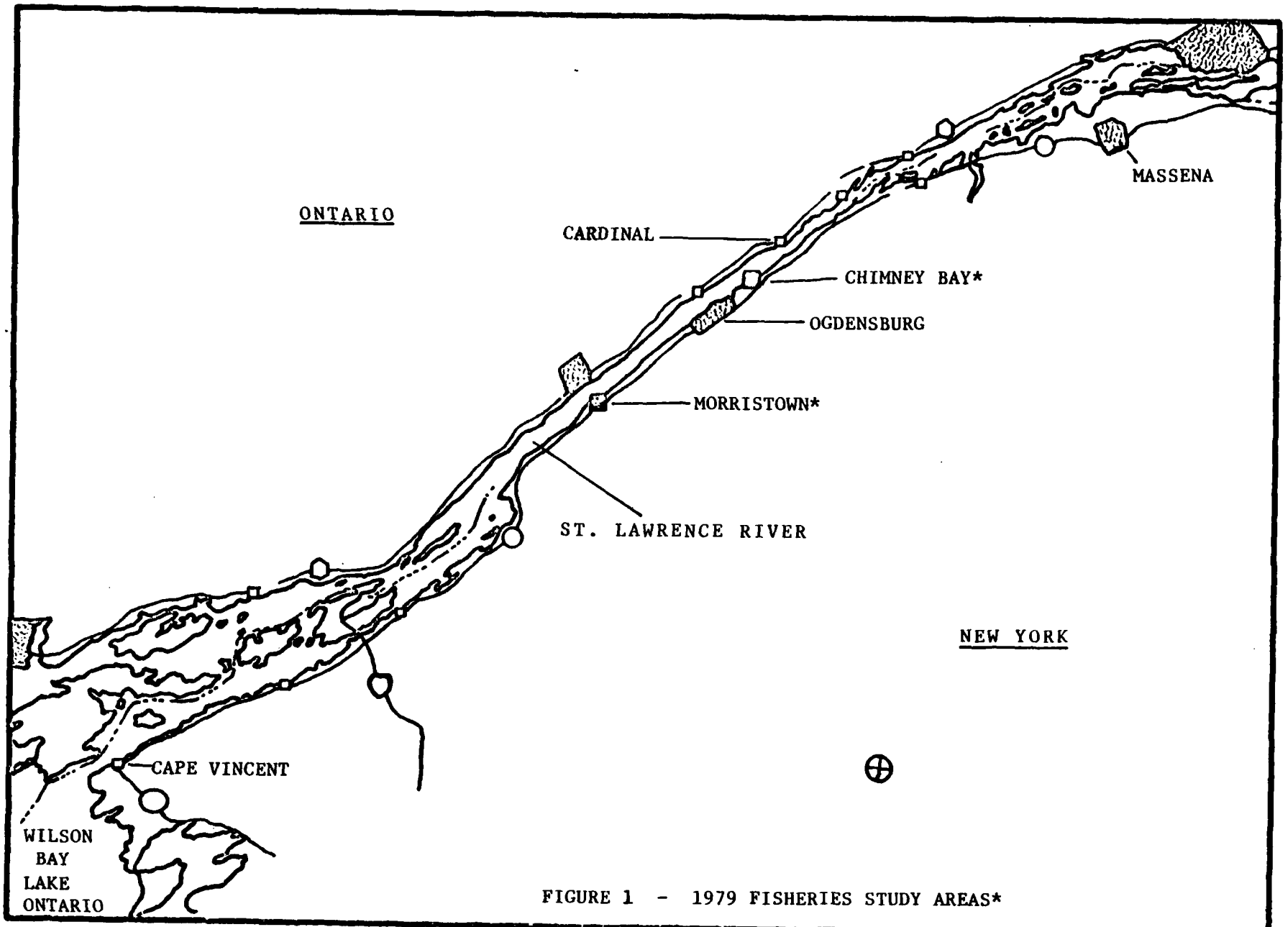

FIGURE 1 - 1979 FISHERIES STUDY AREAS*

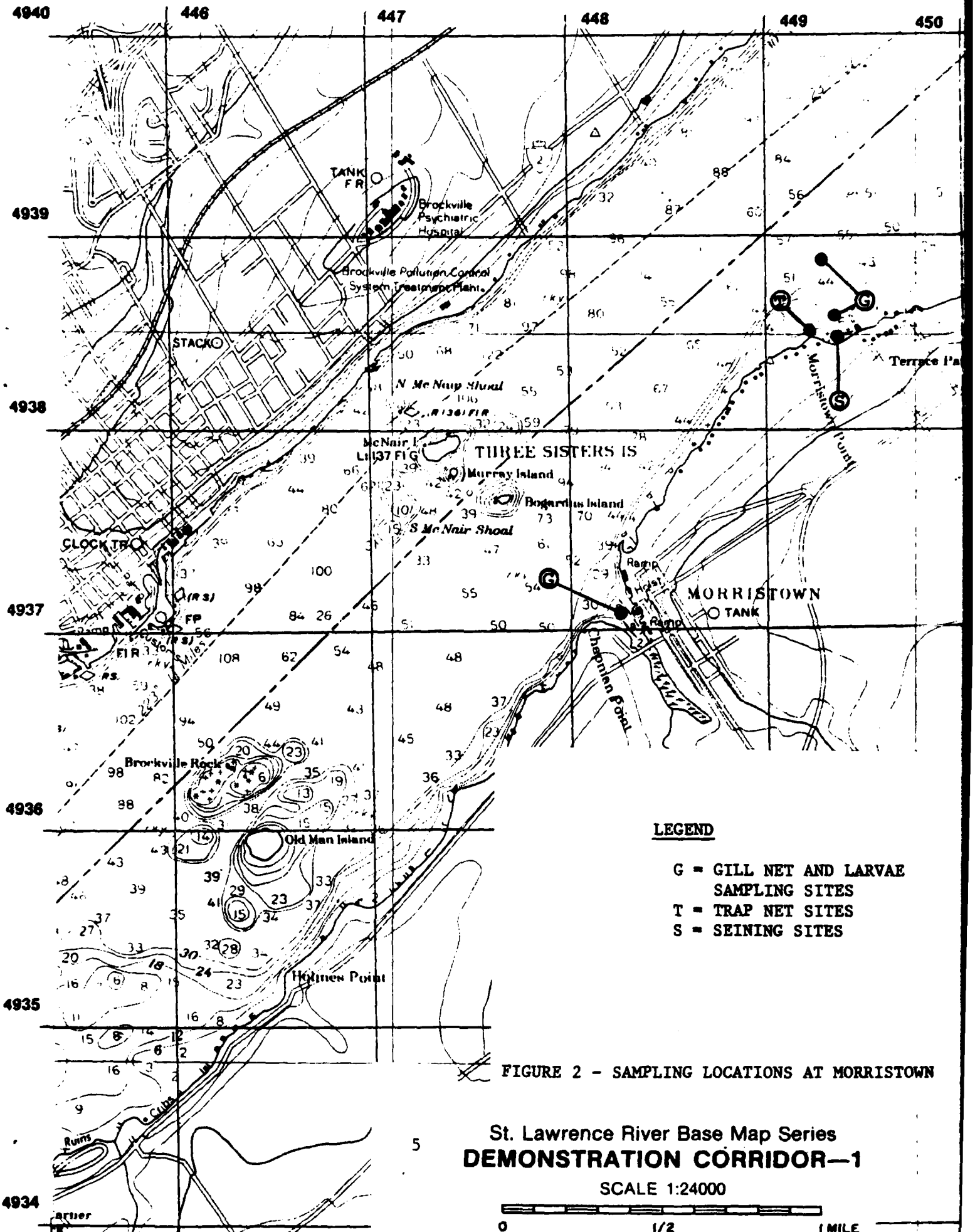

FIGURE 2 - SAMPLING LOCATIONS AT MORRISTOWN

St. Lawrence River Base Map Series

DEMONSTRATION CORRIDOR—1

SCALE 1:24000

0 1/2 1 MILE

Data base from: NOAA—National Ocean Survey, Lake Survey Center

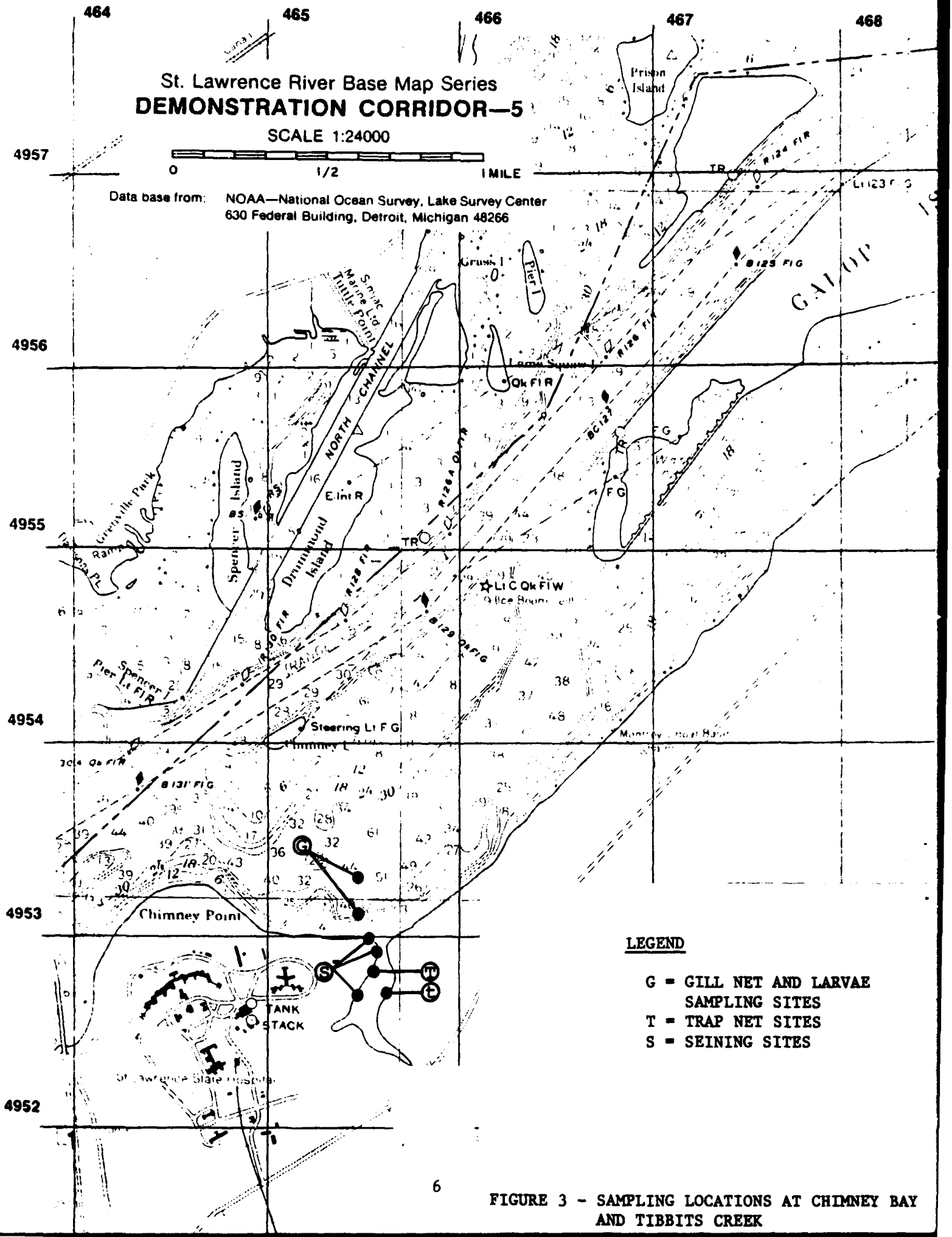

FIGURE 3 - SAMPLING LOCATIONS AT CHIMNEY BAY AND TIBBITS CREEK

Winter Sampling

Winter sampling was designed to collect data on adult fishes in the shallow littoral zone and deeper channel-like areas of the river.

Gear. Paired, shallow (1.5-2.0m, 4.9-6.6' deep) and deep (15m, 49.2' deep) set gill nets, fished on bottom for a 24 hour period, were set twice weekly at Morristown Point (Figure 2) and Chimney Bay (Figure 3), except when conditions prohibited this procedure. The gill nets set in shallow water measured 1.22 m (4') by 68.58 m (225') and consisted of nine 7.6 m (25') multifilament panels with bar mesh sizes of 1.3 cm (0.50"), 1.9 cm (0.75"), 2.5 cm (1.00"), 3.2 cm (1.25"), 3.8 cm (1.50"), 4.4 cm (1.75"), 5.1 cm (2.00"), 6.4 cm (2.50") and 7.6 cm (3.00"). The twine sizes used in the construction of the panels were; #210/2 for the 1.3 cm to 4.4 cm mesh panels, #69 for the 5.1 cm and 6.4 cm mesh panels, and #104 for the 7.6 cm mesh panel. The gill nets set in deep water were the same as those set in shallow water except that they were 2.44 m (8') high instead of 1.22 m (4') high. At Morristown Point a 1.22 m deep gill net was set at the mouth of the harbor in 4.5 m (15') of water. No deep water gill net sets were made there.

The procedure for setting gill nets under the ice was as follows. A line of holes was drilled in the ice about 77 m (253') long, using a 3 horsepower Jiffy ice drill. A line was passed under the ice between the holes using a bamboo pole until the line connected the two end holes. The two end holes were enlarged, by the use of an ice spud, enough so that an anchor could be dropped through them. A gill net was attached to one end of the line. The line and the attached gill net were then pulled under the ice from the opposite end hole. The gill net was stretched and lowered to the bottom with anchors and markers attached. When a gill net was removed, a line was left under the ice so that it need not be rethreaded the next time a gill net was to be set. Gill nets were set with the river current which was usually parallel to the shoreline.

Length, weight, sex and reproductive conditions were recorded for all fishes except those in the cyprinid family. Sex and reproductive condition were determined by external and internal examination. Scale samples were taken from northern pike, yellow perch and smallmouth bass for age determinations. The stomach contents of northern pike, yellow perch and smallmouth bass were analyzed. Items in each stomach were identified and enumerated. Obvious parasites and infections were also noted for northern pike, yellow perch and smallmouth bass.

Rationale. Eckert and Hanlon (1976), in their 1976 survey of the St. Lawrence River fisheries, utilized gill nets measuring 60.96 m (200') by 2.44 m (8')which contained eight multifilament panels with bar mesh sizes ranging from 1.9 cm (0.75") to 7.6 cm (3.0"), graded in the same increments as those found in the gill nets employed during the current study.

During their 1978 winter investigation of the fisheries of the St. Lawrence River, Dunning et al. (1978) experimentally employed gill nets which were 1.22 m (4') deep, in water less than 2.44 m (8') deep. Substantial numbers of fish were captured in these 1.22 m nets.

It is expected that the potential direct physical impacts of winter navigation activities on the fisheries of the St. Lawrence River would probably be most noticeable in near-shore, shallow water areas (Dunning et al., 1978). Proceeding offshore these areas are often characterized by a gently sloping shelf which drops off quite precipitously. Due to the ice cover present during the winter on the St. Lawrence River and the topography of the river bottom, the water depth from the substrate to the bottom of the ice cover was often less than 2.44 m (8'). As a result, 1.22 m (4') deep gill nets were used in sampling shallow water during 1979. Deep water sampling (about 15 m, 49.2') was accomplished using 2.44 m (8') high nets to maintain continuity with previous data collections and to try and increase the number of fish captured at this depth. Catch data from winter fish sampling on the St. Lawrence River during 1978 (Dunning et al., 1978) indicated that the number of fish captured in deep water gill nets was low in comparison to shallow water gill net catches during the winter and both shallow and deep gill net catches during the spring.

Dunning et al. (1978) found that using gill nets with 1.9 cm (0.75") as the smallest bar mesh size, negatively biased the capture of younger northern pike, yellow perch and smallmouth bass. In addition, certain species of fish which were found in the stomachs of gill netted northern pike, were themselves not captured or infrequently caught in gill nets, e.g. spottail shiner (*Notropis hudsonius*) and rainbow smelt (*Osmerus mordax*). As a result, gill nets used during 1979 contained one panel with 1.3 cm (0.50") bar mesh.

Spring Sampling - Adult Fishes

Spring sampling for adult fishes, as in winter, was designed to collect data in the shallow littoral zone and deeper channel-like areas of the river.

Gear. Paired shallow (1.5 - 2.0 m, 4.9 - 6.6' deep) and deep (15 m, 49.2' deep) set gill nets, fished for a 24 hour period, were set once per week at Morristown Point (Figure 2) and Chimney Bay (Figure 3). Gill nets having the same dimensions as those used during the winter were employed during the spring with the 1.22 m (4') deep nets being set in shallow water areas and the 2.44 m (8') deep nets being set in deep water areas. All nets were set with the current.

A Connecticut style trap net was set weekly at Morristown Point (Figure 2) and at the mouth of Tibbits Creek (Figure 3). The nets were fished perpendicular to shore in water 1.5 to 2 m deep from one to three nights per week. When the nets were fished more than one night, they were checked at 24 hour intervals. The nets were constructed of 2.5 cm (1.00") bar mesh tarred nylon, measured 1.22 m (4') by 1.22 m by 1.83 m (6') and had 12.19 m (40') wings and a 27.43 m (90') leader.

A box trap net was set weekly in Tibbits Creek from the week of April 9 through the week of May 7 to sample smaller sized fishes than those expected to be captured by the Connecticut style trap net(Figure 3). The box trap net had an external frame measuring 0.91 m (3') by 0.91 m by 1.83 m (6') made of aluminum with speedrail connectors at the corners. It was constructed with

0.6 cm (0.25") knotless netting and had two 7.6 m (25') wings. The net was set parallel to shore with the throat facing the mouth of the creek. One wing extended almost to the shoreline and the other extended out into the creek.

Seine hauls were made on a weekly basis at representative sites at Morristown Point (Figure 2), Chimney Bay and Tibbits Creek (Figure 3). Seining was done using a 15.24 m (50') by 1.22 m (4') bag seine constructed with 0.6 cm (0.25") nylon mesh. Seine hauls were made parallel and perpendicular to shore when possible.

Data from fishes captured in gill nets during the spring were collected in the same manner as data collected during the winter. Length, weight, and sex, as determined by internal examination, were recorded and scale samples taken from a representative sample of northern pike and yellow perch captured in trap nets and seines. All other fishes captured in trap nets and seines were enumerated.

Rationale. A variety of gear types were employed to capture fishes during the spring in an attempt to reduce sampling bias resulting from gear selectivity and to optimize sampling efforts. The 0.6 cm (.25") bar mesh box trap net was set on an experimental basis in Tibbits Creek to determine its effectiveness.

Northern pike and yellow perch captured in trap nets were generally not examined for stomach contents in order to minimize the number of fish sacrificed.

Spring Sampling - Larval Fishes

Larval fish sampling was conducted weekly using paired Miller High-Speed Samplers at Morristown Harbor, Morristown Point and Chimney Bay from April 4 to May 17. Only daytime sampling was accomplished during the week of May 7, and only nightime sampling was possible during the week of May 14. Sampling was not conducted at Morristown Harbor during the week of April 2. During the week of May 14 paired 0.5 m (1.6') diameter plankton nets were used in addition to the Miller Samplers. Two sites at Morristown Point (Figure 2) and Chimney Bay (Figure 3), having depths of 2 m (6.6') and 15 m (49.2'), and one site at Morristown Harbor, having a depth of 5 m (16.4'), were selected for sampling. The sites at Morristown Point and Chimney Bay corresponded to spring gill net sites in these areas. Each survey period was designed to include daytime and nighttime sampling at the prescribed stations and depths (surface at 2 m and 5 m, and surface and bottom at 15 m). Day and night sampling were usually completed within the time frame of 1130 - 1630 hours and 2400 - 0430 hours, respectively.

Gear. All survey tows were conducted from a 5.8 m (19') boat (Slickcraft Robalo 190) powered by a 135 hp. outboard motor. The boat was outfitted with a dual range (0-45.7 m, 0-150' and 0-91.4 m, 0-300') sonar system (Ray Jefferson, Model 5300) which provided a permanent echogram. A hand operated winch and cable, used to lower and retrieve sampling gear, was

attached to a starboard mounted davit. The sampling gear was towed essentially parallel to shore, along designated depth contours and away from the boat's wake.

Each Miller High-Speed Sampler consisted of a fiberglass tubular body (60 cm (24")long and 14 cm (5.5")inside diameter) and a 90 cm (36") long, conical shaped, 571μ mesh nylon net fitted with a collection cup, trailing aft. The two Miller samplers used during each tow were both attached to a common steel cable and were vertically separated by 44.5 cm (17.5"). A digital flow meter (General Oceanics, Model 2030) was attached to the cable between the samplers and a depressor. The depressor (fashioned after Netsch, Houser and Vogele 1971) was attached to the end of the cable to maintain the samplers at the desired depth.

To ensure sampling appropriate strata of the water column for bottom tows a hand clinometer was used in conjunction with a table of calibrations and the sonar system to determine the length of cable that was to be let out. The sampling equipment quickly lowered toward a desired depth while the boat moved slowly. As the sampling equipment approached the desired depth, boat speed was quickly increased to 3 m/sec (9.8'/sec). Towing duration for the Miller Samplers was usually 10 minutes and provided filtration of about 15 m^3 (529.7 ft^3) of river water. Upon completion of each tow the sampling equipment was quickly retrieved (0.5 m/sec, 1.6'/sec) and rinsed. Ichthyoplankton samples were transferred to plastic containers and immediately preserved in 10% formalin. Net and collection cup were washed between samplings to maintain constant filtration efficiency.

The 0.5 m diameter plankton nets used were conical shaped (1:3 mouth to length ratio) with "0" mesh (571μ). Two 0.5 m nets were attached to a bongo frame, thus enabling replicate samples to be taken simultaneously. Boat towing speed was approximately 1.6 m/sec (5.2'/sec). Tows were made for eight minutes, which yielded a filtration of about 120 m^3 (4237.2 ft^3) of water through each net.

A series of data were recorded for each sample. Included were chronological time, an exact tow-time interval (as measured with a stop watch), initial and final flow meter readings, station location and tow depths.

Rationale. The adequacy of Miller High-Speed Samplers for sampling larval fishes has been demonstrated by Werner (1976) on the St. Lawrence River, Forney (1976) in sampling for larval walleyes and Noble (1968) in sampling for larval yellow perch and walleye. Werner (1976), with respect to larval fishes in the St. Lawrence River, stated:

> *Miller High-Speed Samplers seemed to sample abundant species adequately. Avoidance was apparently low and there was relatively little variation in the catch. They worked reasonably well in close to shore (1-4 m) as long as the area was not weedy. Unfortunately, they clogged rapidly with weeds. It appears that for quantitative sampling of abundant larval fishes in non-weedy areas Miller samplers would work adequately.*

Since larval fish sampling during the spring of 1979 was scheduled to occur in early spring before heavy weed growth, clogging of the Miller Samplers by aquatic macrophytes was not expected to be a major problem.

