LAKE ONTARIO FISH COMMUNITIES AND FISHERIES:

1999 ANNUAL REPORT OF THE LAKE ONTARIO MANAGEMENT UNIT

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Table of contents

Lake Ontario Fish Communities and Fisheries: 1999 Annual Report of the Lake Ontario Management Unit

Introduction

The Lake Ontario Management Unit (LOMU), is part of the Fish & Wildlife Branch, Natural Resource Management Division of the Ontario Ministry of Natural Resources (OMNR). The LOMU is OMNR's lead administrative unit for fisheries management on Lake Ontario and the St. Lawrence River.

The 1999 Annual Report documents results of LOMU programs, completed in 1999, to assess the fish communities and fisheries of Lake Ontario.

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Acknowledgements

The contributions of all Lake Ontario Management Unit staff are gratefully acknowledged. Also, we would like to acknowledge the help and information provided by our many partners and volunteers.

Species Highlights

Alewife
- Initially strong 1998 year-class reduce by predation (Chapter 1)

Chinook salmon
- Continued improvement in growth (Chapter 1)
- Catch rates in boat fishery good, similar to 1998 (Chapter 8)

Eels
- Eel counts at Cornwall eel ladder decline further (Chapter 4)
- Continued declines in Lake Ontario commercial fish harvest (Chapter 6)

Lake trout
- Stocked fish survival declines (Chapter 2)
- Condition of sub-adults declines (Chapter 2)
- Adult abundance declines (Chapter 2)

Lake whitefish
- Continued poor condition (Chapter 2)
- Decline in growth (Chapter 2)
- Poor recruitment (Chapter 2)
- Continued decline in adult abundance (Chapter 2)
- Decline in commercial fishery harvests (Chapter 6)

Rainbow trout
- Catch and harvest rates in boat fishery good, similar to 1998 (Chapter 8)
- Counts at Ganaraska remain low (Chapter 1)
- Possible high level of exploitation of Ganaraska population (Chapter 11)
- Anglers report creel limit preferences (Chapter 11)

Round goby
- First evidence for Bay of Quinte colonization (Chapter 3)

Smallmouth bass
- Continued improvement in year-class strength (Chapter 3)
- Increased angling catches in the Bay of Quinte (Chapter 7)

Walleye
- Continued decline in population (Chapter 3)
- Continued decline in open-water angling catch, harvests, and effort (Chapter 7)
- Increased harvest in 1999 winter fishery (Chapter 7)
- Continued increase in aboriginal spear fishing harvests (Chapter 9)
- Decline in commercial harvest in 1999 (Chapter 6)
- A summary of what is happening to walleye (Chapter 10)

Yellow perch
- Increased abundance in the Bay of Quinte (Chapter 3)
- Increased abundance in the Thousand Islands, St. Lawrence River (Chapter 4)
- Increased commercial harvests in the Bay Quinte, Thousand Islands, and E. Lake Ontario (Chapter 5 and 6)
- Increased angling catches in the Bay of Quinte (Chapter 7)

1

Lake Ontario Offshore Pelagic Fish Community

T. Schaner, J. N. Bowlby, M. Daniels, and B. F. Lantry[1]

Introduction

The principal members of the offshore pelagic community in Lake Ontario are alewife and rainbow smelt, and their salmonine predators – chinook, coho and Atlantic salmon, lake trout, rainbow trout, and brown trout. Some of the less abundant species include threespine stickleback, emerald shiner and gizzard shad.

Alewife and rainbow smelt are not native to Lake Ontario, but they have long been well established in the lake. Their numbers, especially those of alewife, have declined recently as a result of several factors. The nutrient loading into the lake decreased due to improved land use and sewage treatment practices in the recent decades. In the early 1990s the lake was colonized by the zebra mussel. These two factors resulted in reduced plankton productivity, and therefore less available forage for alewife and smelt. Meanwhile the alewife and smelt continued to suffer from predation by the piscivores – salmon and trout.

The salmon and trout in Lake Ontario are largely maintained by stocking, although limited natural reproduction occurs in several species. Chinook salmon are the principal stocked species, followed by rainbow trout and lake trout, and lesser numbers of coho and Atlantic salmon, and brown trout. In the late 1980s and early 1990s the numbers of fish stocked yearly by the Canadian and U.S agencies reached more than 8 million. With the declining populations of alewife and smelt there were concerns that predator demand would exceed the available prey, and starting in 1993 stocking levels for all species were reduced to levels that would lower prey consumption by approximately a half. Based on further public consultation stocking was modestly increased in 1997 (Stewart *et al.* 1999)

This chapter describes our current information on the status of alewife, rainbow smelt, chinook salmon and rainbow trout. Lake trout, which play a significant role in the offshore pelagic community, but are also associated with the benthic community, are discussed in the next section (Chapter 2 of this report).

Information sources

Alewife and smelt populations are assessed in hydroacoustic surveys conducted cooperatively in the summer and fall by OMNR and the New York State Department of Environmental Conservation (Schaner and Schneider 1995). In these surveys we collect hydroacoustic data and midwater trawl samples. Due to a variety of reasons, only partial surveys were completed in 1999. Only two cross-lake transects in the summer, and three in the fall were surveyed out of the usual seven, and no data were obtained from the western half of the lake during either survey. The results therefore apply only to the eastern portion of the lake (east of the line between Scotch Bonnet Sill and Hamlin), and conclusions based on these partial surveys are limited by the uncertainty in extrapolating the results to the whole lake.

Salmon and trout are assessed in a variety of ways. Chinook salmon growth is monitored during the spawning run in the Credit River at the Reid Milling dam in Streetsville, when fish are caught for spawn collection for the Ringwood Fish Culture Station. Spawning rainbow trout are monitored at the Ganaraska River fishway. The angler catches of chinook salmon and rainbow trout are are monitored in angler catches from the boat fishery in western Lake Ontario (Chapter 8 in this report).

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Alewife

The 1999 population of yearling-and-older (YAO) alewife in the surveyed eastern portion of the lake were 0.9 billion and 1.1 billion fish, as estimated in the summer and fall surveys, respectively. Data from previous years indicate that the area surveyed in 1999 generally accounts for half or more of the entire alewife population, suggesting that the total population of YAO alewife in 1999 was no more than approximately 2 billion fish.

This estimate is somewhat less than the abundances measured over the last three years (Fig.1), a period during which the 1995 cohort dominated the population. The 1998 cohort appeared to be strong in the spring of 1999 (R. O'Gorman, U.S. Geological Survey, Great Lakes Science Center, Lake Ontario Biological Station, Oswego, NY, 13126, personal communication), and should have resulted in high abundance of YAO alewife. The fact that the 1999 estimates do not exceed the estimates from the previous three years suggests that the 1998 cohort suffered from heavy predation in the spring and early summer of 1999.

The trawl catches of alewife from the summer and fall surveys show two prominent size groups of fish (Fig. 2). The larger fish (145-150 mm) belong largely to the 1995 year class. The smaller fish (115 mm in the summer and 120 mm in the fall) are the fish of the 1998 year class. The average size of the 1998 year class in either season indicates exceptionally fast growth.

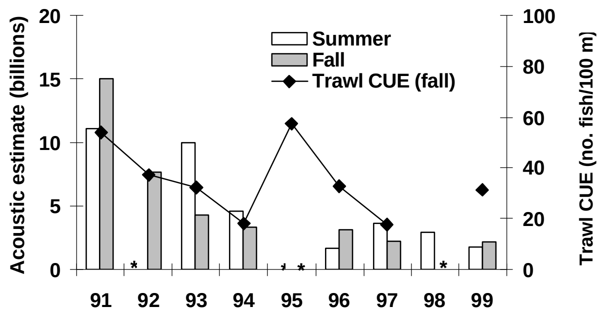

FIG. 1. Acoustic estimates of absolute abundance, and midwater trawl indices of relative abundance (CUE) of alewife in Lake Ontario, 1991 to 1999. Asterisks indicate missing surveys.

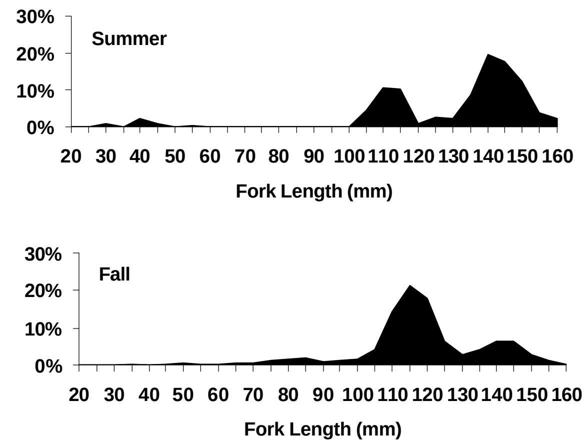

FIG. 2. Length frequency distribution of alewife from midwater trawls conducted in summer and fall of 1999.

Rainbow Smelt

The 1999 estimates of YAO smelt in the eastern Lake Ontario were 414 and 488 million fish in summer and fall respectively. Expansion of this estimate to the whole lake is even more problematic than it is in the case of alewife, since experience from previous years shows that the east-to-west variability in numbers of smelt is greater than it is for alewife. Our best estimate for the whole lake population of YAO smelt is double the estimate for the eastern portion, or 0.8 and 1.0 billion for the summer and fall surveys respectively.

The numbers of smelt in Lake Ontario oscillate on a two year cycle, with strong cohorts produced in

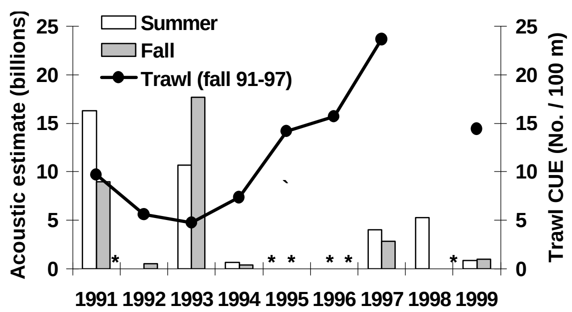

FIG. 3. Acoustic estimates of absolute abundance, and midwater trawl indices of relative abundance (CUE) of smelt in Lake Ontario, 1991 to 1999. Asterisks indicate missing surveys or data yet to be analysed (1996 surveys).

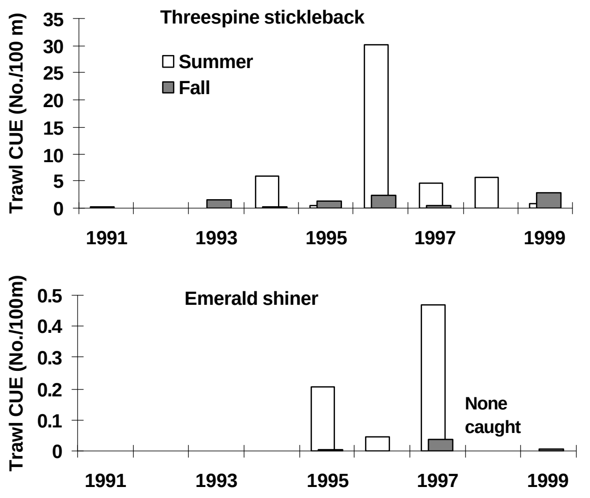

FIG. 4. Catch rates of threespine stickleback and emerald shiner in midwater trawls in Lake Ontario, 1991 to 1999.

even numbered years, resulting in high estimates of YAO smelt in the odd numbered years that follow, due to the contribution of yearlings from the strong cohorts. The 1998 yearlings were indeed the predominant group in the trawl catches of smelt in 1999, however the overall estimate of smelt population size is low, the lowest estimate for a yearling-dominated population (odd numbered year) since the start of the survey series in 1991 (Fig .3).

Other pelagic prey species

Threespine sticklebacks and emerald shiners continued to be found in the midwater trawl catches in 1999 (Fig. 4). Their distribution is uneven, and with the reduced survey effort in 1999, it is difficult to make conclusions about their recent population trends. Interestingly, for the first time since the beginning of the survey program in 1991, two of the trawls made in the fall contained a high number of gizzard shad, where in our past experience we only occasionally saw one or two individuals in a catch.

Stocking Program

In 1999, OMNR stocked over 1.7 million salmon and trout into Lake Ontario (Table 1). About 366,000 chinook salmon spring fingerlings were stocked at various locations, mainly in the western end of the lake, to provide put-grow-and-take fishing opportunities. A high level of premature hatch resulted a shortfall for chinook of approximately 174,000 fish. About 135,000 coho salmon fall fingerlings and spring yearlings were stocked into the Credit River, as part of the recently re-instated coho program. We expect to begin a wild egg collection for coho salmon in the Credit River in the fall of 2000. In support of an ongoing research program to determine the feasibility of restoring Atlantic salmon, just over 200,000 Atlantic salmon fry were stocked into various Lake Ontario tributaries by OMNR and our partners. The program is designed to evaluate growth and survival of Atlantic salmon fry in various habitat types in Lake Ontario streams, and

TABLE 1. Salmon and trout stocked in the Province of Ontario waters of Lake Ontario in 1999, and targets for 2000.

Species	Number stocked in 1999	Target for 2000
Atlantic salmon		
Eggs	12,036	
Early fry	131,252	
Advanced fry	117,313	
Yearlings	2,325	
Adults	290	
Atlantic salmon total	263,216	160,000
Chinook salmon		
Spring fingerlings	365,705	540,000
Coho salmon		
Fall fingerlings	61,485	75,000
Yearlings	73,412	75,000
Coho salmon total	134,897	150,000
Lake trout		
Yearlings	463,214	440,000
Rainbow trout		
Fry	204,876	
Fall fingerlings	5,000	
Yearlings	145,364	140,000
Rainbow trout total	355,240	140,000
Brown trout		
Yearlings	155,542	165,000
TOTAL	1,737,814	1,595,000

the ability of juvenile Atlantic salmon to compete with rainbow trout. An additional 35,000 fry, that were surplus to our research requirements, were stocked into the Credit and Humber Rivers. About 200 pre-spawning adults, some with radio tags, were also released into the Credit River to study spawning success and substrate quality. About 463,000 lake trout yearlings were stocked as part of a long-term rehabilitation program. Efforts are focused in eastern Lake Ontario where most of the historic spawning shoals are found. About 145,000 rainbow trout yearlings were stocked by OMNR, and just over 200,000 fry were reared by local community groups. About 156,000 brown trout yearlings were stocked at various locations to provide shore and boat fishing opportunities.

Detailed information about 1999 OMNR stocking activities is found in Appendix A. The New York Department of Environmental Conservation (NYDEC) also stocked 3.7 million salmon and trout into Lake Ontario in 1999 (Eckert 2000).

Chinook Salmon

Abundance

Catch rates from the launch-daily boat fishery in western Lake Ontario (Chapter 8 in this report) provide our only index of abundance for chinook salmon. These catch rates have increased slightly (6%) from 1998 to 1999 (Fig. 5). Chinook salmon populations have been steady for the past three years.

Analyses of year class strength for chinook salmon are not available. Until recently, we have aged chinook salmon from this fishery by length frequency analysis. However, we have lost confidence in this method, and are reluctant to provide ages of chinook salmon from this fishery.

Growth

The growth rates of mature chinook salmon were monitored using the spawning run in the Credit River at the Reid Milling dam in Streetsville. The lengths of male and female chinook salmon were measured when the fish were collected for spawn.

The length of male and female 2-yr-old and 3-yr-old chinook salmon in the Credit River during fall 1999 continued the increasing trend, observed for the past several years (Fig. 6). The length of chinook salmon had declined sharply in 1994, consistent with declines in alewife and smelt populations. The subsequent increases in growth were consistent with the stocking reductions from 1993 to 1996. Apparently, the stocking reductions resulted in a predator-prey ratio which prevented further reductions in chinook salmon growth rates. Moreover, chinook growth rates continued to increase with the availability of the strong 1998 year-class of alewife for food.

The pattern of body condition of chinook salmon (Fig. 7) shows no significant relationship with length-at-age (Fig. 6). Whereas, length-at-age integrates growth over the life of the fish, body condition may reflect recent changes in the availability and nutrition of prey.

Rainbow Trout

Lake Ontario

Catch rate of rainbow trout from the launch-daily boat fishery in western Lake Ontario (Chapter 8 in this report) is our primary index of rainbow trout abundance for the Ontario portion of Lake Ontario. In 1999 the catch rate declined from 1998, to a level typical of the previous 10 years (Fig. 5).

Ganaraska River

The difficulties in sampling rainbow trout in Lake Ontario has led us to use the Ganaraska River population to gain some insights into the status of rainbow trout in Lake Ontario. The spawning migration during spring has been a great opportunity to count mature rainbow trout from lake Ontario. Since 1974, counts of rainbow trout at the Ganaraska River fishway have been used to index rainbow trout abundance. During 1998, these counts were incomplete due to a power failure at the fishway and were not reported last year. However, some counts were made and these were expanded here into estimates of the whole run.

In 1998 and 1999, the estimated run past the fishway during spring decreased considerably from 1997 levels to 5,288 and 6,442 fish respectively (Fig. 8). This run had been relatively constant from 1993 to 1997 at a level about 50% higher than 1998 and 1999. Previous declines in the run were related to increases in the age of maturity (Bowlby *et al*. 1998). However, this most recent decline in the run may be related to a high level of harvest and a poor 1994 year class of wild fish (Bowlby *et al.* 1999).

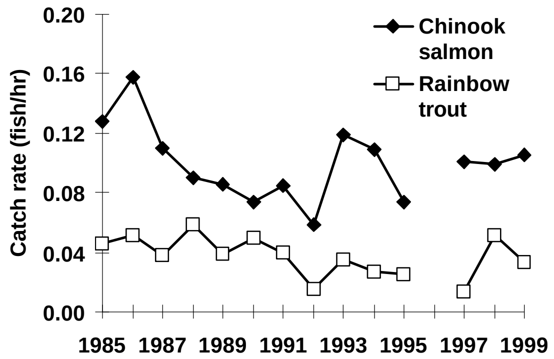

FIG. 5. The catch rate of chinook salmon and rainbow trout in the western Lake Ontario launch daily salmonid boat fishery (Ontario portion) from 1985 to 1998.

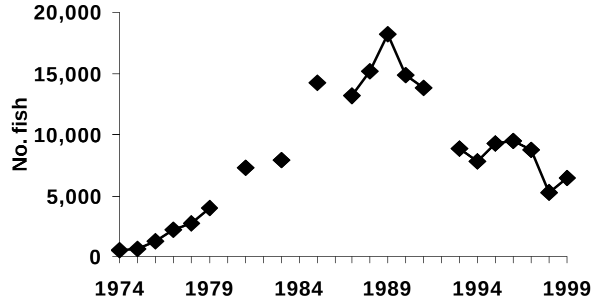

FIG. 8. The estimated upstream count of rainbow trout at the Ganaraska River fishway at Port Hope, Ontario during April and May.

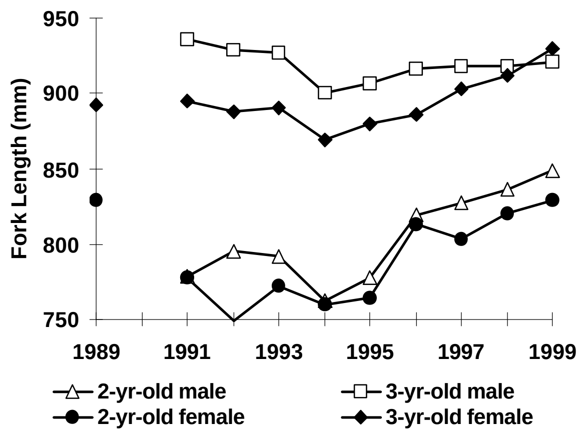

FIG.6. Fork length of chinook salmon in the Credit River during spawning run in September and October.

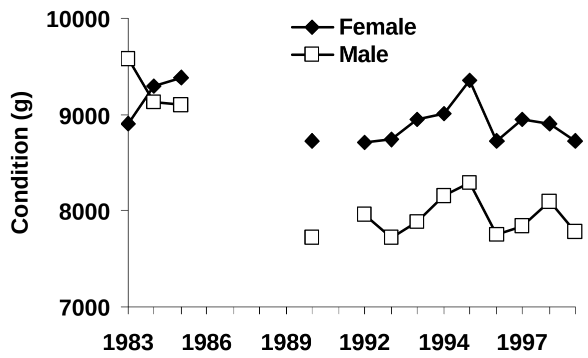

FIG. 7. Condition (mean weight, afjusted for length) chinook salmon in the Credit River during the spawning run in September and October.

Recent decreases in the repeat spawner rates of Ganaraska rainbow trout (Fig.9) are consistent with higher levels of fishing mortality. In 1999 the repeat spawner rate again dipped below the recommended limit of 50% (Swanson 1985), suggesting overharvest of the population in the previous year. The harvest of rainbow trout in the boat fishery was unusually high in 1998 (Hoyle and Bowlby 1999). Moreover, in a 1999 angler survey in the Ganaraska River we found that 1,649 mature rainbow trout (about 26% of the run) were harvested by stream anglers (Chapter 11 in this report). In addition, past surveys indicated harvest by shore anglers at the mouth of the Ganaraska River during fall 1991 and spring 1992 was even greater (unpublished data).

Juvenile rainbow trout surveys indicated a strong 1995 year class of wild rainbow trout in Ontario streams (Bowlby et al. 1999). Whether or not the 1995 year class improves the fishway counts depends on the degree of exploitation that it experiences.

Body condition of adult rainbow trout in the Ganaraska River was determined as the least-square mean weight after adjusting for length using analysis of covariance. In 1999, body condition for both female and male rainbow trout was similar to 1998 (Fig. 10). Body condition of rainbow trout was consistent with past observations by Bowlby *et al*. (1994) that condition of salmon and trout in Lake Ontario is inversely related to chinook salmon numbers.

Atlantic Salmon

The review of the first 5-year phase of our Atlantic salmon restoration program has begun. We

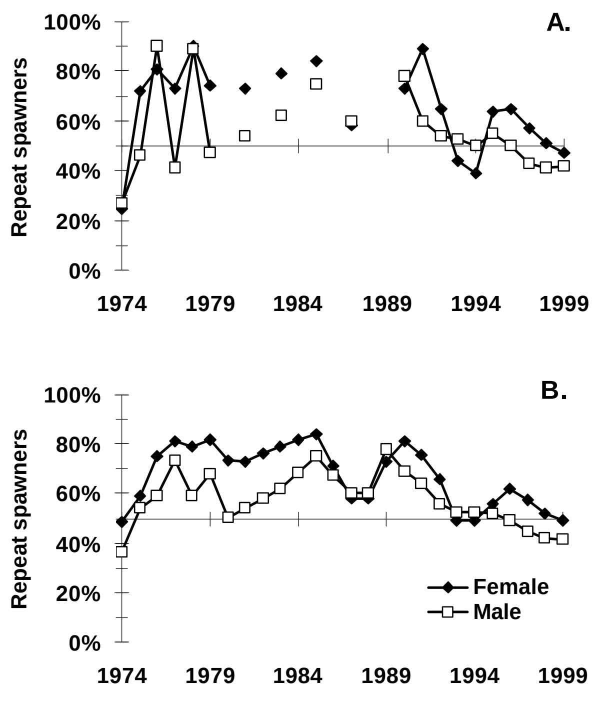

FIG.9. The repeat spawner rate of rainbow trout n April at the Ganaraska River fishway, in Port Hope, Ontario. A. Yearly values. B. Three-year running averages to reduce the effect of strong and weak year classes.

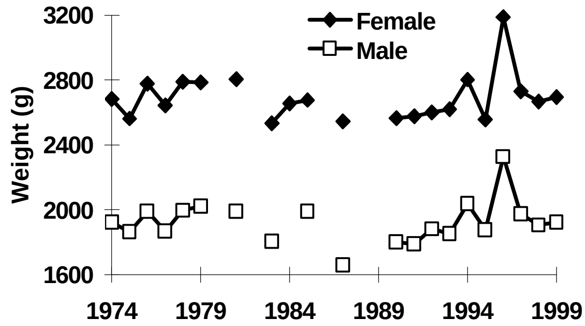

FIG. 10. Condition (mean weight, afjusted for length) of rainbow trout in April at the Ganaraska River fishway, in Port Hope, Ontario.

plan to analyse, interpret and report on the research data collected under the plan by OMNR and it's partners, and to measure progress against the benchmarks set out in the original plan. The results will be reported in the future.

Management Implications

The populations of alewife and smelt remained at a low level in 1999. It must be stressed that our estimates are based on only partial surveys, however, fairly similar estimates for both species, and from both surveys (summer and fall), lend additional support to this conclusion. There are no signs of recovery from the low abundances observed since he early 1990s. Predation is likely the main factor keeping the prey populations in check, indicating that predator stocks are near capacity for the current lake productivity.

Chinook salmon and rainbow trout populations in Lake Ontario have stabilized since the mid 1990s, as a result of the stocking reductions in 1993 and 1994. Despite some natural reproduction in both of these species, the stability in salmonid stocking has likely played a major role in stablilizing these populations.

The rainbow trout population in the Ganaraska River is almost entirely dependent on natural reproduction rather than stocking. The declines in the counts at the fishway and in the repeat spawner index, especially in the last 2 years, are consistent with significant exploitation of this population. The spring and fall shore fisheries, the boat fishery, and the stream fishery, all contribute to this exploitation. An angler survey of the stream fishery in 1999 observed an exploitation rate of 26% (Chapter 11 in this report). There is a need to determine an appropriate level of exploitation for rainbow trout, especially in light of the management objective (Stewart *et al.* 1999) to encourage wild production of rainbow trout in Lake Ontario.

Assessment and Research Needs

The Lake Ontario ecosystem continues to change. This is demonstrated in changing composition and general reduction in prey fish assemblage, natural production of salmonids, and shifts in fish distribution in response to physical parameters. Having accumulated several years of observations of the changing system, it may be time to re-evaluate the bioenergetic models, and update our understanding of the trophic relationships in the lake.

The increasing difficulties in aging chinook salmon by length or scales, has made it difficult to estimate year class strength. The emergence of this problem coincides with the increases in natural reproduction of chinook salmon (Bowlby *et al*. 1998). We suspect the differing size and age between wild and stocked chinook smolts has obscured the length-frequency distributions that used to clearly separate age groups, and the prevalence of small yearling alewife has given yearling chinook faster growth relative to other age groups. We should obtain ages of chinook salmon from otoliths, which we have been collecting since 1991.

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2

Lake Ontario Offshore Benthic Fish Community

J. A. Hoyle and T. Schaner

Introduction

The Lake Ontario offshore benthic fish community is low in diversity. The most abundant species include one top predator, lake trout, and two benthivores, lake whitefish and slimy sculpin. Much less abundant benthic species include burbot, round whitefish and deepwater sculpin. Other, primarily pelagic species, overlapping in distribution with the benthic community includes alewife, smelt, lake herring and threespine stickleback.

The benthic fish community has undergone tremendous change. Stress brought about by over-exploitation, degraded water quality, the parasitic sea lamprey, and increases in larval fish predators (alewife and smelt) caused lake trout, four species of deepwater cisco and deepwater sculpin to be extirpated, and lake whitefish and burbot to decline to very low numbers by the 1960s and 1970s.

Harvest control, improvement to water quality, lamprey control, and large-scale stocking of salmon and trout, all initiated in the 1970s, have since led to recovery of some species. Lake trout numbers are maintained largely by stocking but modest levels of natural reproduction have occurred since 1993. Lake whitefish recruitment increased beginning in the late 1970s and populations of two major spawning stocks (Bay of Quinte and Lake Ontario) recovered over the mid-1980s to early 1990s time-period. Slimy sculpin, which did not experience major negative impacts during the 1960s and 1970s, declined in abundance under intense predation pressure (lake trout) through the 1980s and early 1990s—at least in the shallow regions of their distribution. Burbot abundance remained low. Changes in round whitefish abundance (a species confined largely to north central Lake Ontario waters), are not well documented and are not considered further here. Deepwater sculpin, thought to be extirpated from Lake Ontario since the early 1970s, re-appeared in small numbers beginning in 1996. Deepwater cisco remained absent.

Most recently, following the invasion and proliferation of dreissenid mussels in the early 1990s, profound impacts on the benthic fish community are now being played out. Dreissenid mussels have negatively impacted the native benthic invertebrate community. In particular, *Diporeia* (deepwater amphipod), an important diet item for benthic fish (e. g., juvenile lake trout, lake whitefish, slimy sculpin and deepwater sculpin), have declined to negligible levels in the presence of *Dreissenia*. The biggest impacts documented to date have been on lake whitefish and include declines in abundance, recruitment, and body condition.

This chapter updates the status of lake trout, lake whitefish, slimy sculpin and deepwater sculpin for 1999.

Information Sources

Information on the benthic fish community is collected in the eastern Lake Ontario fish community index gillnetting and trawling program (Fig. 1, Hoyle 1999a), and also, in the case of lake whitefish, from commercial catch sampling during lake whitefish spawning runs (Hoyle 1999b). For a complete list of species-specific catches in this program, see Appendix B.

Lake Trout

Abundance

The abundance of lake trout has declined in the 1990s. Part of this decline can be attributed to a

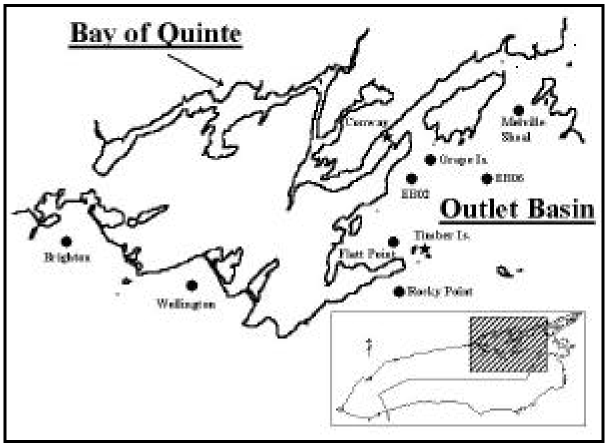

FIG. 1. Map of northeastern Lake Ontario showing fish community index gillnetting (circles) and trawling (stars) locations in the Outlet Basin and the lower Bay of Quinte.

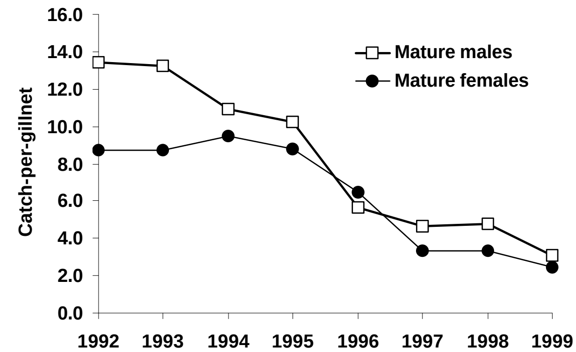

FIG. 2. Mature lake trout catch-per-gillnet in the community index gillnetting program. Only catches from July-September made at bottom temperatures less than 12oC were used.

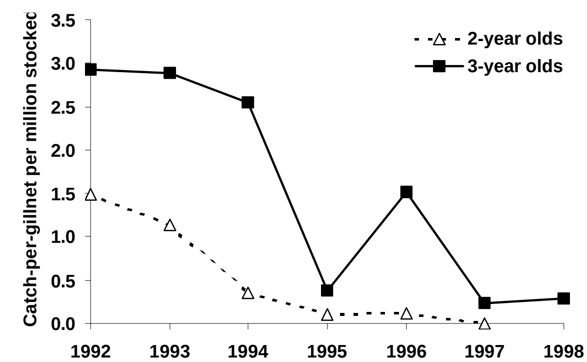

FIG. 3. Survival of stocked lake trout to ages 2 and 3. The graph shows the catches-per-gillnet in the community index gillnetting program divided by the number of yearlings (in millions) of the corresponding year-class stocked in the Canadian waters east of Brighton.

reduction in stocking in 1993 to approximately half the previous levels. However, in Canadian waters the reduction was carried out mainly in the western portion of the lake, while in the east the stocking continued at only moderately reduced levels. Lake trout tend remain near their stocking location (for example lake trout stocked in the nearby U.S. waters make up less than 10% of our catches), and therefore reduced stocking cannot account for the four-fold decline in the abundance of adults in the east (Fig. 2).

Much of the decline in the numbers of adults can be explained by reduced early survival of the stocked fish. A decline in the early survival has been observed since 1980s (Elrod et al. 1995). During the early to mid-1990s, however, the survival dropped precipitously. This is illustrated by the catch-per-unit-effort of 2 and 3-year old fish corrected for the number of fish originally stocked, which fell by approximately ten-fold (Fig. 3). This means that the effective stocking levels have declined by the same amount, and the decline will be reflected in reduced numbers of adults in the future. A shift in size composition of adults that is symptomatic of this trend, can already be observed. The mean size of mature lake trout has increased, especially since the mid 1990s, which is consistent with a lack of recruitment to the adult population, which then becomes dominated by large old fish.

Body condition and growth

The body condition of the lake trout is assessed as the mean weight at a standard length, as predicted from length-weight regressions. The condition of large fish remained more or less unchanged through the 1990s (Fig 4, 680 mm fish), with higher values in 1995-96 and 1998, which could be attributed to strong 1995 and 1998 year-classes of alewife (see section 1 in this report). The condition of small lake trout (Fig. 4, 430 mm fish) appears to have decreased over the same period, although not enough small fish were captured in recent years to provide a statistically valid sample. The suspected decrease in body condition of small lake trout is similar to the trend observed over a similar period for lake whitefish (see below), and was probably linked to changes in availability of benthic invertebrate prey.

Lamprey wounding

The frequency of fresh lamprey wounds in lake trout has been demonstrated to be a direct indicator of mortality due to lamprey. Overall, the lamprey wounding levels in 1990s remained well below the rates observed during the previous decades, due to successful control of lamprey in the Great Lakes. The most recent trends (Fig. 5) indicate that the frequency of wounds increased slightly starting in 1995, and decreased again in 1999.

Natural reproduction

Emergence of naturally produced lake trout fry has been documented in Lake Ontario since the late 1980s, and successful survival beyond larval stage was first demonstrated in 1994, when yearling and 2-year old fish began to be caught in bottom trawls. Fish of every year-class starting with 1992 have so far been caught, albeit in small numbers. Most of the catches come from the U.S waters, where there are several extensive bottom trawling programs in which young lake trout are routinely caught. Bottom trawling in Canadian waters is limited, and over the years since 1994 we only caught 15 naturally produced lake trout, and none in 1999. The catches from both sides of the border indicate prominent 1993 and 1994 year-classes, while fewer fish were caught from the later year-classes.

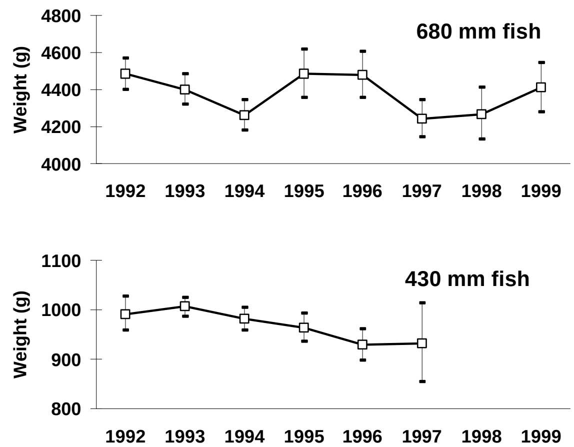

FIG. 4. Weights of 430 and 680 mm lake trout. The weights were calculated from regression of log transformed round weight on log transformed fork length, and only data from a 50 mm bracket around the shown values of fork length were used in the regressions (i.e., 405-455mm and 655-705mm). The error bars represent 95% confidence intervals on the estimated weight. There was insufficient data to estimate weights of 430 mm fish for 1998 and 1999.

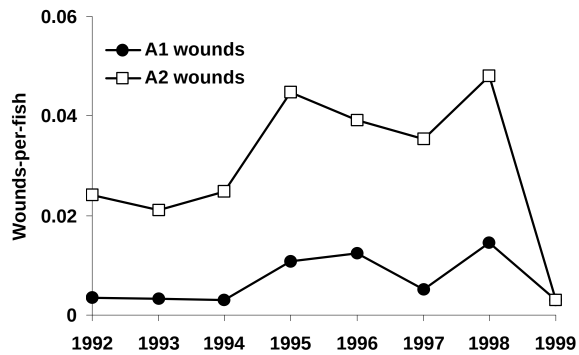

FIG. 5. Number of A1 and A2 (International Joint Commission classification) lamprey wounds per lake trout observed in the index gillnetting program. The frequency of A1 wounds is traditionally used to assess lamprey impacts, however, due to low wounding rates, and recent declines in the numbers of lake trout caught in the surveys, the observed number of A1 wounds was too low to provide a reliable index, and therefore A2 wounding rate is shown as well.

Lake Whitefish

Abundance

Lake whitefish abundance (1 yr-olds and older) is monitored at several gillnetting locations in eastern Lake Ontario (Fig. 1). Abundance declined in 1999, to the lowest level observed in over ten years, thus continuing the trend of decline since 1993 (Fig. 6).

Body condition and growth

The body condition of spawning fish (both major stocks) was very poor in 1999 (Fig. 7). Body condition has been consistently poor since 1994, and has been attributed to the dramatic decline in *Diporeia* (deepwater amphipod) abundance—formerly the most important prey item in the whitefish diet—following dreissenid mussel invasion (Hoyle et al. 1999). Lake whitefish growth (length-at-age) declined markedly after 1996 for both major spawning stocks (Fig. 8 and Fig. 9).

Recruitment

Lake whitefish recruitment is measured as young-of-the-year (YOY) catch in bottom trawls. No YOY fish was observed for either stock in 1999 (Fig. 6). This result follows only very low levels of recruitment since 1996. (Note: Although no YOY fish were observed in our routine index trawls (August) some individuals were observed in late June and early July

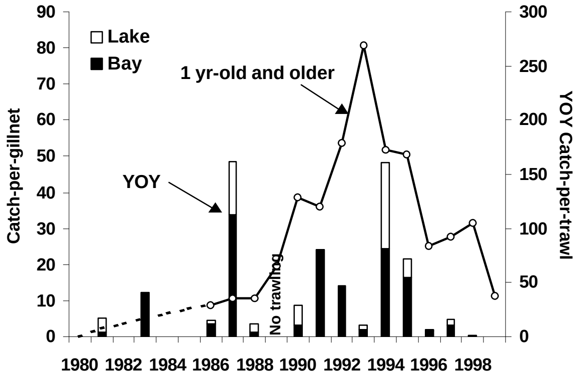

FIG. 6. Lake whitefish catch-per-gillnet (sum of catch adjusted to 100 m of each mesh size, 1 1/2 to 6 in, in the Outlet Basin of Lake Ontario, 1986 to 1999 (solid line; and extrapolated back to 1980, dotted line); and year-class strength for Lake (Timber Island) and Bay (Conway) stocks (stacked bars) as represented by young-of-the-year (YOY) catch-per-trawl (adjusted to 12 min duration), 1980 to 1999.

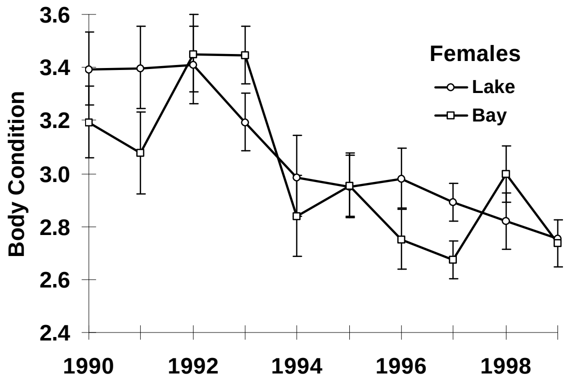

FIG 7. Female lake whitefish body condition (least-squares mean round weight adjusted for differences in length among years) in samples collected during fall spawning runs for Lake Ontario and Bay of Quinte stocks, 1990 to 1999.

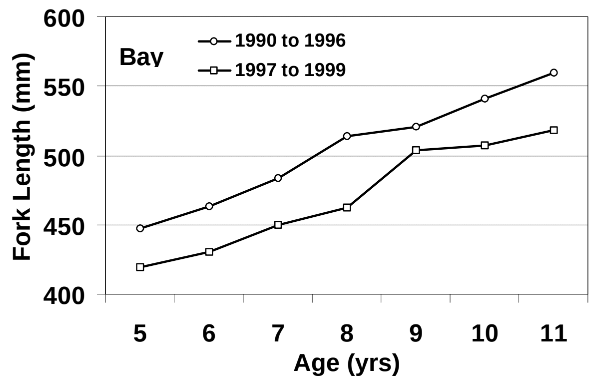

FIG. 8. Lake whitefish length-at-age for the Lake Ontario stock, males and females combined in samples collected during fall spawning runs for Lake Ontario and Bay of Quinte stocks. Two time-periods are shown, 1988 to 1996 and 1997 to 1999. Length was recorded at the end of the growing season.

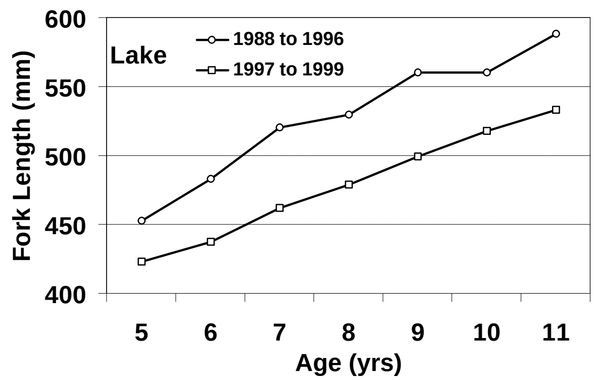

FIG. 9. Lake whitefish length-at-age for the Bay of Quinte stock, males and females combined in samples collected during fall spawning runs for Lake Ontario and Bay of Quinte stocks. Two time-periods are shown, 1988 to 1996 and 1997 to 1999. Length was recorded at the end of the growing season.

indicating that the year-class may not be a total failure).

Slimy Sculpin

Slimy sculpin abundance remained low in the Outlet Basin of Lake Ontario (Fig. 10), and has now been low since the early 1990s. The decline in abundance was likely related to intense predation pressure by stocked lake trout. Most recently, low abundance levels are also likely being maintained by the same factors that are limiting lake whitefish, changes in the benthic food web due to dreissenid mussel impacts.

Burbot

Burbot catches in the Outlet Basin of Lake Ontario declined in 1999 (Fig. 11). Catches had previously increased during the early 1990s and peaked in 1997. But even at its peak, burbot abundance was very low relative to other species.

Deepwater sculpin

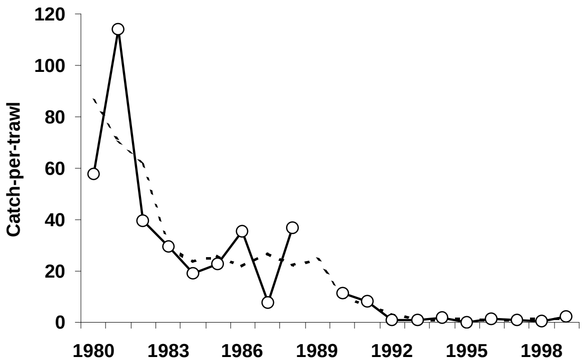

FIG. 10. Slimy sculpin abundance (catch-per-trawl at EB02 and EB06) in the Outlet Basin of Lake Ontario, 1980 to 1999 (solid line, no trawling in 1989, and 3-yr running average, dotted line).

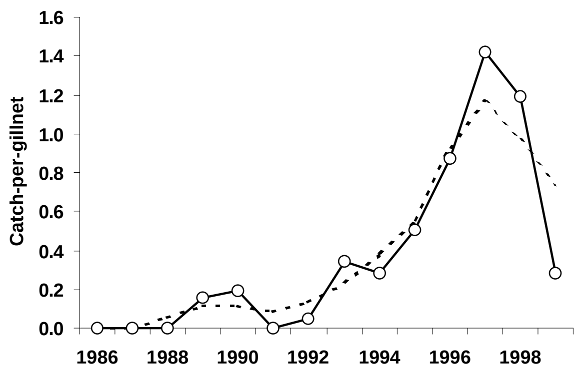

FIG. 11. Burbot abundance (catch-per-gillnet) in the Outlet Basin of Lake Ontario, 1986 to 1999 (solid line, and 3-yr running average, dotted line).

No deepwater sculpin were caught in 1999, although only a small amount of bottom trawling was conducted in areas suitable for this species. Three deepwater sculpin were captured in U.S. programs on Lake Ontario during 1999 including one in Canadian waters (Randy Owens, U. S. Geological Survey, Great Lakes Science Center, Lake Ontario Biological Station, Oswego, New York, personal communication).

Management Implications

The lake trout in Lake Ontario are currently maintained through stocking. The main goal of the stocking program is to re-establish this species as a self-sustaining part of the fish community. The numbers and population characteristics that were deemed to be necessary for natural reproduction to occur, have been in place since the 1980s, but it wasn't until the early 1990s that we observed the first naturally produced fish. Unfortunately just as the natural reproduction is improving, it appears that we entered a period of reduced early survival of stocked fish. In the coming years this will result in a decline in the numbers of mature fish that are relied upon to produce the first generations of a self-sustaining population. This decline could jeopardize lake trout rehabilitation. It will be more critical than ever to closely monitor the early survival of stocked fish as well as the numbers of adults, and to be prepared to take corrective action.

The future outlook for lake whitefish is extremely uncertain. Although the density of whitefish has declined significantly for several years, body condition remains poor, indicating that food resources are still limiting. More recently, a significant decline in body length-at-age has been observed. An optimistic prediction would be that the latter result will soon be followed by improvements in body condition, and a new growth regime of smaller, slower growing fish. But ultimate abundance levels cannot be predicted. Also troublesome is that several consecutive poor year-classes have now occurred. Therefore a further decline in lake whitefish abundance is expected. These results make harvest level recommendations very difficult. Harvest levels during the mid-1990s of the recently recovered whitefish stocks matched historical long-term average harvest. But clearly, current harvest levels cannot be sustained.

Fish community objectives for Lake Ontario's offshore benthic fish community (Stewart et al. 1999) suggested that ecological conditions of the early 1990s were favorable for rehabilitation of the offshore benthic food web. Negative impacts observed on this food web following dreissenid mussel invasion will make achievement of management objectives for the offshore benthic food web more difficult.

Assessment and Research Needs

The information used to assess lake trout comes from the community index gillnetting survey in eastern Lake Ontario. Formerly, the data were collected in a bi-national program that was dedicated to lake trout assessment. In the past few years the catches of lake trout in the index gillnetting program fell below levels needed to accurately monitor the population status in

Canadian waters. Although similar indices continue to be measured intensively by U.S agencies in nearby waters, thereby providing some insight applicable to the lake trout population in the Canadian waters, we need to amend our community index gillnetting program to increase the catches of lake trout. Our second uncertainty concerns the reasons for the recent sharp decline in the early survival of stocked lake trout. The cause for this decline should be investigated in order to determine what mitigative actions are possible. Finally, we must recognize that the monitoring of naturally produced lake trout in Canadian waters is inadequate. Currently the levels of natural reproduction are low, and only point to the feasibility of rehabilitation. In the future when natural production of lake trout increases to critical levels, the extent of this production will have to be monitored, and to this end methods to routinely identify naturally produced fish will be needed. This will require either (or both) a program to monitor lake trout at early stages, where natural and hatchery fish are readily distinguished through external characteristics, or a procedure to identify naturally produced individuals among the older fish, using calcified structures.

Currently, lake whitefish stock status is assessed with detailed information on abundance, recruitment and biological attributes. Commercial harvest allocation has been conservative with increases in quota in conjunction with abundance increases. A more precise approach, for example a statistically based catch-age stock assessment, may provide better predictive capabilities. The recent decline in lake whitfish abundance warrants a more rigorous determination and application of a total allowable catch. This approach would fit an age-structured population model to the heterogeneous mix of fishery and survey data currently available.

The cause of low YOY lake whitefish catches in mid-summer assessment bottom trawls is not known. Low recruitment levels are not surprising given the very poor body condition of adult fish in the spawning stocks. Also, in the case of the Bay of Quinte stock, predation by yellow perch may also be a factor. Yellow perch, a known larval lake whitefish predator, has increased dramatically in abundance. Other posibilities include: increased water clarity may have affected vulnerability of fish to the sampling gear, and the distribution of the larval fish may have changed. A study to determine the critical life stage (larval to mid-summer YOY) being impacted is warrented.

Documented impacts on lake whitefish following dreissenid mussel invasion suggest that other benthivores may also have been impacted. A review of slimy sculpin biological attribute data (e.g., body condition) would broaden our understanding of impacts on the benthic food web.

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3

Lake Ontario Nearshore Fish Community

J. A. Hoyle

Introduction

The Lake Ontario nearshore fish community is highly diverse. There are six common top predators: longnose gar, bowfin, northern pike, smallmouth bass, largemouth bass, and walleye. Other common species include gizzard shad, various species of minnows, white sucker, brown bullhead, American eel, trout-perch, white perch, several sunfishes (e.g., rock bass, pumpkinseed, bluegill, black crappie), yellow perch, and freshwater drum. The benthivorous lake sturgeon—which inhabits a wide-range of water depths—is a formerly common species showing increased abundance in the past few years. The alewife, primarily an offshore pelagic species, utilizes the nearshore as a spawning and nursery area and can be seasonally very abundant in nearshore areas.