On the basis of the above information, Miller High-Speed Samplers were adopted as the primary collection gear for larval fishes during the spring of 1979. The 0.5 m plankton nets on a bongo frame are presently being utilized at several power plant sites on Lake Ontario, and were used in this survey on an experimental basis as a comparative technique with the Miller Samplers.

Samples were taken from surface and bottom waters both during the day and at night to monitor variations in vertical distribution or activity of larvae within the water column. Two replications were made at each sampling site to increase statistical reliability.

DATA ANALYSIS

As a result of the fact that gill netting in shallow water (1.5 -2.0 m, 4.9 - 6.6' deep) was accomplished using 1.22 m (4') high nets while deep water gill netting (15 m, 49.2' deep) was accomplished using 2 44 m (8') high nets, the catch per unit of effort of 1.22 m high nets was not directly comparable with that of 2.44 m high nets. To account for this difference in net size, the vertical distribution of fish in each 2.44 m net was determined. The proportion of fish, by species, found in the lower half of the 2.44 m gill nets was calculated. These adjusted values were then used to make direct comparisons of catch per unit of effort between 1.22 m high gill nets and 2.44 m high gill nets. On the average, 50% of the northern pike and yellow perch, 89% of the white suckers and 22% of the spottail shiners, were collected in the lower half of the net. In appropriate tables, both adjusted and absolute catch per net values were listed for comparative purposes.

The taxonomic reference for the common and scientific names of fishes used in this report was the American Fisheries Society Special Publication No. 6 (1970).

The field data sheets and species codes for adult fishes used during this study were those developed for the 1978 St. Lawrence River fisheries study (Dunning et al. 1978) and are compatable with those used by the New York State Department of Environmental Conservation for Great Lakes surveys (Appendix A).

Fish lengths as reported in this paper were determined by measuring total length.

Scale samples for all fishes were taken just ventral and anterior of the dorsal fin. Scales were impressed on strips of cellulose acetate and examined with a Bausch and Lomb microprojector. Ages for smallmouth bass, northern pike and yellow perch were determined by annuli counts. Annuli were distinguished according to criteria described by Jobes (1952) for yellow perch, Casselman (1967) for northern pike and Tesch (1968) for smallmouth bass.

Stomachs of northern pike and smallmouth bass were analyzed in the field when data on length, weight and sex were taken. Yellow perch stomachs were excised, preserved in 10% formalin and examined at a later time. Stomach contents were identified to the lowest taxonomic level possible and enumerated.

Larval fishes were identified by taxa and stage of development (larvae vs. juvenile). The criteria used for distinguishing stages of larval development were those prescribed by Lippson and Moran (1974).

RESULTS

ABUNDANCE AND DISTRIBUTION OF ADULT FISHES

A total of 38 species of fish were collected from the week of February 12 through the week of May 7, 1979 by gill netting, trap netting and seining. The distribution of species collected during 1979 is recorded in Table 1. A comparison of these species with those reported by other investigators on the St. Lawrence River (Greeley and Greene 1931, Eckert and Hanlon 1976 and Dunning, Evans and Tarby 1978) is also provided in Table 1. Three species captured during 1979 at Tibbits Creek, northern redbelly dace (*Chrosomus eos*), finescale dace (*Chrosomus neogaeus*) and river redhorse sucker (*Moxostoma carinatum*), were not identified in any of the three major surveys of the St. Lawrence River mentioned above. In addition, 12 other species of fish were captured during 1979 at Morristown, Chimney Bay and Tibbits Creek which were not captured in these areas during 1978; they included the alewife (*Alosa pseudoharengus*), central mudminnow (*Umbra limi*), brassy minnow (*Hybognathus hankinsoni*), silvery minnow (*Hybognathus nuchalis*), blacknose shiner (*Notropis heterolepis*), spotfin shiner (*Notropis spilopterus*), sand shiner (*Notropis stramineus*), fathead minnow (*Pimephales promelas*), brook silverside (*Labidesthes sicculus*), johnny darter (*Etheostoma nigrum*), logperch (*Percina caprodes*) and walleye (*Stizostedion vitreum*). Five species of fish captured during 1978 in the current study areas, were not captured during 1979; they included the gizzard shad (*Dorosoma cepedianum*), yellow bullhead (*Ictaluras natalis*), channel catfish (*Ictaluras punctatus*), troutperch (*Percopsis omiscomaycus*) and bluegill (*Lepomis macrochirus*). A combination of three factors operating during the 1979 study, in addition to possible differences in spatial and temporal distribution, probably contributed to the capture and identification of the 12 additional species not taken during 1978 in comparable study areas. These factors were (1) the use of a small mesh trap net, (0.6cm, 0.25" bar) (2) the addition of a smaller mesh panel in each gill net, (1.3cm, 0.5" bar) and (3) a different selection of seining sites. The distribution of species among the various types of sampling gear used during 1979 is provided in Table 2. Although five species of fish were captured during 1978 and not during 1979 in the current study areas, it should be noted that sampling during 1978 continued through the second week of June while sampling during the current study was terminated after the second week in May. A direct comparison of fishes caught during 1979 with similar areas during the 1976 survey collections (Eckert and Hanlon 1976) was not possible since exact locations of capture were not cited in the 1976 report. Also, the 1976 sampling was conducted during the spring, summer and fall seasons, but not during the winter.

Trap Netting

2.5 cm (1.00") Bar Mesh Trap Net. Twenty-four trap net sets made in the study area from the week of March 26 through the week of May 7, 1979 resulted in the collection of 2,022 fish, comprising 11 species.

Table 1. Fish Species Collected in the St. Lawrence River During the Current Study and Those Species Reported by Greeley and Green (1931), Greeley and Bishop (1932), Eckert and Hanlon (1976), and Dunning, Evans and Tarby (1978).

Species	1931-1932	1976	1978	1979
Ichthyomyzon unicuspis - Silver Lamprey	X[a]	X	-	-
Petromyzon marinus - Sea Lamprey	X	X	-	-
Acipenser fulvescens - Lake sturgeon	X	X	X	-
Lepisosteus osseus - Longnose gar	X	X	X	-
Amia calva - Bowfin	X	X	M,T	T[b]
Anguilla rostrata - American eel	X	X	M,T	M[c]
Alosa pseudoharengus - Alewife	X	X	-	M
Alosa sapidissima - American shad	X	-	-	-
Dorosoma cepedianum - Gizzard shad	-	X	T	-
Hiodon tergisus - Mooneye	X	X	-	-
Coregonus artedii - Cisco	X	-	-	-
Salmo gairdneri - Rainbow trout	-	X	-	-
Salmo trutta - Brown trout	-	X	-	-
Osmerus mordax - Rainbow smelt	-	X	C[d]	M,C
Umbra limi - Central mudminnow	X	X	-	T
Esox americanus - Redfin pickerel	X	X	-	-
Esox lucius - Northern pike	X	X	M,C,T	M,C,T
Esox masquinongy - Muskellunge	X	X	X	-
Carassius auratus - Goldfish	-	-	X	-
Cyprinus carpio - Carp	X	X	X	-
Exoglossum maxillingua - Cutlips minnow	X	X	-	-

(Continued)

Table 1. (Continued)

Species	1931-1932	1976	1978	1979
Hybognathus hankinsoni - Brassy minnow	-	X	-	T
Hybognathus nuchalis - Silvery minnow	-	X	X	T
Notemigonus crysoleucas - Golden shiner	X	X	M,C,T	M,T
Notropis anogenus - Pugnose shiner	X	X	-	-
Notropis atherinoides - Emerald shiner	X	X	M	M
Notropis bifrenatus - Bridle shiner	X	X	-	-
Notropis cornutus - Common shiner	X	X	-	-
Notropis heterodon - Blackchin shiner	X	X	-	-
Notropis heterolepis - Blacknose shiner	X	X	-	T
Notropis hudsonius - Spottail shiner	X	X	M,T,C	M,C,T
Notropis rubellus - Rosyface shiner	-	X	-	-
Notropis spilopterus - Spotfin shiner	X	X	X	T
Notropis stramineus - Sand shiner	X	X	-	T
Notropis volucellus - Mimic shiner	X	X	-	-
Chrosomus eos - Northern redbelly dace	-	-	-	T
Chrosomus neogaeus - Finescale dace	-	-	-	T
Pimephales notatus - Bluntnose minnow	X	X	M	M,T
Pimephales promelas - Fathead minnow	X	X	-	T
Rhinichthys cataractae - Longnose dace	X	X	-	-
Semotilus atromaculatus - Creek chub	X	X	-	-
Semotilus corporalis - Fallfish	X	X	M	T
Carpiodes cyprinus - Quillback	-	-	X	-
Catostomus commersoni - White sucker	X	X	M,C,T	M,C,T

(Continued)

Table 1. (Continued)

Species	1931-1932	1976	1978	1979
Moxostoma anisurum - Silver redhorse	X	X	M	C
Moxostoma macrolepidotum - Shorthead redhorse	X	X	-	-
Moxostoma valenciennesi - Greater redhorse	X	X	-	-
Moxostoma carinatum - River redhorse	-	-	-	M
Ictalurus natalis - Yellow bullhead	-	X	M	-
Ictalurus nebulosus - Brown bullhead	X	X	M,T,C	M,C,T
Ictalurus punctatus - Channel catfish	X	X	M	-
Noturus flavus - Stonecat	X	-	X	-
Noturus gyrinus - Tadpole madtom	X	X	-	-
Percopsis omiscomaycus - Trout-perch	X	X	X	-
Lota lota - Burbot	X	X	C	C
Fundulus diaphanus - Banded Killifish	X	X	M,C	M,T
Labidesthes sicculus - Brook silverside	X	X	X	M
Culaea inconstans - Brook stickleback	X	X	C	T
Gasterosteus aculeatus - Threespine stickleback	X	X	X	-
Morone americana - White perch	-	X	M,T,C	M,C
Morone chrysops - White bass	-	X	X	-
Ambloplites rupestris - Rock bass	X	X	M,T,C	M,C,T
Lepomis gibbosus - Pumpkinseed	X	X	M,T,C	M,T
Lepomis macrochirus - Bluegill	-	X	M,C	-
Micropterus dolomieui - Smallmouth bass	X	X	M,T,C	M,C
Micropterus salmoides - Largemouth bass	X	X	M,T	T,C
Pomoxis nigromaculatus - Black crappie	X	X	M,T	C,T

(Continued)

Table 1. (Concluded)

Species	1931-1932	1976	1978	1979
Etheostoma exile - Iowa darter	X	X	-	-
Etheostoma flabellare - Fantail darter	X	-	-	-
Etheostoma nigrum - Johnny darter	X	X	X	T
Perca flavescens - Yellow perch	X	X	M,T,C	M,T,C
Percina caprodes - Logperch	X	X	X	C,T
Percina copelandi - Channel darter	X	-	-	-
Stizostedion vitreum - Walleye	X	X	X	C
Aplodinotus grunniens - Freshwater drum	-	X	-	-
Cottus bairdi - Mottled sculpin	X	X	C	M
Cottus cognatus - Slimy sculpin	-	X	-	-
TOTALS	59	67	43	38

a. X - For 1931-1932 and 1976 studies, species found in the St. Lawrence River, exact location unknown. For 1978 study, species found in the St. Lawrence River at a location other than Morristown, Chimney Bay and Tibbits Creek.

b. T - Species caught at Tibbits Creek.

c. M - Species caught at Morristown.

d. C - Species caught at Chimney Bay.

Table 2. Fish Species Collected at Morristown, Chimney Bay, and Tibbits Creek by Gill Netting (G), Trap Netting (T-2.5cm, t-0.6cm bar mesh), and Seining (S) during the Winter and Spring of 1979.

Species	Location				
	Morristown		Chimney Bay		Tibbits Creek
	Winter	Spring	Winter	Spring	Winter[a] Spring
Bowfin	-	-	-	-	T
American eel	-	T	-	-	-
Alewife	-	G	-	-	-
Rainbow smelt	-	G	G	G	-
Central mudminnow	-	-	-	-	T
Northern pike	G	G,T	G	G	T,S,t
Golden shiner	G[b]	S,G[b]	G	-	T,t,S
Emerald shiner	-	S	-	-	-
Spottail shiner	G	G,S	G	G	T,S
Sand shiner	-	-	-	-	t
Spotfin shiner	-	-	-	-	t
Blacknose shiner	-	-	-	-	t,S
Northern redbelly dace	-	-	-	-	t
Finescale dace	-	-	-	-	t
Silvery minnow	-	-	-	-	t
Brassy minnow	-	-	-	-	t,S
Bluntnose minnow	-	S	-	-	t,S
Fathead minnow	-	-	-	-	t
Fallfish	-	S	-	-	t,s
White sucker	G	G,T,S	G	G	T

(Continued)

Table 2. (Concluded)

Species	Location					
	Morristown		Chimney Bay		Tibbits Creek	
	Winter	Spring	Winter	Spring	Winter[a]	Spring
Silver redhorse	-	-	-	G		-
River redhorse	-	G	-	-		-
Brown bullhead	-	G,T	-	G		T,t
Burbot	-	-	-	G		-
Banded killifish	-	S	-	S		t,S
Brook silverside	-	S	-	-		-
Brook stickleback	-	-	-	S		t,S
White perch	-	G	-	G		-
Rock bass	-	T,G	-	G		T,t,S
Pumpkinseed sunfish	G[b]	T,G[b]	-	-		T,t,S
Smallmouth bass	-	G	G	-		-
Largemouth bass	-	-	G	-		t
Black crappie	-	-	G	-		T,t,S
Johnny darter	-	-	-	-		S
Yellow perch	G	G,T,S	G	G,S		G,T,t,S
Log perch	-	-	-	G		t
Walleye	-	-	-	G		-
Mottled sculpin	-	G	-	-		-

a. No sampling was conducted in Tibbits Creek during the winter.

b. Fish caught at Morristown Harbor

At Morristown Point 301 fish, comprising 7 species, were collected in 12 trap net sets. Yellow perch, brown bullhead (*Ictaluras nebulosus*) and pumpkinseed (*Lepomis gibbosus*) were the most abundant species and accounted for 91% of total trap net catch (Table 3). The largest total catches per net occurred during the weeks of April 23 and April 30 when the water temperature in the bay area at Morristown Point was 8° C (46.4° F).[1] These large catches resulted primarily from an abundance of yellow perch (80.5 per net the week of April 23 and 22.5 per net the week of April 30). The number of species collected increased from one, during the week of March 26, to six during the week of April 23.

A direct comparison of trap net catches between 1979 and 1978 (Dunning et al. 1978) at Morristown Point was not possible because sampling did not begin until the third week of May in 1978 while sampling ended with the second week of May in 1979. Twelve species of fish were collected at Morristown Point as a result of trap netting during 1978 as compared with seven species collected by trap netting during 1979. The additional species caught during 1978 were primarily centrarchids.

At Tibbits Creek 1,727 fish, comprising 10 species, were collected in 12 trap net sets. Yellow perch, white sucker (*Catostomus commersoni*) and pumpkinseed were the most abundant species and accounted for 85% of the total trap net catch (Table 4). The largest number of fish per net (260.0) occurred during the week of March 26, the first week after ice-out, when the water temperature was 2° C (35.6° F). This was attributable to a great abundance of pumpkinseeds (205.0/net). The catch per net declined subsequently until the week of April 16, when it began to increase, and peaked again during the week of April 23. The increase observed was primarily attributable to large numbers of white suckers and brown bullheads during the week of April 16, and yellow perch during the week of April 23. The water temperature in Tibbits Creek increased to 10° C (50.0° F) during the week of April 16 and increased to 14° C (57.2° F) during the week of April 23. Species composition of trap net catches in Tibbits Creek remained fairly constant throughout the spring.

For the five week period when comparable trap net data were available for 1978 (Dunning et al. 1978) and 1979 the total catch per net for all species of fish combined was highest during the week of May 1 in 1978, but was noted one week earlier (April 23) during 1979 (Table 5). The time of seasonal peaks in abundance occurred differentially among species and did not necessarily coincide with the highest combined weekly catches. For example, during 1978 yellow perch, black crappie (*Pomoxis nigromaculatus*), pumpkinseed and northern pike peaked at times other than May 1, and during 1979, brown bullhead and white sucker peaked at times other than April 23. Maximum numbers of yellow perch were collected in both years when the water temperature was near 13° C (55.4° F) to 14° C (57.2° F).

Ice-out at Tibbits Creek occurred about a week and a half later during 1978 as compared with 1979. As a result, water temperature in the creek during 1978 correspondingly lagged behind that during 1979.

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[1]Recorded water temperatures are listed in Appendix B.

Table 3. Number and Species of Fish Collected by Trap Netting (2.5cm, 1" bar mesh) at Morristown Point from the Week of March 26 Through the Week of May 7, 1979.

Species	Number of Fish Collected																
	March 26		April 2		April 9		April 16		April 23		April 30		May 7				
	Total 1[a]	Catch/ net	Total 1	Catch/ net	Total 3	Catch/ net	Total 2	Catch/ net	Total 2	Catch/ net	Total 2	Catch/ net	Total 1	Catch/ net	Total 12	% of Total	Catch/net
Northern pike	0	0.0	1	1.0	0	0.0	1	0.3	1	0.5	4	2.0	0	0.0	7	2.3	0.6
Yellow perch	1	1.0	1	1.0	4	1.3	6	3.0	161	80.5	45	22.5	9	9.0	227	75.4	18.9
Pumpkinseed	0	0.0	0	0.0	1	0.3	0	0.0	13	6.5	3	1.5	4	4.0	21	7.0	1.8
Rock bass	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	3.0	3	1.0	0.3
White sucker	0	0.0	0	0.0	1	0.3	1	0.3	5	2.5	2	1.0	0	0.0	9	3.0	0.6
Brown bullhead	0	0.0	0	0.0	0	0.0	0	0.0	9	4.5	8	4.0	9	9.0	26	8.6	2.2
American eel	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	5	2.5	2	2.0	8	2.7	0.7
Total	1	1.0	2	2.0	6	2.0	8	4.0	190	95.0	67	33.5	27	27.0	301	100.0	25.1

a. Number of trap net sets

Table 4. Number and Species of Fish Collected by Trap Netting (2.5cm, 1" bar mesh) at Tibbits Creek from the Week of March 26 Through the Week of May 7, 1979.

Species	Number of Fish Collected																
	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Total	% of Total	Catch/net
	Total 1[a]	Catch/ net	Total 1	Catch/ net	Total 3	Catch/ net	Total 2	Catch/ net	Total 2	Catch/ net	Total 2	Catch/ net	Total 1	Catch/ net	12		
Northern pike	6	6.0	4	4.0	0	0.0	1	0.5	0	0.0	1	0.5	1	1.0	13	1.0	1.1
Yellow perch	2	2.0	26	26.0	121	40.3	90	45.0	407	203.5	20	10.0	57	57.0	723	41.9	60.3
Pumpkinseed	205	205.0	46	46.0	19	6.3	15	7.5	13	6.5	6	3.0	15	15.0	319	18.3	26.6
Rock bass	14	14.0	3	3.0	3	1.0	0	0.0	2	1.0	0	0.0	4	4.0	26	1.5	2.2
Black crappie	9	9.0	2	2.0	3	1.0	7	3.5	27	13.5	1	0.5	3	3.0	52	3.0	4.3
White sucker	7	7.0	47	47.0	70	23.3	269	134.5	7	3.5	17	8.5	7	7.0	424	24.6	35.3
Brown bullhead	17	17.0	7	7.0	9	3.0	55	47.5	12	6.0	52	26.0	12	12.0	164	9.5	13.7
Redhorse sucker	0	0.0	0	0.0	0	0.0	4	2.0	0	0.0	0	0.0	0	0.0	4	0.2	0.3
Bowfin	0	0.0	1	1.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	0.1
Golden shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	1	0.1	0.1
Total	260	260.0	136	136.0	225	75.0	441	220.5	468	234.0	98	49.0	99	99.0	1,727	100.2	143.9

a. Number of trap net sets.

Table 5. Number and Species of Fish Collected Per Trap Net (2.5cm, 1" bar mesh) at Tibbits Creek During 1978 and 1979.

Species	Number of Fish Collected Per Trap Net										Total	
	4/10/78	4/9/79	4/17/78	4/16/79	4/24/78	4/23/79	5/1/78	4/30/79	5/8/78	5/7/79	1978	1979
	6[a]	3	8	2	4	2	4	2	4	1		
	1[b]	6-9	2-5	8-10	7-9	14	7-9	12-13	13	17	26	10
Northern pike	0.8	0.0	6.3	0.5	4.8	0.0	4.3	0.5	2.3	1.0	3.8	0.3
Yellow perch	56.8	40.3	28.4	45.0	43.5	203.5	31.5	10.0	100.5	57.0	48.8	69.5
Pumpkinseed	82.5	6.3	97.8	7.5	79.8	6.5	71.0	3.0	6.5	15.0	73.3	6.8
Black crappie	8.3	1.0	28.8	3.5	8.0	13.5	4.8	0.5	2.8	3.0	13.2	4.1
Rock bass	0.8	1.0	2.0	0.0	0.8	1.0	0.0	0.0	0.8	4.0	1.0	0.9
Smallmouth bass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.1	0.0
Largemouth bass	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.03	0.0
Brown bullhead	13.5	3.0	20.4	47.5	6.8	6.0	91.5	26.0	4.5	12.0	25.2	14.0
White sucker	0.2	23.3	11.9	134.5	17.0	3.5	22.5	8.5	20.0	57.0	13.1	37.0
Redhorse sucker	0.0	0.0	0.0	2.0	0.3	0.0	0.0	0.0	3.3	0.0	0.5	0.4
Carp	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0
Golden shiner	0.0	0.0	0.6	0.0	0.3	0.0	0.5	0.5	1.0	0.0	0.5	0.1
Bowfin	0.0	0.0	0.8	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.3	0.0
White perch	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.5	0.0	0.3	0.0
Gizzard shad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.03	0.0
Total	164.5	75.0	196.8	220.5	161.5	234.0	227.8	49.0	143.3	99.0	180.4	213.5

a. Number of net sets.

b. Water temperature in degrees centigrade.

0.6 cm (0.25") Bar Mesh Box Trap Net. Eight box trap net sets made at Tibbits Creek from the week of April 9 through the week of May 7, 1979 resulted in the capture of 1,708 fish comprising 20 species. Bluntnose minnow (*Pimephales notatus*), spottail shiner (*Notropis hudsonius*), fallfish (*Semotilus corporalis*) and yellow perch were the four most abundant species and accounted for 92% of the total trap net catch (Table 6). The largest total catch in the box trap net occurred during the week of May 7 when 1,514 fish, comprising 13 species, were collected.

Seven species of fish were collected exclusively in the box trap net. These included the central mudminnow, sand shiner, spotfin shiner, northern redbelly dace, finescale dace, silvery minnow and fathead minnow. The northern redbelly dace and finescale dace were not collected in previous studies on the St. Lawrence River by Greeley and Greene (1931), Greeley and Bishop (1932), Eckert and Hanlon (1976) and Dunning et al. (1978). These two species have been cited as occurring in the St. Lawrence River (Scott and Crossman 1973). None of the four previous studies mentioned above utilized a small mesh (0.6 cm bar) trap net.

Seining

Twenty seine hauls made in the study area from the week of March 26 through the week of May 7, 1979 resulted in the collection of 754 fish, comprising 17 species.

At Morristown Point, a total 309 fish, comprising 9 species, were collected in 6 seine hauls (Table 7). Bluntnose minnow, spottail shiner and banded killifish (*Fundulus diaphanus*) were the most abundant species and accounted for 90% of the total catch over the spring study period. The total number of fish as well as species increased progressively from the week of March 26 through the week of May 7. Over the same period of time during 1978 (Dunning et al. 1978) only five species of fish were taken in three seine hauls. These species were, in order of increasing abundance, bluntnose minnow, spottail shiner, fallfish, banded killifish and yellow perch. The relative number of fish collected during 1978 and 1979 by seining at Morristown was similar.

At Chimney Bay and Tibbits Creek, a total of 445 fish, comprising 14 species were collected in 8 seine hauls (Table 8). Yellow perch, bluntnose minnow, fallfish and pumpkinseed were the most abundant species and accounted for 84% of the total catch over the spring study period. The total number of fish per seine haul and species diversity were greatest in Tibbits Creek during the weeks of April 30 and May 7, the first week seining was conducted on the west shore Tibbits Creek seine site (Figure 3). High water levels prevented seining at this site throughout the spring study period. A habitat difference existed between the two Tibbits Creek sites. The site along the west shore of Tibbits Creek was characterized by submerged grass, resulting from high water levels, and a mud-silt bottom. The other seine site in Tibbits Creek, near the mouth, was characterized by heavy cattail growth and a mud-sand bottom. These habitat differences may have influenced the particular catches obtained at each site.

Table 6. Number and Species of Fish Collected by Trap Netting (0.6cm, 0.25" bar mesh) at Tibbits Creek from the Week of April 9 Through the Week of May 7, 1979.

Species	Number of Fish Collected												
	April 9		April 16		April 23		April 30		May 7		Total	% of Total	Catch/net
	Total	Catch/ net	Total	Catch/ net	Total	Catch/ net	Total	Catch/ net	Total	Catch/ net			
	3[a]		1		1		2		1		8		
Northern pike	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	0.1
Yellow perch	3	1.0	0	0.0	95	95.0	4	2.0	88	88.0	190	11.1	23.8
Largemouth bass	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0	1	0.1	0.1
Pumpkinseed	10	3.3	2	2.0	6	6.0	10	5.0	2	2.0	30	1.8	3.6
Rock bass	3	1.0	1	1.0	2	2.0	3	1.5	2	2.0	11	0.6	1.4
Black crappie	3	1.0	1	1.0	2	2.0	1	0.5	0	0.0	7	0.4	0.9
Brown bullhead	2	0.7	3	3.0	7	7.0	1	0.5	0	0.0	13	0.8	1.6
Log perch	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0	1	0.1	0.1
Golden shiner	0	0.0	0	0.0	2	2.0	0	0.0	6	6.0	8	0.5	1.0
Bluntnose minnow	16	5.3	1	1.0	4	4.0	8	4.0	892	892.0	921	53.9	115.1
Banded killifish	0	0.0	0	0.0	0	0.0	0	0.0	39	39.0	39	2.3	4.9
Central mudminnow	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0	1	0.1	0.1
Spottail shiner	0	0.0	0	0.0	0	0.0	0	0.0	252	252.0	252	14.6	31.5
Fall fish	0	0.0	0	0.0	0	0.0	0	0.0	213	213.0	213	12.5	26.6

(Continued)

Table 6. (Concluded)

Species	Number of Fish Collected												Catch/net
	April 9		April 16		April 23		April 30		May 7		Total	% of Total	
	Total	Catch/ net	Total	Catch/ net	Total	Catch/ net	Total	Catch/ net	Total	Catch/ net			
	3[a]		1		1		2		1		8		
Fathead minnow	0	0.0	0	0.0	0	0.0	0	0.0	2	2.0	2	0.1	0.3
Sand shiner	0	0.0	0	0.0	0	0.0	0	0.0	3	3.0	3	0.2	0.4
Spotfin shiner	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	1	0.1	0.1
Silvery minnow	0	0.0	0	0.0	0	0.0	0	0.0	11	11.0	11	0.6	1.4
Northern redbelly dace	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	1	0.1	0.1
Finescale dace	0	0.0	0	0.0	0	0.0	0	0.0	2	2.0	2	0.1	0.3
Total	38	12.7	8	8.0	121	121.0	27	13.5	1514	1514.0	1708	100.1[b]	213.5

a. Number of trap net sets.

b. Total does not add up to 100% due to rounding off.

Table 7. Number and Species of Fish Collected by Seining at Morristown Point from the Week of March 26 Through the Week of April 30, 1979.[a]

Species	Number of Fish Collected						% of Total	Catch/net
	March 26	April 9	April 16	April 30	May 7	Total		
	1[b]	1	1	2	1	6		
Golden shiner	0	0	0	1	0	1	0.3	0.2
Emerald shiner	1	0	0	0	4	5	1.6	.8
Spottail shiner	0	4	2	8	58	72	23.3	12.0
Bluntnose minnow	0	2	0	18	120	140	45.3	23.3
Fallfish	0	0	0	0	7	7	2.3	1.2
White sucker	0	0	0	0	1	1	0.3	0.2
Banded killifish	0	0	4	62	1	67	21.7	11.2
Brook silverside	0	0	1	0	0	1	0.3	0.2
Yellow perch	0	0	0	0	15	15	4.9	2.5
Total	1	6	7	89	206	309	51.5	100.0

a. No Seining done week of April 2 and April 23.

b. Number of seine hauls.

Table 8. Number and Species of Fish Collected by Seining at Chimney Bay and Tibbits Creek From the Week of March 26 Through the Week of May 7, 1979.

Species	Number of Fish Collected															% of Total	Catch/net
	March 26		April 2		April 9		April 16		April 23		April 30			May 7	Total		
	C[a]	T[b]	C	T	C	T	C	T	C	T	TT	C	T	TT	14		
Northern pike	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0.4	0.1
Brassy minnow	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0.2	0.1
Golden shiner	0	1	0	0	2	0	0	0	0	0	1	0	0	1	5	1.1	0.4
Blacknose shiner	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0.2	0.1
Spottail shiner	0	0	0	0	1	1	0	0	0	0	1	1	0	4	8	1.8	0.6
Bluntnose minnow	0	1	0	0	1	0	0	0	0	0	41	0	0	72	115	25.8	8.2
Fallfish	0	0	0	0	0	0	0	0	0	0	23	0	0	3	26	5.8	1.9
Banded killifish	1	1	0	0	0	2	0	0	1	1	6	0	0	1	13	2.9	0.9
Brook stickleback	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.2	0.1
Rock bass	0	3	0	1	4	4	2	1	0	0	0	0	0	3	18	4.0	1.3
Pumpkinseed	0	1	0	1	2	2	1	1	0	0	0	0	0	18	26	5.8	1.9
Black crappie	1	1	1	0	0	0	0	0	0	0	1	0	0	3	7	1.6	0.5
Johnny darter	0	0	0	1	1	1	5	2	4	0	1	0	1	0	16	3.6	1.1
Yellow perch	0	1	0	1	0	0	0	0	0	0	40	0	1	163	206	46.3	14.7
Total	2	9	1	4	11	10	9	4	5	1	116	1	2	270	445	99.7[d]	31.8

a. C - Chimney Bay.
b. T - Tibbits Creek-near mouth.
c. TT - Tibbits Creek-along west shore.
d. Total does not add up to 100% due to rounding off.

Gill Netting

Sixty-nine gill net sets made in the study area from the week of February 4 through the week of May 7, 1979 resulted in the collection of 849 fish with representatives from 20 species.

Winter. During the winter (the week of February 12 through the week of March 19) 41 gill net sets resulted in the collection of 197 fish comprising 10 species. Twenty-seven gill nets set in shallow water (1.5 - 2.0 m, 4.9 - 6.6' deep) collected 102 fish totaling 7 species while 14 gill nets set in deep water (15 m, 49.2' deep) yielded 95 fish totaling 6 species.

At Morristown Point 70 fish, comprising 4 species, were captured in 19 gill net sets. The species were yellow perch, white sucker, northern pike and spottail shiner (Table 9). The number of fish per species varied by depth. Although not statistically different ($P>.05$), the mean numbers of northern pike and white sucker were greater in shallow water nets compared with deep water nets. The mean number of yellow perch taken in deep water gill nets was significantly greater than the number taken in shallow water gill nets (t-test, $P\leq 0.05$). This was true when both absolute and adjusted deep water catches were compared with shallow water catches.[2] The ratio of average catch per net in shallow water versus deep water increased from 0.53:1 to 1:1 when the deep water gill net catch was adjusted.

A direct comparison of winter gill net catches at Morristown Point between 1978 (Dunning et al. 1978) and 1979 was impossible because of experimentation with different size gill nets during the winter of 1978. From the available data, the catch per shallow gill net of northern pike and yellow perch during 1979 was slightly less than half that obtained during 1978, while total catch per net during both years was similar. It should be noted that the two spottail shiners and 10% of the yellow perch caught during 1979 were captured in the 0.6cm (0.5") bar mesh panel. This mesh size was not present in gill nets used during 1978.

At Morristown Harbor, 5 shallow water gill net sets captured 29 fish consisting of 5 species. The species were northern pike, white sucker, yellow perch, pumpkinseed and golden shiner (*Notemigonus crysoleucas*) (Table 10). Four shallow gill net sets were made at Morristown Harbor during the week of March 20, 1978. Adjusting the 1978 gill net catch data and comparing it with that from 1979 indicated that the catch per net of northern pike during 1979 was slightly greater than twice that for 1978; the catch per net of white sucker during 1979 was about half that for 1978 and the catch per net of yellow perch, as well as the total catch, were similar in both years.

At Chimney Bay 98 fish, comprising 8 species, were captured in 17 gill net sets. Spottail shiner, northern pike, white sucker and yellow perch were the most abundant species and accounted for 93% of the total catch (Table 11). The number of fish per species varied with depth. Although not statistically different ($P>.05$), the mean numbers of northern pike and yellow perch in shallow water gill nets exceeded those from deep water gill nets . The reverse existed

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[2]For an explanation of adjusted catch, refer to the Materials and Methods section.

Table 9. Number and Species of Fish Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of February 12 Through the Week of March 19, 1979.

Species	Number of Fish Collected														% of Total		Catch/net		
	February 12		February 19		February 26		March 5		March 12		March 19		Total						
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m[b]	1.5m	15m[b]	1.5m	15m	1.5m	15m	1.5m	15m	15m[c]
	2[a]	1	2	2	2	2	2	2	2	0	2	0	12	7					
Northern pike	1	0	0	0	2	2	2	0	1	-	4	-	10	2	30.3	5.4	0.8	0.3	0.15
Yellow perch	0	0	1	9	0	6	0	14	0	-	1	-	2	29	6.1	78.4	0.2	4.1	2.05
White sucker	3	1	3	0	3	3	5	0	3	-	4	-	21	4	63.6	10.8	1.8	0.6	0.53
Spottail shiner	0	0	0	2	0	0	0	0	0	-	0	-	0	2	0.0	5.4	0.0	0.3	0.07
Total	4	1	4	11	5	11	7	14	4	-	9	-	33	37	100.0	100.0	2.8	5.3	2.80

a. Number of gill net sets.

b. No nets were set.

c. Adjusted catch per net. (See Materials and Methods section)

Table 10. Number and Species of Fish Collected by Gill Netting at Morristown Harbor From the Week of March 5 Through the Week of March 19, 1979.

Species	Number of Fish Caught				% of Total	Catch/net
	March 5	March 12	March 19	Total		
	2[a]	1	2	5		
Northern pike	2	3	11	16	55.2	3.2
Yellow perch	1	0	2	3	10.3	0.6
Pumpkinseed	0	0	1	1	3.4	0.2
White sucker	2	2	4	8	27.6	1.6
Golden shiner	0	1	0	1	3.4	0.2
Total	5	6	18	29	99.9	5.8

a. Number of gill net sets.

Table 11. Number and Species of Fish Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths in Chimney Bay From the Week of February 12 Through the Week of March 12, 1979.

Species	Number of Fish Collected												% of Total		Catch/net		
	February 12		February 19		February 26		March 5		March 12		Total						
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m[b]	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	15m[c]
	2[a]	1	2	2	2	2	2	2	2	0	10	7					
Northern pike	7	0	2	0	6	0	2	-	1	0	18	0	45.0	0.0	1.8	0.0	0.00
Yellow perch	0	0	2	0	2	0	4	-	0	4	8	4	20.0	6.9	0.8	0.6	0.30
Largemouth bass	0	0	0	0	1	0	0	-	0	0	1	0	2.5	0.0	0.1	0.0	0.00
Smallmouth bass	0	0	0	0	0	0	0	-	0	1	0	1	0.0	1.7	0.0	0.1	0.00
Black crappie	0	0	0	0	1	0	0	-	0	0	1	0	2.5	0.0	0.1	0.0	0.00
White sucker	1	0	3	3	1	3	1	-	0	4	6	10	15.0	17.2	0.6	1.4	1.20
Spottail shiner	0	0	0	31	3	2	0	-	0	9	3	42	7.5	72.4	0.3	6.0	1.30
Golden shiner	0	0	0	0	1	0	2	-	0	0	3	0	7.5	0.0	0.3	0.0	0.00
Rainbow smelt	0	0	0	1	0	0	0	-	0	0	0	1	0.0	1.7	0.0	0.1	0.05
Total	8	0	7	35	15	5	9	-	1	18	40	58	100.0	99.9	4.0	8.3	2.90

a. Number of gill net sets.

b. No nets were set.

c. Adjusted catch per net. (See Materials and Methods section)

for white sucker and spottail shiner where deep water catches exceeded those from shallow water. This was true when both absolute and adjusted deep water catches were compared to shallow water catches. The ratio of total catch per net in shallow water versus deep water increased from 0.48:1 to 1.38:1 when the deep water gill net catch was adjusted.

When shallow water gill net catch data from Chimney Bay during the winter of 1978 were adjusted and contrasted with comparable data from 1979 it was found that the catch per net of northern pike, yellow perch and all species combined was similar between years. When deep water gill net catch data from 1978 and 1979 were compared it was found that yellow perch were twice as abundant during 1979 compared to 1978; no northern pike were captured during 1979, while 1.3 northern pike per net were captured during 1978, and the total catch per net during 1979 was about four times as great as in 1978. The larger total catch per net during 1979 was primarily a result of large numbers of spottail shiners. Three species of fish captured during the winter of 1978 were not taken during the winter of 1979; they included muskellunge (*Esox masquinongy*), rock bass (*Ambloplites rupestris*) and brown bullhead. Conversely, five species of fish captured during the winter of 1979 were not captured during the winter of 1978; they included black crappie (*Pomoxis nigromaculatus*), largemouth bass, smallmouth bass, golden shiner and spottail shiner. All of the spottail shiners and 25% of the yellow perch caught by gill netting during the winter of 1979 were captured in the 0.6 cm (0.50") bar mesh panel.

Spring. During the spring (the week of March 26 through the week of May 7) 28 gill net sets resulted in the collection of 662 fish with representatives from 18 species. Fourteen gill net sets in shallow water collected 380 fish totaling 14 species, and 14 gill net sets in deep water resulted in 282 fish, totaling 11 species.

At Morristown Point 235 fish, comprising 13 species, were collected in 14 gill net sets. Yellow perch, white sucker and northern pike were the most abundant species and accounted for 90% of the total catch (Table 12). The number of fish per species varied with depth. Although not statistically different ($P>.05$), the mean numbers of yellow perch and white sucker in shallow water gill nets were greater than those numbers from deep water gill nets. Northern pike were significantly greater in shallow water gill nets than in deep water gill nets (t-test, $P\leq.001$). This was true when both absolute and adjusted deep water catches were used in comparison with shallow water catches. The ratio of total catch per net in shallow water versus deep water increased from 2.50:1 to 4.20:1 when the deep water gill net catch was adjusted.

Gill netting did not occur during the same weeks in 1978 and 1979, thus precluding a direct comparison of catches between years.

At Chimney Bay 427 fish, comprising 15 species, were collected in 14 gill net sets. Yellow perch, spottail shiner, white sucker and northern pike were the most abundant species and accounted for 92% of the total catch (Table 13). The number of fish varied with depth. Although not statistically different ($P>.05$), the mean numbers of yellow perch and white sucker in shallow water gill nets were greater than those in deep water gill nets, while the reverse was

Table 12. Number and Species of Fish Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of March 26 Through the Week of May 7, 1979.

Species	Number of Fish Collected																% of Total		Catch/net		
	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Total						
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	15m[b]
	1[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	7	7					
Northern pike	0	0	4	0	4	0	4	0	6	1	3	0	4	0	25	1	14.9	1.5	3.6	0.1	0.07
Yellow perch	0	6	0	3	7	1	3	2	63	11	20	5	10	7	103	35	61.3	52.2	14.7	5.0	2.50
Smallmouth bass	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	1.2	0.0	0.3	0.0	0.00
Pumpkinseed	0	0	1	0	0	0	0	0	0	0	0	0	2	0	3	0	1.8	0.0	0.4	0.0	0.00
Rock bass	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	2	0.6	3.0	0.1	0.3	0.00
White perch	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0.0	4.5	0.0	0.4	0.43
White suckers	2	0	3	3	4	4	8	3	3	6	4	0	4	3	28	19	16.7	28.4	4.0	2.7	2.42
Silver redhorse	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	2	0.6	3.0	0.1	0.3	0.29
Spottail shiner	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	3	0.0	4.5	0.0	0.4	0.00
Brown bullhead	0	0	0	0	1	0	1	0	0	0	2	0	0	0	4	0	2.4	0.0	0.6	0.0	0.00
Mottled sculpin	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0.6	0.0	0.1	0.0	0.00
Rainbow smelt	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.0	1.5	0.0	0.1	0.00
Alewife	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.0	1.5	0.0	0.1	0.00
Total	2	6	8	7	16	5	16	7	73	22	29	6	24	14	168	67	100.1[c]	100.1[c]	24.0	9.6	5.71

a. Number of gill net sets.

b. Adjusted catch per net. (See Materials and Methods section)

c. Total does not add up to 100% due to rounding off.

Table 13. Number and Species of Fish Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths in Chimney Bay From the Week of March 26 Through the Week of May 7, 1979.

Species	Number of Fish Collected																% of Total		Catch/net		
	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Total						
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	15m[b]
	1[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	7	7					
Northern pike	5	0	6	1	6	0	7	0	10	0	3	1	8	0	45	2	21.2	0.9	6.4	0.3	0.14
Yellow perch	1	7	4	7	2	5	6	3	10	16	41	4	26	14	90	56	42.5	26.0	12.9	8.0	4.00
Walleye	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0.5	0.0	0.1	0.0	0.00
Log perch	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	2	0.5	0.9	0.1	0.3	0.29
Pumpkinseed	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0.5	0.0	0.1	0.0	0.00
Rock bass	0	0	0	0	0	0	0	4	0	1	0	1	0	0	0	6	0.0	2.8	0.0	0.9	0.71
Black crappie	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0.5	0.0	0.1	0.0	0.00
White perch	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.0	0.5	0.0	0.1	0.00
White sucker	7	3	11	5	10	6	5	5	3	2	7	6	1	7	44	34	20.8	15.8	6.3	4.9	4.32
Silver redhorse	0	0	0	0	0	0	0	0	1	0	5	2	1	0	7	2	3.3	0.9	1.0	0.3	0.00
River redhorse	0	0	1	0	0	0	2	0	0	0	0	0	0	0	3	0	1.4	0.0	0.4	0.0	0.00
Spottail shiner	0	19	1	11	0	28	0	23	1	16	3	10	9	1	14	108	6.6	50.2	2.0	15.4	3.39
Brown bullhead	1	0	1	0	2	0	0	0	0	0	0	0	1	0	5	0	2.4	0.0	0.7	0.0	0.00
Rainbow smelt	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0.0	1.4	0.0	0.4	0.00
Burbot	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0	0.5	0.0	0.1	0.00
Total	15	30	24	24	20	39	22	37	25	35	60	27	46	23	212	215	100.2[c]	99.9[c]	30.3	30.7	12.85

a. Number of gill net sets.

b. Adjusted catch per net. (See Materials and Methods section)

c. Total does not add up to 100% due to rounding off.

apparent for spottail shiners. The mean number of northern pike was significantly greater in shallow water than in deep water gill nets (t-test, $P \leq .001$). This was true when both absolute and adjusted deep water catches were used in comparison with shallow water catches. The ratio of total catch per net in shallow water versus deep water increased from 1:1 to 2.36:1 when the deep water gill net catch was adjusted.

Gill netting in 1978 and 1979 was not undertaken during the same weeks and precluded a direct comparison of catches between years.

ABUNDANCE AND DISTRIBUTION OF LARVAL FISHES

A total of 1,271 fish larvae and 1 fish egg were collected at Morristown Harbor, Morristown Point and Chimney Bay during April and May 1979. Larvae were absent in collections made prior to May 10. Six larvae were collected during day sampling on May 10. The remainder of the larvae were collected during night sampling conducted on May 17. Yellow perch were the most numerous larvae collected constituting 100% of the larvae on May 10 and 96.8% on May 17. Five additional taxa were also collected including burbot, smelt, white sucker, johnny darter (*Etheostoma nigrum*) and an unidentified cyprinid.

At Morristown Harbor, where samples were only taken at the surface, no larvae were collected on May 10. On May 17 the Miller Samplers collected a single damaged specimen, resulting in an average density of 37.3 larvae/1,000 m^3 while the 0.5 m plankton nets collected an average density of 458.5 larvae/1,000 m^3 (Table 14). Of the larvae collected in the 0.5 m plankton nets, 98.3% were yellow perch, with burbot and smelt each comprising less than 1% of the total.

On May 10 at Morristown Point, one yellow perch was collected at the surface with Miller Samplers at the 15 m station. This resulted in an average density of 11 larvae/1,000 m^3 (Table 15). On May 17, the highest mean densities of larvae at any of the three sites were collected. A mean density of 606.7 larvae/1,000 m^3 was obtained with the Miller Samplers (96.3% were yellow perch and 3.7% were damaged specimens). The 0.5 m plankton nets collected an average density of 2,087.8 larvae/1,000 m^3, all of which were yellow perch. Greatest densities using both gear types were found at the 2 m station. At the 15 m station, using Miller Samplers, somewhat greater densities were found at the bottom than at the surface (Appendix C).

At Chimney Bay, an average density of 55.4 larvae/1,000 m^3 was collected on May 10 (Table 16). All of these larvae were yellow perch and all were taken at the 15 m station. On May 17, the average density collected with Miller Samplers (50.1 larvae/1,000 m^3) was similar to the density collected on May 10. These larvae were yellow perch (50.9%), white sucker (24.2%), and damaged and unidentifiable (24.9%). The 0.5 m plankton nets collected a similar average density (68.0 larvae/1,000 m^3) and also yielded the greatest species diversity taken at any site, date or gear. Five different taxa were collected. Yellow perch were most abundant, comprising 79.1% of the total, with burbot (*Lota lota*) (3.1%), white sucker (8.6%), johnny darter (3.1%), unidentified cyprinids (3.1%) and damaged larvae (3.1%) making up the remainder. Larval densities were nearly similar at the 2m and 15m stations (Appendix D). All larvae taken with Miller Samplers were in surface samples. The only fish egg collected was from a 15m surface sample using Miller Samplers on May 17.