The fish community in the coastal nearshore areas surrounding the main body of Lake Ontario is relatively sparse. Therefore, much of the nearshore fish community production comes from major embayments such as the Bay of Quinte, and Lake Ontario's relatively shallow Outlet Basin. Here, several species of particular management interest have shown dramatic changes in abundance in the past decade.

The Bay of Quinte and eastern Lake Ontario ecosystems have undergone tremendous change, both gradually since water quality clean-up efforts initiated in the late 1970s, and rapidly following the invasion and proliferation of dreissenid mussels in the early to mid-1990s. The ecosystem change has included increased water clarity, increased levels of aquatic vegetation, and a modified fish community.

Smallmouth bass, abundant throughout the 1980s, declined dramatically in the Outlet Basin of Lake Ontario after 1992. The decline appears to be largely due to unfavorable summer water temperatures during the exceptionally cool years of the early 1990s (Hoyle et al. 1999) but has also been attributed to predation by the avian predator, the cormorant, in the New York waters of eastern Lake Ontario (Schneider et al. 1999).

Yellow perch have increased dramatically in very recent years in the Bay of Quinte and to a lesser degree in eastern Lake Ontario. This species appears to be capitalizing on changes in habitat and declines in competitors (e.g., alewife) and predators (alewife and walleye).

Walleye, having recovered to very high levels of abundance through the early 1980s and early 1990s, is currently declining in abundance. The decline to date has been limited to young fish. The abundance of large, mature walleye has not yet declined.

This chapter focuses on the nearshore areas of northeastern Lake Ontario and the Bay of Quinte, and in particular on three species of particular management interest, smallmouth bass, yellow perch, and walleye. Also included are an update on lake sturgeon catches in 1999, and a report on the first observation of round goby in the Bay of Quinte.

Information Sources

Information on the nearshore fish community is collected annually during the eastern Lake Ontario and Bay of Quinte fish community index gillnetting and trawling program (Hoyle 1999). For a complete list of species-specific catches in this program, see Appendix B. Information on round goby was obtained from an angler awareness program that was initiated following the first reported sighting of round goby during the summer of 1999.

Smallmouth bass

Abundance

Smallmouth bass abundance in eastern Lake Ontario (Fig. 1) was high in the late 1970s, declined through the early and mid-1980s, then remained steady or increased slightly to the early 1990s. After 1992, abundance declined rapidly to 1996 but then showed a moderate increase over the next three years to 1999 (Fig. 2). Trends in abundance were age-specific. Young bass (i.e., 2 to 5 yrs-old) showed a cyclical pattern of abundance with peaks during the years 1980, 1983 to 1985, 1991 to 1993, 1998 and 1999, and low points during 1981, 1986 to 1990, and 1994 to 1997 (Fig. 3). Older bass (>5 yrs-old) showed a marked decrease throughout the past 20 years.

Year-class Strength

Trends in year-class strength revealed that the eastern Lake Ontario smallmouth bass population is characterized by periodic strong year-classes, and intervening years of weak year-classes (Fig. 4).

Cumulative gillnet CUEs for ages 2 to 4 yrs showed strong year-classes in 1980, 1983, 1987, 1988 and 1995. Only extremely weak year-classes were produced through the 6-yr period from 1989 to 1994. The strongest year-class during this period, 1991, was only of moderate strength.

Direct and complete estimates of year-class strength were not possible beyond 1995. However, smallmouth bass year-class strength in eastern Lake Ontario is positively correlated with July/August water temperatures during the first year of life (Hoyle et al. 1999). This allows prediction of smallmouth bass year-class strength, based on mid-summer water temperature for the years 1996 to 1999. The 1998 and 1999 year-classes were predicted to be high and above average. Year-classes from 1996 and 1997 were

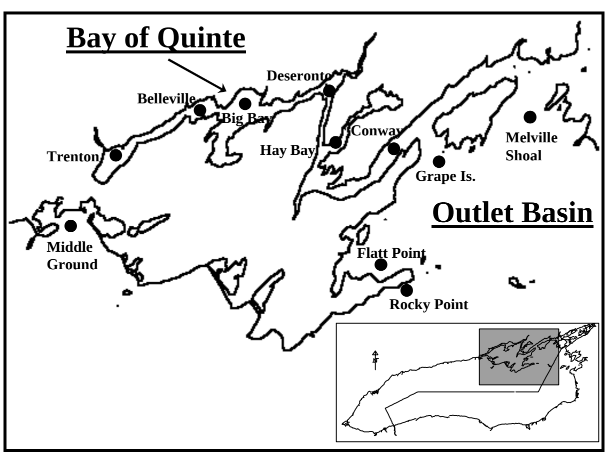


FIG. 1. Map of northeastern Lake Ontario showing fish community index gillnetting and trawling locations in the Outlet Basin and the Bay of Quinte.

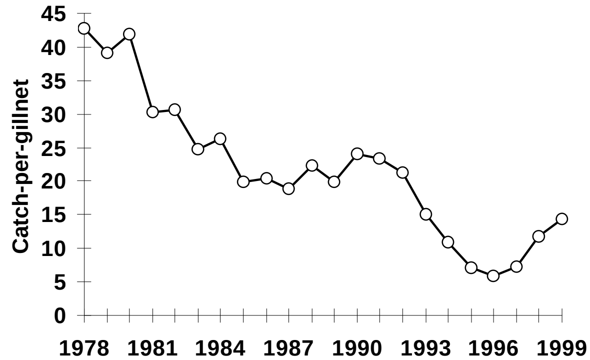


FIG. 2. Smallmouth bass abundance (3-yr running average) in eastern Lake Ontario index gillnets during mid-summer, 1978 to 1999. One site (Simcoe Island) was sampled for the years 1978 to 1985, while three sites (Melville Shoal, Grape Island, and Rocky Point, Fig. 1) were sampled from 1986 to

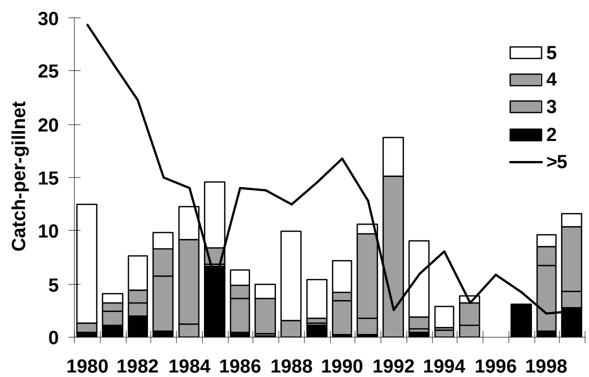


FIG. 3. Smallmouth bass age-specific abundance trends for ages 2, 3, 4, 5 (stacked bars) and >5 yrs-old (solid line) in eastern Lake Ontario index gillnets during mid-summer, 1980 to 1999.

probably relatively weak but, with the exception of 1991, stronger than during the period of very weak year-classes from 1989 to 1994 (Fig. 4).

These results suggest that smallmouth bass abundance will continue to increase in eastern Lake Ontario over the next several years.

Bay of Quinte

Smallmouth bass abundance in the Bay of Quinte (Big Bay, Fig. 5) was high in the late 1970s and early 1980s. Abundance declined dramatically through the mid-1980s, and very few smallmouth bass were caught during the late 1980s and early 1990s. Despite the decline in 1999, smallmouth bass now appear to be on the increase as the Bay of Quinte undergoes dramatic ecosystem change (Fig. 5). The year-class composition of the increased catches in recent years

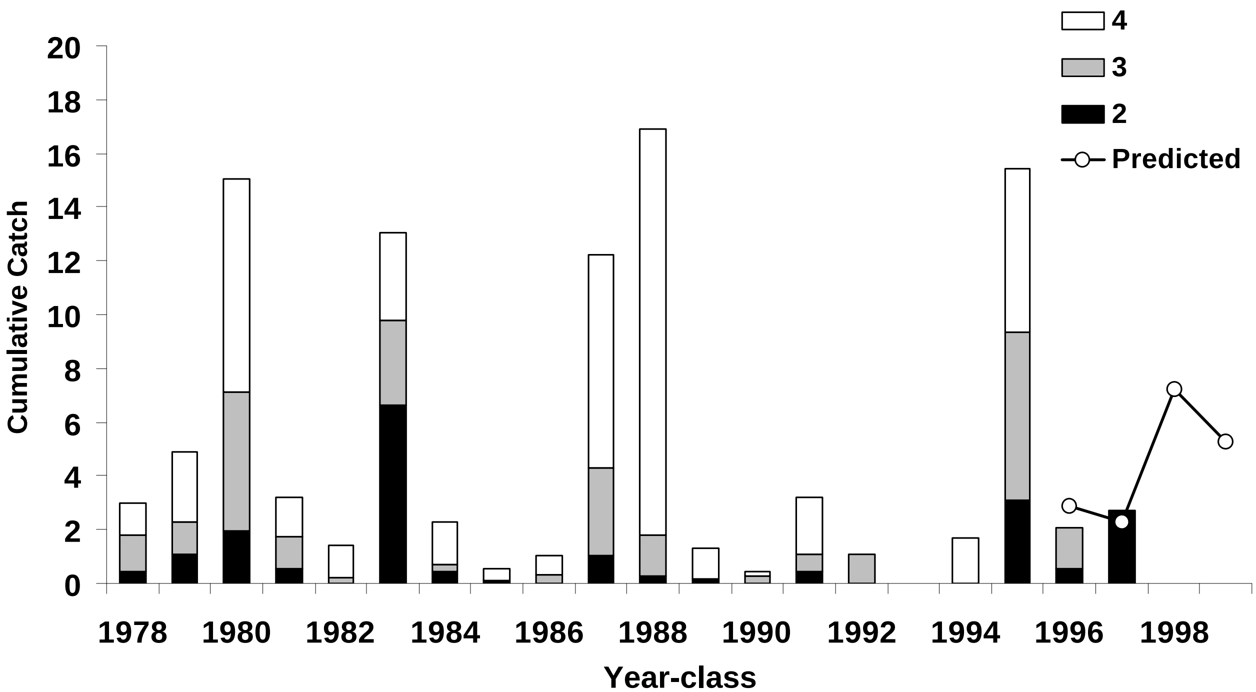


FIG. 4. Smallmouth bass year-class strength measured as the cumulative catch-per-gillnet of ages 2 to 4 yrs-old for the 1978 to 1995 year-classes (ages 2 to 3 yrs-old for 1996, and age 2 yrs-old for 1997 are also shown; stacked bars). Year-class strength for the 1996, 1997, 1998 and 1999 year-classes was also estimated (solid line) based on the following water temperature vs. year-class strength relationship: Log10(CUE) = 0.329(Water Temperature) - 6.241, r = .74, p = .003, N = 14).*

(1996 to 1999) was comprised of young fish; all fish were from the 1994 to 1998 year-classes, and 48% originating from the 1995 year-class.

Yellow Perch

Yellow perch are the most common species caught in our index netting surveys. Their distribution is wide ranging throughout northeastern Lake Ontario and the Bay of Quinte. Here, several abundance indices are presented corresponding to areas of major commercial harvest interests.

Bay of Quinte

Yellow perch have increased dramatically in recent years in the Bay of Quinte (Big Bay, Fig. 6). The age distribution indicates that the fish are young (mean age = 2.5 yrs-old, Fig. 7). The increase in abundance is due to increased year-class strength beginning as early as 1993 but especially by 1995 (Fig. 8). The lack of 4-yr-old fish from the 1995 year-class in the Big Bay sample in summer 1999 is puzzling. As 3-yr-olds, this year-class dominated the catch (Fig. 7), and

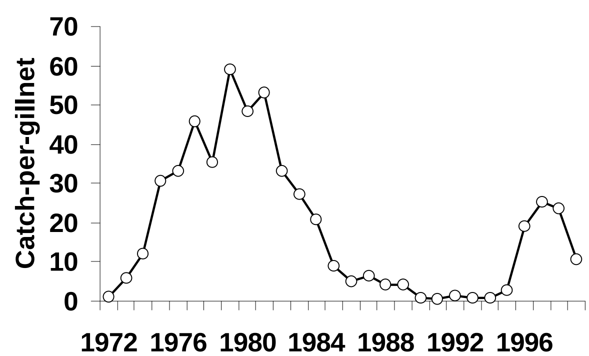


FIG. 5. Smallmouth bass abundance (3-yr running average) in Bay of Quinte index gillnets (Big Bay site) during mid-summer, 1972 to 1999.

were still prominent in the spring catches of 1999 (unpublished data). Conversely, gillnet catches of the 1996 and 1997 year-classes in 1999 were relatively weak and strong respectively (Fig. 6), as predicted by the YOY catches (Fig. 8).

Yellow perch catches in the Outlet Basin (Melville Shoal and Flatt Point, Fig. 6) have increased only slightly, albeit steadily, since 1995. The mean ages of the 1999 catches were 3.8 and 4.3 yrs-old at Melville Shoal and Flatt Point, respectively (Fig. 7).

Yellow perch catches at Middle Ground have increased since 1997 (Fig. 6). The mean age of the 1999 catch was 3.0 yrs-old (Fig. 7). The relatively large numbers of 4-yr-old fish was an encouraging sign given that few fish over 3 yrs-old have been observed for a number of years.

Walleye

Bay of Quinte walleye are the target of one of Lake Ontario's largest recreational fisheries (see Chapter 7 in this report). Walleye also are allocated to the Lake Ontario commercial fishery which is largely otherwise supported by lake whitefish, yellow perch and eel (see Chapter 5 in this report), and provide a spring

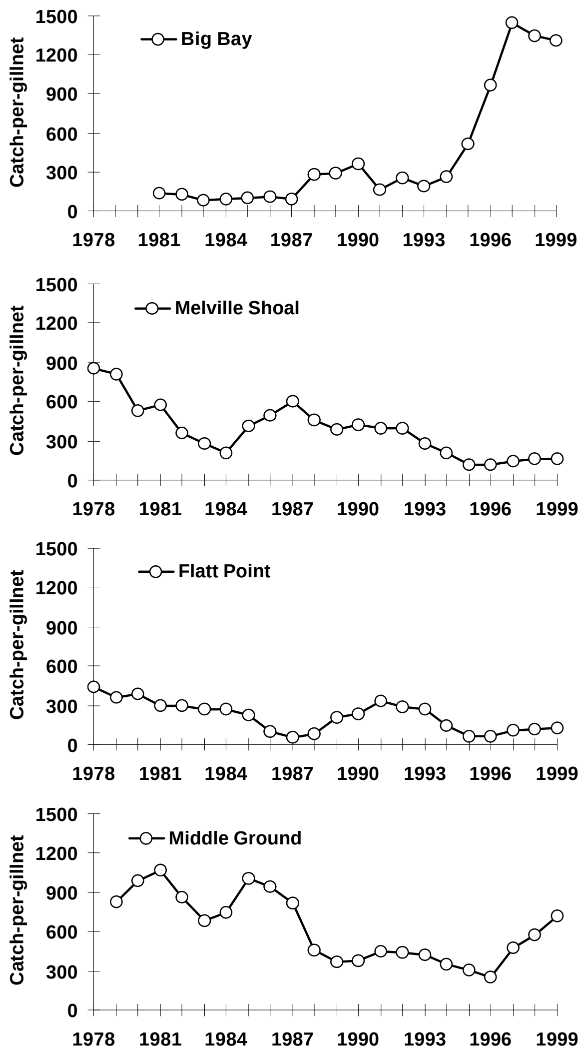


FIG. 6. Yellow perch abundance (catch-per-gillnet, 3-yr running average) in the Bay of Quinte (Big Bay, 1981 to 1999) and eastern Lake Ontario (Melville Shoal, 1978 to 1999; Flatt Point, 1978 to 1999, and Middle Ground (1979 to 1999).

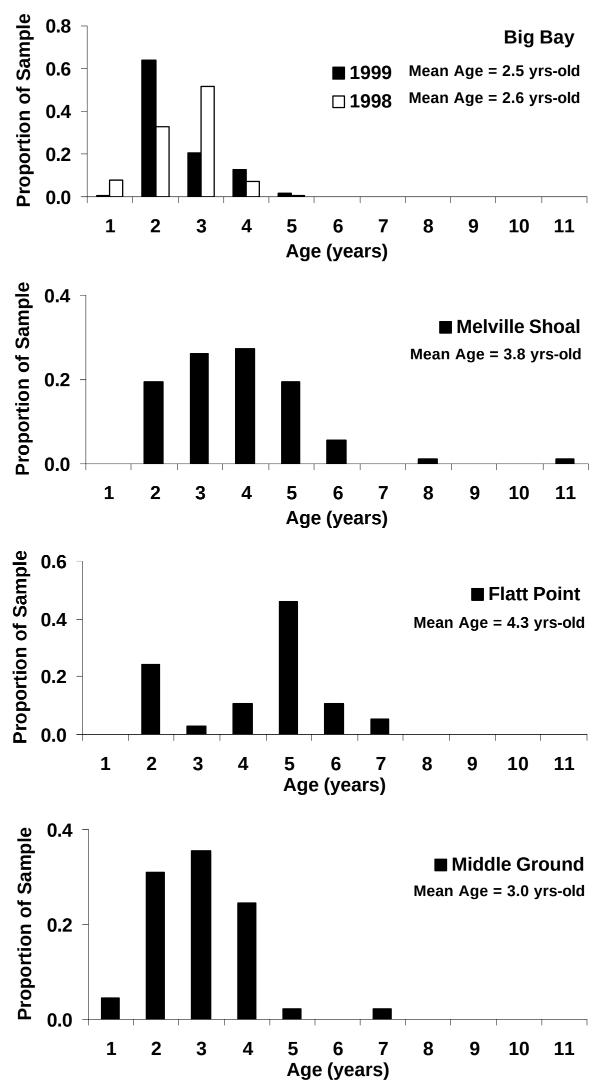


FIG. 7. Yellow perch age distribution in gillnet catches in the Bay of Quinte (Big Bay) and eastern Lake Ontario (Melville Shoal, Flatt Point, and Middle Ground), summer 1999.

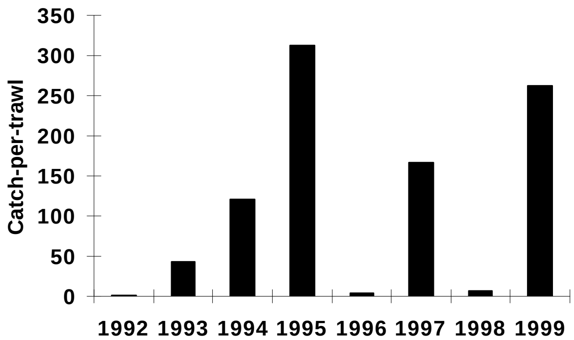


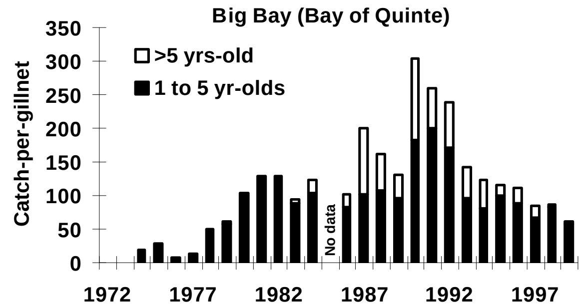
FIG. 8. Yellow perch year-class strength in the Bay of Quinte as represented by YOY catch-per-trawl (6 min duration; six sites: Trenton, Belleville, Big Bay, Deseronto, Hay Bay and Conway), 1992 to 1999.

aboriginal spear fishery in the rivers of the Bay of Quinte (see Chapter 9 in this report). Adult walleye migrate to Lake Ontario immediately following spawning in the Bay of Quinte, and then move back into the bay in the fall to over-winter.

Abundance Trends

Walleye abundance was monitored at Big Bay (Bay of Quinte) and Melville Shoal (Outlet Basin of Lake Ontario, Fig. 1). Walleye age-class composition at the two sites reflected the age-specific distribution pattern of walleye during mid-summer; young fish at Big Bay (e.g., mainly 1 to 5 yrs-old but also some older fish) and older fish at Melville Shoal (e.g., mainly greater than 5 yrs-old but also some younger fish). Walleye abundance increased, beginning in the early 1980s at Big Bay and in the mid-to latter 1980s at Melville Shoal, following production of the 1978 year-class (Fig. 9). Walleye abundance peaked in the early 1990s (Big Bay 1990, Melville Shoal 1992) and then declined markedly in Big Bay but only slightly at Melville Shoal. The 1999 catch at Big Bay was the lowest since 1979. The most recent trends in abundance were age-specific. Young fish (1 to 5 yrs-old) declined at both sites while older fish (>5 yrs-old) declined at Big Bay but increased or remained steady at Melville Shoal (Fig. 9). The latter observation may have resulted from increased movement of older walleye from the Bay of Quinte to eastern Lake Ontario for the summer months.

Walleye year-class was measured two ways (Fig. 10). Young-of-the-year walleye were measured in August bottom trawls at three Bay of Quinte sites, Big Bay, Hay Bay and Conway. In addition, a measure of year-class strength was determined by tracking year-



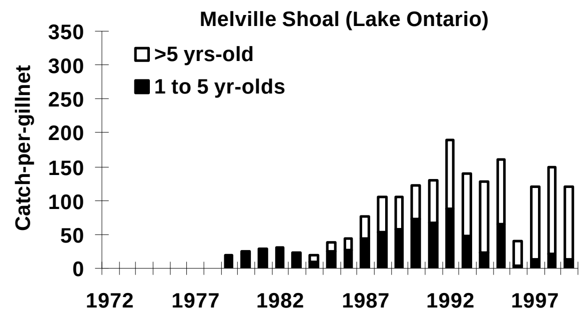


FIG. 9. Walleye catch-per-gillnet, for age-classes 1 to 5 yrs-old and >5 yrs-old, in the Bay of Quinte (Big Bay, 1972 to 1999, upper panel) and the Outlet Basin (Melville Shoal, 1977 to 1999, lower panel) in mid-summer.

class specific gillnet catches over time for ages 2 to 5 yrs-old (i.e., cumulative catch-per-gillnet) at Big Bay and Melville Shoal.

Catches of YOY walleye indicated virtually no reproduction of walleye prior to 1978, a large 1978 year-class, a general pattern of increasing catches from 1981 to 1990, and finally a decline—with the exception of 1994—to a very low level in 1998. A modest increase occurred in 1999, with catches of YOY fish similar to those of 1995 to 1997.

Tracking year-class over time for walleye aged 2 to 5 yrs showed the very large 1978 year-class, a steady increase in year-class strength from 1979 to 1988, and then a general decline with the exception of an 'up-tick' in 1994.

Lake sturgeon

Eastern Lake Ontario commercial fishermen have reported moderate numbers of small lake sturgeon annually since 1996 (e.g., 49 fish in 1998 and 35 fish in 1999). These fish are primarily caught incidentally in gillnets set for yellow perch. Small numbers of sturgeon have also been caught in the eastern Lake

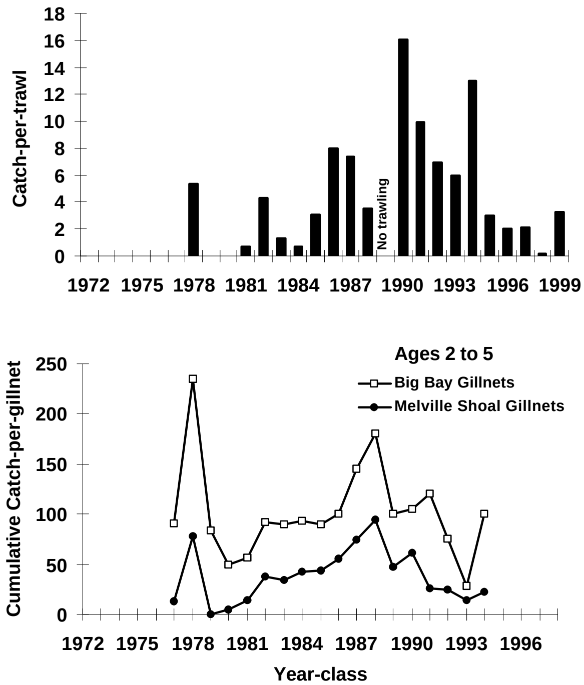


FIG. 10. Walleye year-class strength; measured as young-of-the-year (YOY) catch-per-trawl in the Bay of Quinte (6 min duration), 1970 to 1999 (no trawling in 1989), and as cumulative catch-per-gillnet of each year-class measured at ages 2 to 5 yrs-old for the 1977 to 1994 year-classes in the Bay of Quinte (Big Bay) and the Outlet Basin of Lake Ontario (Melville Shoal).