Table 14. Mean Density of Larval Fishes (No./1000m^3) and Percent Composition by Species at Morristown Harbor on May10 and May 17, 1979.[a,f]

Species	Mean Density of Larval Fishes-% Composition					
	May 10[b]		May 17[c]		May 17[d]	
	Density	% Comp.	Density	% Comp.	Density	% Comp.
Yellow perch	0.0	-	0.0	0.0	450.7	98.3
Burbot	0.0	-	0.0	0.0	3.9	0.9
Rainbow smelt	0.0	-	0.0	0.0	3.9	0.9
Damaged	0.0	-	37.3	100.0	0.0	0.0
Total	0.0	-	37.3	100.0	458.5	100.1[e]

a. Densities based on a mean of two replicates at the surface at 5m water depth.

b. Samples taken during the day using Miller Samplers.

c. Samples taken at night using Miller Samplers.

d. Samples taken at night using two 0.5m plankton nets on a bongo frame.

e. Total does not add up to 100% due to rounding off.

f. No larvae present in day and nighttime samples taken April 3-4, 11-12, 18-19, 24-25, and May 2-3.

Table 15. Mean Density of Larval Fishes (No./1000m^3) and Percent Composition by Species at Morristown Point on May 10 and May 17, 1979.[a,e]

Species	Mean Density of Larval Fishes-% Composition					
	May 10[b]		May 17[c]		May 17[d]	
	Density	% Comp.	Density	% Comp.	Density	% Comp.
Yellow perch	11.0	100.0	584.5	96.3	2,087.8	100.0
Damaged	0.0	0.0	22.2	3.7	0.0	0.0
Total	11.0	100.0	606.7	100.0	2,087.8	100.0

a. Densities based on a mean of two replicates at 2m surface, 15m surface and 15m bottom.

b. Samples taken during the day using Miller Samplers.

c. Samples taken at night using Miller Samplers.

d. Samples taken at night using two 0.5 plankton nets on a bongo frame.

e. No larvae present in day and nighttime samples taken April 3-4, 11-12, 18-19, 24-25, and May 2-3.

Table 16. Mean Density of Larval Fishes (No./1000m^3) and Percent Composition by Species at Chimney Bay on May 10 and May 17, 1979.[a,f]

Species	Mean Density of Larval Fishes-% Composition					
	May 10[b]		May 17[c]		May 17[d]	
	Density	% Comp.	Density	% Comp.	Density	% Comp.
Yellow perch	55.4	100.0	25.5	50.9	53.8	79.1
Burbot	0.0	0.0	0.0	0.0	2.1	3.1
White sucker	0.0	0.0	12.0	24.2	5.9	8.6
Johnny darter	0.0	0.0	0.0	0.0	2.1	3.1
Unidentified Cyprinid sp.	0.0	0.0	0.0	0.0	2.1	3.1
Damaged	0.0	0.0	12.5	24.9	2.1	3.1
Total	55.4	100.0	50.1	100.0	68.0	100.1[e]

a. Densities based on a mean of two replicates at 2m surface, 15m surface and 15m bottom.

b. Samples taken during the day using Miller Samplers.

c. Samples taken at night using Miller Samplers.

d. Samples taken at night using two 0.5m plankton nets on a bongo frame.

e. Total does not add up to 100% due to rounding off.

f. No larvae present in day and nightime samples taken April 3-4, 11-12, 18-19, 24-25, and May 2-3.

SPECIES CHARACTERISTICS

Northern Pike

Age and Growth. Age and growth of northern pike during 1979 were studied by examining scales from 53 fish collected at Morristown Point and 76 fish collected at Chimney Bay and Tibbits Creek. These fish were collected by gill netting, trap netting and seining.

At Morristown Point, a comparison of mean observed lengths between male and female northern pike suggested that sexually dimorphic growth occurred (Table 17). Female northern pike were consistently larger than males of the same age, collected by the same gear. This is in agreement with previously collected data on northern pike in the St. Lawrence River (Dunning et al. 1978). The only exception at Morristown Point during 1979 was for 3 year old trap netted pike, where the length of a single female (310mm) was 220 mm less than the mean for two males. The greater mean length of the two males in comparison with the one female was probably attributable to the small number of observations. Small sample sizes also precluded comparing the selectivity of trap netting versus gill netting.

A comparison of mean observed lengths at age for northern pike collected at Morristown during 1978 (Dunning et al. 1978) and 1979 did not seem to indicate consistent differences between years (Table 18). It should be noted that sampling periods during 1978 and 1979 at Morristown Point did not overlap and that the available 1978 data included a large number of pike collected at Morristown Harbor. Netting during 1979 (the weeks of March 26 through May 7) included the period of time when peak spawning activity was believed to have occurred, while netting during 1978 did not begin until the third week in May, presumably after peak spawning. As a result, mature fish may have been more abundantly sampled during 1979. The mean lengths for the mature fish may have been different from those of immature fish at the same age.

Two northern pike collected during 1979 at Morristown Point were tagged during the 1978 fisheries program on the St. Lawrence River (Dunning et al. 1978). A male pike, collected in a trap net and tagged with a standard Floy dart tag at Morristown Point on May 19, 1978, was recaptured at Morristown Point on April 4, 1979. This fish showed a growth of 7mm (655-662mm) over that period of time and was determined to be 4 years old during 1979. A female pike, collected in a trap net and tagged with a standard Floy dart tag at Morristown Point on June 7, 1978, was recaptured at Morristown Harbor on March 26,1979. This fish showed a growth of 20 mm (788-808mm) and was determined to be 6 years old in 1979. The reason for an apparently small increase in length exhibited by the recaptured male northern pike is not known, however growth in length by the recaptured female northern pike does not appear unusual on the basis of available data.

At Chimney Bay, a comparison of mean observed lengths at age between male and female northern pike suggested that sexually dimorphic growth occurred (Table 19). As at Morristown Point, female northern pike were consistently

Table 17. Mean Lengths, Ranges and Standard Error of the Means for Northern Pike Collected at Morristown Point by Age, Sex and Gear From the Week of February 12 Through the Week of May 7, 1979.

Sex	Gear		Age 1	2	3	4	5	6	7	8
Males	Gill Net	$\overline{TL}$	-	367	571	610	633	684	-	-
		S.E.	-	0.0	46.2	38.9	53.6	0.0	-	-
		Range	-	-	498-630	559-645	575-681	-	-	-
Males	Trap Net (2.5cm)[a]	$\overline{TL}$	-	437	530	522	-	-	-	-
		S.E.	-	0.0	21.2	0.0	-	-	-	-
		Range	-	-	515-545	-	-	-	-	-
Females	Gill Net	$\overline{TL}$	-	417	611	657	748	805	856	843
		S.E.	-	48.8	105.4	47.6	59.9	59.7	54.4	0.0
		Range	-	382-451	505-744	577-717	694-848	720-850	810-916	-
Females	Trap Net (2.5cm)[a]	$\overline{TL}$	-	-	310	719	-	-	-	-
		S.E.	-	-	0.0	9.2	-	-	-	-
		Range	-	-	-	712-725	-	-	-	-

a. Bar mesh size.

Table 18. Comparison of Mean Lengths and Numbers of Northern Pike Collected at Morristown During 1978[a] and 1979 by Age, Sex and Gear.

Sex	Gear		Age 1	2	3	4	5	6	7	8
Males	Gill Net	1979	-	367[b]	571	610	633	684	-	-
			(0)	(1)[c]	(8)	(4)	(3)	(1)	(0)	(0)
		1978	-	-	530	596	658	660	-	-
			(0)	(0)	(27)	(7)	(2)	(1)	(0)	(0)
Males	Trap Net (2.5cm)[d]	1979	-	437	530	522	-	-	-	-
			(0)	(1)	(2)	(1)	(0)	(0)	(0)	(0)
		1978	-	444	544	632	671	716	-	-
			(0)	(5)	(20)	(8)	(1)	(1)	(0)	(0)
Females	Gill Net	1979	-	417	611	657	748	805	856	843
			(0)	(2)	(4)	(9)	(6)	(4)	(3)	(1)
		1978	-	425	593	690	740	725	843	-
			(0)	(1)	(7)	(5)	(5)	(1)	(2)	(0)
Females	Trap Net (2.5cm)[d]	1979	-	-	310	719	-	-	-	-
			(0)	(0)	(1)	(2)	(0)	(0)	(0)	(0)
		1978	-	-	522	671	762	747	-	-
			(0)	(0)	(17)	(15)	(6)	(5)	(0)	(0)
Males	All Gears	1979	-	402	563	592	633	684	-	-
			(0)	(2)	(10)	(5)	(3)	(1)	(0)	(0)
		1978	-	444	538	615	662	688	-	-
			(0)	(5)	(48)	(15)	(3)	(2)	(0)	(0)
Females	All Gears	1979	-	417	551	668	748	805	856	843
			(0)	(2)	(5)	(11)	(6)	(4)	(3)	(1)
		1978	-	425	582	672	749	725	843	-
			(0)	(1)	(22)	(23)	(17)	(1)	(2)	(0)

a. Dunning et al. 1978.

b. Mean length.

c. Number of fish.

d. Bar mesh size.

Table 19. Mean Lengths, Ranges and Standard Error of the Means for Northern Pike Collected at Chimney Bay and Tibbits Creek by Age, Sex and Gear From the Week of February 12 Through the Week of May 7, 1979.

Sex	Gear		Age 1	2	3	4	5	6	7	8
Males	Gill Net	$\overline{TL}$	-	467	544	539	582	645	-	-
		S.E.	-	20.5	51.0	74.7	54.4	0.0	-	-
		Range	-	447-497	423-610	464-671	543-620	-	-	-
Males	Trap Net (2.5cm)[a]	$\overline{TL}$	-	357	489	663	-	-	-	-
		S.E.	-	48.3	84.7	0.0	-	-	-	-
		Range	-	287-398	392-550	-	-	-	-	-
Males	Trap Net (0.6cm)[a]	$\overline{TL}$	274	-	-	-	-	-	-	-
		S.E.	0.0	-	-	-	-	-	-	-
		Range	-	-	-	-	-	-	-	-
Males	Seine	$\overline{TL}$	236	-	-	-	-	-	-	-
		S.E.	83.4	-	-	-	-	-	-	-
		Range	177-295	-	-	-	-	-	-	-
Females	Gill Net	$\overline{TL}$	-	458	596	666	701	704	837	-
		S.E.	-	44.0	54.7	30.5	63.4	48.8	0.0	-
		Range	-	396-497	508-677	631-711	612-760	669-738	-	-
Females	Trap Net (2.5cm)[a]	$\overline{TL}$	-	-	605	660	732	-	-	-
		S.E.	-	-	0.0	0.0	0.0	-	-	-
		Range	-	-	-	-	-	-	-	-
Females	Trap Net (0.6cm)[a]	$\overline{TL}$	-	-	-	-	-	-	-	-
		S.E.	-	-	-	-	-	-	-	-
		Range	-	-	-	-	-	-	-	-
Females	Seine	$\overline{TL}$	-	-	-	-	-	-	-	-
		S.E.	-	-	-	-	-	-	-	-
		Range	-	-	-	-	-	-	-	-

a. Bar mesh size.

larger than males of the same age, collected by the same gear. The only exception at Chimney Bay during 1979 was 2 year old pike, where the mean length for four females (458mm) was 9mm less than that for five males. The only exception at Tibbits Creek during 1979 was 4 year old trap netted pike, where the mean length for one female (660mm) was 3mm less than that for one male. The greater mean lengths of the males in comparison with the females, in the two instances above, is probably attributable to the small number of observations. Small sample sizes also precluded comparing the selectivity of trap netting versus gill netting. Seining was highly selective for age one fish.

A comparison of mean observed lengths at age for northern pike collected at Chimney Bay and Tibbits Creek during 1978 (Dunning et al. 1978) and 1979 did not indicate consistent differences between years (Table 20). However, female northern pike collected by gill netting during 1979 had somewhat smaller mean lengths at ages 2-5. In addition, the mean lengths of age 4 and 5 northern pike during 1979, were smaller than those reported in 1978 (Dunning et al. 1978), based on data from gill netting and trap netting combined.

One male northern pike, collected on April 4, 1979 at Chimney Bay, was previously collected in a trap net and tagged with a Floy standard dart tag at Tibbits Creek on April 20, 1978 as part of the 1978 fisheries study on the St. Lawrence River (Dunning et al. 1978). This fish, whose age was determined to be 3 during 1979, grew approximately 14mm (479-493mm) between the time of release and recapture. It was surprising to note that during the same period, the weight of this fish decreased from 720gm to 668 gm. Reasons for the apparently small increase in length exhibited by this fish are not clear. The decrease in weight may have resulted from a difference in the amount of stomach contents present when the fish was weighed on each occasion, normal errors in determining weight of fish in the field, a decrease in the general condition of the fish, or any combination of the above factors.

Considering all gear types employed during 1979, mean lengths at age for northern pike at Morristown Point were greater than those for pike of similar ages at Chimney Bay and Tibbits Creek starting at age 3 for males and age 4 for females (Tables 18 and 20). One year old fish from Morristown were not available for comparisons. Mean lengths of northern pike males, collected during 1979, ages 4 and 5, were smaller than those of male northern pike of comparative ages collected during 1978. Based on a combination of gill net and trap net catches, the largest numbers of male northern pike occured at age 3, while the largest number of females occurred at age 4 at Morristown Point and at age 3 at Chimney Bay (Tables 21 and 22). Data collected during 1978, based on a combination of gill net and trap net catches (Dunning et al. 1978), indicated that the largest numbers of male northern pike occurred at age 3, while the largest number of females occurred at age 4. Everhart et al. (1975) noted that the age group having the largest numbers of fish may or may not be completely vulnerable to the gear being used for capture. On the basis of the available data, a conservative estimate of the first fully recruited age, to the gear being employed during 1978 and 1979 on the St. Lawrence River, was 4 for males and 5 for females.

Table 20. Comparison of Mean Lengths and Numbers of Northern Pike Collected at Chimney Bay and Tibbits Creek During 1978[a] and 1979 by Age, Sex and Gear.

Sex	Gear		Age 1	2	3	4	5	6	7
Males	Gill Net	1979	-	467[b]	544	539	582	645	-
			(0)	(5)[c]	(13)	(7)	(2)	(1)	(0)
		1978	-	-	575	516	650	-	-
			(0)	(0)	(8)	(5)	(1)	(0)	(0)
Males	Trap Net (2.5cm)[d]	1979	274	357	489	663	-	-	-
			(1)	(4)	(3)	(1)	(0)	(0)	(0)
		1978	272	406	513	602	650	-	-
			(16)	(12)	(30)	(10)	(1)	(0)	(0)
Females	Gill Net	1979	-	458	596	666	701	704	837
			(0)	(4)	(10)	(9)	(8)	(2)	(1)
		1978	-	482	622	676	756	-	-
			(0)	(1)	(4)	(6)	(3)	(0)	(0)
Females	Trap Net (2.5cm)[d]	1979	-	-	605	660	732	-	-
			(0)	(0)	(1)	(1)	(1)	(0)	(0)
		1978	274	440	582	655	651	808	815
			(1)	(2)	(9)	(12)	(8)	(3)	(1)
Males	All Gears	1979[e]	249	418	534	555	582	645	-
			(3)	(9)	(16)	(8)	(2)	(1)	(0)
		1978	272	406	526	612	678	-	-
			(16)	(12)	(38)	(16)	(4)	(0)	(0)
Females	All Gears	1979	-	458	597	665	704	704	837
			(0)	(4)	(11)	(10)	(9)	(2)	(1)
		1978	274	454	594	664	736	808	815
			(1)	(3)	(13)	(20)	(12)	(3)	(1)

a. Dunning et al. 1978.

b. Mean length.

c. Number of fish.

d. Bar mesh size.

e. Includes 3 seined fish.

Table 21. Percentage and Number of Northern Pike Collected at Morristown by Age, Sex and Gear From the Week of February 12 Through the Week of May 7, 1979.

Sex	Gear	Age 1	2	3	4	5	6	7	8	Total
Males	Gill Net	0.0[a]	5.9	47.1	23.5	17.6	5.9	0.0	0.0	100.0
		(0)	(1)	(8)	(4)	(3)	(1)	(0)	(0)	(17)
Males	Trap Net (2.5cm)[c]	0.0	25.0	50.0	25.0	0.0	0.0	0.0	0.0	100.0
		(0)	(1)	(2)	(1)	(0)	(0)	(0)	(0)	(4)
Females	Gill Net	0.0	6.9	13.8	31.0	20.7	13.8	10.3	3.4	99.9[d]
		(0)	(2)	(4)	(9)	(6)	(4)	(3)	(1)	(29)
Females	Trap Net (2.5cm)[c]	0.0	0.0	33.3	66.7	0.0	0.0	0.0	0.0	100.0
		(0)	(0)	(1)	(2)	(0)	(0)	(0)	(0)	(3)
Males	All Gears	0.0	9.5	47.6	23.8	14.3	4.8	0.0	0.0	100.0
		(0)	(2)	(10)	(5)	(3)	(1)	(0)	(0)	(21)
Females	All Gears	0.0	6.3	15.6	34.4	18.8	12.5	9.4	3.1	100.1[d]
		(0)	(2)	(5)	(11)	(6)	(4)	(3)	(1)	(32)

a. Percentage of the total.

b. Number of fish.

c. Bar mesh size

d. Total does not add up to 100% due to rounding off.

Table 22. Percentages and Numbers of Northern Pike Collected at Chimney Bay and Tibbits Creek by Age, Sex and Gear From the Week of February 12 Through the Week of May 7, 1979.

Sex	Gear	Age 1	2	3	4	5	6	7	Total
Males	Gill Net	0.0[a]	17.9	46.4	25.0	7.1	3.6	0.0	100.0
		(0)[b]	(5)	(13)	(7)	(2)	(1)	(0)	(28)
Males	Trap Net (2.5cm)[c]	0.0	50.0	37.5	12.5	0.0	0.0	0.0	100.0
		(0)	(4)	(3)	(1)	(0)	(0)	(0)	(8)
Males	Trap Net (0.6cm)[c]	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
		(1)	(0)	(0)	(0)	(0)	(0)	(0)	(1)
Males	Seine	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
		(2)	(0)	(0)	(0)	(0)	(0)	(0)	(2)
Females	Gill Net	0.0	11.8	29.4	26.6	23.5	5.9	2.9	100.0
		(0)	(4)	(10)	(9)	(8)	(2)	(1)	(34)
Females	Trap Net (2.5cm)[c]	0.0	0.0	33.3	33.3	33.3	0.0	0.0	99.9[d]
		(0)	(0)	(1)	(1)	(1)	(0)	(0)	(3)
Females	Trap Net (0.6cm)[c]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Females	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Males	All Gear	7.7	23.1	41.0	20.5	5.1	2.6	0.0	100.0
		(3)	(9)	(16)	(8)	(2)	(1)	(0)	(39)
Females	All Gear	0.0	10.8	29.7	27.0	24.3	5.4	2.7	99.9[d]
		(0)	(4)	(11)	(10)	(9)	(2)	(1)	(37)

a. Percentage of the total.

b. Number of fish.

c. Bar mesh size.

d. Total does not add up to 100% due to rounding off.

Sex Ratios and Maturity. An examination of the sex ratios of northern pike collected during 1979 revealed differences between areas and gear. Female northern pike were more abundant in the combined gill and trap net catch at Morristown Point (male:female, 0.66:1, N=53), the gill net catch at Morristown Point (M:F, 0.59:1, N=46) and the gill net catch at Chimney Bay (M:F, 0.82:1, N=62); note Tables 21 and 22. Male northern pike were more abundant in the trap net catch at Chimney Bay (M:F, 2.67:1, N=11). Male and female northern pike were found in almost equal abundance in the trap catch at Morristown Point, and the combined trap and gill net catch at Chimney Bay (M:F, 0.97:1, N=76). A comparison of the male to female sex ratios between 1978 and 1979 indicated that the number of male northern pike, relative to females during 1979, decreased at Morristown (1978 M:F, 1.11:1, N=139 and 1979 M:F, 0.66:1, N=53) and, decreased at Chimney Bay and Tibbits Creek (1978 M:F, 1.65:1, N=138 and 1979 M:F, 0.97:1, N=73).

At Morristown Point during 1979, three immature fish were collected; two males and one female, all age 2.

At Chimney Bay and Tibbits Creek during 1979, two immature northern pike were collected. Both were males age 1. One fish was collected in a seine haul and the other was taken in the 0.6cm (1") bar mesh trap net.

It is evident from the data presented in Tables 21 and 22 that, in general, more males than females were collected at the younger ages, and more females than males were collected at the older ages. These data suggested that female pike are longer lived than male pike. This is in agreement with previous studies by Dunning et al. (1978) and Casselman (1967) on the St. Lawrence River, Clark and Steinbach (1959) on Lake Erie and Miller and Kennedy (1948) on four northern Canadian lakes.

Although little data from 1979 were available on the age of northern pike at maturity, the larger number of males at the younger ages was probably attributable to the fact that male pike matured earlier than did females. Male pike that were mature at ages 1, 2 and 3 were more likely to move into spawning grounds than immature females at those ages, and thus, had a greater chance of being captured in nets set during the spawning season. Dunning et al. (1978) reported that all male pike were mature by age 2 and all female pike were mature by age 4; this was based on data collected during the 1978 fisheries study on the St. Lawrence River. An additional factor probably influenced the greater abundance of female northern pike at older ages relative to males, and that is the northern pike sport fishery in New York State. The current minimum size limit for harvest of northern pike is 26 inches (660.4mm). The first age at which the mean length of male northern pike reaches or exceeds this limit is age 6 (Tables 21 and 22). As a result, a very small percentage of the male northern pike appear to reach the legal harvestable size. Therefore, the preponderance of northern pike available for harvest are females. Although the females at older ages were found in greater numbers than males, the positive bias toward the capture of females, probably acted to depress the numbers of older female northern pike.

Survival. It is customary not to include in an estimate of survival any age groups containing less than 5 to 10 fish and patently ridiculous when the extreme of 1 is reached (Everhart, Eipper and Youngs 1975). Since male and female northern pike appear to have different growth rates, and females seem to live longer, it is advantageous to examine the sexes separately when computing survival extimates. Survival extimates for northern pike were not attempted on a site specific basis during 1979 since insufficient numbers of fish were available for these calculations. Combining the numbers of northern pike from both Morristown Point and Chimney Bay - Tibbits Creek, still yielded relatively small sample sizes, but sufficient to conduct gross survival estimates based on the estimator proposed by Chapman and Robson (1960). Two estimates were calculated for male and female northern pike collected at Morristown and Chimney Bay - Tibbits Creek, during 1978 and 1979. The first estimate assumed the first year of full recruitment as being age 4 for males and age 5 for females, while the second assumed the first year of full recruitment as age 3 for males and age 4 for females (refer to the section on age and growth for additional information on recruitment).