Ontario index netting program annually since 1997. In 1999, four sturgeon were caught (Table 1). The fish caught in 1999 averaged slightly larger in size than in previous years, perhaps indicating growth by the members of a single year-class.

Round Goby

Round goby is an exotic species that was brought into the Great Lakes in ballast water around 1990, and spread throughout Lakes Erie and St.Clair since then. The first sighting in Lake Ontario occurred in 1998 in the western portion of the lake near St.Catherines, Ontario. Further reports of round gobies in western Lake Ontario were reported at Burlington in 1999. Also in 1999, a number of specimens were caught by anglers in the eastern part of the lake in Picton Bay, Bay of Quinte. The distribution of these latter fish was isolated to Picton Bay despite an angler awareness program across the entire Bay of Quinte. A commercial fisherman at a nearby location off

TABLE 1. Statistics for four lake sturgeon caught during

Site	Date	Depth (m)	Water Temp	Mesh Size	Total Length	Weight (g)
FP28	13-Jul	27.5	11.4	140	659	1528
MS18	13-Jul	17.5	20.2	140	677	1508
MS18	13-Jul	17.5	20.2	Released Alive		
GI18	14-Jul	17.5	19.2	76	722	2215

Amherst Island captured one additional goby. The locations of the Picton Bay and Amherst Island sitings are consistent with the hypothesis that the gobies recently arrived in ship's ballast since both are in close proximity to docking facilities for Great Lakes shipping vessels. It appears that the round goby is established in at least two locations—the western end of Lake Ontario and the Bay of Quinte—and it will likely proceed to spread throughout the lake in the coming years.

Management Implications

Summer water temperature determines eastern Lake Ontario smallmouth bass year-class strength. As a result, smallmouth bass population abundance is largely determined by the recent annual pattern of summer water temperatures. Smallmouth bass abundance in assessment gillnets was low following poor year-class production during the 1989 to 1994 time period. An strong year-class in 1995 caused smallmouth bass abundance to increase after 1997. Smallmouth bass gillnet catches should be similar to or somewhat higher in 2000 relative to 1999. Exceptionally warm water temperatures in 1998 and 1999 will likely result in good year-class production that will, in turn, cause smallmouth bass catches to increase significantly beginning in 2001. This prediction is significant because of pressures to manage double-crested cormorant populations (an avian piscivore) in eastern Lake Ontario with the expectation of increasing smallmouth bass abundance.

Yellow perch are a valuable commercial species that appears to be generally increasing in abundance, including dramatically in some areas (i.e., Bay of Quinte). Pressures to maximize harvest, and thereby commercial benefits, are high. Increased harvest levels can likely be supported. Still, some basic life history details, such as local stock abundance and seasonal distribution patterns, remain to be clarified before large increases in harvest can be recommended.

The Bay of Quinte walleye and the open-water walleye recreational fishery (see Chapter 7 in this report) have declined in recent years. Future trends in walleye and walleye fisheries are of particular management interest. An increase in the catch of YOY walleye in 1999 bottom trawls is encouraging after a very poor 1998 year-class. However, 1999 walleye year-class strength is still low relative to year-classes produced in the late 1980 and early 1990s, and does not signal a reversal to the declining recreational angling catch rates. The abundance of large, old walleye will decline over the next several years because small, young walleye are not abundant enough to replace the current numbers of older fish. This trend will impact walleye fisheries that exploit large fish, the ice-angling fishery, the commercial fishery, and the aboriginal fishery. Further walleye management recommendations can be found in Chapter 10 of this report.

Assessment and Research Needs

Smallmouth bass support a modest-sized recreational fishery in the Ontario waters of eastern Lake Ontario. Information from routinely conducted surveys would better support the management of this fishery. In the Bay of Quinte, smallmouth bass abundance is expected to continue to increase due to the ecosystem/fish community changes currently unfolding. The species has the potential to generate considerable interest in the Bay of Quinte recreational fishery.

Yellow perch populations are generally on the increase, especially in the Bay of Quinte. The lack of large fish (e.g., >3 yr-olds) in the Bay is problematic. So to is the lack of significant increase in the abundance of perch in Outlet Basin assessment gillnets despite increased commercial harvest in this area. These observations require further study. As for smallmouth bass, yellow perch could potentially provide additional recreational fishing opportunities in the Bay of Quinte. However, the average size of fish caught will likely have to increase before they become attractive to anglers.

Rigorous management of Bay of Quinte walleye, due to wide-ranging interests, necessitates detailed and precise population assessment information. All current assessment programs are important to maintain and to be continually evaluated. In addition, programs to determine the factors currently limiting the production of young walleye would provide better predictive capabilities.

Small lake sturgeon have now been caught in index gillnets and trawls for three consecutive years. Commercial fishermen have reported incidental capture of these small fish for the past four years. The size distribution of the fish suggests that only one or two year-classes were involved. Also, the origin of these fish is not known. Efforts to determine the age structure and origin (e.g., spawning areas) of these lake sturgeon would help management efforts to rehabilitate this species.

Consideration should be given to round goby assessment, since this species will likely proliferate in the habitat offered by the Bay of Quinte. This species is not vulnerable to the fish community index netting methodology currently employed in the bay but may reasonably be tracked in the Bay of Quinte recreational angling survey—with the help of an angler awareness campaign—since gobies are very vulnerable to angling.

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4

St. Lawrence River Fish Community

A. Mathers

Introduction

The St. Lawrence River fish community is dominated by a rich assemblage of warm-water species; over 85 fish species have been reported. Smallmouth bass and northern pike are the most abundant top predators, while other important members of the fish community include yellow perch, rock bass, brown bullhead, and pumpkinseed. Other less abundant, but important, fish species inhabiting the St. Lawrence River include walleye, lake sturgeon and muskellunge. Yellow perch, smallmouth bass, and northern pike provide an important recreational fishery in the Thousand Islands area (Bendig 1995). In addition, the yellow perch and eel support an important commercial fishery (Chapter 6 in this report).

The waters of the St. Lawrence River, and in the Great Lakes in general, have undergone dramatic changes over the past two decades. Nutrient levels have declined, zebra mussels have invaded, and water clarity has increased. Fish populations of the St. Lawrence River have also undergone changes. The abundance of bass in fall gillnetting programs in the Thousand Islands area has declined throughout most of the 1990s. In eastern Lake Ontario, where a very similar trend has been observed, the decline was attributed to the cold water temperatures during the early 1990s (Hoyle *et* al. 1999) and increasing predation by cormorants (Schneider *et* al. 1999).

Populations of pike have declined throughout the 1990s. A variety of factors including cool spring weather, low spring water levels, and changes in the aquatic vegetation have been suggested as contributing to poor pike reproduction during this time period.

American eel spawn in the Sargasso Sea and a portion of the juvenile population migrates up the St. Lawrence River into Lake Ontario. The eels reside in Lake Ontario for several years before migrating back to sea. While in Lake Ontario the eels provide for a highly valued commercial fishery (Stewart *et al*. 1997). Eel populations show evidence of decline in many areas of eastern Canada and particularly in Lake Ontario and the upper St. Lawrence River (Ritter *et al*. 1997). Declines have been attributed to habitat loss and deterioration (e.g. dams), over-fishing, and environmental change in the northern Atlantic Ocean.

This chapter summarizes index-gillnetting catches for all fish species in 1999 and updates trends in abundance for yellow perch, smallmouth bass, northern pike and American eels.

Information Sources

Fisheries assessment activities on the St. Lawrence River have included standardized fall gillnetting, creel surveys, and monitoring the eels migrating over the ladder at the R. H. Saunders Hydroelectric Dam in Cornwall. The fall gillnetting program is designed to detect long-term changes in the fish communities and has been established in four distinct sections of the river; Thousand Islands, Middle Corridor, Lake St. Lawrence, and Lake St. Francis. These programs have been coordinated with the New York State Department of Environmental Conservation (NYSDEC) assessment programs to provide ‘river-wide’ coverage of fisheries resources. The 1999 netting in the Thousands Islands was conducted between September 8 and October 7, 1999, using methods described by Mathers (1999). This program maintained the database established in 1987 and represented the seventh netting program in the Thousand Islands section of the St. Lawrence River.

An eel ladder was installed at the R.H. Saunders Hydroelectric Dam in Cornwall in 1974 to assist with

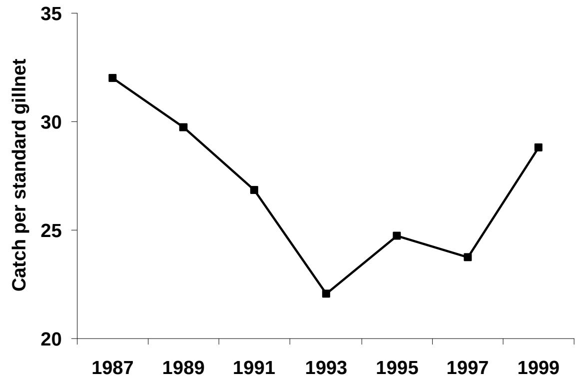

FIG. 1. Total number of fish captured in standard gillnets in the Thousand Islands area, St Lawrence River, 1987-1999

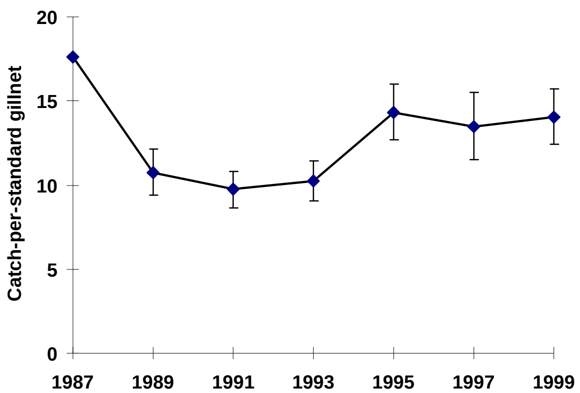

FIG. 2. Yellow perch catch in standard gillnets set in the Thousand Islands area 1987- 1999 (upper panel) Age distribution of yellow perch caught during 1999 (lower panel).

the migration of the eel upstream of the dam. Annual counts and a new index of recruitment, based on mean daily counts, was reported for the years 1974 to 1995 (Casselman *et al.* 1997). In this report, we provide estimates for the total number of eels ascending the ladder and update the recruitment index for 1999.

Fish Species Update

The overall catch from 48 gillnet sets in the 1999 Thousand Islands project was 1,383 fish comprising 19 species (a complete summary of standardized gillnet catch-per-unit-effort is listed in Appendix C). The average number of fish captured per net set during 1999 (28.8 fish per net) was higher than has been observed during recent surveys, however, the numbers of fish are still somewhat lower than those observed during the late 1980s (Fig. 1). For the first time since this program was initiated in 1987, a lake sturgeon (total length 752 mm, captured at 4 m water depth) was captured in the Thousand Islands project. Historical records of commercial fishing catches suggest that sturgeon were common in the St. Lawrence at one time but their numbers have been low throughout Lake Ontario throughout the 1900s (Baldwin *et al.* 1979).

Yellow Perch

The yellow perch continued to be the most abundant fish captured in the Thousand Islands gillnet program. The catches of yellow perch since 1995 have been good relative to the period between 1989 and 1993 (Fig. 2). McCullough and Klindt (1999) reported a similar trend for the catches of yellow perch in the New York waters of the Thousand Islands. Catches of yellow perch in the Eastern Basin of Lake Ontario have also increased during the past two years (Chapter 3 in this report). Fish aged 2, 3 and 4 yrs-old (1997, 1996 and 1995 year classes respectively) made up 75% of the total catch (Fig. 2).

Smallmouth Bass

Smallmouth bass abundance in gillnets has improved from the low catches observed during 1993 to 1997 (Fig. 3). A similar recovery in smallmouth bass catches have been reported over the same time period in the Eastern Basin of Lake Ontario (Chapter 3 in this report). Fish aged 1 yr-old and 4 yrs-old (1998 and 1995 –year-classes respectively) were relatively abundant in the catch (Fig. 3). Relative year-class strengths observed in bass from the Thousand Islands (Fig. 3), are very similar to pattern observed by Hoyle *et al.* (1999) in eastern Lake Ontario where variation in smallmouth bass year-class strength was attributed to water temperature. It is likely that temperature exerts a similar influence on the year-class strength of smallmouth bass in the Thousand Islands.

Northern Pike

Northern pike catches have declined throughout the 1990s (Fig. 4). A similar decline in northern pike catches has been reported over the same time period in the New York waters of the Thousand Islands (McCullough and Klindt 1999). Fish aged 1 yr-old (1998 year-class) were 23% of the total catch, which is

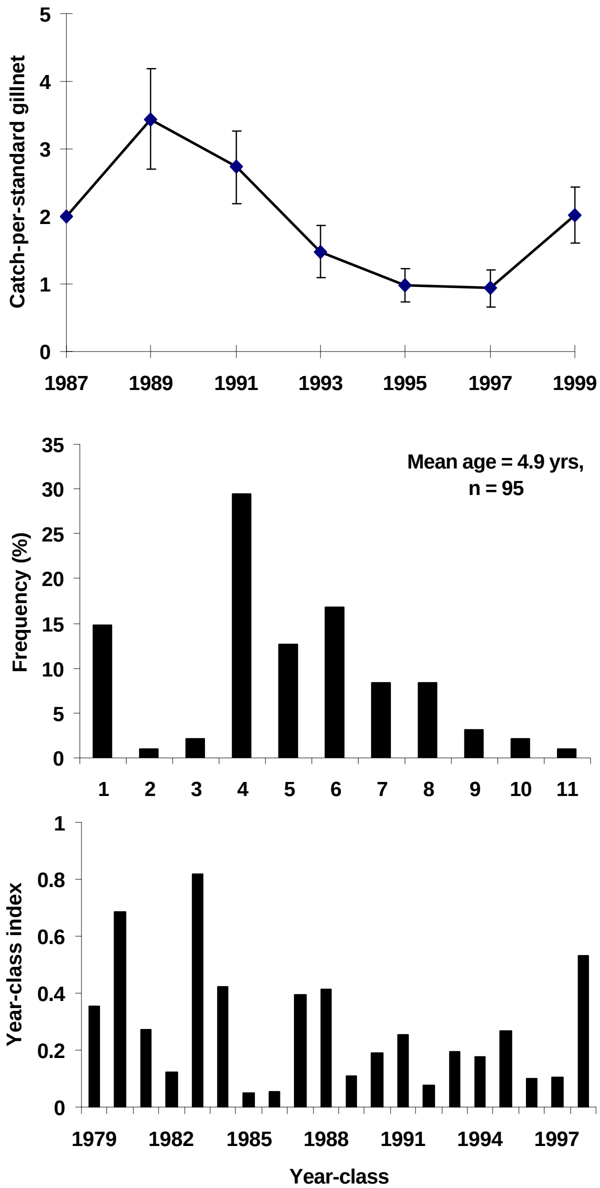

FIG. 3. Smallmouth bass catch in standard gillnets set in the Thousand Islands area, St. Lawrence River, 1987-1999 (upper panel). Age distribution of smallmouth bass caught during 1999 (middle panel). An index of year-class strength smallmouth bass in Canadian waters of the Thousand Islands, based on the catch-per-gillnet of fish aged 1 to 8 yrs-old for the 1979 to 1998 year classes (lower panel)

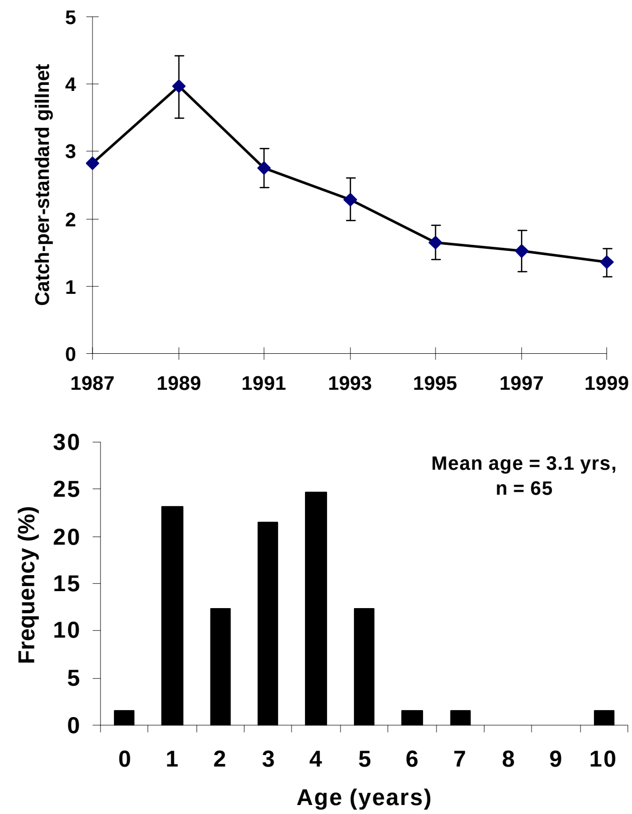

FIG. 4. Northern pike catch in standard gillnets set in the Thousand Islands area, St. Lawrence River, 1987-1999 (upper panel). Age distribution of northern pike caught during 1999 (lower panel).

unusually large when compared to previous surveys. In addition, these fish appear to be growing relatively quickly. This finding supports the observations of large numbers of the same year class of pike being captured in commercial fishing gear during 1998 and 1999 in eastern Lake Ontario (J. Hoyle and J. Casselman, personal communication, OMNR, Glenora Fisheries Station).

Other Species

Pumpkinseed and rock bass are also monitored by this program and are commercially harvested on the St. Lawrence River. Pumpkinseed populations appear to have followed a similar trend as the smallmouth bass, peaking in 1989 and gradually declining over the next 8 years (Appendix C). Catches of pumpkinseed increased during 1999, but have not returned to the numbers observed during the 1987 to 1991. Rock bass abundance increased dramatically during 1989, and is now the second most abundant species captured (Appendix C).

American Eel

The eel ladder was opened on June 1 and closed on October 28 (149 days). All eels migrating over the

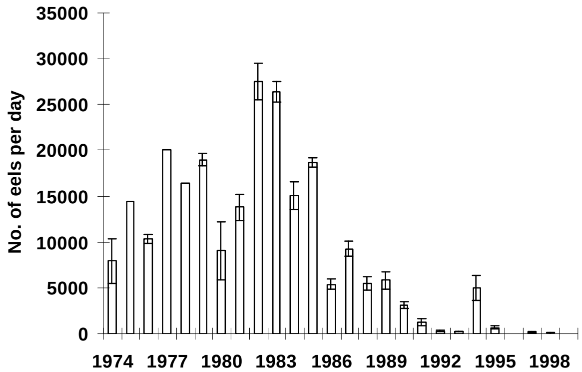

FIG. 5. Mean number of eels ascending the eel ladder per day at the R. H Saunders Hydroelectric Dam, Cornwall, Ontario, during a 31-day peak migration period for 1974 to 1999. Vertical bars indicated the 95% confidence intervals. No counts were available for 1996. (Data from 1974-1995 re-drawn from data provide in Table 1, Casselman et al. 1997a)

ladder were captured in a net at the top of the ladder and counted. The total count of eels was 1,860, the lowest recorded since the installation of the ladder in 1974. The recruitment index (Casselman *et al*.1997a) was calculated to be 27.4 eels/ day, based on the 31-day peak migration period occurring from June 19 to July 19, and was also the lowest value estimated in the operation of the ladder (Fig. 5). The recruitment index was correlated with commercial catches of eel 8 years later in Lake Ontario (Casselman *et al*.1997).

Management Implications

The future outlook for the angling fishery in the Thousand Islands is promising. Strong year-classes observed for smallmouth bass (both 1995 and 1998 year-classes) and northern pike (1998 year-class) will likely recruit to the angling fishery in the near future

.Improved commercial fish harvests of yellow perch in quota zone 1-5 (Chapter 6 in this report) are consistent with the observed increases in yellow perch index fishing catches beginning in 1995 (Fig 2). The strong 1997 year-classes of yellow perch should recruit to both the commercial and sport fisheries in the near future and provide for continued good abundance of 'fishable-sized' yellow perch early indication of stress in the global eel population.

The low levels of eel recruitment over the last decade do not bode well for the future commercial eel fishery in Lake Ontario and the upper St. Lawrence River. The St. Lawrence river stock is thought to be a major component of the global eel population (Castonguay et al. 1994a and 1994b). Continued declines in the number of eels ascending the ladder to almost negligible levels are a further indication of stress in the global eel population. The complex global nature of the eel's life-cycle, uncertainty regarding the cause of their decline, and economic interest in eels among numerous international management jurisdictions poses a significant challenge to effective management to sustain the population.

Assessment and Research Needs

Other smallmouth bass populations in the region have been studied for effects of temperature (Hoyle *et al*. 1999) and cormorant feeding (Schneider *et al*. 1999). Similar investigations in the Thousand Islands region may improve our ability to forecast and manage bass fisheries. A survey of smallmouth bass and perch recreational fishing effort, catch and harvest in the Thousand Islands would be helpful to confirm the magnitude of predicted improvements to the fishery. Our ability to effectively manage eels in the upper St. Lawrence River and Lake Ontario would be improved by a better understanding of the status of American eel throughout their range. Accurate information on changes in the age-structure of the commercial eel harvest and of eels ascending the ladder would be helpful in examining hypotheses regarding the cause of the eel decline and for developing mitigative measures.

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5

Lake Ontario Commercial Fishery

J. A. Hoyle, R. Harvey, and S. Orsatti

Introduction

Lake Ontario supports a relatively small but locally significant commercial fish industry. The commercial harvest comes primarily from the Canadian waters of eastern Lake Ontario and the Bay of Quinte. Here, the most important species in the harvest include yellow perch, lake whitefish, walleye, eel and brown bullhead. About one million lbs (wholesale value of $1 million) are harvested annually from Canadian waters.

This chapter updates 1998 and 1999 commercial harvest statistics for the Canadian waters of Lake Ontario.

Quota Management

The overall direction of commercial fish management is to support and assist the commercial fishing industry where consistent with the conservation and rehabilitation of fish stocks. In addition to protection of fish stocks, licence conditions attempt to reduce problems of incidental catch, manage the harvest and sale of fish that exceed human consumption guidelines for contaminants, and minimize conflicts with other resource users.

Decisions on commercial allocation are made on a *quota zone* basis (Fig. 1). Fish species for which direct harvest controls are necessary to meet fisheries

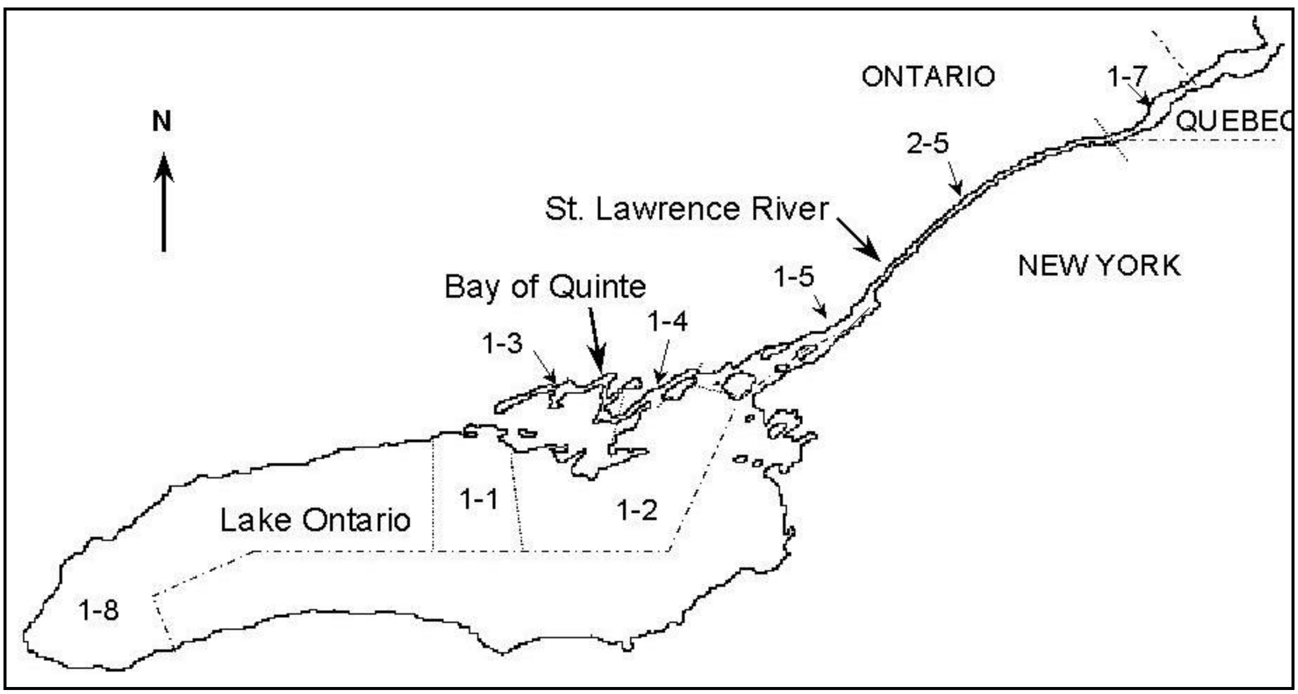

FIG. 1. Commercial fish quota zones on the Canadian waters of Lake Ontario.