Survival estimates ($\hat{S}$) calculated for males collected during 1979 ($\hat{S}$=0.400, var=0.008 and $\hat{S}$=0.433, var=0.003) were greater than those calculated for males collected during 1978 ($\hat{S}$=0.220, var=0.004 and $\hat{S}$=0.290, var=0.001). Survival estimates calculated for females collected during 1979 ($\hat{S}$=0.405, var=0.006 and $\hat{S}$=0.483, var=0.003) were also greater than those calculated for females during 1978 ($\hat{S}$=0.220, var=0.004 and $\hat{S}$=0.359, var=0.002). It is apparent that selecting age 4 males and age 5 females as the first fully recruited age, produced the more conservative estimates. For these values to be valid it is assumed that all ages after the first fully recruited one, were sampled in proportion to their abundance, and survival and recruitment were constant. At this time it is not clear whether the differences in the survival estimates calculated for northern pike during 1978 and 1979 were an accurate reflection of changing survival rates, or a result of violating one, or a combination of the assumptions mentioned above.

Stomach Analyses. Northern pike stomachs contained fish exclusively, as food items. Fish contents were found in 57 out of 100 northern pike stomachs collected from both study areas between the weeks of February 12 and May 7, 1979. Fifty-three pike collected in shallow water (56.4% of the total) had food organisms, while in deep water 4 pike (66.7%) had food organisms. Ten species of fish were identified from examination of stomach contents. The species most frequently found (percent occurrence) in northern pike stomachs were yellow perch (16%), largemouth bass (15%), and rainbow smelt (13%). The most abundant species (average total number) present in pike stomachs were rainbow smelt (0.5 per stomach containing food organisms), largemouth bass (0.4 per stomach) and yellow perch (0.3 per stomach).

At Morristown, 17 northern pike stomachs (47.2%) contained fish (7 in winter (63.6%), and 10 in spring (40.0%)); note Tables 23 and 24. Sixteen pike stomachs (48.5%) from shallow water gill nets contained fish, while 1 stomach (33.3%) from deep water contained fish. The mean number of fish per northern pike stomach with food contents during the winter (4.5) was higher than that for the spring (2.7).

Table 23. Stomach Contents of Northern Pike Collected at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of February 12 Through the Week of March 19, 1979.

Stomach Contents	Number of Northern Pike Stomachs Containing Food Organisms															
	February 12		February 19		February 26		March 5		March 12		March 19		Total[a]		% of Total	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
Yellow perch	0	-	-	-	1	0	1	-	0	-	1	-	3	0	50.0	0.0
Rainbow smelt	0	-	-	-	0	0	0	-	1	-	0	-	1	0	16.7	0.0
Shiner sp.	0	-	-	-	1	0	0	-	0	-	0	-	1	0	16.7	0.0
Northern pike	0	-	-	-	0	0	0	-	0	-	1	-	1	0	16.7	0.0
Unidentified Fish remains	0	-	-	-	2	1	1	-	0	-	2	-	5	1	-	-
Total													6	0	100.1[c]	0.0
No. of Fish	1	0	0	0	2	2	2	0	1	0	3	0	9	2		
No. of Stomachs with contents	0	-	-	-	2	1	1	-	1	-	2	-	6	1		
% of Stomachs with contents	0.0	-	-	-	100.0	50.0	50.0	-	100.0	-	66.7	-	66.7	50.0		

a. Unidentified fish remains not included in total.

b. Unidentified fish remains not included in percent of total.

c. Total does not add up to 100% due to rounding off.

Table 24. Stomach Contents of Northern Pike Collected at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of March 26 Through the Week of May 7, 1979.

Stomach Contents	Number of Northern Pike Stomachs Containing Food Organisms																	
	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Total[a]		% of Total[b]	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
Yellow perch	-	-	0	-	2	-	1	-	0	0	0	-	0	-	3	0	23.1	-
Largemouth bass	-	-	0	-	1	-	0	-	0	0	0	-	0	-	1	0	7.7	-
Bluntnose minnow	-	-	0	-	2	-	0	-	0	0	0	-	0	-	2	0	15.4	-
Spottail shiner	-	-	0	-	1	-	0	-	1	0	0	-	0	-	2.	0	15.4	-
Rainbow smelt	-	-	0	-	2	-	1	-	0	0	0	-	1	-	4	0	30.8	-
Alewife	-	-	0	-	0	-	0	-	0	0	0	-	1	-	1	0	7.7	-
Unidentified Fish remains	-	-	1	-	1	-	0	-	0	0	1	-	1	-	4	0	-	-
Total															13	0	100.0	-
No. of Fish	0	0	4	0	4	0	4	0	6	1	3	0	3	0	24	1	-	-
No. with contents	-	-	1	-	4	-	2	-	1	0	1	-	1	-	10	0	-	-
% of stomachs with contents	-	-	25.0	-	100.0	-	50.0	-	16.7	0.0	33.3	-	33.3	-	41.7	0.0	-	-

a. Unidentified fish remains not included in total.

b. Unidentified fish remains not included in percent of total.

Seven taxa of fish were identified from northern pike stomachs collected at Morristown; four during the winter and six during the spring (Tables 23 and 24). Since only one fish collected in deep water gill nets had stomach contents, and they consisted of unidentifiable fish remains, the following discussion on feeding of pike at Morristown focuses on shallow water results. During the winter, yellow perch and rainbow smelt were important items in the diet of pike. Yellow perch were observed in three stomachs containing food contents (50.0% of the winter total), while rainbow smelt were found in one stomach (16.7%); note Table 23. Rainbow smelt comprised 76.1% of the total number of food items consumed by northern pike in the winter (2.7 smelt/stomach), and yellow perch comprised 14.2% of the total (0.5 perch/stomach); note Table 25.

During the spring, yellow perch and rainbow smelt were again important items in the diet of northern pike. At this time rainbow smelt were observed in four stomachs (30.8% of the spring total), while yellow perch were found in three stomachs (23.1%); note Table 24. Rainbow smelt comprised 40.0% of the total number of food items consumed by northern pike in the spring (0.6 smelt/stomach), and yellow perch comprised 20.0% of the total (0.3 perch/stomach); note Table 26.

At Chimney Bay, 40 northern pike stomachs (62.5%) contained fish (15 in winter (83.3%),and 25 in the spring (54.3%)); note Tables 27 and 28. Thirty-seven pike stomachs (60.7%) from shallow water gill nets contained fish, while all (100%) of the stomachs (3) from deep water contained fish. The mean number of fish per northern pike stomach with food contents during the winter (3.0) was slightly higher than that for the spring (2.8).

Eleven taxa of fish were identified from northern pike stomachs collected at Chimney Bay; 6 during the winter and 10 during the spring. During the winter, largemouth bass and black crappie were important items in the diet of northern pike collected in shallow water (no fish were collected in deep water). Largemouth bass were observed in five stomachs containing food contents (38.5% of the winter total), while black crappie were found in three stomachs (23.1%); note Table 27. Largemouth bass comprised 54.2% of the total number of food items consumed by northern pike in the winter (0.9 bass/stomach), and black crappie comprised 16.7% of the total (0.3 crappie/stomach); note Table 29.

During the spring, yellow perch, largemouth bass and rainbow smelt were important items in the diet of northern pike collected in shallow water. Yellow perch were observed in nine pike stomachs (23.7% of the spring total), and largemouth bass and rainbow smelt were each found in 7 stomachs (18.9%); note Table 29. Yellow perch comprised 27.3% of the total number of food items consumed by northern pike collected in shallow water during the spring (0.6 perch/stomach), largemouth bass comprised 20.5% of the total (0.41 bass/stomach) and rainbow smelt comprised 18.2% of the total (0.36 smelt/stomach); note Table 30. An unidentified darter was found in the only pike collected during the spring in deep water (0.3 darters/stomach); note Table 30.

The diversity of fish species found in the stomachs of northern pike at Morristown Point and Chimney Bay seemed to reflect an opportunistic feeding behavior, one of consuming whatever fishes were available. The percentage of northern pike stomachs containing fish decreased at the time spawning was thought to have occurred (the weeks of April 16 through April 30).

Table 25. Mean Number of Organisms Per Stomach From Northern Pike Collected at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of February 12 Through the Week of March 19, 1979.[a]

Stomach Contents	Mean Number of Organisms Per Stomach															
	February 12		February 19		February 26		March 5		March 12		March 19		Total		% of Total	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	0[b]	0	0	0	2	1	1	0	1	0	2	0	6	1		
Yellow perch	-	-	-	-	0.5	0.0	1.0	-	0.0	-	0.5	-	0.50	0	14.2	-
Rainbow smelt	-	-	-	-	0.0	0.0	0.0	-	16.0	-	0.0	-	2.67	0	76.1	-
Shiner sp.	-	-	-	-	0.5	0.0	0.0	-	0.0	-	0.0	-	0.17	0	4.8	-
Northern pike	-	-	-	-	0.0	0.0	0.0	-	0.0	-	0.5	-	0.17	0	4.8	-
Unidentified Fish remains	-	-	-	-	1.0	1.0	1.0	-	0.0	-	1.5	-	1.00	1	-	-
Total	-	-	-	-	2.0	1.0	2.0	-	16.0	-	2.5	-	4.51	1	99.9[d]	-

a. Only stomachs which contained food organisms were included in the analysis.

b. Number of fish with stomach contents.

c. Unidentified fish remains not included in percent of total.

d. Total does not add up to 100% due to rounding off.

Table 26. Mean Number of Organisms Per Stomach From Northern Pike Collected at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of March 26 Through the Week of May 7, 1979.[a]

Stomach Contents	Mean Number of Organisms Per Stomach																% of Total[c]	
	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Total			
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	0[b]	0	1	0	4	0	2	0	1	0	1	0	1	0	10	0		
Yellow perch	-	-	0.0	-	0.5	-	0.5	-	0.0	-	0.0	-	0.0	-	0.30	-	20.0	-
Largemouth bass	-	-	0.0	-	0.3	-	0.0	-	0.0	-	0.0	-	0.0	-	0.10	-	6.7	-
Bluntnose minnow	-	-	0.0	-	0.5	-	0.0	-	0.0	-	0.0	-	0.0	-	0.20	-	13.3	-
Spottail shiner	-	-	0.0	-	0.3	-	0.0	-	1.0	-	0.0	-	0.0	-	0.20	-	13.3	-
Rainbow smelt	-	-	0.0	-	1.0	-	1.0	-	0.0	-	0.0	-	0.0	-	0.60	-	40.0	-
Alewife	-	-	0.0	-	0.0	-	0.0	-	0.0	-	0.0	-	1.0	-	0.10	-	6.7	-
Unidentified Fish remains	-	-	1.0	-	0.3	-	0.0	-	0.0	-	1.0	-	9.0	-	1.20	-	-	-
Total	-	-	1.0	-	2.9	-	1.5	-	1.0	-	1.0	-	10.0	-	2.70	-	100.0	-

a. Only stomachs which contained food organisms were included in the analysis.

b. Number of fish with stomach contents.

c. Unidentified fish remains were not included in percent of total.

Table 27. Stomach Contents of Northern Pike Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths in Chimney Bay From the Week of February 12 Through the Week of March 12, 1979.

Contents	Number of Northern Pike Stomachs Containing Food Organisms													
	February 12		February 19		February 26		March 5		March 12		Total[a]		% of Total[b]	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
Yellow perch	1	-	0	-	0	-	0	-	0	-	1	-	7.7	-
Largemouth bass	0	-	0	-	4	-	1	-	0	-	5	-	38.5	-
Rainbow smelt	1	-	0	-	0	-	0	-	0	-	1	-	7.6	-
Black crappie	1	-	0	-	2	-	0	-	0	-	3	-	23.1	-
Sunfish sp.	0	-	0	-	1	-	1	-	0	-	2	-	15.4	-
Shiner sp.	0	-	0	-	1	-	0	-	0	-	1	-	7.7	-
Unidentified fish remains	5	-	1	-	3	-	2	-	1	-	12	-	-	-
Total											13	0	100.0	-
No. of Fish	7	0	2	0	6	0	2	0	1	0	18	0		
No. with contents	5	-	1	-	6	-	2	-	1	-	15	-	-	-
% of Stomachs with contents	71.4	-	50.0	-	100.0	-	100.0	-	100.0	-	83.3	-	-	-

a. Unidentified fish remains not included in total.

b. Unidentified fish remains not included in percent of total.

Table 28. Stomach Contents of Northern Pike Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths in Chimney Bay From the Week of March 26 Through the Week of May 7, 1979.

Stomach Contents	Number of Northern Pike Stomachs Containing Food Organisms																		% of Total[b]	
	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Total[a]					
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m			1.5m	15m
Yellow perch	4	0	2	0	2	-	0	-	0	-	0	0	1	-	9	0			24.4	0.0
Darter sp.	0	0	2	0	0	-	0	-	0	-	0	1	0	-	2	1			5.4	100.0
Rainbow smelt	2	0	0	0	1	-	0	-	2	-	1	0	1	-	7	0			18.9	0.0
Largemouth bass	2	0	3	0	0	-	0	-	0	-	0	0	2	-	7	0			18.9	0.0
Sunfish sp.	1	0	1	0	1	-	0	-	0	-	0	0	0	-	3	0			8.1	0.0
Black crappie	1	0	1	0	1	-	0	-	0	-	0	0	0	-	3	0			8.1	0.0
Rock bass	0	0	0	0	2	-	0	-	0	-	0	0	0	-	2	0			5.4	0.0
Spottail shiner	0	0	0	0	0	-	0	-	0	-	0	0	1	-	1	0			2.7	0.0
Mottled sculpin	0	0	0	0	0	-	1	-	0	-	0	0	0	-	1	0			2.7	0.0
Alewife	0	0	0	0	0	-	0	-	0	-	0	0	1	-	1	0			2.7	0.0
Salmonid	0	0	0	0	0	-	0	-	1	-	0	0	0	-	1	0			2.7	0.0
Unidentified Fish remains	2	1	2	1	3	-	1	-	0	-	0	1	2	-	10	3			-	-
Total															37	1			100.0	100.0
No. of Fish	5	1	6	1	6	0	6	0	9	0	3	1	8	0	43	3			-	-
No. with contents	5	1	4	1	4	0	2	-	3	-	1	1	3	-	22	3			-	-
% of Stomachs with contents	100.0	100.0	66.7	100.0	66.7	-	33.3	-	33.3	-	33.3	100.0	37.5	-	51.2	100.0			-	-

a. Unidentified fish remains not included in total.

b. Unidentified fish remains not included in percent of total.

Table 29. Mean Number of Organisms Per Stomach From Northern Pike Collected at 1.5m (4.9') and 15m (49.2') Water Depths in Chimney Bay From the Week of February 12 Through the Week of March 12.[a]

Contnets	Mean Number of Organisms Per Stomach													
	February 12		February 19		February 26		March 5		March 12		Total		% of Total[c]	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	5[b]	0	1	0	6	0	2	0	1	0	15	0		
Yellow perch	0.2	-	0.0	-	0.0	-	0.0	-	0.0	-	0.06	-	4.2	-
Rainbow smelt	0.2	-	0.0	-	0.0	-	0.0	-	0.0	-	0.06	-	4.2	-
Largemouth bass	0.0	-	0.0	-	1.8	-	1.0	-	0.0	-	0.87	-	54.2	-
Sunfish sp.	0.0	-	0.0	-	0.2	-	1.5	-	0.0	-	0.27	-	16.7	-
Black crappie	0.4	-	0.0		0.7	-	0.0	-	0.0	-	0.27	-	16.7	-
Shiner sp.	0.0	-	0.0	-	0.2	-	0.0	-	0.0	-	0.06	-	4.2	-
Unidentified Fish remains	2.4	-	1.0	-	0.5	-	1.0	-	3.0	-	1.40	-	-	-
Total	3.2	-	1.0	-	3.4	-	3.5	-	3.0	-	2.99	-	100.2	-

a. Only stomachs which contained food organisms were included in the analysis.

b. Number of fish containing food organisms.

c. Unidentified fish remains were not included in percent of total.

Table 30. Mean Number of Organisms Per Stomach From Northern Pike Collected at 1.5m (4.9') and 15m (49.2') Water Depths in Chimney Bay From the Week of March 26 Through the Week of May 7, 1979.[a]

Stomach Contents	Mean Number of Organisms Per Stomach																% of Total[c]	
	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Total			
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	5[b]	1	4	1	4	0	2	0	3	0	1	1	3	0	22	3		
Yellow perch	1.0	0.0	0.5	0.0	1.0	-	0.0	-	0.0	-	0.0	0.0	0.3	-	0.55	0.0	27.3	0.0
Darter sp.	0.0	0.0	0.5	0.0	0.0	-	0.0	-	0.0	-	0.0	0.5	0.0	-	0.09	0.33	4.5	100.0
Rainbow smelt	0.4	0.0	0.0	0.0	0.3	-	0.0	-	0.7	-	1.0	0.0	0.7	-	0.36	0.0	18.2	0.0
Largemouth bass	1.2	0.0	0.8	0.0	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0	-	0.41	0.0	20.5	0.0
Sunfish sp.	0.2	0.0	0.3	0.0	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	-	0.14	0.0	6.8	0.0
Black crappie	0.2	0.0	0.3	0.0	0.3	-	0.0	-	0.0	-	0.0	0.0	0.0	-	0.14	0.0	6.8	0.0
Rock bass	0.0	0.0	0.0	0.0	0.5	-	0.0	-	0.0	-	0.0	0.0	0.0	-	0.09	0.0	4.5	0.0
Spottail shiner	0.0	0.0	0.0	0.0	0.0	-	0.0	-	0.0	-	0.0	0.0	0.3	-	0.05	0.0	2.3	0.0
Mottled sculpin	0.0	0.0	0.0	0.0	0.0	-	0.5	-	0.0	-	0.0	0.0	0.0	-	0.05	0.0	2.3	0.0
Alewife	0.0	0.0	0.0	0.0	0.0	-	0.0	-	0.0	-	0.0	0.0	0.7	-	0.09	0.0	4.5	0.0
Salmonid	0.0	0.0	0.0	0.0	0.0	-	0.0	-	0.3	-	0.0	0.0	0.0	-	0.09	0.0	2.3	0.0
Unidentified Fish remains	0.4	1.0	1.0	1.0	2.0	-	0.5	-	0.0	-	0.0	0.5	0.7	-	0.77	1.0	-	-
Total	3.4	1.0	3.4	5.0	4.4	-	1.0	-	1.0	-	1.0	2.0	2.7	-	2.83	1.00	100.0	100.0

a. Only stomachs which contained food organisms were included in the analysis.
b. Number of fish containing food organisms.
c. Unidentified fish remains were not included in percent of total.

External Parasites. Of the 60 northern pike examined from Morristown, two each had a single lamprey wound behind the left pectoral fin, and two others appeared to be suffering from lymphosarcoma, an infection causing large sores on the skin. None of the fish examined were infected with black spot, the externally encysted stage of the tremetode (*Uvulifer ambloplitis*).

At Chimney Bay and Tibbits Creek, 7 out of 81 northern pike (8.6%) were infected with black spot. No other obvious parasites were observed on these fish. Dunning et al. (1978) reported that 7.4% of the northern pike collected at Chimney Bay during 1978 were infested with black spot and only one northern pike (0.5%) exhibited a lamprey scar.

Movement. Three northern pike, one male and two females, netted during the current study were tagged and released in 1978 by Dunning et al. (1978). The male was collected in a shallow set gill net in Chimney Bay on April 4, 1979; it was originally captured in a trap net and tagged in Tibbits Creek on April 20, 1978. One of the two females was collected in a shallow set gill net at Morristown Point on April 4, 1979, and was initially captured in a trap net and tagged at Morristown Point on May 19, 1978. The other female, collected in a gill net at Morristown Harbor on March 23, 1979, was captured in a trap net and tagged at Morristown Point on June 7, 1978. Dunning et al (1978) reported that movement by northern pike in the St. Lawrence River was limited, averaging 3.2 miles, with 89% of the pike traveling less than 1.5 miles. Limited northern pike recapture data from 1979 support this theory.

Yellow Perch

Age and Growth. Age and growth of yellow perch were studied by examining scales from 296 fish collected at Morristown Point and 611 fish collected at Chimney Bay and Tibbits Creek. These fish were collected by gill netting, trap netting and seining.

Although the 1979 age data for yellow perch at Morristown Point were limited, a comparison of mean observed lengths between males and females suggested the occurrence of sexually dimorphic growth (Table 31). Female perch were generally larger than males of the same age when collected by the same gear. This is in agreement with previously collected data on yellow perch in the St. Lawrence River (Dunning et al. 1978). The only exceptions at Morristown Point were for 2 year old gill netted perch where the mean length for three males (119mm) was 5mm larger than the mean length for three females, and for 4 year old trap netted perch where the mean length of eight males (191mm) was 4mm larger than the mean length of 127 females. Small sample sizes precluded comparing the selectivity of trap netting versus gill netting (Table 32).

A comparison of mean observed lengths at age for yellow perch collected at Morristown during 1978 (Dunning et al. 1978) and 1979 did not indicate consistent differences between years for individuals age 6 and older (Table 33). In 1979 females of ages 3-5 and males of ages 4 and 5 exhibited smaller mean lengths than perch of similar ages and sex collected during 1978. The reason(s) for these differences in length are not clear.

At Chimney Bay and Tibbits Creek a comparison of mean observed lengths between male and female yellow perch did not reveal sexually dimorphic growth until age 4 (Table 34). Sexually dimorphic growth was expected to be evident at age 2 based on data reported by Dunning et al. (1978). However, since the

Table 31. Mean Lengths, Ranges and Standard Error of the Means for Yellow Perch Collected at Morristown by Age, Sex and Gear From the Week of February 12 Through the Week of May 7, 1979.

Sex	Gear		Age 1	2	3	4	5	6	7	8	9
Males	Gill Net	$\overline{TL}$	-	119	-	168	188	222	-	-	-
		S.E.	-	4.7	-	21.3	10.6	11.3	-	-	-
		Range		115-124	-	138-209	180-195	214-230	-	-	-
Males	Trap Net (2.5cm)[a]	$\overline{TL}$	-	-	-	191	184	-	-	-	-
		S.E.	-	-	-	17.5	0.0	-	-	-	-
		Range	-	-	-	169-218	-	-	-	-	-
Females	Gill Net	$\overline{TL}$	-	114	108	186	200	252	274	-	255
		S.E.	-	11.7	0.0	16.0	18	20.9	21.2	-	0.0
		Range	-	104-127	-	137-221	177-233	226-269	259-289	-	-
Females	Trap Net (2.5cm)[a]	$\overline{TL}$	-	-	166	187	203	230	242	257	217
		S.E.	-	-	0.0	14.8	21.8	22.9	19.0	0.0	0.0
		Range	-	-	-	162-237	174-246	198-249	224-274	-	-
Unknown	Gill Net	$\overline{TL}$	-	118	-	-	-	-	-	-	-
		S.E.	-	6.2	-	-	-	-	-	-	-
		Range	-	111-123	-	-	-	-	-	-	-
Unknown	Trap Net (2.5cm)[a]	$\overline{TL}$	-	-	-	191	-	-	-	-	-
		S.E.	-	-	-	2.1	-	-	-	-	-
		Range	-	-	-	189-192	-	-	-	-	-

a. Bar mesh size.