TABLE 1. Commercial harvest quotas (lb) for the Canadian waters of Lake Ontario, 1999. See Fig. 1 for a map of the quota zones. Quota for species such as bullheads and sunfish in Lake Ontario embayments (e.g., East Lake, West Lake, Consecon Lake) are not given here.

	Quota (lb) by Quota Zone					
Species	1-1	1-2	1-3	1-4	1-8	Total
Lake whitefish	39,310	408,880	98,850	121,940	800	669,780
Lake herring	15,690	15,300	7,850	7,350	-	46,190
Round whitefish	10,000	-	-	-	-	10,000
Eel	41,150	220,630	66,130	34,035	3,600	365,585
Black crappie	3,940	2,500	14,130	800	2,400	23,770
Yellow perch	32,350	154,744	90,228	97,503	11,500	386,325
Walleye	6,770	55,560	-	16,200	500	79,030

management objectives are placed under quota management (Table 1). These species include premium commercial species (e.g., lake whitefish, eel, black crappie, yellow perch), species with large allocations to other users (e.g., walleye), and species at low levels of abundance or requiring rehabilitation (e. g., lake herring). In addition, some species traditionally thought of as coarse fish, have harvest controls for only some areas within a quota zone (e.g., bullheads, sunfish, carp and channel catfish in embayments of Lake Ontario).

Changes to commercial fish licensing conditions in 1999 included minor adjustments to quota; compare Table 1 in this report to Table 1 in Hoyle and Harvey (1999).

Information Sources

Commercial harvest statistics were compliled from daily catch report (DCR) records as stored in the Commercial Fisheries Harvest Information System (CFHIS). This system was developed by the Ministry of Natural Resources in 1998/99 to manage records related to the commercial food fishing industry in Ontario. In addition, a fall commercial catch sampling program was conducted to obtain biological information on lake whitefish.

Commercial Harvest Summary

Commercial harvest statistics for 1998 and 1999 are shown in Tables 2 and 3. In 1999, 50 fishers held 117 commercial fishing licences. The total harvest of all species was 973,049 lb ($1,052,215.97) in 1998 and 964,743 lb ($1,067,904.05) in 1999.

Lake whitefish

Lake whitefish harvest was 354,893 lb and 311,243 lb in 1998 and 1999, respectively. The 1999 harvest was 46% of available quota (ranged from 7% in quota zone 1-4 to 82% in quota zone 1-3). The annual lake whitefish harvest has declined since 1996.

Eel

Eel harvest was 16,116 lb and 14,214 lb in 1998 and 1999, respectively. Eel harvest has been in decline since 1992.

Yellow perch

Yellow perch harvest was 221,931 lb and 269,163 lb in 1998 and 1999, respectively. The 1999 harvest was 71% of available quota (ranged from 19% in quota zone 1-1 to 91% in quota zone 1-4). Yellow perch harvest has increased significantly over the last three years.

Walleye

Walleye harvest was 36,754 lb and 18,688 lb in 1998 and 1999, respectively. The lower harvest in 1999 is the first significant change in walleye harvest for the past number of years.

Biological Characteristics of the Harvest

Lake whitefish were monitored for biological characteristics. Sampling activities focused on the fall

Table 2. Commercial fish harvest (lb) and value ($) for fish species in the Canadian waters of Lake Ontario, 1998.

Species	Harvest by Quota Zone (lb) 1-1	1-2	1-3	1-4	1-6	1-8	Total	Price-per-lb	Value
Bowfin	2,127	310	5,822	0	403	0	8,662	$0.28	$2,425.36
Lake whitefish	16,157	205,984	86,487	46,265	0	0	354,893	$0.77	$273,267.61
Lake herring	148	436	4,562	456	0	0	5,602	$0.33	$1,848.66
Suckers	129	244	5,077	411	0	0	5,861	$0.12	$703.32
Common carp	215	178	6,552	0	0	0	6,945	$0.19	$1,319.55
Brown bullhead	36,594	4,490	139,926	7,123	5,718	385	194,236	$0.40	$77,694.40
Channel catfish	5	162	1,006	82	0	2,114	3,369	$0.46	$1,549.74
Eel	2,948	5,197	6,198	845	247	681	16,116	$1.28	$20,628.48
Burbot	0	0	30	13	0	0	43	$0.10	$4.30
White perch	28	70	3,705	800	0	688	5,291	$0.65	$3,439.15
White bass	0	6	4	264	0	207	481	$0.85	$408.85
Rock bass	2,259	1,791	2,740	369	257	1,006	8,422	$0.37	$3,116.14
Black crappie	196	92	8,995	30	103	696	10,112	$2.24	$22,650.88
Sunfish	5,335	1,432	48,665	1,112	2,202	0	58,746	$1.11	$65,208.06
Yellow perch	6,202	99,919	40,674	71,763	0	3,373	221,931	$2.32	$514,879.92
Walleye	4,427	21,861	0	10,138	0	328	36,754	$1.80	$66,157.20
Freshwater drum	595	6,361	24,418	4,211	0	0	35,585	$0.11	$3,914.35
Total	77,365	348,533	384,861	143,882	8,930	9,478	973,049		$1,059,215.97

spawning run fisheries: October/November trapnet fishery in the Bay of Quinte (Quota Zone 3), and the November gillnet fishery on the south shore of Prince Edward County (Quota Zone 2). As such, our sampling covered the largest components of the total annual lake whitefish harvest.

Lake whitefish harvest peaked in the early 1920s. From 1930 to the early 1960s the harvest was sustained at about 420,000 lb annually prior to crashing to insignificance in the 1970s (Christie 1973). Lake whitefish populations recovered during the 1980s and early 1990s thanks to good recruitment of two major spawning stocks; Lake Ontario and Bay of Quinte (Casselman et al. 1996). Most recently, following the invasion and proliferation of dreissenid mussels in the early 1990s, profound impacts on the benthic fish community, including lake whitefish populations, are now being played out. Dreissenid mussels have likely negatively impacted the native benthic invertebrate community. In particular, *Diporeia* (deepwater amphipod), an important diet item for lake whitefish have declined to negligible levels in the presence of *Dreissenia*. Impacts on lake whitefish include declines in abundance, recruitment, and body condition, and a change in diet (Hoyle et al. 1999).

Mean length and age in Quota Zone 2, representing the Lake Ontario whitefish stock, were 474 mm and 9.1 yrs-old, respectively (Fig. 2). The 1991 and 1992 year-classes contributed to nearly 50% of the harvest. In the Bay of Quinte (Quota Zone 3), the mean length and age were 444 mm and 7.9 yrs-old, respectively (Fig. 3). For the sixth year in succession, the 1991 year-class dominated the harvest.

The lack of strong year-classes entering the commercial fishery is problematic, and results from

Table 3. Commercial fish harvest (lb) and value ($) for fish species in the Canadian waters of Lake Ontario, 1999.

	Harvest by Quota Zone (lb)								
Species	1-1	1-2	1-3	1-4	1-6	1-8	Total	Price-per-lb	Value
Bowfin	3,021	350	7,414	0		0	10,785	$0.28	$3,019.80
Lake whitefish	7,394	214,464	80,805	8,580		0	311,243	$0.76	$236,544.68
Lake herring	117	127	3,335	186		0	3,765	$0.28	$1,054.20
Suckers	14	8	5,040	63		0	5,125	$0.12	$615.00
Common carp	24	1,647	1,182	1,426		0	4,279	$0.16	$684.64
Brown bullhead	33,296	1,977	166,239	8,610		155	210,277	$0.32	$67,288.64
Channel catfish	0	268	693	18		34	1,013	$0.25	$253.25
Eel	32	2,016	8,125	4,041		0	14,214	$1.36	$19,331.04
White perch	33	393	7,181	1,988		53	9,648	$0.54	$5,209.92
White bass	0	6	4	64		0	74	$0.94	$69.56
Rock bass	3,309	4,115	4,090	330		489	12,333	$0.37	$4,563.21
Black crappie	323	95	7,917	25		13	8,373	$2.21	$18,504.33
Sunfish	7,873	3,364	48,626	685		0	60,548	$1.04	$62,969.92
Yellow perch	6,188	131,165	40,895	88,325		2,590	269,163	$2.28	$613,691.64
Walleye	1,946	12,421	0	4,321		0	18,688	$1.69	$31,582.72
Freshwater drum	245	6,795	14,109	4,066			25,215	$0.10	$2,521.50

,728

poor survival of young fish as well as lower growth rates after the mid-1990s (Chapter 2 in this report).

Management Implications

In spite of a significant decline in the density of whitefish over the past several years, body condition is poor and indicates that the food resource is limiting. There has also been poor production of young fish for several years leading to the expectation that lake whitefish populations will continue to decline (see Chapter 2 in this report). Harvest levels by the commercial fishery have also declined over the past three years. The rapidly changing Lake Ontario and Bay of Quinte ecosystems create a backdrop of uncertainty in terms of how whitefish populations will respond in the future.

In light of declining abundance, poor recruitment, poor body condition, and declines in the commercial harvest, along with the uncertain future because of ecosystem change, it would be prudent to manage whitefish populations conservatively. Although harvest has not likely contributed to the recent declines in abundance, harvest may be a stress factor in the future if it is unresponsive to population declines. Harvest levels will need to be managed to prevent placing the sustainability of whitefish at greater risk.

Eel harvest has been in decline since 1992. The low numbers of new eel recruits passing the eel ladder at the Cornwall dam (see Chapter 4 of this report) accounts for the continued low harvest in Lake Ontario. Harvests below the dam (prior to the eels ascending the ladder) now represents the majority of the harvest (including Lake Ontario). If local management actions are deemed appropriate in the face of dwindling eel numbers, then the interactions among the various fisheries and the consequences to eel migration must be considered. The complex global nature of the eel life-cycle, uncertainty regarding the

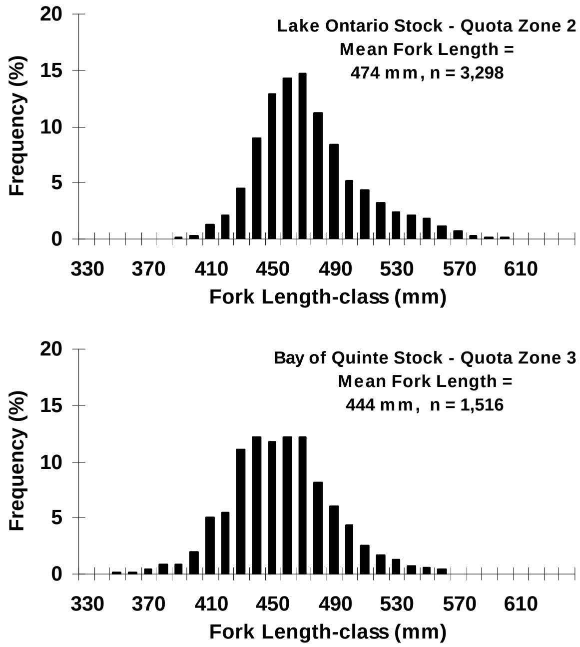

Fig. 2. Fork length (mm) distribution of lake whitefish in Quota Zone 2 and 3 in the 1999 commercial harvest.

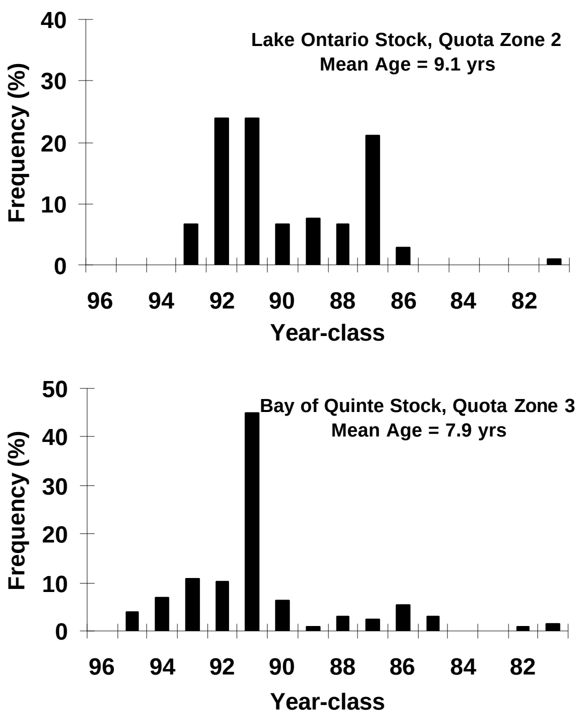

Fig. 3. Age distribution of lake whitefish in Quota Zone 2 and 3 in the 1999 commercial harvest.

cause of their decline, and economic interest in eels among numerous international management jurisdictions poses a significant challenge to effective management to sustain the population.

Yellow perch are a valuable commercial species that appears to be increasing in abundance generally, and dramatically in some areas (i.e., Bay of Quinte). Pressures to maximize harvest, and therefore commercial benefits, are high. Given the status of yellow perch stocks in eastern Lake Ontario (see Chapter 3 in this report), an increased harvest could likely be supported.

The significantly lower commercial harvest of walleye in 1999 may signal the first impact on the commercial fishery resulting from a declining walleye population (see Chapter 10 in this report).

Other species under quota management include lake herring, round whitefish, and black crappie. Lake herring and round whitefish populations are low in eastern Lake Ontario and cannot support a viable commercial harvest. Black crappie harvest occurs primarily in quota zone 1-3, the Bay of Quinte. Recent the ecosystem changes in the Bay of Quinte should favor species such as black crappie.

Assessment and Research Needs

Currently, lake whitefish stock status is assessed with detailed information on abundance, recruitment and biological attributes. Commercial harvest allocation has been conservative with increases in quota in conjunction with abundance increases. A more precise approach, for example a statistically based catch-age stock assessment, may provide better predictive capabilities. The recent decline in lake whitfish abundance warrants a more rigorous determination and application of a total allowable catch. This approach would fit an age-structured population model to the heterogeneous mix of fishery and survey data currently available.

Biological samples of eels from all commercial fisheries should be obtained to examine changes in the age-structure of the commercial eel harvest to support investigation into the cause of decline, and to assist with the determination of appropriate mitigative measures.

While yellow perch abundance has generally increased, some basic life history details, such as local stock abundance and seasonal distribution patterns, remain to be clarified (see Chapter 3 in this report). For example, the lack of large yellow perch in the Bay of Quinte is problematic. So to is the lack of significant increase in the abundance of perch in Outlet Basin assessment gillnets despite increased commercial harvest in this area. These observations require further study.

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6

St. Lawrence River Commercial Fishery

J. A. Hoyle, R. Harvey, and T. J. Stewart

Introduction

The St. Lawrence River supports a commercial fishery supporting an annual harvest of about 350,000 lb with a landed value of about $400,000. The most important species in the harvest include yellow perch, sunfish, brown bullhead, and eel. This chapter updates 1998 and 1999 commercial harvest statistics for the Canadian waters of Lake Ontario.

Quota Management

The overall direction of commercial fish management is to support and assist the commercial fishing industry where consistent with the conservation and rehabilitation of fish stocks. In addition to protection of fish stocks, licence conditions attempt to reduce problems of incidental catch, and minimize conflicts with other resource users.

Decisions on commercial allocation are made on a *quota zone* basis (Fig. 1). Fish species for which direct harvest controls are necessary to meet fisheries management objectives are placed under quota management (Table 1). These species include premium commercial species such as eel, black crappie and yellow perch. In addition, some species traditionally thought of as coarse fish, have harvest controls for some areas (e.g., bullheads and sunfish).

Changes to commercial fish licensing conditions in 1999 included minor adjustments to quota; compare Table 1 in this report to Table 2 in Hoyle and Harvey (1999).

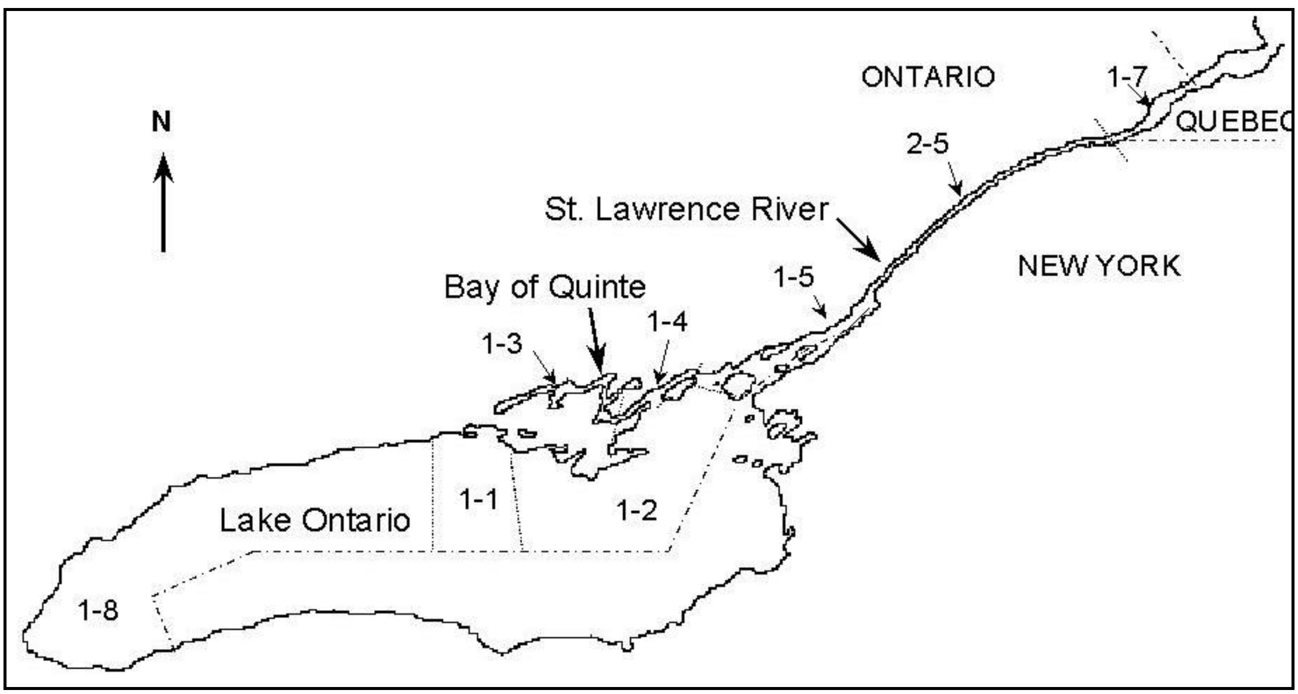

FIG. 1. Commercial fish quota zones on the Canadian waters of Lake Ontario and the St. Lawrence River.

Information Sources

Commercial harvest statistics were complied from daily catch report (DCR) records as stored in the Commercial Fisheries Harvest Information System (CFHIS). This system was developed by the Ministry of Natural Resources in 1998/99 to manage records related to the commercial food fishing industry in Ontario.

Commercial Harvest Summary

Commercial harvest statistics for 1998 and 1999 are shown in Tables 2 and 3. In 1999, 20 fishers held 32 commercial fishing licences. The total harvest of all species was 378,729 lb ($424,110.78) in 1998 and 368,035 lb ($438,580.69) in 1999.

Eel

Eel harvest was 31,700 lb and 32,625 lb in 1998 and 1999, respectively. The majority of the eel harvest comes from below the dam at Cornwall (quota zone 1-7).

Yellow perch

Yellow perch harvest was 78,001 lb and 94,620 lb in 1998 and 1999, respectively. The harvest in quota zone 1-5 increased significantly in 1999 (63% higher than 1998), representing 84% of the quota.

TABLE 1. Commercial harvest quotas (lb) for the Canadian waters of the St. Lawrence River, 1999. See Fig. 1 for a map of the

	Quota (lb) by Quota Zone			
Species	Napanee (1-5)	Corwall (1-7)	Brockville (2-5)	Total
Eel	30,690	47,986	22,970	101,646
Black crappie	28,590	4,840	12,365	45,795
Yellow perch	59,177	5,760	69,312	134,249
Total	118,457	130,586	133,847	382,890

Table 2. Commercial fish harvest (lb) and value ($) for fish species in the Canadian waters of the St. Lawrence River, 1998.

	Harvest by Quota Zone (lb)					
Species	Napanee (1-5)	Cornwall (1-7)	Brockville (2-5)	Total	Price-per-lb	Value
Bowfin	2,299	0	0	2,299	$0.28	$643.72
Suckers	0	6,577	0	6,577	$0.12	$789.24
Common carp	823	0	170	993	$0.19	$188.67
Brown bullhead	46,794	54,746	42,615	144,155	$0.40	$57,662.00
Channel catfish	412	0	0	412	$0.46	$189.52
Eel	4,879	25,073	1,748	31,700	$1.28	$40,576.00
White perch	3,136	0	0	3,136	$0.65	$2,038.40
Rock bass	803	0	716	1,519	$0.37	$562.03
Black crappie	14,198	374	1,865	16,437	$2.24	$36,818.88
Sunfish	52,958	15,348	25,089	93,395	$1.11	$103,668.45
Yellow perch	30,738	4,825	42,438	78,001	$2.32	$180,962.32
Freshwater drum	105	0	0	105	$0.11	$11.55
Total	157,145	106,943	114,641	378,729		$424,110.78

Table 3. Commercial fish harvest (lb) and value ($) for fish species in the Canadian waters of the St. Lawrence River, 1999.

	Harvest by Quota Zone (lb)					
Species	Napanee (1-5)	Cornwall (1-7)	Brockville (2-5)	Total	Price-per-lb	Value
Bowfin	4,940	0	0	4,940	0.28	$1,383.20
Suckers	210	5,046	0	5,256	0.12	$630.72
Common carp	1,326	0	0	1,326	0.16	$212.16
Brown bullhead	43,777	50,548	23,202	117,527	0.32	$37,608.64
Channel catfish	91	0	0	91	0.25	$22.75
Eel	4,891	26,965	769	32,625	1.36	$44,370.00
White perch	2,273	0	0	2,273	0.54	$1,227.42
Rock bass	1,741	0	1,365	3,106	0.37	$1,149.22
Black crappie	20,474	598	940	22,012	2.21	$48,646.52
Sunfish	40,759	26,120	17,345	84,224	1.04	$87,592.96
Yellow perch	49,981	4,096	40,543	94,620	2.28	$215,733.60
Freshwater drum	35	0	0	35	0.10	$3.50
Total	170,498	113,373	84,164	368,035		$438,580.69

Other species

As was the case for yellow perch, the commercial harvest of black crappie also increased significantly in quota zone 1-5 (44% higher than 1998), and represented 72% of the quota.

Management Implications

The low numbers of new eel recruits passing the eel ladder at the Cornwall dam (see Chapter 4 of this report) accounts for the low harvest levels above the dam (quota zone 2-5), and the continued low harvest in Lake Ontario (Chapter 5 in this report). Harvests below the dam (prior to the eels ascending the ladder) now represents the majority of the harvest (including Lake Ontario). If local management actions are deemed appropriate in the face of dwindling eel numbers, then the interactions among the various fisheries and the consequences to eel migration must be considered. The complex global nature of the eel life-cycle, uncertainty regarding the cause of their decline, and economic interest in eels among numerous international management jurisdictions poses a significant challenge to effective management to sustain the population.

Improved harvests of yellow perch in quota zone 1-5 are consistent with the observed increases in yellow perch index gillneting catches beginning in 1995 (Chapter 4 in this report). A strong 1997 yellow perch year-class is expected to recruit to the fishery (Chapter 4 in this report), and can likely sustain the fishery at its current level.

Assessment and Research Needs

Biological samples of eels from all commercial fisheries should be obtained to examine changes in the age-structure of the commercial eel harvest to support investigation into the cause of decline, and to assist with the determination of appropriate mitigative measures.