Table 32. Percentages and Numbers of Yellow Perch Collected at Morristown by Age, Sex and Gear From the Week of February 12 Through the Week of May 7, 1979.

Sex	Gear	Age 1	2	3	4	5	6	7	8	9	Total
Males	Gill Net	0.0 [a]	13.0	0.0	69.6	8.7	8.7	0.0	0.0	0.0	100.0
		(0)[b]	(3)	(0)	(16)	(2)	(2)	(0)	(0)	(0)	(23)
Males	Trap Net (2.5cm)[c]	0.0	0.0	0.0	88.9	11.1	0.0	0.0	0.0	0.0	100.0
		(0)	(0)	(0)	(8)	(1)	(0)	(0)	(0)	(0)	(9)
Males	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Females	Gill Net	0.0	3.0	1.0	74.7	14.1	4.0	2.0	0.0	1.0	99.8[d]
		(0)	(3)	(1)	(74)	(14)	(4)	(2)	(0)	(1)	(99)
Females	Trap Net (2.5cm)[c]	0.0	0.0	0.6	77.0	15.2	3.0	3.0	0.6	0.6	100.0
		(0)	(0)	(1)	(127)	(25)	(5)	(5)	(1)	(1)	(165)
Females	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Unknowns	Gill Net	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
		(0)	(3)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(3)
Unknowns	Trap Net	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0
		(0)	(0)	(0)	(2)	(0)	(0)	(0)	(0)	(0)	(2)

(Continued)

Table 32. (Concluded)

Sex	Gear	Age 1	2	3	4	5	6	7	8	9	Total
Unknowns	Seine	100.0 (15)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	100.0 (15)
Males	All Gear	0.0 (0)	9.4 (3)	0.0 (0)	75.0 (24)	9.4 (3)	6.3 (2)	0.0 (0)	0.0 (0)	0.0 (0)	100.1[d] (32)
Females	All Gear	0.0 (0)	1.1 (3)	0.8 (2)	76.1 (201)	14.8 (39)	3.4 (9)	2.7 (7)	0.4 (1)	0.8 (2)	100.1[d] (264)

a. Percentage of the total.

b. Number of fish.

c. Bar mesh size.

d. Total does not add up to 100% due to rounding off.

Table 33. Comparison of Mean Lengths and Numbers of Yellow Perch Collected at Morristown During 1978[a] and 1979 by Age, Sex and Gear.

Sex	Gear		Age 1	2	3	4	5	6	7	8	9
Males	Gill Net	1979	-	119[b]	-	168	188	222	-	-	-
			(0)	(3)[c]	(0)	(16)	(2)	(2)	(0)	(0)	(0)
		1978	72[e]	115[e]	152	182	215	222	199	227	-
					(29)	(8)	(6)	(3)	(1)	(1)	(1)
Males	Trap Net (2.5cm)[d]	1979	-	-	-	191	184	-	-	-	-
			(0)	(0)	(0)	(8)	(1)	(0)	(0)	(0)	(0)
		1978	-	-	150	189	199	221	217	-	-
			(0)	(0)	(32)	(15)	(20)	(3)	(1)	(0)	(0)
Females	Gill Net	1979	-	114	108	186	200	252	274	-	255
			(0)	(3)	(1)	(75)	(14)	(4)	(2)	(0)	(1)
		1978	75[e]	129[e]	161	200	229	233	240	277	-
					(45)	(14)	(30)	(18)	(8)	(1)	(0)
Females	Trap Net (2.5cm)	1979	-	-	166	187	203	226	242	257	-
			(0)	(0)	(1)	(127)	(25)	(5)	(5)	(1)	(0)
		1978	-	-	173	217	209	231	223	-	-
			(0)	(0)	(10)	(5)	(18)	(11)	(2)	(0)	(0)
Males	All Gears	1979	-	119	-	176	187	222	-	-	-
			(0)	(3)	(0)	(24)	(3)	(2)	(0)	(0)	(0)
		1978	-	-	151	187	203	222	208	227	-
			(0)	(0)	(61)	(23)	(26)	(5)	(2)	(1)	(0)
Females	All Gears	1979	-	114	137	187	202	238	251	257	255
			(0)	(3)	(2)	(202)	(39)	(9)	(7)	(1)	(1)
		1978	-	-	163	204	222	232	237	277	-
			(0)	(0)	(55)	(1)	(48)	(29)	(10)	(1)	(0)

a. Dunning et al. 1978. b. Mean length. c. Number of fish. d. Bar mesh. e. Calculated length.

Table 34. Mean Lengths, Ranges and Standard Error of the Means for Yellow Perch Collected at Chimney Bay by Age, Sex and Gear From the Week of February 12 Through the Week of May 7, 1979.

Sex	Gear		Age 1	2	3	4	5	6	7	8	9
Males	Gill Net	$\overline{TL}$	-	135	144	184	204	223	-	-	-
		S.E.	-	14.7	6.8	11.4	16.4	8.5	-	-	-
		Range	-	100-152	136-155	152-213	184-220	217-233	-	-	-
Males	Trap Net (2.5cm)[a]	$\overline{TL}$	-	-	-	191	209	213	214	-	-
		S.E.	-	-	-	12.7	14.3	12.3	10.4	-	-
		Range	-	-	-	168-233	175-235	183-232	203-228	-	-
Males	Trap Net (0.6cm)[a]	$\overline{TL}$	87.0	-	-	-	-	-	-	-	-
		S.E.	10.1	-	-	-	-	-	-	-	-
		Range	73-99	-	-	-	-	-	-	-	-
Females	Gill Net	$\overline{TL}$	-	128	137	196	220	247	260	-	240
		S.E.	-	12.1	0.0	15.9	22.1	32.8	17.7	-	0.0
		Range	-	114-137	-	170-235	178-253	200-283	245-285	-	-
Females	Trap Net (2.5cm)[a]	$\overline{TL}$	-	-	-	204	218	241	242	284	-
		S.E.	-	-	-	16.0	27.4	14.0	12.0	0.0	-
		Range	-	-	-	165-297	166-258	216-257	233-250	-	-
Unknown	Gill Net	$\overline{TL}$	-	135	-	-	175	-	-	-	-
		S.E.	-	0.0	-	-	0.0	-	-	-	-
		Range	-	-	-	-	-	-	-	-	-

(Continued)

Table 34. (Concluded)

Sex	Gear		Age 1	2	3	4	5	6	7	8	9
Unknown	Trap Net (2.5cm)[a]	$\overline{TL}$	-	-	-	189	-	-	-	-	-
		S.E.	-	-	-	10.5	-	-	-	-	-
		Range	-	-	-	171-205	-	-	-	-	-
Unknown	Trap Net (0.6cm)[a]	$\overline{TL}$	80	-	-	-	-	-	-	-	-
		S.E.	8.1	-	-	-	-	-	-	-	-
		Range	57-103	-	-	-	-	-	-	-	-
Unknown	Seine	$\overline{TL}$	80	-	-	-	-	-	-	-	-
		S.E.	11.4	-	-	-	-	-	-	-	-
		Range	71-93	-	-	-	-	-	-	-	-

a. Bar mesh size.

quantity of female yellow perch collected during 1979 at ages 2 (3 fish) and 3 (one fish) was small, it is possible that the absence of an expected difference in mean length between sexes was in part, attributable to reduced sample sizes. Small sample sizes also precluded comparing the selectivity of trap netting versus gill netting (Table 35).

A comparison of mean observed lengths at age for yellow perch collected at Chimney Bay during 1978 (Dunning et al. 1978) and 1979 did not indicate consistent differences between years for perch age 6 and older (Table 36). Females of ages 2-5 and males of ages 3-6 collected during 1979 exhibited smaller mean lengths than perch of similar ages and sex, collected during 1978. The reasons for these differences between mean lengths are not clear.

In 1978 Dunning et al. (1978) reported that the 1975 year class (age 3 fish) appeared strong, representing 37% of the total gill net catch and 34% of the total trap net catch. Examination of the age distribution data for perch taken in 1979 again revealed that the 1975 year class (age 4 during 1979) was by far the most dominant. Combining data from all types of sampling used during 1979 at Morristown Point, one finds that 75% of all male yellow perch (N=32) and 76% of all female perch (N=264), belonged to the 1975 year class; at Chimney Bay and Tibbits Creek, 65% of all male yellow perch (N=364) and 78% of all females(N=247), belonged to the 1975 year class. These data appear to confirm the existence of a strong 1975 year class. It is interesting to note that although age 3 fish were well represented during 1978, they were poorly represented during 1979. At Morristown Point age 3 yellow perch comprised 0.8% of the total number of females and were not represented among males. At Chimney Bay and Tibbits Creek age 3 yellow perch comprised 0.4% of the total females and 1.9% of the total number of males. The reduced quantity of age 3 perch during 1979 (1976 year class) may be a compensatory response resulting from the dominant 1975 year class. Density dependent factors, such as cannibalism, some forms of predation and competition for food, tend to regulate populations in the direction of the long term average. The presence of this strong 1975 year class may also have been a factor influencing smaller mean lengths at age observed for yellow perch during 1979 in comparison with 1978.

Survival. Survival estimates, based on data collected during 1979, were calculated for yellow perch at Morristown Point and the Chimney Bay - Tibbits Creek area using an estimator derived by Chapman and Robson (1960). To calculate a survival value using this estimator, it is necessary to determine the age at which a population is completely vulnerable to the gear being employed; this age frequently follows the age containing the greatest representation of individuals. Based on data collected during 1978 (Dunning et al. 1978), the greatest number of yellow perch were age 3 (Tables 33 and 36). In 1979 the largest class of yellow perch was age 4. This large group of age 4 fish was derived from the very strong year class which appeared as age 3 in 1978 (refer to the section on age and growth). It is believed that the 1979 age-frequency distribution for yellow perch was atypical. Therefore, based on the 1978 age-frequency distribution, age 4 was selected as the first age completely vulnerable to capture.

Table 35. Percentages and Numbers of Yellow Perch Collected at Chimney Bay and Tibbits Creek From the Week of February 12 Through the Week of May 7, 1979 by Age, Sex and Gear.[a]

Sex	Gear	Age 1	2	3	4	5	6	7	8	9	Total
Males	Gill Net	0.0[b] (0)[c]	32.5 (25)	9.1 (7)	46.8 (36)	7.8 (6)	3.9 (3)	0.0 (0)	0.0 (0)	0.0 (0)	100.1[e] (77)
Males	Trap Net (2.5cm)[d]	0.0 (0)	0.0 (0)	0.0 (0)	71.5 (201)	19.6 (55)	7.1 (20)	1.8 (5)	0.0 (0)	0.0 (0)	100.0 (281)
Males	Trap Net (0.6cm)[d]	100.0 (6)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	100.0 (6)
Males	Seine	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Females	Gill Net	0.0 (0)	3.9 (3)	1.3 (1)	63.6 (49)	18.2 (14)	6.5 (5)	5.2 (4)	0.0 (0)	1.3 (1)	100.0 (77)
Females	Trap Net (2.5cm)[d]	0.0 (0)	0.0 (0)	0.0 (0)	84.7 (144)	9.4 (16)	4.1 (7)	1.1 (2)	0.6 (1)	0.0 (0)	99.9[e] (170)
Females	Trap Net (0.6cm)[d]	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Females	Seine	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Unknowns	Trap Net (0.6cm)[d]	100.0 (168)[c]	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	100.0 (168)
Unknowns	Seine	100.0 (178)[c]	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	100.0 (178)

(Continued)

Table 35. (Concluded)

Sex	Gear	Age 1	2	3	4	5	6	7	8	9	Total
Males	All Gear	1.6	6.9	1.9	65.1	16.8	6.3	1.4	0.0	0.0	100.0
		(6)	(25)	(7)	(237)	(61)	(23)	(5)	(0)	(0)	(364)
Females	All Gear	0.0	1.2	0.4	78.1	12.1	4.9	2.4	0.4	0.4	99.8[e]
		(0)	(3)	(1)	(193)	(30)	(12)	(6)	(1)	(1)	(247)
Unknowns	All Gear	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
		(346)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(346)

a. 15 adult perch collected by trap netting (0.6cm bar mesh) and 24 adult perch collected by seining were not aged and therefore are not represented in this table.

b. Percentage of the total

c. Number of fish.

d. Bar mesh size.

e. Total does not add up to 100% due to rounding off.

Table 36. Comparison of Mean Lengths and Numbers of Yellow Perch Collected at Chimney Bay and Tibbits Creek During 1978[a] and 1979 by Age, Sex and Gear.

Sex	Gear		Age 1	2	3	4	5	6	7	8	9
Males	Gill Net	1979	-	135[b]	144	184	204	223	-	-	-
			(0)	(25)[c]	(7)	(36)	(6)	(3)	(0)	(0)	(0)
		1978	73[e]	115[e]	158	184	209	230	-	-	-
					(9)	(3)	(4)	(1)	(0)	(0)	(0)
Males	Trap Net (2.5cm)[d]	1979	-	-	-	191	209	213	214	-	-
			(0)	(0)	(0)	(201)	(55)	(20)	(5)	(0)	(0)
		1978	-	134	168	204	212	222	218	215	214
			(0)	(1)	(77)	(68)	(54)	(12)	(4)	(3)	(3)
Females	Gill Net	1979	-	128	137	196	220	247	260	-	240
			(0)	(3)	(1)	(49)	(14)	(5)	(4)	(0)	(1)
		1978	76[e]	119[e]	166	206	233	234	272	-	-
					(35)	(146)	(15)	(8)	(2)	(0)	(0)
Females	Trap Net (0.6cm)	1979	-	-	-	204	218	241	242	284	-
			(0)	(0)	(0)	(146)	(16)	(7)	(2)	(1)	(0)
		1978	-	146	176	209	236	248	248	262	308
			(0)	(4)	(104)	(55)	(75)	(23)	(11)	(2)	(1)
Males	All Gears	1979	84	132	144	190	208	214	214	-	-
			(7)	(25)	(7)	(237)	(61)	(23)	(5)	(0)	(0)
		1978	-	-	167	203	212	223	218	215	214
			(0)	(0)	(86)	(71)	(58)	(13)	(4)	(3)	(3)
Females	All Gears	1979	-	128	137	202	219	244	254	284	240
			(0)	(3)	(1)	(195)	(30)	(12)	(6)	(1)	(1)
		1978	-	146	173	206	236	244	251	262	308
			(0)	(4)	(139)	(201)	(90)	(31)	(13)	(2)	(1)

a. Dunning et al. 1978. b. Mean length. c. Number of fish. d. Bar mesh. e. Calculated length.

The 1979 Survival estimates ($\hat{S}$) for female yellow perch were similar between Morristown Point ($\hat{S}$=0.263, var=0.001) and Chimney Bay - Tibbits Creek ($\hat{S}$=0.251, var=0.001). For male yellow perch, estimates were possible only for Chimney Bay and Tibbits Creek (S=0.273, var<0.000), because of a small sample size at Morristown Point.

Survival estimates based on 1978 data (Dunning et al. 1978) were substantially higher, relative to 1979, for both female (Morristown $\hat{S}$=0.614, var=0.001 and Chimney Bay - Tibbits Creek $\hat{S}$=0.300, var<.000) and male yellow perch (Morristown $\hat{S}$=0.451, var=.002 and Chimney Bay - Tibbits Creek $\hat{S}$=0.449, var=0.019). The underlying cause for this annual variation remains unclear. It may be that the strong 1975 year class (age 4 fish in 1979) biased the results by not meeting the necessary assumption of constant recruitment and survival.

Sex Ratios and Maturity. An examination of the sex ratios of yellow perch collected during 1979 revealed large differences by area and gear. Females were more abundant in the combined (M:F, 0.09:1, N=296) and individual gill (M:F, 0.23:1, N=122) and trap net (M:F, 0.05:1, N=174) catches at Morristown Point. At Chimney Bay, male yellow perch were more abundant in the combined gill and trap net catch (M:F, 1:45:1, N=605) and the trap net catch (M:F, 1:65:1, N=451). Male and female perch were found to be equally abundant in the gill net catch at Chimney Bay. A comparison of the ratio of male to female yellow perch between 1978 and 1979 indicated a decrease in the number of males during 1979 at Morristown (1978 M:F, 0.73:1, N=281 and 1979 M:F, 0.09:1, N=296), and an increase at Chimney Bay and Tibbits Creek (1978 M:F, 0.68:1, N=594 and 1979 M:F, 1.45:1, N=605).

Most male yellow perch appeared to reach maturity by age 2. At Morristown Point and Chimney Bay - Tibbits Creek, 83.3% (N=6) and 85.2% (N=27) of the males respectively, were mature at age 2. No immature males were found during 1979 which were older than age 2.

Most female yellow perch appeared to reach maturity by age 4. At Morristown Point 95.1% of the females (N=205) and, at Chimney Bay and Tibbits Creek 97.6% of the females (N=207) were mature at age 4. A single immature female, of age 5, was found at Morristown Point.

Stomach Analysis. At Morristown Point during the winter, 100% (N=2) and 33% (N=21) of the yellow perch taken in shallow and deep gill nets, respectively had stomachs containing food (Table 37). The average total number of items per stomach for shallow and deep net perch was 20.5 and 1.0, respectively (Table 38). Food organisms found in perch from shallow nets included amphipods, isopods, and chironomid larvae; they comprised 71%, 5%, and 24% of the total numbers of food organisms consumed, respectively (Table 38). In contrast, diets of yellow perch collected from deep nets consisted of amphipods (40% of the total number of food items), spottail shiners (30%), unidentifiable fish (30%) and debris. Amphipods were the most frequently eaten organisms, occurring in 100% of the shallow net perch and 43% of those from the deep net.

In the spring at Morristown Point, 96% (N=92) of the yellow perch taken in shallow gill nets, and 79% (N=28) taken in deep gill nets, contained food in their stomachs (Table 39). The diversity and total numbers of food organisms were much greater in the spring than in the winter. Yellow perch from shallow nets contained food items from 17 different categories; amphipods and chironomid pupae comprised 58% and 39% of the total numbers of organisms eaten,

Table 37. Percentages of Occurrence of Food Items in the Diets of Yellow Perch Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of February 19 Through the Week of March 19, 1979.

	February 19		February 26		March 5		March 12		March 19		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
No. of Stomachs Examined	1	7	0	5	0	9	0	0	1	0	2	21
% of Stomachs Containing Food	100	71	-[b]	20	-	11	0	-	100	-	100	33
	Percentages of Occurrence											
Food Type												
Amphipoda	100	20	-	100	-	100	-	-	100	-	100	43
Isopoda	100	0	-	0	-	0	-	-	100	-	100	0
Decapoda												
Ostracoda												
Acari	0	0	-	0	-	0	-	-	100	-	50	0
Chironomid larva												
Chironomid pupa												
Zygoptera nymph												
Trichoptera larva												
Ephemeroptera nymph												
Lepidoptera larva												
Gastropoda												
Sphaeriidae												
Hirudinea												
Notropis hudsonius	0	40	-	0	-	0	-	-	0	-	0	29
Perca flavescens												
Etheostoma spp.												
Cottus spp.												

(Continued)

Table 37. (Concluded)

	February 19		February 26		March 5		March 12		March 19		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	Percentages of Occurrence											
Food Type												
Centrarchid YOY												
Unidentifiable fish	0	20	-	0	-	100	-	-	0	-	0	29
Fish eggs												
Green algae												
Myriophyllum fragments												
Plant debris												
Animal debris	0	20	-	0	-	0	-	-	0	-	0	14
Inorganic debris	0	20	-	0	-	0	-	-	0	-	0	14

a. Weighted mean is an average of data based upon number of fish at each sampling date.

b. - indicates no fish with food in stomach were collected.

Table 38. Percentages of Total Numbers of Food Items in the Diets of Yellow Perch Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of February 19 Through the Week of March 19, 1979.

	February 19		February 26		March 5		March 12		March 19		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
No. of Fish With Food in Stomach	1	5	0	1	0	1	0	0	1	0	2	7
Average Total No. Items Per Stomach	6.0	0.8	-[c]	1.0	-	2.0	-	-	35.0	-	20.5	1.0
	Percentages of Total Numbers											
Food Type												
Amphipoda	83	25	-	100	-	50	-	-	69	-	71	40
Isopoda	17	0	-	0	-	0	-	-	3	-	5	0
Decapoda												
Ostracoda												
Acari												
Chironomid larva	0	0	-	0	-	0	-	-	29	-	24	0
Chironomid pupa												
Zygoptera nymph												
Trichoptera larva												
Ephemeroptera nymph												
Lepidoptera larva												
Gastropoda												
Sphaeriidae												
Hirudinea												
Notropis hudsonius	0	50	-	0	-	0	-	-	0	-	0	30
Perca flavescens												
Etheostoma spp.												
Cottus spp.												

(Continued)

Table 38. (Concluded)

	February 19		February 26		March 5		March 12		March 19		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	Percentages of Total Numbers											
Food Type												
Centrarchid YOY												
Unidentifiable fish	0	25	-	0	-	50	-	-	0	-	0	30
Fish eggs												
Green algae												
Myriophyllum fragments												
Plant debris												
Animal debris	0	X[b]	-	0	-	0	-	-	0	-	0	X
Inorganic debris	0	X	-	0	-	0	-	-	0	-	0	X

a. Weighted mean is an average of data based upon number of fish at each sampling date.

b. X indicates item was present but could not be quantified.

c. - indicates no fish with food in stomach were collected.

Table 39. Percentages of Occurrence of Food Items in the Diets of Yellow Perch Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of March 26 Through the Week of May 7, 1979.

	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
No. of Stomachs Examined	1	5	1	2	6	1	3	1	63	10	9	1	9	7	92	28
% of Stomachs Containing Food	0	80	0	0	83	100	100	50	95	90	100	100	100	100	96	79
	Percentages of Occurrence															
Food Type																
Amphipoda	-	50	-	-	100	100	100	100	90	89	89	0	78	87	90	78
Isopoda	-	25	-	-	40	0	33	100	43	33	33	0	11	43	38	35
Decapoda	-	0	-	-	0	0	0	100	0	0	0	0	0	0	0	4
Ostracoda																
Acari	-	0	-	-	0	0	0	0	5	0	0	0	0	0	3	0
Chironomid larva	-	25	-	-	0	0	0	100	35	11	11	0	11	0	27	13
Chironomid pupa	-	0	-	-	0	0	0	0	88	44	89	100	11	0	73	22
Zygoptera nymph																
Trichoptera larva	-	0	-	-	0	0	0	0	8	0	0	0	0	0	6	0
Ephemeroptera nymph																
Lepidoptera larva																
Gastropoda	-	0	-	-	0	0	33	0	23	22	11	0	22	14	21	13
Sphaeriidae																
Hirudinea	-	0	-	-	0	0	0	0	0	0	0	0	0	14	0	4
Notropis hudsonius																
Perca flavescens	-	0	-	-	0	0	0	0	2	0	0	0	0	0	1	0
Etheostoma spp.	-	0	-	-	0	0	0	0	0	0	0	0	11	0	1	0
Cottus spp.	-	0	-	-	0	0	0	0	2	0	0	0	0	0	1	0

(Continued)

Table 39. (Concluded)

Food Type	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	Percentages of Occurrence															
Centrarchid YOY	-	0	-	-	20	0	0	0	2	0	0	0	0	0	2	0
Unidentifiable fish	-	25	-	-	20	0	0	0	10	0	0	0	11	0	9	4
Fish eggs	-	0	-	-	0	0	0	0	5	0	0	0	0	0	3	0
Green algae	-	0	-	-	0	0	0	0	10	11	0	0	0	0	7	4
Myriophyllum fragments	-	0	-	-	0	0	33	0	0	0	0	0	0	0	1	0
Plant debris	-	0	-	-	20	0	0	0	3	0	0	0	0	0	3	0
Animal debris	-	50	-	-	0	0	33	0	12	55	0	0	44	29	14	39
Inorganic debris																

a. Weighted mean is an average of data based upon number of fish at each sampling date.

respectively (Table 40). The average total number of items per stomach was 101.7. Those organisms occurring in the greatest percentage of yellow perch were amphipods (90%), chironomid pupae (73%), isopods (38%), chironomid larvae (27%), and gastropods (21%).

Perch taken in deep nets during the spring contained food from 10 different categories, and averaged 30.1 items per stomach; this was less than one third as many items as in the shallow net perch. The organisms comprising the greatest percentage of the total numbers eaten were amphipods (73%) and isopods (22%). Food items occurring in the greatest percentage of perch were amphipods (78%), isopods (35%), and chironomid pupae (22%).

At Morristown Harbor, wintertime gill net sets at 4.5m (14.8') yielded 3 yellow perch, and 2 of these had stomachs containing food. Amphipods and isopods were the most abundant food items present.

Focusing on winter feeding data from Chimney Bay, 100% (N=8) of the yellow perch taken in shallow gill nets, and 67% (N=3) taken in deep gill nets contained food in their stomachs (Table 41). The average total number of items per stomach was 14.1 for shallow net fish and 7.5 for deep net fish (Table 42). Perch from shallow nets fed mainly on amphipods (90% of the total number of items eaten) and isopods (9%). Amphipods occurred in all of the perch with food items in their stomach, taken in shallow nets, while isopods occurred in only 38%. Both of the perch taken from deep nets consumed only amphipods and fish; amphipods comprised 87% of the total number of items eaten.

During the spring at Chimney Bay, 99% of the yellow perch (N=84) taken in shallow nets and 87% (N=39) taken in deep nets had stomachs containing food (Table 43). The average total number of items per stomach was 14.1 and 9.3 for shallow and deep net fish, respectively; these were very similar to the winter values (Table 44). As at Morristown Point, Chimney Bay perch taken in the spring had a greater dietary diversity, possibly due either to the larger sample sizes, or to increasing activity of the perch or their prey. Thirteen categories of food were consumed by shallow net fish and 11 categories of food were eaten by those from deep nets. The organisms comprising the greatest percentages of total items taken by shallow net fish were amphipods (82%), isopods (12%) and trichoptera larvae (3%). The organisms occurring most frequently in the diet of shallow net perch were amphipods (83%), isopods (45%), and chironomid larvae (17%). Deep net fish consumed primarily amphipods (84% of total numbers of items), trichoptera larvae (4%) and isopods (3%). Those organisms occurring most frequently in deep net fish were amphipods (68%), isopods (15%), unidentifiable fish remains (15%), trichoptera larvae (12%), and gastropods (12%).

At Tibbits Creek in the spring, 41% (N=164) of the yellow perch collected by trap netting (0.6cm. mesh), and 95% (N=39) collected by seining contained food in their stomachs (Table 45). The average total number of organisms per stomach of trap netted perch was 0.8, and of seined perch, 5.3 (Table 46). The most abundant food organism in terms of percent of total numbers and percent occurrence for perch taken in Tibbits Creek was the amphipod.

Table 40. Percentages of Total Numbers of Food Items in the Diets of Yellow Perch Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Morristown Point From the Week of March 26 Through the Week of May 7, 1979.

	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
No. of Fish With Food in Stomach	0	4	0	0	5	1	3	1	60	9	9	1	9	7	86	23
Average Total No. Items Per Stomach	-[d]	2.2	-	-	5.0	1	42.4	3.5	122.5	50.1	134.4	6	4.3	32.2	101.7	30.1
	Percentages of Total Numbers															
Food Type																
Amphipoda	-	59	-	-	52	100	96	29	57	95	60	0	63	31	58	73
Isopoda	-	14	-	-	12	0	2	14	1	0.8	0.6	0	16	65	1	22
Decapoda	-	0	-	-	0	0	0	14	0	0	0	0	0	0	0	1
Ostracoda																
Acari	-	0	-	-	0	0	0	0	0.1	0	0	0	0	0	0.1	0
Chironomid larva	-	14	-	-	0	0	0	43	1	0.4	0.1	0	2	0	0.6	1
Chironomid pupa	-	0	-	-	4	0	0	0	40	4	39	100	2	0	39	3
Zygoptera nymph																
Trichoptera larva	-	0	-	-	0	0	0	0	0.1	0	0	0	0	0	0.1	0
Ephemeroptera nymph																
Lepidoptera larva																
Gastropoda	-	0	-	-	0	0	2	0	0.5	0.4	0.1	0	5	0.3	0.5	0.3
Sphaeriidae																
Hirudinea	-	0	-	-	0	0	0	0	0	0	0	0	0	3	0	1
Notropis hudsonius																
Perca flavescens	-	0	-	-	0	0	0	0	Tr[c]	0	0	0	0	0	0.01	0
Etheostoma spp.	-	0	-	-	0	0	0	0	0	0	0	0	2	0	0.01	0
Cottus spp.	-	0	-	-	0	0	0	0	Tr	0	0	0	0	0	0.01	0

(Continued)

Table 40. (Concluded)

	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	Percentages of Total Numbers															
Food Type																
Centrarchid YOY	-	0	-	-	28	0	0	0	Tr	0	0	0	0	0	0.1	0
Unidentifiable fish	-	14	-	-	4	0	0	0	1	0	0	0	9	0	0.1	0
Fish eggs	-	0	-	-	0	0	0	0	0.1	0	0	0	0	0	0.1	0
Green algae	-	0	-	-	0	0	0	0	X	X	0	0	0	0	X	X
Myriophyllum fragments	-	0	-	-	0	0	X	0	0	0	0	0	0	0	X	0
Plant debris	-	0	-	-	X	0	0	0	X	X	0	0	0	0	X	X
Animal debris	-	X[b]	-	-	0	0	X	0	X	0	0	0	0	X	X	X
Inorganic debris																

a. Weighted mean is an average of data based upon number of fish at each sampling date.

b. X indicates item was present but could not be quantified.

c. Tr = <0.1%

d. - indicates no fish with food in stomach were collected.

Table 41. Percentages of Occurrence of Food Items in the Diets of Yellow Perch Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Chimney Bay From the Week of February 19 Through the Week of March 19, 1979.

	February 19		February 26		March 5		March 12		March 19		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
No. of Stomachs Examined	2	0	2	0	4	0	0	3	0	0	8	3
% of Stomachs Containing Food	100	-[b]	100	-	100	-	-	67	-	-	100	67
	Percentages of Occurrence											
Food Type												
Amphipoda	100	-	100	-	100	-	-	100	-	-	100	100
Isopoda	0	-	100	-	25	-	-	0	-	-	38	0
Decapoda												
Ostracoda												
Acari												
Chironomid larva												
Chironomid pupa												
Zygoptera nymph												
Trichoptera larva												
Ephemeroptera nymph												
Lepidoptera larva												
Gastropoda												
Sphaeriidae												
Hirudinea												
Notropis hudsonius												
Perca flavescens												
Etheostoma spp.												
Cottus spp.												

(Continued)

Table 41. (Concluded)

	February 19		February 26		March 5		March 12		March 19		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	Percentages of Occurrence											
Food Type												
Centrarchid YOY												
Unidentifiable fish	0	-	50	-	0	-	-	100	-	-	13	100
Fish eggs												
Green algae	0	-	50	-	0	-	-	0	-	-	13	0
Myriophyllum fragments												
Plant debris												
Animal debris	0	-	0	-	25	-	-	0	-	-	13	0
Inorganic debris												

a. Weighted mean is an average of data based upon number of fish at each sampling date.

b. - indicates no fish with food in stomach were collected.

Table 42. Percentages of Total Numbers of Food Items in the Diets of Yellow Perch Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Chimney Bay From the Week of February 19 Through the Week of March 19, 1979.

	February 19		February 26		March 5		March 12		March 19		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
No. of Fish With Food in Stomach	2	0	2	0	4	0	0	2	0	0	8	2
Average Total No. Items per Stomach	1.0	-	6.0	-	24.6	-	0	7.5	-	-	14.1	7.5
	Percentages of Total Numbers											
Food Type												
Amphipoda	100	-	50	-	95	-	-	87	-	-	90	87
Isopoda	0	-	42	-	5	-	-	0	-	-	9	0
Decapoda												
Ostracoda												
Acari												
Chironomid larva												
Chironomid pupa												
Zygoptera nymph												
Trichoptera larva												
Ephemeroptera nymph												
Lepidoptera larva												
Gastropoda												
Sphaeriidae												
Hirudinea												
Notropis hudsonius												
Perca flavescens												
Etheostoma spp.												
Cottus spp.												

(Continued)

Table 42. (Concluded)

Food Type	February 19		February 26		March 5		March 12		March 19		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	Percentages of Total Numbers											
Centrarchid YOY												
Unidentifiable fish	0	-	8	-	0	-	-	13	-	-	1	13
Fish eggs												
Green algae	0	-	X[b]	-	0	-	-	0	-	-	X	0
Myriophyllum fragments												
Plant debris												
Animal debris	0	-	0	-	X	-	-	0	-	-	X	0
Inorganic debris												

a. Weighted mean is an average of data based upon number of fish at each sampling date.

b. X indicates item was present but could not be quantified.

Table 43. Percentages of Occurrence of Food Items in the Diets of Yellow Perch Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Chimney Bay From the Week of March 26 Through the Week of May 7, 1979.

	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
No. of Stomachs Examined	1	5	4	6	2	4	5	2	8	9	40	4	24	9	84	39
% of Stomachs Containing Food	100	60	100	83	100	50	100	100	88	100	100	100	100	100	99	87
	Percentages of Occurrence															
Food Type																
Amphipoda	100	66	100	40	100	50	100	100	86	77	85	75	71	66	83	68
Isopoda	0	66	75	0	50	0	20	0	29	11	35	25	67	11	45	15
Decapoda																
Ostracoda																
Acari																
Chironomid larva	0	0	25	0	0	0	0	0	0	0	18	0	25	0	17	0
Chironomid pupa	0	0	25	0	0	0	0	0	0	0	5	0	0	0	4	0
Zygoptera nymph	0	0	0	0	0	0	20	0	29	0	3	0	4	0	6	0
Trichoptera larva	0	0	0	0	0	0	0	0	14	0	10	25	17	33	11	12
Ephemeroptera nymph	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0
Lepidoptera larva																
Gastropoda	0	0	25	0	0	0	0	50	14	11	8	25	8	11	8	12
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	0	25	0	11	0	6
Hirudinea																
Notropis hudsonius																
Perca flavescens																
Etheostoma spp.	0	0	0	0	0	0	0	11	0	0	0	0	13	11	4	6
Cottus spp.	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	6

(Continued)

Table 43. (Concluded)

	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	Percentages of Occurrence															
Food Type																
Centrarchid YOY	0	0	0	0	0	0	0	0	0	11	0	0	4	0	1	3
Unidentifiable fish	0	33	25	20	0	0	20	0	14	0	5	25	8	22	8	15
Fish eggs																
Green algae																
Myriophyllum fragments																
Plant debris	0	33	0	20	0	0	0	50	0	0	0	0	0	11	0	12
Animal debris	0	0	0	20	50	50	0	0	43	66	15	0	58	66	29	41
Inorganic	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0

a. Weighted mean is an average of data based upon number of fish at each sampling date.

Table 44. Percentages of Total Numbers of Food Items in the Diets of Yellow Perch Collected by Gill Netting at 1.5m (4.9') and 15m (49.2') Water Depths at Chimney Bay From the Week of March 26 Through the Week of May 7, 1979.

	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
No. of Fish With Food in Stomach	1	3	4	5	2	2	5	2	7	9	40	4	24	9	83	34
Average Total No. Items Per Stomach	13	5.3	23	7.8	3	0.5	7	40.5	37.3	6.4	9.9	4.5	15.6	11	14.1	9.3
	Percentages of Total Numbers															
Food Type																
Amphipoda	100	62	88	94	83	100	83	91	96	94	88	40	60	83	82	84
Isopoda	0	32	7	0	17	0	6	1	2	3	6	6	27	0.9	12	3
Decapoda																
Ostracoda																
Acari																
Chironomid larva	0	0	1	0	0	0	0	0	0	0	2	0	3	0	1	0
Chironomid pupa	0	0	1	0	0	0	0	0	0	0	0.8	0	0	0	0.4	0
Zygoptera nymph	0	0	0	0	0	0	9	0	0.8	0	0.3	0	0.3	0	0.6	0
Trichoptera larva	0	0	0	0	0	0	0	0	0.3	0	1	11	8	11	3	4
Ephemeroptera nymph																
Lepidoptera larva																
Gastropoda	0	0	1	0	0	0	0	7	0.3	0	0.8	6	0.5	0.9	0.6	2
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	0	6	0	0.9	0	1
Hirudinea																
Notropis hudsonius																
Perca flavescens																
Etheostoma spp.	0	0	0	3	0	0	0	0	0	1.5	0	0	0.6	0.9	0.2	1
Cottus spp.	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	2

(Continued)

Table 44. (Concluded)

Food Type	March 26		April 2		April 9		April 16		April 23		April 30		May 7		Weighted[a] Mean	
	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m	1.5m	15m
	Percentages of Total Numbers															
Centrarchid YOY	0	0	0	0	0	0	0	0	0	1.5	0	0	0.3	0	0.1	0.3
Unidentifiable fish	0	6	1	3	0	0	3	0	0.3	0	0.5	6	0.5	3	0.6	2
Fish eggs																
Green algae																
Myriophyllum fragments																
Plant debris	0	X[b]	0	0	0	0	0	X	0	0	0	0	0	X	0	X
Animal debris	0	0	0	X	X	X	0	0	X	X	X	0	X	X	X	X
Inorganic debris	0	0	0	0	0	0	0	0	0	0	X	0	0	0	X	0

a. Weighted mean is an average of data based upon number of fish at each sampling date.

b. X indicates item was present but could not be quantified.

Table 45. Percentages of Occurrence of Food Items in the Diets of Yellow Perch Collected by Trap Netting (0.6cm mesh) and Seining at Tibbits Creek From the Week of April 23 Through the Week of May 7, 1979.

	April 23 Trap Net	April 30 Seining	May 7 Trap Net	Weighted[a] Mean Trap	Weighted[a] Mean Seine
No. of Stomachs Examined	81	37	83	164	39
% of Stomachs Containing Food	59	95	24	41	95
	Percentages of Occurrence				
Food Type					
Amphipoda	31	97	35	32	97
Isopoda	2	19	5	3	19
Decapoda					
Ostracoda	0	0	5	1	0
Acari					
Chironomid larva	8	0	10	9	0
Chironomid pupa	0	0	5	1	0
Zygoptera nymph	2	8	5	3	8
Trichoptera larva					
Ephemeroptera nymph					
Lepidoptera larva	0	3	0	0	3
Gastropoda	0	3	0	0	3
Sphaeriidae					
Hirudinea					
Notropis hudsonius					
Perca Plavescens					
Etheostoma spp.					
Cottus spp.					
Centrarchid YOY					
Unidentifiable fish					
Fish eggs	2	5	0	1	5
Green algae					
Myriophyllum fragments					
Plant debris	2	0	0	1	0
Animal debris	67	0	50	62	0
Inorganic debris					

a. Weighted mean is an average of data based upon number of fish at each sampling date.

Table 46. Percentages of Total Numbers of Food Items in the Diets of Yellow Perch Collected by Trap Netting (0.6cm mesh) and Seining at Tibbits Creek From the Week of April 23 Through the Week of May 7, 1979.

	April 23 Trap Net	April 30 Seining	May 7 Trap Net	Weighted[a] Mean Trap	Weighted[a] Mean Seine
No. of Fish with Food in Stomach	48	37	20	68	37
Average Total No. items per Stomach	0.56	5.33	1.25	0.77	5.33
	Percentages of Total Numbers				
Food Type					
Amphipoda	71	86	56	65	86
Isopoda	4	4	4	4	4
Decapoda					
Ostracoda	0	0	16	8	0
Acari					
Chironomid larva	14	0	4	9	0
Chironomid pupa	0	0	8	4	0
Zygoptera nymph	4	2	8	5	2
Trichoptera larva	0	0	4	1	0
Ephemeroptera nymph					
Lepidoptera larva	0	0.4	0	0	0.4
Gastropoda	0	0.5	0	0	0.5
Sphaeriidae					
Hirudinea					
Notropis hudsonius					
Perca flavescens					
Etheostoma spp.					
Cottus spp.					
Centrarchid YOY					
Unidentifiable fish					
Fish eggs	7	7	0	4	7
Green algae					
Myriophyllum fragments					
Plant debris	X[b]	X	X	0	0
Animal debris	X	0	X	0	0
Inorganic debris					

a. Weighted mean is an average of data based upon number of fish at each sampling date.

b. X indicates organisms which were present but not quatifiable.

Parasites. At Morristown, 276 yellow perch were examined and found to have no obvious external parasites. Examination of the stomachs and liver surface from 124 perch revealed that 112 (90.3%) were infected with cestodes, believed to be bass tapeworm (*Proteocephalus ambloplitis*) or nematodes. Of the 112 parasitized fish, 1.8% harbored adult nematodes, 2 (1.8%) harbored adult cestodes and 100% harbored plerocercoids. Light infestation with plerocercoids (1-5 per fish) characterized 17.9% of the yellow perch, moderate infestation (6-15 per fish) 17.9% and heavy infestation (16 or more per fish) 2.7%.

At Chimney Bay and Tibbits Creek, where a total of 1,071 yellow perch were examined for external parasites, only one fish was found to have black spot. At Chimney Bay, examination of the stomachs and liver surface of 185 yellow perch revealed that 135 (73.0%) were infected with cestodes or nematodes. Of the 135 parasitized fish, 7 (5.2%) harbored adult nematodes, 2 (1.5%) harbored adult cestodes and 100% harbored plerocercoids. Light infestation with plercocercoids characterized 71.1% of the perch and moderate infestation characterized 4.4%. At Tibbits Creek, where only YOY yellow perch were examined for internal parasites, only 12 fish (6.2%) were infected. Of the 12 fish, 6 harbored plerocercoids and 6 harbored nematodes. Plerocercoid infestation was light in all fish.

The percent of yellow perch infested with plerocercoids and adult cestodes, and the number of plerocercoids and adult cestodes found per fish was probably underestimated. This resulted from the fact that only the stomach and the surface of the liver of perch were examined. Adult cestodes inhabit the intestine and pyloric ceca of fish, while plerocercoids, a larval form of cestodes, are found in the viscera (Hoffman 1967). In addition, only YOY yellow perch were examined for internal parasites at Tibbits Creek.

Movement. Three yellow perch (two males and one female) netted during the current study were previously tagged in 1978 by Dunning et al. (1978). All three were originally collected and tagged in a trap net set in Tibbits Creek. The female, collected this year on April 26, 1979, was initially tagged on April 17, 1978. One male, collected on April 19, 1979, was tagged on April 18, 1978. The other male, collected on May 3, 1979, was tagged on April 17, 1978. Dunning et al. (1978) reported that movement by yellow perch in the St. Lawrence River was limited, averaging 2.6 miles, with 92% of the perch traveling less than 5 miles. Limited yellow perch recapture data from 1979 support this contention.

DISCUSSION

ABUNDANCE AND DISTRIBUTION OF ADULT FISHES

Relative species abundance and distribution of fishes collected during the current study, varied by gear, location, depth and date of sampling. In general, relatively fewer fishes were collected in gill nets during the winter in contrast to the spring. The greater spring catches probably resulted from increased fish activity associated with feeding and spawning. During 1978, a similar increase in spring gill net catches, as compared with those in winter was reported by Dunning et al. (1978).

Concerning spatial distributions, the data for Morristown Point indicated that the average catch per gill net in shallow water during the winter, was equal to the adjusted catch per net in deep water when all species were combined. At Chimney Bay during the winter, the average catch per gill net in shallow water was greater than the adjusted catch per net in deep water when all species were combined. At both locations, the relative distribution of fish between shallow and deep waters was species specific; some exhibited higher average catches near shore while others exhibited higher catches off shore. Spatial differences noted in the winter of 1979 were not as great as those reported for 1978 by Dunning et al. (1978).

Focusing on the spring distribution, the average gill net catch in shallow water at Morristown Point, for all species combined, was over four times greater than the adjusted deep net catch. At Chimney Bay, the average gill net catch in shallow water, for all species combined, was over twice the adjusted catch for deep water. Similar to winter findings, the relative spatial (shallow-deep) distribution of fish at both Chimney Bay and Morristown Point was species specific. These data appear generally consistent with those reported for the spring of 1978 by Dunning et al. (1978). The inclusion of a 1.3 cm (0.5") bar mesh panel in the gill nets during 1979 resulted in the capture of fish species and sizes not collected during 1978, when this panel size was absent.

Species diversity was higher at Chimney Bay and Tibbits Creek in comparison with Morristown Point, based on collections from gill nets, trap nets and seines; this finding appeared to reflect the greater diversity and abundance of productive habitats for fish at the former location. The total number and species of fish collected per trap net at Tibbits Creek during 1978 and 1979 were generally similar, although exceptions did occur where certain species were more abundant in one year than another. The small mesh trap net (0.6 cm, 0.25" bar) placed in Tibbits Creek proved extremely effective in sampling smaller fishes. This net collected fish not obtained by other gear .

ABUNDANCE AND DISTRIBUTION OF LARVAL FISHES

The presence and abundance of yellow perch larvae at Morristown Point, Morristown Harbor and Chimney Bay seemed to indicate that these sites were yellow perch spawning and/or nursery areas. This was supported by the large numbers of ripe and gravid adults taken at the Chimney Bay - Tibbits Creek and Morristown Point sites. Since yellow perch eggs occur in long gelatinous strands which adhere to submerged vegetation (Scott and Crossman 1973), the absence of yellow perch eggs in pelagic tow samples was to be expected.

The low density of the other species of larvae collected could have indicated minor spawning in the immediate areas of collection, or could have resulted from downstream drift. Another plausible reason for low density is that several species, such as northern pike and white sucker, have larvae which often remain inshore in very shallow water, and thus would have been unavailable for collection by the sampling gear used. In addition, the spawning periods of many of the St. Lawrence River species occur in late spring and early summer, beyond the time period permitted for this study.