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7

Bay of Quinte Recreational Fishery

J. A. Hoyle

Introduction

The Bay of Quinte supports a large and economically important recreational fishery. Walleye have been the dominant species sought and harvested in the fishery since the early 1980s. This recreational fishery developed as the walleye population recovered following production of the large 1978 year-class of fish.

The size of the fishery grew throughout the 1980s and early 1990s, peaking in 1996 at over one million hours of angling effort. Total annual walleye harvest peaked earlier, in 1991, at about 220,000 fish.

A major feature of the Bay of Quinte walleye population is that large mature walleye migrate to Lake Ontario following spawning, in the Bay of Quinte, each spring to spend the summer months. Young walleye (e.g., age 1 to 4 yrs-old) reside in the Bay of Quinte year-round. This life history characteristic is important because it influences the size and age of walleye available for harvest in the recreational fishery.

There are two major components to the walleye angling fishery, the winter ice fishery and the open-water fishery.

The ice-fishery is the smaller of the two; traditionally comprising roughly 35% of the fishing effort and 15% of the walleye harvest on an annual basis. Much of the annual variation in fishing pressure and success during the ice-fishery is due to unpredictable ice conditions. Walleye of all sizes are harvested in the winter fishery.

The open-water fishery is larger and the harvest consists mainly of young immature fish. In contrast to the winter ice-fishery, the open-water fishery has shown a steady decline in walleye fishing success and harvest since 1991. The decline in the fishery parallels changes in the walleye population in response to dramatic shifts in the Bay of Quinte ecosystem (Chapter 10 in this report). These ecosystem changes include increased water clarity and aquatic vegetation, and have favored fish species such as yellow perch and centrarchids (bass and sunfish). To date, these changes have resulted in a decline in the abundance of young walleye—those residing year-round in the Bay of Quinte; thus the greatest impact has been on the open-water recreational fishery.

This chapter updates the results of ice and open-water recreational angling surveys conducted in 1999. The open-water angling survey was unique in that the entire season was surveyed (the last complete open-water survey was conducted in 1993), and also included a survey of the Picton Bay late fall “night” fishery.

Information Sources

Recreational angling surveys are conducted annually on the Bay of Quinte, from Trenton in the west to Glenora in the east (Fig. 1), during the walleye angling season (January 1 to February 28 and first Saturday in May to December 31). Angling effort is measured using aerial counts during ice fishing surveys, and a combination of aerial counts and on-water counts during open-water surveys. On-ice and on-water angler interviews provide information on catch/harvest rates and biological characteristics of the harvest. Hoyle (1998, 1999) reports detailed survey designs for ice and open-water surveys, respectively. In addition to the annual ice and open-water surveys, in 1999 an access survey was conducted at the Picton Bay harbor during late fall. Shore and boat fishermen were counted, interviewed and their catch sampled.

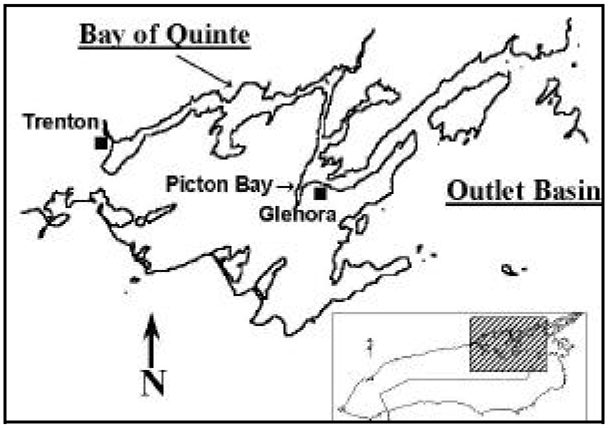

FIG. 1. Map of the Bay of Quinte showing the extent of recreational angling surveys from Trenton in the west to Glenora in the east, and the location of Picton Bay.

TABLE 1. Bay of Quinte walleye recreational angling effort (angler hours), catch and harvest, 1999.

Season	Effort	Catch	Harvest
Ice Fishery:			
Ice-fishing total	140,363	23,293	15,285
Open-water fishery:			
Opening weekend	74,897	2,195	1,672
May	121,837	25,731	19,362
June	46,900	8,630	5,178
July	30,972	3,780	2,038
August	45,367	3,121	2,745
Fall	54,155	4,104	2,580
Open-water total	374,128	47,562	33,575
Annual total	514,491	70,855	48,860

Although, this local fishery occurs primarily at night, some of the angling effort observed in this survey overlapped with that of the regular open-water roving survey. Hence, results of the Picton Bay survey are reported separately. Separate reporting of results maintains the comparability of the open-water survey to previous years.

Fisheries Update

Ice Fishery

Ice angling effort was estimated to be 140,363 rod-hours (Table 1). The fishing pressure was slightly greater than the previous year but was down over 50% from the previous 5-yr average (Fig. 2). Low fishing pressure may have, as in the previous year, been partly related to poor ice conditions but poor ice conditions also occurred in 1995 when effort was considerably higher. This suggests that a real decline in angling effort may have occurred over the last two years. An estimated 23,293 walleye were caught of which 15,285 were harvested. The number of walleye harvested was more than double that of the previous year and similar to the previous 5-yr average (Fig. 3). Fishing success rate was also nearly double that of the previous year and among the highest recorded during past winter surveys (Fig. 4). For the first time since surveys began, ice fishing success rates surpassed those of open-water angling. The average walleye harvested during the ice fishery was 558 mm fork length and weighed 2.3 kg.

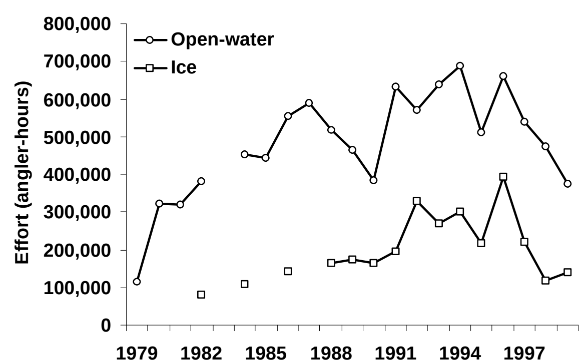

FIG. 2. Angling effort during the Bay of Quinte ice and open-water recreational fisheries, 1979 to 1999.

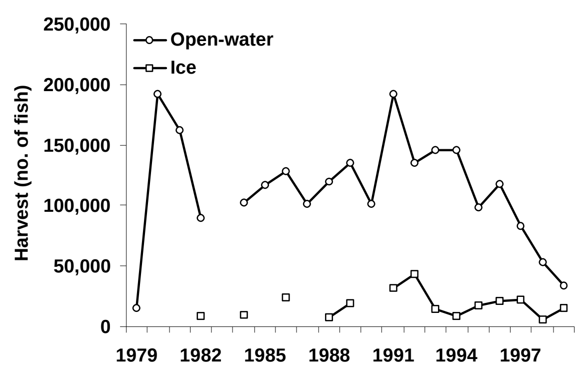

FIG. 3. Walleye harvest during the Bay of Quinte ice and open-water recreational fisheries, 1979 to 1999.

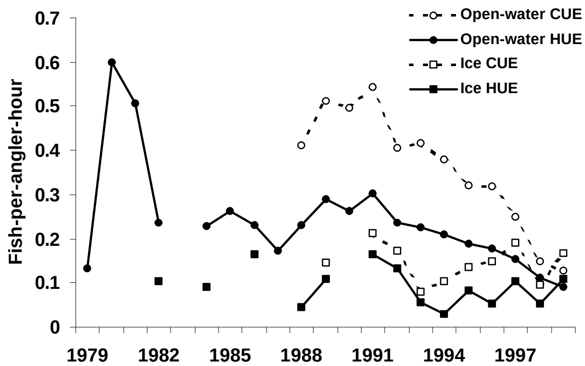

FIG. 4. Walleye catch and harvest-per-unit-effort (CUE and HUE) during the Bay of Quinte ice and open-water recreational fisheries, 1979 to 1999.

Open-water Fishery

Open-water angling effort was estimated to be 374,128 angler-hours (Table 1, Fig. 2). Angling effort has declined for three consecutive years to its lowest level since 1990. Walleye catch was estimated at 47,562 fish of which 33,575 were harvested. The number of walleye harvested was down 35% from last year and has now declined for three consecutive years to its lowest level since 1979 (Fig. 3). Walleye angling success (0.127 and 0.090 walleye caught and harvested-per-rod-hour, respectively, in 1999) has been declining since 1991 (Fig. 4). As fishing success declines, CUE and HUE appear to be converging (Fig. 4), indicating that walleye release rates are also declining—anglers are keeping a higher percentage of their catch. The average walleye harvested during the open-water fishery was 430 mm fork length and weighed 0.96 kg. This is an unusually large mean size, and is consistent with the observation that recruitment of small, young fish has declined (see Chapter 3 in this report). Total open-water walleye harvest by weight (32,165 kg) was, for the first time, less than that of the winter ice fishery (35,156 kg), and has now declined over 75% from its peak in 1993 (132,560 kg).

Prior to 1999, the last complete open-water survey was conducted in 1993. For the years 1994 through 1998, survey results from selected time-periods within the open-water season were extrapolated to the entire season based on the seasonal pattern of fishing effort and success. The 1999 survey now allows re-calculation of the 1994 to 1998 results based on interpolation between the two complete survey years, 1993 and 1999. The updated results are presented in Table 2.

To examine changes in the Bay of Quinte recreational fishery, a summary of 1993 and 1999 catch statistics is presented in Table 3. Total fishing pressure (all anglers) has dropped 41% from 644,477 to 379,012 angler hours while walleye catch, harvest and success rates have declined from 70 to 80%. In spite of these results, the Bay of Quinte fishery remains a walleye fishery, with 99% of observed fishing pressure being targeted toward walleye.

Other species in the fishery are, for the most part, caught incidentally by walleye anglers, and some notable changes have occurred between 1993 and 1999. In general, the Centrarchid family of fish is much more prominent in the anglers catch; sunfish, smallmouth bass, and largemouth bass have all increased. Yellow perch catches have dramatically increased. And, although the catch of northern pike increased only slightly, this was accomplished with much less total fishing pressure. These trends in catches are consistent with a changing ecosystem. Increased water clarity and aquatic vegetation favored these species. The other observation of note is that round gobies were observed in the angler survey in 1999, the first year that gobies were known to have invaded the Quinte area.

Picton Bay late fall fishery

Picton Bay shore and boat anglers caught 1,010 walleye of which 572 were harvested during the last three weeks of November and first week of December. Nearly 6,000 hours of fishing effort occurred during this time. Over 80% of the participants in this fishery originated from outside the Quinte area. Boat anglers caught the vast majority of the walleye (988 fish). The average walleye harvested was 590 mm fork length and weighed 2.5 kg. This is a much larger average size of fish than that caught during the rest of the open-water fishery, and reflects the movement of large, mature fish back to the Bay of Quinte from Lake Ontario in the fall.

The Picton Bay fishery represents one of several small, seasonal angling fisheries not adequately covered by the annual open-water angling survey. This small fishery was thought to be one of the larger of these small fisheries, and although it may be becoming increasingly important relative to the open-water fishery as a whole, it still only represented 2% (by number) and 4% (by weight) of the measured 1999 open-water walleye harvest.

TABLE 2. Walleye catch statistics for the Bay of Quinte open-water recreational fishery. Data for 1994 through 1998 were estimated by interpolation based on data collected in "index" sesaons, and expanded to represent the entire open-water season using the seasonal pattern of angling effort and success measured during complete surveys in 1993 and 1999. Catch and harvest are by all anglers, effort is by anglers targetting walleye, and CUE and HUE are number of walleye caught and harvested-per-angler-hour, by walleye anglers, respectively.

	Catch	Harvest	Mean Weight (kg)	Effort (angler-hours)	CUE	HUE
1993	266,638	145,383	0.912	637,401	0.417	0.227
1994	262,760	145,642	0.763	689,543	0.378	0.209
1995	166,229	98,537	0.710	512,054	0.320	0.189
1996	209,280	117,931	0.781	660,005	0.317	0.179
1997	134,651	82,790	0.747	539,276	0.250	0.154
1998	70,527	52,844	0.670	475,678	0.148	0.111
1999	47,562	33,575	0.958	374,128	0.127	0.090

TABLE 3. Catch, harvest, and targetted angling effort (angler hours) statistics for the Bay of Quinte open-water recreational fishery, 1993 and 1999, the only years when complete surveys were conducted.

			1993			1999
	Catch	Harvest	Effort	Catch	Harvest	Effort
Bowfin	-	-	-	30	-	-
Rainbow trout	107	107	-	28	28	-
Lake trout	169	169	2,539	-	-	-
Lake whitefish	140	-	-	-	-	-
Northern pike	10,318	2,279	12,014	11,577	1,413	7,174
White sucker				25	-	-
Common carp	20	-	-	-	-	-
Brown bullhead	2,976	286	2,073	4,262	161	51
Channel catfish	2,480	245	659	613	-	649
American eel	113	-	-	47	-	-
White perch	19,859	713	4,429	11,856	1,131	1,842
Sunfishes[1]	2,531	460	336	13,667	766	1,521
Rock bass	10,499	1,609	3,634	3,192	51	-
Smallmouth bass	6,258	1,205	5,989	8,055	1,183	4,522
Largemouth bass	98	24	96	11,045	2,036	8,282
Black crappie	217	-	679	80	-	-
Yellow perch	141,424	8,205	16,109	391,708	35,102	14,161
Walleye	266,638	145,383	637,401	47,562	33,575	374,128
Round goby	-	-	-	372	372	-
Freshwater drum	24,992	2,183	8,019	7,057	414	2,688

[1]Sunfishes includes pumpkinseed and bluegill sunfish.

Management Implications

Fish community objectives for Lake Ontario (Stewart *et* al. 1999) proposed that walleye fisheries be maintained at early 1990s catch rates. The current Bay of Quinte walleye fishery now falls far short of this objective. Although alternative species appear to be increasing in abundance, anglers have yet to target species other than walleye. Nonetheless, catches of species such as bass and pike will likely continue to increase in the future. Promotion of other species and a review of harvest regulations may be prudent at this time.

Assessment and Research Needs

Changes in the Bay of Quinte recreational fishery relate largely to broad ecosystem changes brought about by efforts to control pollution and, especially, more recently accelerated by dreissenid mussel invasion. Aquatic vegetation increased tremendously in the mid-1990s but has not been recently surveyed. The density of dreissenid mussels has not been surveyed since 1997. Assessment of the extent to which ecosystem change continues would benefit from a re-survey of aquatic vegetation and mussel densities.

The extent to which round gobies, an exotic species first detected in 1999, will become an influence on the Bay of Quinte ecosystem, and thus the recreational fishery, is not known. Largemouth bass, which increased dramatically in anglers' catches between 1993 and 1999, are not adequately assessed in index netting programs. Independent indices of abundance and biological attributes (e.g., year-class strength) of bass and goby populations would be useful.

Changes in the Bay of Quinte ecosystem have reduced the potential sustainable yield of walleye. Efforts need to be made to refine estimates of the sustainable level of walleye exploitation. To this end, it is vital to continue to estimate walleye harvest from all fisheries and update estimates of walleye population size.

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8

The Boat Fishery for Salmon and Trout in Western Lake Ontario

J.N. Bowlby and T. J. Stewart

Introduction

The angling fishery for salmon and trout in Lake Ontario entered a modern era with the introduction of coho salmon by New York State in 1968. The Province of Ontario followed suit and began stocking coho the following year. Over the years, stocking of chinook salmon, rainbow trout, brown trout and lake trout also have added significantly to various components of this fishery. Stocked salmon and trout have always been the mainstay of this fishery, although, in recent years natural reproduction of most stocked salmonids has increased. In 1989 the fishery for salmon and trout made up about 79% of the Canadian angling effort for fish from Lake Ontario and the Bay of Quinte(Savoie and Bowlby 1991).This percentage has not changed significantly in recent years (unpublished data). Accordingly, salmon and trout remain the most valuable recreational species in Lake Ontario. The boat fishery for salmon and trout in western Lake Ontario represents about one-third of the salmon and trout fishery; stream and shoreline fisheries account for the remaining two-thirds. We have monitored various aspects of the salmon and trout fishery of Lake Ontario since the 1970s. However, we have relied on the boat fishery survey in western Lake Ontario to gauge salmonid fish populations and the fishery, since 1982. Efforts to sustain this fishery through management of stocking has important fish community impacts through the influence of predator levels on alewife abundance (Stewart et al. 1999). This chapter describes the status of the boat fishery for salmon and trout in western Lake Ontario. The status of chinook salmon, rainbow trout, and lake trout populations are described in Chapters 1 and 2 of this report.

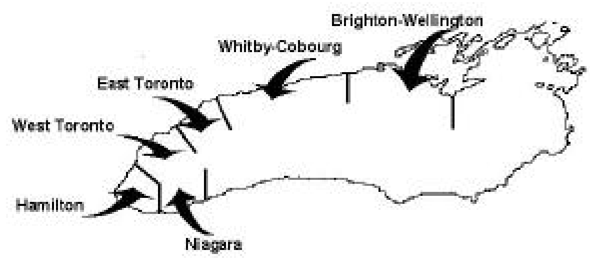

FIG.1. The location of sectors used for stratifying the survey western Lake Ontario boat anglers/

Information Sources

The portion of the salmon and trout fishery in Western Lake Ontario that launches boats from ramps was monitored in 1999. This survey design is consistent with our surveys from 1982 to 1998 (Hoyle et al. 1999).

The design was based on seasonal stratification by month from April to September, and spatial stratification into 6 sectors from the Niagara River to Wellington (Fig. 1). The spatial stratification into these sectors has been based on consistency in the composition of angler catch. However, these sectors coincidentally correspond to temperature zones in Lake Ontario as described by El-Shaarawi and Kwiatkowski (1977). Anglers were interviewed after fishing was completed at 6 launch ramp locations: St. Catharines Game and Fish, Fisherman's Wharf, Port Credit, Bluffers Park, Port Darlington, and Wellington, each representing catch and harvest statistics for a sector. Boat trailers were counted to estimate effort at all ramps from the Niagara River to Wellington (Table 1), and these counts were used to scale up effort, catch, and harvest, accordingly.

TABLE 1. Average daily trailer count on weekend days in 1999 during 1000 - 1400 hours at launch ramps along western Lake Ontario (Ontario portion). Ramps (and values) where anglers were counted and interviewed are indicated with italics.

Sector	Ramp	Apr	May	Jun	Jul	Aug	Sep	Total
Niagara	Queenston Sand Docks	8.0	10.8	4.5	6.5	9.5	11.3	50.5
	Port Weller	0.0	0.0	2.5	3.3	7.0	2.0	14.8
	St.Catharines Game and Fish	***10.3***	***16.0***	***11.0***	***7.0***	***12.0***	***13.5***	***69.8***
	Beacon Motor Inn	4.8	3.5	2.5	4.8	2.8	3.0	21.3
	Sector total	23.0	30.3	20.5	21.5	31.3	29.8	156.3
Hamilton	Grimsby Municipal Ramp	1.3	0.8	0.5	0.3	0.5	0.5	3.8
	Foran's Marine	6.5	4.0	1.0	1.8	2.3	1.0	16.5
	Lakecourt Marina	2.8	2.5	0.8	0.5	0.5	0.5	7.5
	HRCA 50 Pt. Ramp	***17.0***	***17.5***	***15.3***	***10.3***	***12.3***	***10.3***	***82.5***
	Fisherman's Wharf	9.5	20.0	14.3	23.8	26.8	21.0	115.3
	Bronte Beach	3.0	8.0	9.8	16.5	35.8	21.3	94.3
	Shipyard Park	0.0	1.8	4.3	6.3	12.3	4.8	29.3
	Busby Park	0.5	0.5	1.0	1.3	0.8	0.3	4.3
	Sector total	40.5	55.0	46.8	60.5	91.0	59.5	353.3
West Toronto	***Port Credit Ramp***	0.7	***5.8***	***8.5***	***20.0***	***47.3***	***18.5***	***100.7***
	Lakefront Promenade Park	0.7	5.3	12.0	16.5	39.5	14.3	88.2
	Marie-Curtis Park	0.0	0.5	0.8	2.8	4.0	0.8	8.8
	Humber Bay West	0.0	4.5	10.8	20.3	23.0	11.8	70.3
	Sector total	1.4	16.0	32.0	59.5	113.8	45.3	267.9
East Toronto	Ashbridges Bay	1.4	2.5	3.5	18.8	15.3	4.3	45.7
	Bluffers Park	1.4	***7.8***	***18.0***	***43.0***	***52.8***	***7.3***	***130.2***
	Frenchman's Bay West	0.0	1.5	1.8	3.8	4.0	1.5	12.5
	Frenchman's Bay East	0.7	1.3	3.3	0.5	3.5	1.0	10.2
	Duffin Creek	0.0	0.0	0.5	0.0	0.0	0.5	1.0
	Sector total	3.5	13.0	27.0	66.0	75.5	14.5	199.5
Whitby-Cobourg	Port Whitby Marina	0.0	7.3	0.5	0.3	0.0	0.0	8.0
	Whitby Gov't Ramp	0.0	1.3	7.0	10.8	12.3	3.3	34.6
	Port Oshawa Marina	0.0	2.0	0.3	4.0	5.3	0.8	12.3
	CLOCA P. Darlington Ramp	***0.3***	***0.5***	***2.3***	***12.5***	***13.8***	***6.0***	***35.3***
	Port Newcastle	0.3	0.3	0.8	1.0	2.0	0.3	4.5
	Port Hope Harbour	1.0	0.0	0.8	3.8	8.3	4.3	18.0
	Cobourg Yacht Club	0.8	0.5	2.3	2.3	2.8	1.3	9.8
	Sector total	2.3	11.8	13.8	34.5	44.3	15.8	122.3
Brighton-Wellington	Ontario Street Ramp	1.0	12.0	4.8	16.8	7.5	2.5	44.5
	Brighton Marina	0.0	0.5	0.3	0.5	0.0	0.0	1.3
	Gosport Gov't Ramp	0.3	4.8	1.5	1.3	1.0	0.5	9.3
	Camp Barcovan	0.0	0.5	3.3	2.3	2.0	0.0	8.0
	McSaddens Marina	0.0	0.8	3.8	7.0	2.0	0.8	14.3
	Wellers Bay Marina	0.5	6.3	3.3	5.5	5.3	4.0	24.8
	North Shore Park	0.0	0.0	0.3	1.5	0.8	0.3	2.8
	Wellington Harbour Ramps	***3.5***	***11.3***	***12.5***	***48.0***	***22.5***	***3.3***	***101.0***
	Sector total	5.3	36.0	29.5	82.8	41.0	11.3	205.8
Total		75.9	162.1	169.5	324.8	396.8	176.0	1305.0
Ramps with Angler Interviews		***31.0***	***58.8***	***67.5***	***140.8***	***160.5***	***58.8***	***517.3***
		(41%)	***(36%)***	***(40%)***	***(43%)***	***(40%)***	***(33%)***	***(40%)***

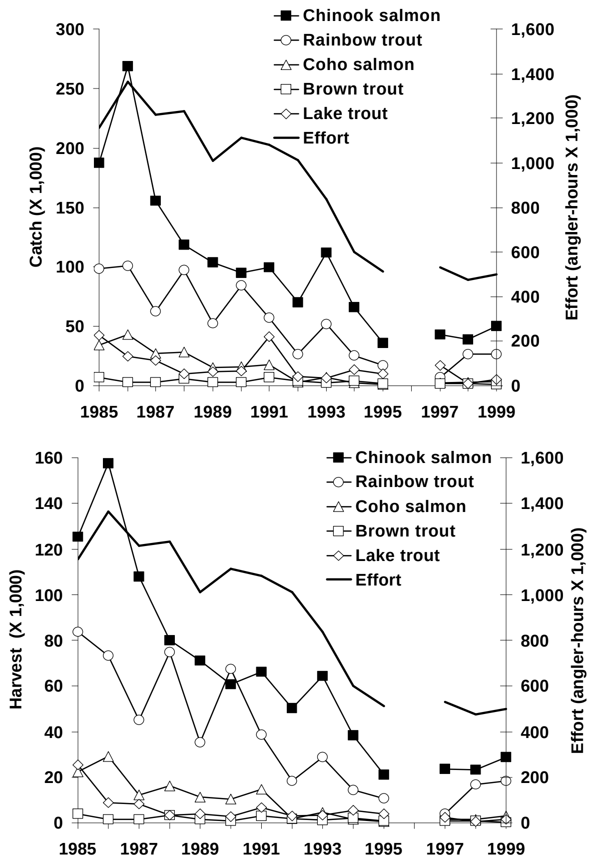

FIG.2. Catch, harvest and effort in the boat fishery for salmon and trout in western Lake Ontario (Ontario Portion,)from 1985 to 1999. In 1996 the survey was incomplete

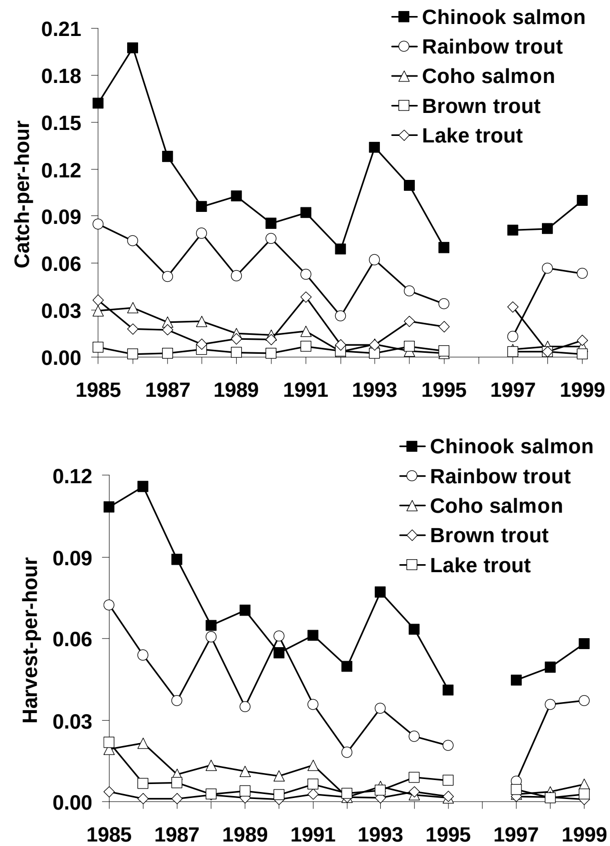

FIG.3. Catch and harvest rates is the boat fishery for salmon and trout in western Lake Ontario (Ontario portion),from 1985 to 1999.

Interviews were conducted at each of the four ramps (above) on 4 weekdays and 4 weekend days each month to cover time periods from 0900 to 2100. Anglers were not surveyed at Port Credit and Bluffers Park during April, and so the catch and harvest rates from May and effort from trailer counts were used to estimate catch and harvest. Estimates for the total fishery were made using the ratio of effort, catch, and harvest between launch daily and marina based fisheries in 1995 (Hoyle et al. 1996).

Fisheries Update

Effort

During 1999, the effort of launch daily anglers and all boat anglers was estimated at 309,941 and 499,159 angler-hours, respectively. Effort in the western Lake Ontario boat fishery has been relatively stable since 1994 (Fig. 2). The largest decline in effort was from 1993 to 1994, despite higher catch rates for chinook salmon than the previous five years (Fig. 3). This decline in effort was most likely a response of anglers to the termination of the Great Salmon Hunt and the announcement of stocking reductions (Savoie et al. 1995). Angler effort has not responded to subsequent reinstatement of the Great Salmon Hunt and stocking increases. More than half of this effort occurred in July and August (Table 1) during the Toronto Star Great Salmon Hunt.

A regulation change allowing two rods per angler in Lake Ontario came into effect during summer 1998. This resulted in effort in rod-hours exceeding angler-hours by 27% in 1999. Catch rates were higher for anglers that used more than one rod (Fig.4). However, the higher catch rates were most pronounced for lone anglers. This complicates the comparison of catch rates over time.

Catch and Harvest

Chinook salmon and rainbow trout accounted for about 88% of the salmonid catch and harvest in the western Lake Ontario boat fishery (Table 2). These were the only species that were consistently targeted in this fishery. The catch and harvest of chinook salmon and rainbow trout in 1999 were similar to 1998 (Fig. 2). Catch and harvest rates of chinook salmon and rainbow trout (Fig. 3) were not significantly different than the previous 14 years. Catch and harvest of brown trout and lake trout remained typically low, because anglers target chinook salmon and rainbow trout. Atlantic salmon catches and harvest remain low because few are stocked. The reported catch may also be low due to misidentification. A majority of tag returns in 1998 and 1999 from stocked adult Atlantic salmon were reported as chinook salmon, coho salmon, brown trout or rainbow trout (L. Carl, Ontario Ministry of Natural Resources, Science and Development and Transfer Branch, 300 Water St., Peterborough, Ontario, K9J 8M5, pers. comm.).

Chinook salmon and rainbow trout catch vary seasonally along the lake (Fig. 5). These patterns were last reported for 1994 (Savoie et al. 1995) and are usually consistent from year to year. Catch peaks in all sectors during July or August (Fig. 5), as a result of the higher fishing effort (Table 1). However, in 1999 chinook salmon failed to show up in the Niagara and Hamilton sectors during spring in usual numbers. As well, in 1999 we did not see the usual increases in rainbow trout catches from Toronto to Cobourg in mid to late June that precede the increases in chinook catches in July and August. Rather, rainbow trout catches peaked in August in several sectors during 1999 (Fig. 5). These minor changes in the seasonal and spatial patterns of catch can usually be attributed to yearly variations in weather, particularly how wind speed and direction affect the currents and water temperature in Lake Ontario.

Management Implications

Catches and effort in the boat fishery for salmon and trout in western Lake Ontario have been stable since 1994. A strong 1998 year class of alewife (Chapter 1 in this report) likely contributed to improved growth of chinook salmon in 1999. However, the 1998 year class did not result in an increased overall abundance of alewife, perhaps due to

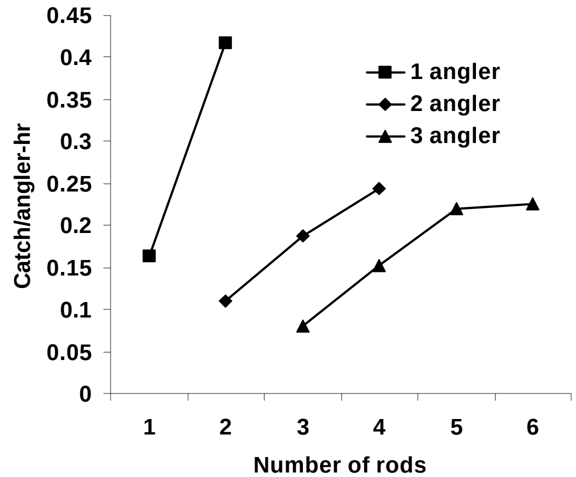

FIG.4. Salmonid catch rate (per angler-hour)of boat anglers in western Lake Ontario during 1999, showing the effect of number of rods in the boat.

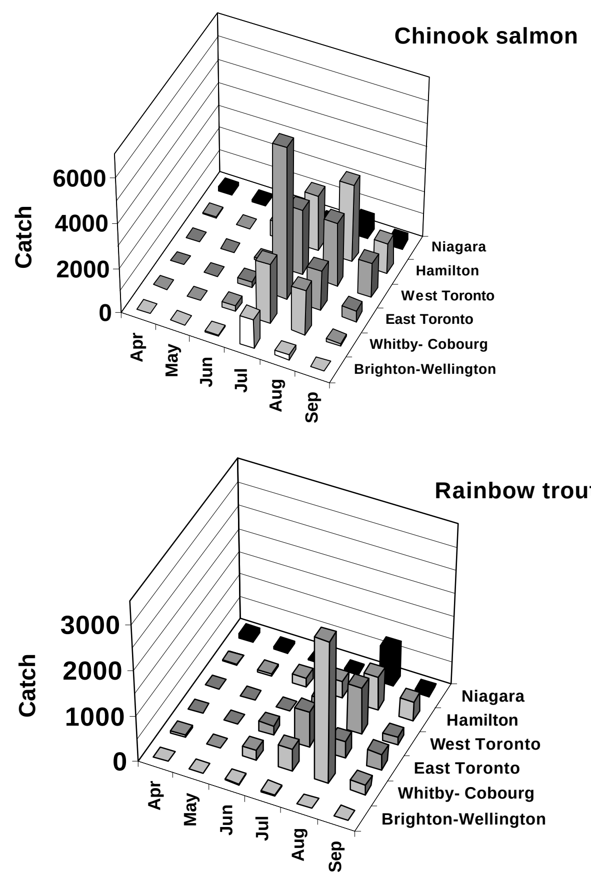

FIG.5. The seasonal and spatial pattern of catch of chinook salmon and rainbow trout by launch daily anglers in western Lake Ontario during 1999.

TABLE 2.Angling Statistics for salmonid boat fisheries in western Lake Ontario (Ontario portion) during April to September 1999. Catch and harvest rates are number of fish per angler-hr.

Species	Launch Daily Anglers					All Boat Anglers				
	Catch	Harvest	Catch rate (fish/anger-hour)	Harvest rate (fish/anger-hour)	Release Rate (%)	Catch	Harvest	Catch rate (fish/anger-hour)	Harvest rate (fish/anger-hour)	Release Rate (%)
Chinook salmon	32,623	16,209	0.1053	0.0523	50	49,843	28,925	0.0999	0.0579	42
Rainbow trout	10,467	6,108	0.0338	0.0197	42	26,539	18,463	0.0532	0.0370	30
Coho salmon	2,182	1,500	0.0070	0.0048	31	3,305	3,211	0.0066	0.0064	3
Brown trout	716	249	0.0023	0.0008	65	904	428	0.0018	0.0009	53
Lake trout	3,384	920	0.0109	0.0030	73	5,366	1,408	0.0107	0.0028	74
Atlantic salmon	120	30	0.0004	0.0001	75	197	58	0.0004	0.0001	71
Pink salmon	37	16	0.0001	0.0001	56	37	16	0.0001	0.0000	56
Unidentified salmonine	409	42	0.0013	0.0010	90	585	60	0.0012	0.0009	90
Total salmonines	49,939	25,075	0.1611	0.0818	50	86,775	52,569	0.1738	0.1061	39

heavy predation (Chapter 1 of this report). This suggests that predator stocks are near capacity for the current lake productivity. Continued stability of the predator community, and of the fishery, depends on continued production of alewife and no large increases in abundance of trout and salmon.

Information and Research Needs

In 1999, the seasonal distribution of salmon and trout, and the resultant fishery changed. Factors influencing salmon and trout distribution remain poorly understood. The influence of variation in weather patterns, including the longer-term impacts of climate warming, on the salmon and trout fishery should be investigated. The two-line regulation started in summer 1998. Last year it applied to the entire fishing season. We need to better understand the impoact of this regulation change on the fishery and fish populations of Lake Ontario.

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9

Bay of Quinte Aboriginal Fishery

A. Mathers

Introduction

The Mohawks of the Bay of Quinte harvest walleye during spring spawning runs on several Bay of Quinte rivers each year. Since 1994, the Mohawks of the Bay of Quinte and the Ontario Ministry of Natural Resources have conducted surveys of the Napanee and Moira River fisheries. By measuring changes in the harvest rates and biological characteristics of the fish harvested, these surveys provide information on the status of the fish populations that are useful to fisheries managers in their attempts sustain the walleye. This chapter updates estimates of fishing effort and walleye harvest by aboriginal spear fisheries in the Bay of Quinte during 1999.

FIG. 1. Map of Bay of Quinte showing locations of Napanee, Salmon and Moira Rivers.

Information Sources

Aboriginal fisheries in the Canadian waters of Lake Ontario include major aboriginal spear fisheries for walleye conducted during the spring at the mouths of the Napanee, Moira, and Salmon Rivers (Fig. 1). A survey of the Napanee and Moira River spear fisheries was conducted during the spring walleye run between April 2 and April 30, 1999. Fishing effort was measured on randomly selected days, using hourly counts of spearing activity on the rivers between 5 p.m. and 12 p.m. (a total of 130 counts were conducted). Fifty-two interviews with fishers provided information on catch rates and biological information on the fish harvested. The information collected during these samples was then expanded to estimate the fishing effort and harvest for the entire survey period.

Fisheries Update

Fishing effort during the 1999 survey period was estimated to be 199 hours and 327 hours for the Napanee and Moira Rivers respectively (Fig. 2). The combined fishing effort for the two rivers has increased since the survey was started in 1994, however, the effort levels observed in 1999 were lower that those observed in 1998. An estimated 4,375 walleye were harvested in the Napanee River during 1999, which was by far the highest level of harvest observed for this river (Fig. 3). The estimate for the Moira River was 7,821 walleye harvested, which is slightly higher than observed in previous years. The low water levels, which occurred during the spring of 1999, may have contributed to the increased harvest.

The fork length of the walleye harvested during 1999 ranged between 300 mm and 760 mm (Fig. 4). Fish in the Napanee River averaged 578mm in length while those harvested in the Moira River averaged 537mm. Previous year's surveys have also shown larger fish being captured in the Napanee River.

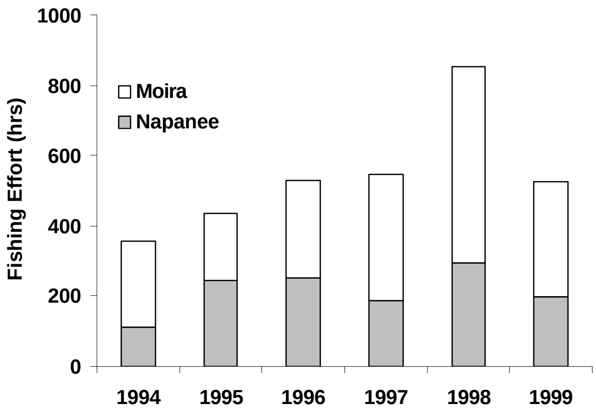

FIG. 2. Spear fishing effort in the Napanee and Moira Rivers for 1994 to 1999.

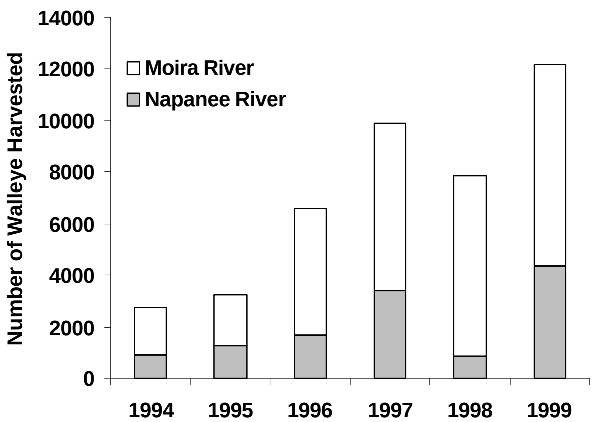

FIG. 3. Walleye harvest during spring spear fisheries in the Napanee and Moira Rivers for 1994 to 1999.

Female fish from both rivers combined averaged 601 mm while males averaged 492 mm in length. The larger size of female fish has also been observed in pervious surveys.

Management Implications

The walleye population has declined, most likely due to habitat and fish community changes (Chapter 3 and 10 in this report). Interest in harvesting walleye continues for the recreational, commercial and aboriginal fisheries. Harvest of walleye from the commercial fishery and the predominant open-water angling fisheries have declined (Chapters 5 and 7 in

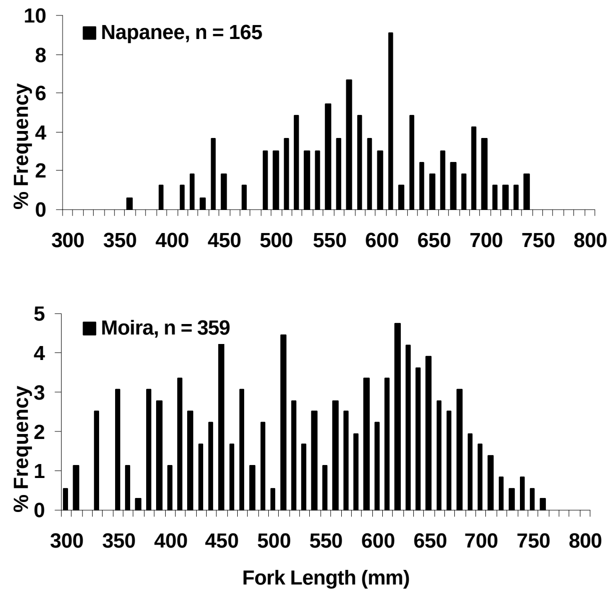

FIG. 4. Fork length of walleye harvested during spring spear fisheries in the Napanee and Moira Rivers during 1999.

this report), while spear fishing harvest has increased. As a result, spear fishing accounts for an increasing portion of the total documented harvest (Chapter 10 in this report). It is important that we continue to monitor the spear fishery harvest and ensure that the level of harvest from all sources does not compromise the sustainability of walleye.

Assessment and Research Needs

Rapid changes in the Bay of Quinte ecosystem have reduced the potential sustainable yield of walleye, Efforts should be made to refine estimates of the sustainable level of exploitation. Monitoring of all walleye fisheries should be maintained, and the fall marking, tagging and recapture of walleye to determine population size should be continued.

Acknowledgements

This report is the product of six years of monitoring which has been conducted jointly by the Mohawks of the Bay of Quinte and the Ontario Ministry of Natural Resources. We would particularly like to acknowledge the contributions of Jake Brant and Tom Northardt for their essential roles in implementing the surveys.

10

Status and Prognosis for Bay of Quinte Walleye

T. J. Stewart, J. Bowlby, J. A. Hoyle, A. Mathers, and T. Schaner

Introduction

The walleye of the Bay of Quinte support important recreational, commercial, and aboriginal fisheries. In this report, the history of walleye, current fisheries, recent changes in the status of walleye and likely causes are described. The future of walleye and walleye fisheries are considered. The information and ideas summarized in this report are based largely on a synthesis of a walleye technical workshop (Stewart et al. 1999) that relied on information current to 1997. If available, information in this report has been updated to include information from 1998 and 1999.

During the 1950s and 1960s walleye were moderately abundant and supported both recreational and commercial fisheries. Beginning in the 1960s, the walleye population declined, most likely due to habitat loss and fish community change associated with excessive nutrients (derived from sewage treatment plants, septic systems, and agricultural run-off) and continued harvest. Walleye populations remained extremely low throughout most of the 1970s.

Die-offs of alewife in 1977 and white perch in 1978, (both were likely predators and competitors of young walleye) lead to production of large numbers of young walleye, especially in 1978. During the 1980s, continued improvements in water quality and habitat, initially low levels of harvest and low levels of white perch and alewife within the bay allowed walleye populations to recover. Over the same period, recreational fisheries expanded. During the 1990s, commercial and aboriginal fishing also increased.

The walleye of the Bay of Quinte and eastern Lake Ontario are one population. The walleye depend on Bay of Quinte tributaries and shoals for reproduction but derive a substantial portion of their food, which is primarily alewife, from the Lake.

In general, juvenile walleye (mostly age-4 or younger) remain in the Bay of Quinte throughout the year. Mature walleye migrate out of the Bay of Quinte to Lake Ontario after spawning in the spring, return in the fall and over-winter in the Bay of Quinte.

The annual migration pattern affects the vulnerability of different walleye life-stages to the various fisheries. Generally, recreational fisheries harvest immature fish in the Bay of Quinte during spring and summer and a broad mix of ages during fall and winter. The aboriginal spear-fishery harvests mature fish in the Bay of Quinte in spring, and the commercial fishery harvest mature fish in the lake year-round.

Fisheries

Angling Fishery

Angling has been the largest fishery through the 1980s and 1990s. Annual angling effort, for both open water and ice-angling combined, peaked at about 1 million angler-hours in 1996, declining to 514,491 angler-hours in 1999 (Fig. 1). Catch and harvest rates have been declining since 1991 (Fig. 2). The decline in harvest rates and fishing effort resulted in a drop in harvest from a peak of approximately 224,000 fish in 1991 to 48,860 in 1999 (Chapter 7 in this report).

Aboriginal Fishery

Walleye are harvested by spearing primarily in Napanee, Moira and Salmon rivers during spring. The Salmon River is located on Tyendinaga Mohawk territory. From 1982 to 1998 harvests from the Salmon River have ranged from 2790 to 5374 fish, but overall have varied little (mean=4008 ±807 s.d.). Renewed interest in spear fishing harvest in the Salmon River in 1982 was consistent with the beginning of the walleye population recovery in 1978. Aboriginal spear fishing in the Napanee and Moira rivers is a more recent development, and began in earnest in 1992 with the harvest of an estimated 813 fish. Harvest in these two rivers has steadily increased, and in 1992 it was at its highest level of 12,527 fish (Chapter 9 in this report). There is also an undocumented aboriginal harvest of walleye from gillnets set in the Bay of Quinte.

Commercial Fishery

Quotas and gear restrictions limit the commercial fishery harvest. Walleye are not commercially fished in the Bay of Quinte, upstream of Glenora. Walleye are caught in entrapment nets, which allows for live sorting by size, and incidentally in gillnets set for whitefish. Commercial fishing, after recovery of walleye in 1978, was limited to incidental catches until 1989, when a walleye quota was established. Commercial harvests increased gradually to a high of 9,495 fish in 1997, but declined to 4,799 in 1999.[1]

Fisheries Summary

Estimated total annual harvest of walleye peaked in 1991 at approximately 236,276 fish (weighing 234 metric tons) and declined to 71,584 fish (weighing 115 metric tons) in 1999[1]. At the peak in 1991, the angling fishery accounted for 96% of the total harvest by number and 92 % by weight. By 1999, the proportion of fish harvested by anglers declined to 70% by number and 60 % by weight. Over the same period, the commercial fishery harvest remained relatively constant (mean=8,167 fish, ± 1,482 s.d.) while the total spear fishing harvest increased. As a result, the commercial and spear fishing harvests comprise an increasing proportion of the total harvest. In 1999, the commercial fishery accounted for 7% by number and weight; the proportion harvested by the aboriginal spear-fishery was 23% by number and 32% by weight.

Recent Changes in the Status of Walleye and the Bay of Quinte Fish Community

The abundance of walleye has declined. Angling catch and harvest rates declined (Fig. 2) as did catches in standardized gillnet and trawl surveys (Chapter 3 in this report). It is estimated that the walleye population peaked in 1991 at 1.7 million fish (2 years-old and older) and declined to 0.9 million by 1998 (Fig. 3)

The habitat available to support walleye has changed. Water clarity in the Bay of Quinte has increased steadily in response to pollution control programs, but increased rapidly beginning in 1995, after zebra and quagga mussels completely colonized the Bay of Quinte (Fig. 4). The increased light has resulted in increased aquatic vegetation.

The fish community of the Bay of Quinte is changing. Many other fish species compete with walleye for food and space, provide food for the walleye, or eat walleye. As described above, prior to 1978, abundant populations of white perch and alewife may have impeded a re-bound of walleye. Currently, these species are low in abundance. On the other hand, yellow perch populations have increased dramatically in the Bay of Quinte (Chapter 3 in this report) and may compete with, and feed on young walleye. Pike, bass and sunfish, which may compete with walleye, are also increasing in the Bay of Quinte (Chapters 3 and 7 in this report).

The production of young walleye has been poor in recent years. For 26-years, OMNR has been tracking the abundance of young-of-the-year walleye by conducting bottom trawl surveys in mid-to late summer in the Bay of Quinte (Chapter 3 in this report). Walleye are caught when they are about 4 months old and usually less than 150 mm (6 inches) in length. The last year that good numbers of young walleye were captured in the trawls was in 1994, and numbers have been getting lower each year (Fig. 5). Although, the catches of young walleye improved in 1999 over 1998, they continue to be relatively low. Studies have shown that, in the past, the catch rate of these young walleye is an indication of how many older walleye will be available in future (Bowlby and Mathers 1989). The declining trawl catches likely mean there will be less walleye in future years.

What factors might be influencing the walleye?

It is uncertain which factors influence walleye abundance and survival. However, some insights may be gained by synthesizing long-term monitoring data on walleye, associated fish species, fisheries, habitat and environmental conditions, and by comparing these data to past studies and other walleye populations.