In 1978 (NALCO 1978), very low ichthyoplankton densities were reported in a study conducted from April 27 to May 10; at Tibbits Creek, only one burbot egg and no larvae were collected. No sampling was conducted at Morristown in 1978. The most abundant larval species taken at other sites was yellow perch as in the 1979 study. The eggs of rainbow smelt, alewife, and burbot were collected in very low densities, and one burbot larva was collected.

The majority of ichthyoplankton collected during 1979 resulted from the use of 0.5 m plankton nets mounted on a bongo frame. Although this gear was used only at night on May 17, to compare its catch with that from Miller Samplers, the preliminary results suggest this gear may be of value in future ichthyoplankton surveys on the St. Lawrence River.

SPECIES CHARACTERISTICS

Northern Pike

Mean lengths of northern pike varied by age, sex, gear and location. Females were generally found to be larger than males starting at age 2, suggesting sexually dimorphic growth. The first fully recruited age of northern pike to the sampling gear used in this study appeared to be age 4 males and age 5 females. Female northern pike appeared to be longer lived and were generally more abundant than males at older ages. Males were generally more numerous at younger ages than females. Differences in the mean length at age for northern pike captured by gill netting and trap netting were observed, but there appeared to be no consistent pattern to these variations. The above findings on northern pike were in agreement with those reported by Dunning et al. (1978). Survival estimates were calculated for male and female northern pike using combined catches from Morristown Point and Chimney Bay - Tibbits

Creek, and applying the data to an estimator proposed by Chapman and Robson (1960). Results indicated greater survival for 1979 than for 1978 (Dunning et al. 1978). The underlying cause(s) of this annual variation is unclear.

During both 1978 and 1979, the survival estimate for female pike was greater than that observed for males. The current New York State minimum size limit for the harvest of northern pike in its sport fishery is 660.4 mm (26"). Relatively few male northern pike were observed at ages 6 and older. The mean observed length for males did not reach or exceed 660.4 mm until age 6. Thus, it appears that the current size limit would result in the selection of a greater proportion of females. However, the relative abundance of female northern pike to males was greater during 1979 than in 1978. Additional data are necessary to understand what changes, if any, have occurred and may yet occur in the sex ratios of northern pike as a result of the 660.4 mm size limit. Failure to deal with this issue could lead one to attribute changes in the sex ratio, to the wrong causes.

Examination of food items found in the stomachs of northern pike revealed apparent differences in feeding behavior by area and season. The percentage of stomachs containing food items, and the mean number of items per stomach, were greater during winter in comparison with spring. The diet of northern pike consisted exclusively of fish. There was a temporal change in the diversity and selection of forage fish consumed between winter and spring; diversity was greater in the spring. This appeared to reflect an increasing abundance of food items and the fact that northern pike are opportunistic predators. It should also be noted that the number of stomachs with food, and the number of items per stomach were lowest during the weeks when spawning of northern pike was thought to have occurred. Thus, it appearedthat feeding was an important activity of northern pike during the winter and a disruption of this activity and/or its forage base might negatively affect the species.

The recapture of three northern pike during 1979 within the same general location at which they were tagged and released during 1978, appeared to indicate limited migrations either up or down the river. Although the recapture of these fish represented a very limited return, the data support the hypothesis of Dunning et al. (1978) that subpopulations of northern pike exist in the St. Lawrence River.

Yellow Perch

Mean lengths of yellow perch varied by age, sex, gear and location. Females were generally found to be larger than males collected at Morristown Point, suggesting sexually dimorphic growth. However, in contrast to data reported by Dunning et al. (1978), and data collected at Morristown Point during 1979, mean observed lengths for yellow perch collected at Chimney Bay and Tibbits Creek did not differ between sexes. The apparent absence of sexually dimorphic growth in this region was probably an artifact, attributable to the small number of females at ages 2 and 3.

An interesting feature in the 1978 yellow perch data reported by Dunning et al. (1978) was the predominance of age 3 (1975 year class) individuals. In view of this distribution, 4 year old perch were assumed to be the first age class completely vulnerable to sampling. In 1979, age 3 yellow perch (1976 year class) were scarcely represented in the total catch. This recent finding of a weak 1976 year class was assumed to be a compensatory response resulting from a complexity of population regulatory mechanisms operating in the wake of a dominant 1975 year class.

Concerning survival estimates, the formula selected in this study assumed a knowledge of the first age class which was completely vulnerable to the gear being used (Chapman and Robson 1960). If 5 year old perch, rather than 4 year old individuals were selected as the first completely vulnerable age, the survival estimates presented in this study would be substantially higher. If sample sizes had been larger, additional estimators would have been possible for the purpose of drawing comparisons.

Examination of food items found in the stomachs of yellow perch revealed apparent differences in feeding behavior by area, depth and season. At both Morristown Point and Chimney Bay, the percentage of yellow perch stomachs containing food items, and the mean number of items per stomach, were greater in shallow water than in deep water during winter and spring. The diversity and number of food organisms present in stomachs collected at Morristown in the spring, was greater than in the winter. At Chimney Bay however, the diversity of organisms increased during the spring but the mean number of organisms remained about the same during both seasons. The underlying cause(s) of the seasonal changes, as noted above, is unclear at this time. Additional data on yellow perch feeding, especially in winter, would be useful.

The recapture of three yellow perch during 1979 at the same general location at which they were tagged and released during 1978, appeared to indicate limited migrations up or down the river. Although the recapture of these fish represented a very limited return, the data support the hypothesis of Dunning et al. (1978) that subpopulations of yellow perch exist in the St. Lawrence River.

POTENTIAL ENVIRONMENTAL EFFECTS OF A DEMONSTRATION

The overall objective of this study was to help evaluate the reasonably forseeable environmental effects of a propsed Winter Navigation Demonstration Program on the fishery resources in the Demonstration Corridor, before project activities commenced. Although the current investigation was limited to the Demonstration Corridor, it should not be assumed from the following discussion that the potential effects of Demonstration activities would be limited to this portion of the St. Lawrence River, but rather, that the scope of the ensuing discussion was limited to the study objective. The Demonstration Program being addressed was that presented by the St. Lawrence Seaway Development Corporation (SLSDC), U.S. Department of Transportation (1978 and 1979) for the Winter Navigation Board.

Appendix D (Environmental Plan of Action) of the draft Survey Study for Great Lakes and St. Lawrence Seaway Navigation Season Extension (U.S. Army Corps of Engineers - USACE 1979) identified 12 engineering developments or actions associated with Winter Navigation on the St. Lawrence River and 14 resulting environmental concerns. The Winter Navigation Demonstration Corridor encompasses only a portion of the St. Lawrence River and Demonstration activities encompass only a portion of the engineering developments or actions, proposed for a system-wide Winter Navigation Program. Therefore, not all of the 14 environmental concerns expressed by the USACE (1979) for a Winter Navigation Program would result from a Winter Navigation Demonstration Program. Those Demonstration activities and resulting environmental concerns expressed by the USACE (1979) regarding Winter Navigation, which were associated with Winter Navigation Demonstration, were used as a framework in the subsequent discussion for analyzing the potential negative impacts of the proposed SLSDC Winter Navigation Demonstration Program (1979) for the St. Lawrence River.

Installation of Supplemental Booms and Ice Anchors

Description of Operational Measure. The ice booms in the Demonstration Corridor are proposed to be increased in number and modified. Ice booms have been installed by the power companies annually for a number of years to minimize ice jams upstream from hydroelectric power plants. These booms would be modified to allow vessel passage and would include 68.6m (225') openings in the main heavy duty ice booms with 304.8m (1,000') wing booms adjacent and parallel to the navigation channel on the upstream side. In addition, light - duty booms would be interspersed upstream from the main booms to stabilize the ice. Anchors will comprise stato or ship anchors or concrete sinkers -- none of which will require any dredging for placement (USACE 1979 and SLSDC 1978).

Environmental Concerns - USACE. These activities could cause significant adverse environmental effects. Water levels and flows would be affected by the structures and by the friction caused by the stabilized ice fields. This effect could have adverse impacts on fish and wildlife resources if flooding and/or dewatering would occur. Effects of the changes in levels and flows could extend beyond the site; therefore, system-wide studies on the ramifications of changes in levels and flows would be done (USACE 1979).

Environmental Concerns - 1979 Fisheries Study. Several factors, including water levels, have been implicated as potentially important in determining year-class strength of northern pike. Johnson (1957) and Hasler (1970) concluded that a high spring water level during spawning and a small decline in the level during egg incubation represented good conditions for the production of a strong northern pike year-class. Howard and Thomas (1970) noted that northern pike larvae were very active for a short period immediately after hatching and that flooded vegetation, comprised of annual grasses and weeds, provided desirable nursery habitat for sac fry. Franklin and Smith (1963) concluded that the greatest survival of fingerling northern pike resulted from stabilization of water levels in the nursery areas for at least three months after egg deposition. High, stable water levels would also be favorable to yellow perch, whose eggs are semibuoyant and can be

easily cast ashore by wind, waves and current and lost (Scott and Crossman 1973). Based upon data collected during 1979, Morristown Point, Chimney Bay and Tibbits Creek appear to be spawning and/or nursery areas for several species of fish, including northern pike and yellow perch. As a result, dewatering and/or fluctuations in water levels could negatively affect the fisheries in these areas by significantly reducing annual recruitment. Other areas, within and outside the Demonstration Corridor, would be susceptible to the same environmental alterations (Dunning et al. 1978 and Eckert and Hanlon 1976).

Vessel Operations

Description of Operational Measure. The primary test vessel will be a chartered 222.5m (730') lake vessel. Specific vessel designation will follow notification to proceed with testing by the Winter Navigation Board and the signing of the charter documents. The most probable schedule envisions 204 transits (48 days: December 20 through January 31 and March 1-31) with a potential of 414 transits and a minimum of 90 transits. Speed will be controlled within strict limits as a function of ice conditions and specific reaches of the Demonstration Corridor. Initially, transits will be limited to speeds of 6 mph through the water, with adjustments made for later transits based on prior observations (SLSDC 1979).

Environmental Concerns - USACE. Vessel movement and high vessel speeds are believed to cause some of the more severe environmental damages. The powerful propeller wash and vessel induced waves can cause bottom scour, sediment movement and transport, high current velocities, destruction of aquatic vegetation and ice breakup and movement. The resulting effects could reduce or destroy fish and wildlife resources and related habitats, and/or severely damage or destroy shoreline habitats. In addition, pollutants, such as saturated hydrocarbons, heavy metals, and PCB's, could be resuspended and redistributed with resulting significant adverse effects on fish and wildlife resources and associated human uses.

Environmental damages appear to be occurring in the St. Marys, St. Clair and Detroit Rivers and could develop with extended winter navigation in the St. Lawrence River. In addition, environmental damages appear to be occurring in some of the shallow bay areas of the Great Lakes system. Similarly, harbors adjacent to shallow areas through which vessels would traverse could experience environmental damages from the ship induced waves (USACE 1979).

Environmental Concerns - 1979 Fisheries Study. Marshall (1978) reported that in the St. Lawrence River during the winter, shallow littoral areas were particularly prone to disturbance as a result of waves propagated by ship passage and that ship passage would exert three significant effects in the littoral zone.

(1) Benthic organisms and weakly rooted overwintering vegetative parts would be uprooted by the focusing of wave surge forces at this interface.

(2) A water level rise resulting from channel jams due to ship passage, coupled with unusually high water levels in the spring, would

disrupt the ice foot at wetland fronts and cause a disruption of bottom features.

(3) A water level decrease would result in additional freeze down at the ice foot and, if water was drained completely from the ice-benthic contact, a substantial die-off of benthic organisms would occur.

Mills, Smith and Forney (1978) reported that during the winter in the St. Lawrence River, benthic invertebrates found in the middle of littoral vegetation deposits were 3.5 times more abundant and their biomass 6 times greater as compared with peripheral areas. They concluded that these deposits provided habitat for a diverse and extremely abundant invertebrate community, and more importantly, that these deposits concentrated and provided an excellent food resource for fish.

Numerous authors have noted the importance of submerged vegetation as a stimulus for northern pike spawning (Fabricus 1952, Kennedy 1970, Clark 1950, et al.). Yellow perch are also reported to spawn over submerged aquatic vegetation (Scott and Crossman 1973). Franklin and Smith (1963) reported that spawning migrations of northern pike coincided with the development of sufficient clearance between inshore ice and the bottom to provide access to spawning areas. Small year classes of northern pike have been associated with high silt deposition (Johnson 1957).

Mount (1967) pointed out that sensitivity to toxic substances often varies with the age of the organism. Frequently, the embryo is rather resistant to toxic chemicals but soon after hatching it becomes increasingly susceptible.

Data from the current investigation on the St. Lawrence River, as well as that from 1978 (Dunning et al.1978) and 1976 (Eckert and Hanlon 1976), suggested that wetlands and littoral areas were one of the most important ecological zones to the river fisheries. Therefore, any alterations of these habitats resulting from vessel operations, as suggested might occur (USACE 1979), including bottom scour, sediment movement and transport, destruction of aquatic vegetation and ice breakup and movement, should be viewed with extreme concern.

The SLSDC (1979) noted that drawdown and surge resulting from vessel passage through the constricted channel cross section in the vicinity of Chimney Island has been identified as a potential source of adverse environmental impacts on Tibbits Creek Marsh and that natural short-term fluctuations of as much as 1.3 feet have been measured at Ogdensburg. Since drawdown and surge is easily predicted and fully controllable by varying the vessel speed, vessel speeds will be limited to eliminate drawdown and surge impacts at the mouth of Tibbits Creek Marsh in excess of $\pm$ six inches or open water values, whichever is less (SLSDC 1979). Several concerns arise as a result of this criterion for preventing significant adverse environmental effects associated with vessel passage. Although short term fluctuations of as much as 1.3 feet have been measured at Ogdensburg, it is doubtful that they occurred with the frequency that would result from the proposed Demonstration Program. The effect of repeated fluctuations may be additive and potentially

quite damaging. In addition, wave drawdown and surge may be reduced in the shallow littoral zone. Even though wave drawdown and surge impacts at the mouth of Tibbits Creek are to be limited, in excess of ± six inches, it may not be sufficient to protect the fragile but important littoral areas in Chimney Bay.

Thus, it appears that the demonstration could cause potentially serious impacts to fish feeding, spawning, movement, distribution and survival.

Icebreaking

Description of Operational Measure. Icebreaking assistance in the vessel tracks above each boom, in the turning basin at Maitland, and in the event of large amounts of ice passing the Galop Boom and hanging up below Cardinal, will be provided by the SLSDC tug ROBINSON BAY, a 1400 HP, 31m (103'), type "C", icebreaking tug (SLSDC 1978).

Environmental Concerns - USACE. Icebreaking activity in the shallow parts of the system, especially in the connecting channels, could cause adverse effects on the environment. Propeller wash could push broken ice under the ice cover on each side of the track. This ice could subsequently freeze, accumulate, and form an ice rampart or underwater ridge on both sides of the track. These underwater ridges could alter existing localized water currents and circulation patterns. The broken vessel track could prohibit or alter animal movement patterns. The exact nature and extent of these effects are not presently known and would be determined through appropriate studies (USACE 1979).

Environmental Concerns - 1979 Fisheries Study. The river current at Chimney Bay was observed to have changed direction by almost 180° during the winter of 1979. This shift in the current flow lasted less than two weeks, beginning with the week of March 12, and appeared to be attributable to ice jamming in Chimney Bay. When the ice jam disappeared, the current returned to its pre-jam direction. The effects of such current changes on local fisheries is not known at this time.

Other Activities

Should other engineering developments or actions, not specifically mentioned in the SLSDC reports (SLSDC 1978 and 1979), occur as a result of a Demonstration Program, they would have the potential to cause additional negative impacts on the fisheries of the St. Lawrence River as cited by the USACE (1979).

Other Concerns - 1979 Fisheries Study

The SLSDC (1979) suggested that on-site environmental monitoring studies be conducted such that near real-time data be provided to allow for identification of adverse impacts of the Demonstration Program as they occurred. The on-site Environmental Advisor would have the authority to recommend operations be halted when significant adverse impacts were observed. Several important concerns arise from these proposals.

(1) If the SLSDC assumed that adverse environmental impacts of a Demonstration Program would be detectable concomitant with vessel transits, and the monitoring of these short-term impacts would therefore provide adequate environmental protection for the fisheries in the Demonstration Corridor, the assumption is weak. The potential long term changes in the fisheries, e.g. recruitment and growth, could be more crucial and probably not observable during any single demonstration period.

(2) Although an on-site Environmental Advisor would have the authority to recommend operations be halted when significant adverse impacts were observed, the criteria to be used were not presented in either SLSDC report concerned with the Demonstration Program (SLSDC 1978 and 1979). In view of the previous concern, very careful consideration should be given to the adoption of acceptable criteria for identifying significant adverse environmental impacts of the Demonstration Program.

(3) Sufficient data, collected before the Demonstration Program, would be necessary to assess the impacts of a Demonstration Program in a meaningful fashion. The current proposed Demonstration Program makes no provision for pre-Demonstration data gathering.

CONCLUSIONS

Since 1931, only two comprehensive studies have been conducted, previous to this investigation, which attempted to characterize the nature of the fish resources of the St. Lawrence River (Dunning et al. 1978 and Eckert and Hanlon 1976). Although the overall objective for all three studies was similar, a lack of uniformity and continuity between studies hampered data collection and analysis, thus reducing the overall efficiency of each succeeding program. Where comparative data were collected, the findings were not always in agreement. This illustrated the complex nature of the St. Lawrence River fisheries.

The current investigation answered some of the questions raised in the two previous studies regarding Winter Navigation on the St. Lawrence River, but also raised additional ones. Each of the studies subsequent to Eckert and Hanlon (1976) examined a smaller section of the St. Lawrence River over a shorter period of time. However, all of these studies conclude that there is a need for additional comprehensive studies of a continuous nature to accurately assess the dynamic processes associated with the St. Lawrence River fish resources and the potential impacts of a proposed Winter Navigation Demonstration Program.

Everhart et al. (1975) noted that no business, particularly environmental management, can operate successfully without a continuing inventory of resources and conditions. It was also noted that without a continuing inventory, serious problems might go unrecognized. Biological inventories of the fisheries of the St. Lawrence River, over an extended period of time, would provide the necessary basis for determining the relative importance of problems and assist in deciding the best solutions as they relate to the ecology of the river system. Since the fisheries of the St. Lawrence River are dependent upon a complex of additional physical, chemical, biological and sociological parameters, concurrent monitoring of these additional parameters is necessary; in their absence, one can only hypothesize as to the causative factors effecting changes in the river fisheries.

RECOMMENDATIONS

1. Continuity in the Collection of Fisheries Data

Three studies, of a comprehensive nature, have been conducted since 1976 (Eckert and Hanlon 1976, Dunning et al. 1978 and the current investigation). Although the overall objective for all three studies was similar, a lack of uniformity and continuity between studies hampered data collection and analysis. In order to collect baseline data in a manner which would be most useful and efficient in assessing the impacts of a proposed Winter Navigation Demonstration Program, a committment to the collection of data over a period of years should be adopted.

2. Expansion of the Current Study Area and Sampling Season

Each of the studies on the St. Lawrence River subsequent to Eckert and Hanlon (1976) examined a smaller section of the St. Lawrence River over a shorter period of time. Data from the current study suggested that the relative abundance and distribution of fishes in the river was spatially and temporally dependent. The period over which sampling occurred and the areas actually sampled during 1979, were limited by the severe time constraints between termination of necessary field work and the date scheduled for submittal of a final draft. To adequately examine the fisheries at the current study locations, the sampling season should be extended to include no less than the entire winter and at least part of the summer. In addition, control sites outside the proposed Winter Navigation Demonstration Corridor should be selected and sampled.

3. Continued Examination of Fish Feeding Ecology

Data collected during 1978 indicated that feeding was an important activity of northern pike and yellow perch during the winter, as well as during the spring. Ringler (1976) suggested that an understanding of fish feeding ecology was necessary to properly assess the effects of environmental modifications on a fish population. Abundant evidence exists which demonstrates the importance of diet in determining the growth of fishes. Changes in growth rate might influence reproduction rates, either directly (via survival) or indirectly (via fecundity). As a result, examination of the feeding ecology for selected species should be continued.

4. Continued Examination of the Growth Rate of Fishes

Rounsefell and Everhart (1953) noted that age and growth are two attributes of fish populations of prime importance in estimating the numbers in a population of fish and their response to various environmental changes. Clark and Steinbach (1959) found that slower growth of age I northern pike in Lake Erie during one year was associated with highly turbid waters, perhaps interfering with sight feeding. Age and growth data have been collected for yellow perch and northern pike during 1978 (Dunning et al. 1978) and 1979, and for smallmouth bass during 1978. To predict what changes in growth are significant, data on the natural variance in growth are needed. Continued examination of age and growth are necessary to satisfy this condition.

5. Continued Monitoring of Relative Fish Abundance and Distribution

Robson and Regier (1968) noted that monitoring of the numerical changes which occur in a population of fish through the course of time, is essential to a basic understanding of population dynamics, production and yield. Rounsefell and Everhart (1953) stated:

> "In order to perpetuate themselves all species must produce a surplus of young. Conversely, all species are held in check by one or more forces. When one of these forces fails, a species may become tremendously abundant for a time, but always the same or another factor steps in to re-establish a balance. Such variations do not indicate that a species is out of balance."

Data collected during 1979 suggested that the distribution of fish in the St. Lawrence River varied depending upon spatial and temporal factors. The extent and nature of this variability is not fully characterized. Therefore, continued monitoring of the relative abundance and distribution of fishes in the St. Lawrence is recommended.

6. Resumption of Tagging Studies of Fishes

When examining a particular fishery, it is essential to know whether the catch comes from one population or perhaps from several. When an entire fishery depends wholly on one stock of fish, it will be affected by changes in abundance at any locality. If, on the other hand, the stocks of fish are local in their distribution, each must be treated as a separate unit.

Results from studies of St. Lawrence River fisheries by Stone et al. (1951), Casselman (1967), Eckert and Hanlon (1976) and Dunning et al. (1978), suggested the existance of local populations of certain species of fish. As a result of the short time frame available to complete the current investigation, tagging was not conducted. Tagging was an integral part of the studies conducted by Eckert and Hanlon (1976) and Dunning et al. (1978). Since knowledge of the extent of local populations of fish is essential in studying their changes, tagging studies of fishes should be resumed and possibly expanded.

7. Additional Studies

Since the fisheries of the St. Lawrence River are dependent upon a complex of additional physical, chemical, biological and sociological parameters, concurrent monitoring of additional parameters, is necessary; in their absence, one can only hypothesize as to the causative factors effecting changes in the river fisheries.

8. Identification and Evaluation of Fish Spawning Areas.

A stable fishery is ultimately dependent upon continued strong recruitment. Modification of spawning habitat may result in lowered reproductive success. Data on larval and adult fishes in this study suggested the existance of spawning habitats of variable quality in the Demonstration Corridor. The contribution of individual spawning areas to the reproductive success of the fishes of the St. Lawrence River is not known at the present time. Environmental changes would probably have a different effect on each of these spawning areas. As a result, fish spawning areas in the river should be identified and evaluated as to their relative importance.

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