Harvest

Up until 1998 the harvest of walleye from all sources has been at a reasonable level. On average,

[1] Estimates for 1999 are preliminary and subject to change

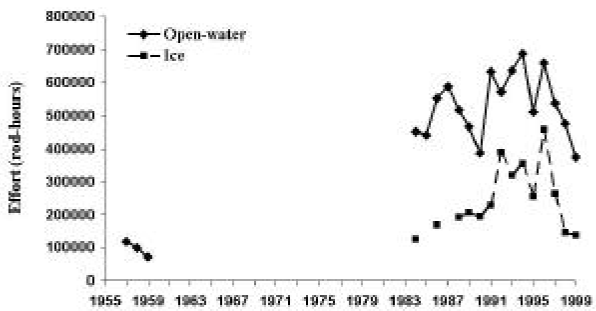

FIG. 1 Fishing effort during the Bay of Quinte ice and open-water angling fisheries, 1957 to 1998

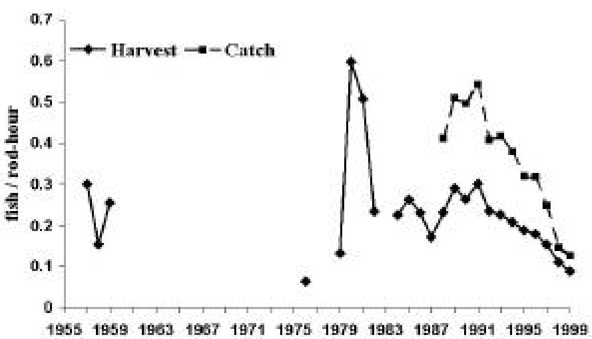

FIG. 2 Catch and harvest rates for walleye in the Bay of Quinte angling fishery during summer, 1957-1999

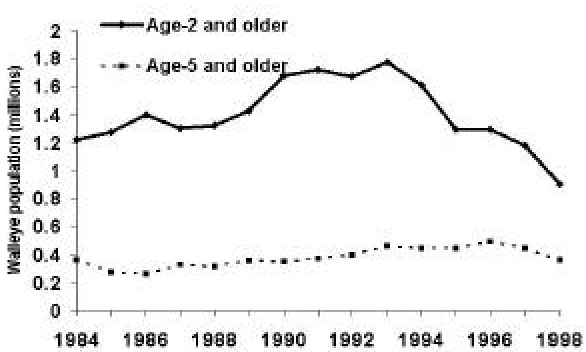

FIG 3. Population of walleye by age-group (determined by CAGEAN), 1984-1998.

about 35-40% of the population of fish (2-years older or older) die each year, from either natural causes or from being harvested in the angling, commercial or aboriginal fisheries. The best estimates are that, of those, about half die of natural causes, and the other half (10-20%) are harvested. The percentage of the total fish population removed by harvesting is called the exploitation rate. In other healthy walleye populations, the level of spawning and reproduction of young walleye has been shown to easily replace the fish that die at the moderate rates observed for the Bay of Quinte walleye. Analyses to date (1998) indicate that the Bay of Quinte walleye have not been over-exploited.

Habitat

Habitat changes in the Bay of Quinte have not favoured walleye. Walleye prefer more turbid water. The increased water clarity and encroachment of areas by aquatic vegetation has reduced the amount of habitat most suitable for walleye, especially in the shallower, upper region of the Bay of Quinte. Lower in the Bay of Quinte and Lake Ontario the preferred low light habitat of the walleye is found more offshore and deeper. Other species, like yellow perch, bass, pike, and sunfish benefit from the increased light and vegetation. Through competition and predation, these species can further limit the space and food available for walleye in some parts of the Bay of Quinte.

Spawners

The low numbers of young walleye are not a result of too few spawning walleye. Walleye have been observed spawning in all major rivers and on rocky shoals throughout the Bay of Quinte. Mature walleye have not declined. In 1998, the population of mature walleye was estimated to be 365,000 fish (Fig. 3, Age-5 and older). The number of spawners has been more than adequate and has likely continued to result in the emergence of large numbers of larval walleye from the spawning rivers and shoals.

Other fish feeding on young walleye

The resurgence of walleye, beginning with the 1977 and 1978 walleye year-classes coincided with the collapse of alewife and white perch populations. These two species of fish are known to feed on the young of other fish species. It is thought that the collapse of alewife and white perch in the late 1970s increased the survival of young walleye and initiated the walleye recovery. The abundance of these potential walleye predators is currently very low.

Yellow perch populations, on the other hand, have significantly increased in the Bay of Quinte (Chapter 3 in this report). This has been attributed to the increased aquatic vegetation and low rates of consumption of yellow perch by walleye and other predators. In June, of 1998, young walleye were observed in stomachs of yellow perch, feeding in the Bay of Quinte. Increased predation by yellow perch may be contributing to the poor survival and production of young walleye.

Other factors

The Bay of Quinte has been changing gradually in response to pollution control programs initiated in the late 1970s. In 1994, mussels completely colonized the Bay of Quinte. In 1995, water clarity, which had been increasing gradually, showed a marked increase (Fig. 4). At the same time the amount of aquatic vegetation increased.

Young walleye feed on a variety of free swimming zooplankton and bottom living organisms. The growth of a young walleye can determine how well it survives. Changes in the water clarity, increases in vegetation, and invasion by mussels may have resulted in a decline in the food available to young walleye. This could be due directly to a decline in the amount of a preferred food item or indirectly through increased competition with other fish species eating the same food organisms. Examples, of potential competitors are young yellow perch, bass and sunfish.

Abundance of young-of-the year alewife may also be influencing walleye survival. Young-of-the-year alewife are important in the diet of young walleye (Hurley 1986). Recent poor production of young walleye since 1995 was coincident with poor alewife production in the Bay of Quinte. The improvement in trawl catch of young walleye in 1999 (Fig. 5) was coincident with an abundant population of young-of-the-year alewife (Chapter 1 and 3 in this report). More study would be needed to confirm how changes in the food supply of young walleye effects their survival. However, the synchronicity of habitat changes due to mussels, and the abundance of young-of-the-year alewife and walleye suggests that changes in food supply may be an important factor.

Lessons from the past

Long-term studies of walleye systems in Ontario and through-out the world have shown that the amount of walleye that a waterbody can consistently produce

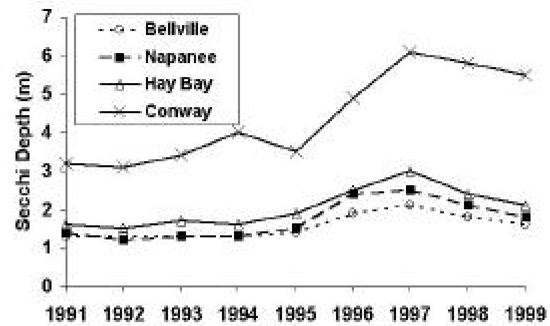

FIG 4. Mean secchi disk depth (a measure of transparency) throughout the Bay of Quinte, during May to October, 1991-1999. (Data provided by Dr. Scott Millard, Department of Fisheries and Oceans, Burlington, Ontario).

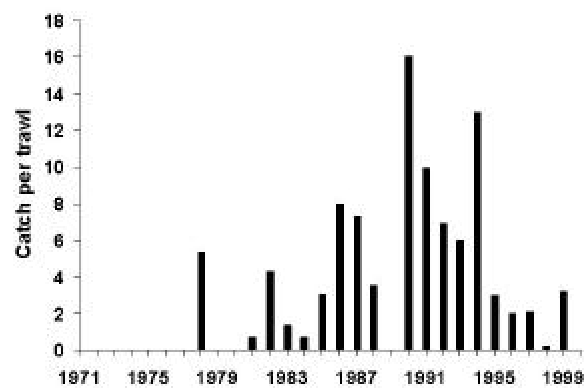

FIG 5. Mean catch of young-of-the-year walleye in trawls in the Bay of Quinte during summer, 1971-1999.

is related to water transparency and the level of nutrients (Hurley and Christie 1977; Olgesby et al. 1987; Lester N. P., Ontario Ministry of Natural Resources, Science Development and Transfer Branch, 300 Water St. Peterborough, Ontario, K9J 8M5, unpublished data). Ideal conditions for walleye are at intermediate levels of transparency and nutrient levels. Waterbodies that are extremely enriched, produce fewer walleye, as do extremely clear, nutrient poor waterbodies (Fig. 6).

The Bay of Quinte likely follows this pattern with one caveat. The connection to Lake Ontario results in higher then expected walleye production compared to isolated waterbodies with the same clarity and level of nutrients. Also, throughout the last 50 years the walleye in the Bay of Quinte have experienced a wide range of conditions. In the late 1970s and 1980s, conditions in the Bay of Quinte were ideal for walleye and world-class walleye sport-fishery developed. This is evident in the very high catch and harvest rates observed during this period (Fig. 2) and is consistent with ideal turbidity and nutrient levels (Fig. 7). In the 1960s and early 1970s, there were no substantive fisheries and this corresponded to conditions of extreme enrichment and turbidity (Fig. 7). In the 1950s, the Bay of Quinte supported moderate levels of recreational fishing (Fig. 1) and an important commercial fishery (Baldwin 1979). This period corresponding to a time when the Bay of Quinte was thought to have lower turbidity and nutrient levels and much higher vegetation (Fig. 7).

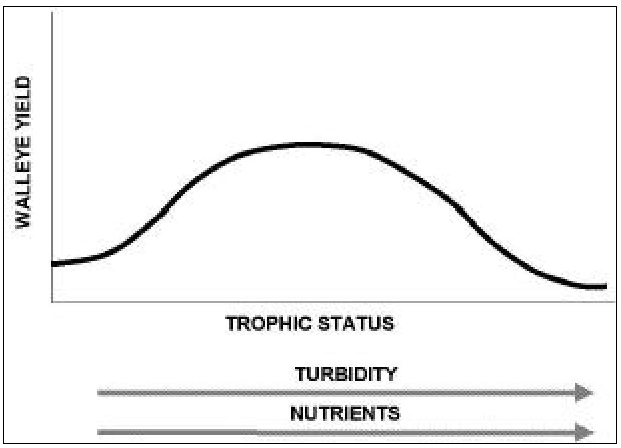

FIG 6. Theoretical relationship between walleye yields and trophic status, as represented by changes in turbidity and the level of nutrients.

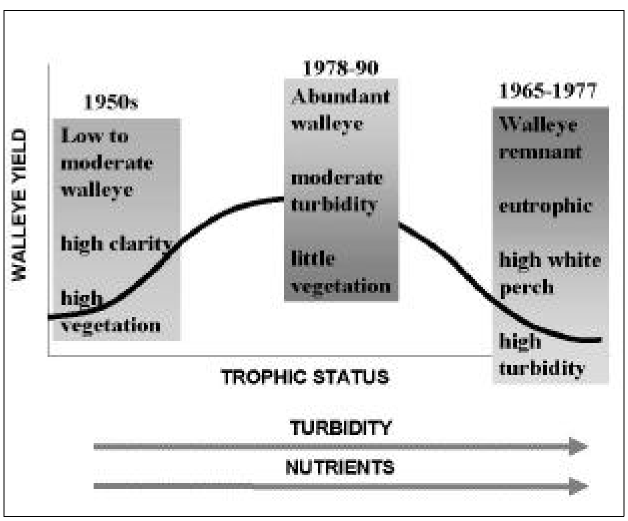

FIG 7. Representation of the status of the Bay of Quinte walleye, in relation to observed conditions over time and the theoretical relationship between walleye yields and trophic status.

Prognosis for walleye and the Bay of Quinte fish community

Pollution control efforts and mussel invasion have moved the Bay of Quinte system during the 1990s towards conditions closer to those experienced in the 1950s. The Bay of Quinte is in state of transition and the endpoint is uncertain. Of particular concern is the poor production of young walleye in recent years. It is uncertain whether this trend will continue or the fish community, habitat conditions, and walleye recruitment will stabilize.

Currently, the walleye spawning stocks are adequate and have the potential to produce large numbers of young walleye. However, even if recruitment improves, walleye population and fisheries yields are expected to be much lower over the next decade.

In the near-term, recent poor recruitment of young walleye will result in further declines in adults. A further decline in summer angling catch and harvest rates (Chapter 7 in this report) and the decline in commercial fish harvests in 1999 portends this trend. Harvest rate and overall harvest in the winter angling fishery will likely decline soon. Declines may not yet be evident because of a predominance of large fish in the harvest (which are still relatively abundant) and large variations in catchability due to ice conditions and other factors. The harvest from the spring spear fishery can likely be maintained for some time. The spear fishery harvests exclusively larger fish and is a very effective means of harvest even at low levels of abundance.

Walleye are changing their behaviour in response to changing fish community and habitat conditions. In turn, anglers have new challenges and opportunities. Alternative fisheries in the lake, offshore, at night, or based on changed seasonal patterns, are developing. Yellow perch, smallmouth bass, largemouth bass and pike populations are benefiting from changes in the Bay of Quinte and fisheries for these species are developing (Chapter 7 in this report).

Approaches to sustaining walleye populations.

The Bay of Quinte walleye population can likely be sustained and continue to support recreational, commercial and aboriginal fisheries with appropriate management. One management approach would be to maintain the same moderate level of exploitation the walleye have experienced thus far. To achieve this, overall harvest must decline in-step with any declines in the population. A strategy that maintains a moderate exploitation rate will require continued monitoring of walleye population and harvests. Regulations to restrict harvest may also be needed if harvest levels approach or exceed the established target.

A complimentary strategy may be to afford additional protection to walleye spawning stocks. This could mean attempting to have a more conservative target exploitation rate for the large reproducing fish achievable through various fish size, fishing season or area specific fishing regulations.

Monitoring the number of spawners is important. If the number of spawners declines to a critically low level then the sustainability of the walleye population would be threatened and special protection would be warranted.

Other fish species will require management as the fisheries continue to develop. Yellow perch, bass and pike may support increased levels of fishing. However, we must be cautious in this regard, recognizing that the Bay of Quinte and the associated fish community are changing rapidly.

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11

A Survey of Rainbow Trout Anglers at the Ganaraska River during Spring 1999

J.N. Bowlby and M.E. Daniels.

Introduction

The spawning run of rainbow trout in the Ganaraska River has been monitored frequently since 1974, at a fishway near the mouth of the stream. Since 1991, the size of the run has declined (Chapter 1 in this report). At the same time, the proportion of repeat spawners in the run declined, suggesting that exploitation might have contributed to the decline in the run. This survey was conducted on stream anglers to determine the level of exploitation of rainbow trout in the Ganaraska River during spring.

During a recent review of Lake Ontario salmon and trout regulations, many members of our public advisory groups advocated a reduced creel limit for rainbow trout. In this survey we asked stream anglers to tell us what creel limit they would prefer to have for rainbow trout from Lake Ontario streams.

Information Sources

Fishing activity was surveyed at 22 sites along the Ganaraska River, from Port Hope to Kendal (Fig. 1). Anglers were interviewed at 5 of these sites (Table 1). In Port Hope, from the CNR bridge to Jocelyn Street, all anglers were counted and a subset was interviewed. At all other sites angler counts were estimated from the number of cars counted at the sites

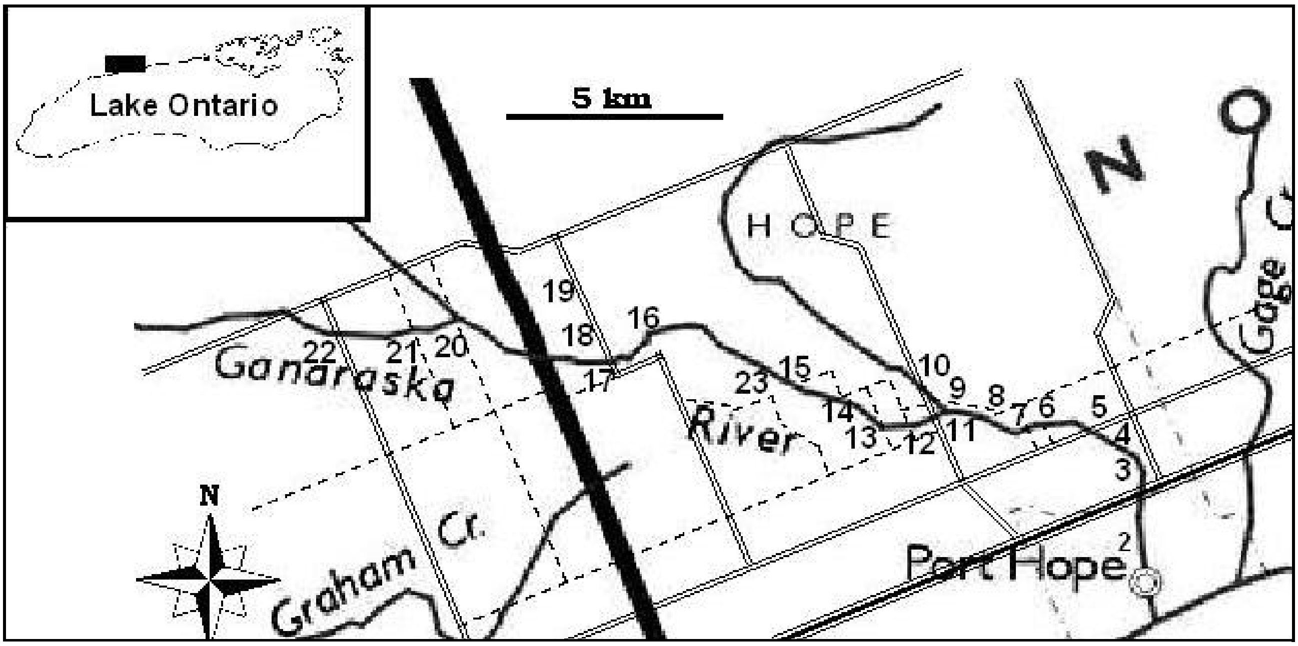

FIG. 1. Map of Ganaraska River showing location of sites for angler survey during spring, 1999. Numbers correspond with the surveys sites listed in Table 1.

Table 1. The observed number of cars and anglers at angling survey sites at the Ganaraska River from Port Hope to Kendall, April 24 to May 31, 1999.

Survey site	Site number	Observed number of cars	Observed number of anglers
CNR bridge to Jocelyn St	2		1023
Conservation Authority	3	52	48
South of Dale Rd	4	86	92
North of Dale Rd	5	137	
Hawkins Rd	6	66	
Sylvan Glen CA	7	403	430
Bend in 4th Line	8	42	
Canton: North Branch at 4thLine	9	24	
Canton: North Branch at County road 10	10	33	
Canton: Main Branch at County road 10	11	32	
Kellog Rd	12	34	
Anderson Rd	13	24	
Shamrock Club (4thLine)	14	30	
Dead end (4thLine)	15	34	
East of Osaca	23	47	
Osaca	16	23	50
County Road 65: Main Branch	17	37	
Canton County Road 65: Elizabethville Ck	18	2	
6th Line: Elizabethville Ck	19	5	
2nd Road east of Kendal	20	2	
1st Road east of Kendal	21	9	
County Road 18: Main Branch (Kendal)	22	5	
Grand Total		563	442

Table 2. Seasonal and sector details of catch and harvest of rainbow trout for the angling fishery in the Ganaraska River from Port Hope to Kendall, April 24 to May 31, 1999.

Season	Sector	Catch	Harvest	Effort (ang-hr)	Catch rate (per hr)	Harvest rate (per hr)
April 24 – April 25	CNR bridge to Jocelyn Street	2,268	398	6,113	0.3710	0.0652
	Highway 401 to north of Dale Road	532	279	934	0.5702	0.2985
	Hawkins Road to Kendal	1,519	388	3,724	0.4079	0.1042
	Total	4,319	1,065	10,770	0.4010	0.0989
April 26 – May 9	CNR bridge to Jocelyn Street	3,755	61	3,934	0.9545	0.0155
	Highway 401 to north of Dale Road	582	65	2,387	0.2438	0.0274
	Hawkins Road to Kendal	1,505	504	5,985	0.2515	0.0841
	Total	5,842	630	12,306	0.4748	0.0512
May 10 – May 31	CNR bridge to Jocelyn Street	400	12	688.34	0.5815	0.0171
	Highway 401 to north of Dale Road	48	0	254.33	0.1869	0.0000
	Hawkins Road to Kendal	83	0	380.92	0.2192	0.0000
	Total	531	12	1,324	0.4014	0.0089

and the mean number of anglers per car because of the difficulty in locating all anglers. The mean number of anglers per car was weighted to account for oversampling cars with more anglers. For analysis, we combined counts of anglers across sites into the following three sectors: CNR bridge to Jocelyn Street (site 2), Highway 401 to north of Dale Road (sites3-5), and Hawkins Road to Kendal (sites 6-23).

Angler interviews collected information to determine catch, harvest and effort by species. In addition, anglers were asked how many years they had fished during spring for rainbow trout in the Ganaraska River, their angling method, distance driven to site, and what creel limit they would like to see for rainbow trout in Lake Ontario streams. Surveyors measured lengths and collected scales from harvested rainbow trout and brown trout. Results from this biological information will be reported elsewhere.

The survey followed a roving design; the surveyors moved from site to site along predetermined routes and schedules. Complete randomization of sites within the routes was not feasible. Instead, the start and end points, and the direction of the routes were varied. The survey ran from the start of trout season on April 24 until the end of May, 1999, and was stratified into 3 seasons, as follows:

April 24–25 (trout season opening weekend),

April 26 – May 9

May 10 – May 31.

Weeks were stratified by weekdays and weekend days. Surveys were conducted on two weekdays and two weekend days each week. Each day was stratified into morning and afternoon survey periods. For each season survey periods were defined as follows:

Season	Morning	Afternoon
1	05:00 – 12:30	12:30 – 21:00
2, 3	06:00 – 13:00	13:00 – 21:00

During the opening weekend, morning and afternoon periods were surveyed on both days. After opening weekend, each scheduled day was surveyed during only one period, such that in a given week both morning and afternoon periods were sampled for weekday and weekend daytypes.

Fisheries Update

Effort

Anglers spent an estimated 24,400 hours fishing for rainbow trout in the Ganaraska River during the spring of 1999. Over 99% of the interviewed anglers declared they were fishing for rainbow trout. In comparison, this fishery was larger than the spring fishery for rainbow trout in Wilmot Creek during 1994 (Stanfield et al. 1998), but smaller than either the spring 1992 or fall 1991 fisheries at Port Hope harbour at the mouth of the Ganaraska River (unpublished data).

Forty-four percent of the effort was during the opening weekend of trout season (Table 2). This is typical of many fisheries. Most of the remaining effort was in the following two weeks. Subsequently, the effort declined as the trout migrated out of the river. Sylvan Glen and the CNR bridge to Jocelyn Street sites accounted for 84% of the effort (Tables 1 and 2). These two sites are more accessible to the public as most of the river bank is private property.

The mean number of anglers per car was 1.8. This number declined very slightly through the season.

Harvest

Catch, harvest, catch rates and harvest rates are presented in Tables 2 and 3. The catch estimates are based on all sizes of fish that were caught. We overlooked asking anglers about the size of the released rainbow trout, and so we were unable to determine how many of these were adults or juveniles.

We estimated that 1,649 (97%) of the rainbow trout harvested were adults. Based on the estimated rainbow trout run of 6,442 (Chapter 1 in this report), this portion of the fishery had an exploitation rate of 26%. This rate may have been slightly elevated as some rainbow trout spawn below the fishway and are not counted. Nevertheless, the spring and fall shore fisheries at Port Hope harbour and the boat fishery on Lake Ontario also harvest substantial numbers of fish from this population (unpublished data). Accordingly, the overall exploitation rate on Ganaraska River rainbow trout was likely significantly higher than 26% in 1999.

Sixty-two percent of the rainbow trout harvest was during the opening weekend of trout season (Table 2). Most of the remaining harvest was during the next

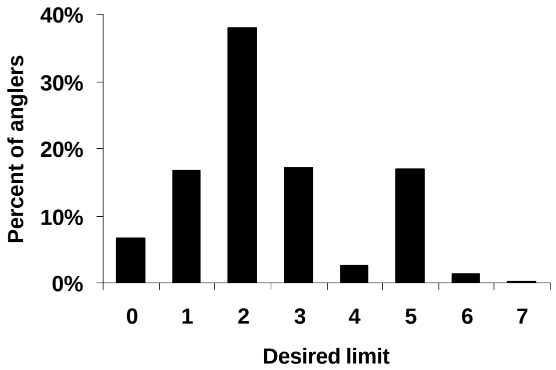

FIG.2. The response of 418 anglers on the Ganaraska River during spring 1999 to the question: "What creel limit would you like to see for rainbow trout in Lake Ontario streams?"

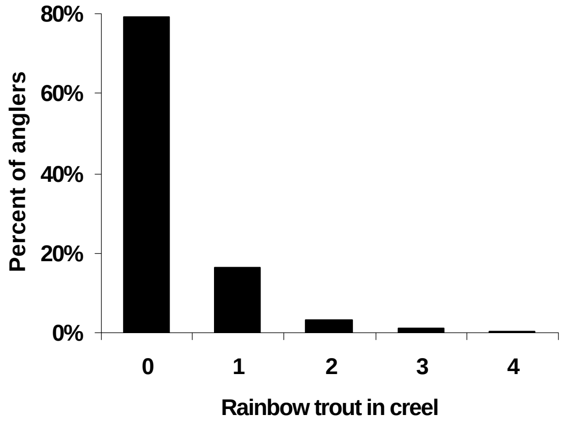

FIG. 4. The estimated number of rainbow trout in the creel of individual anglers at completion of fishing on the Ganaraska River during spring 1999.

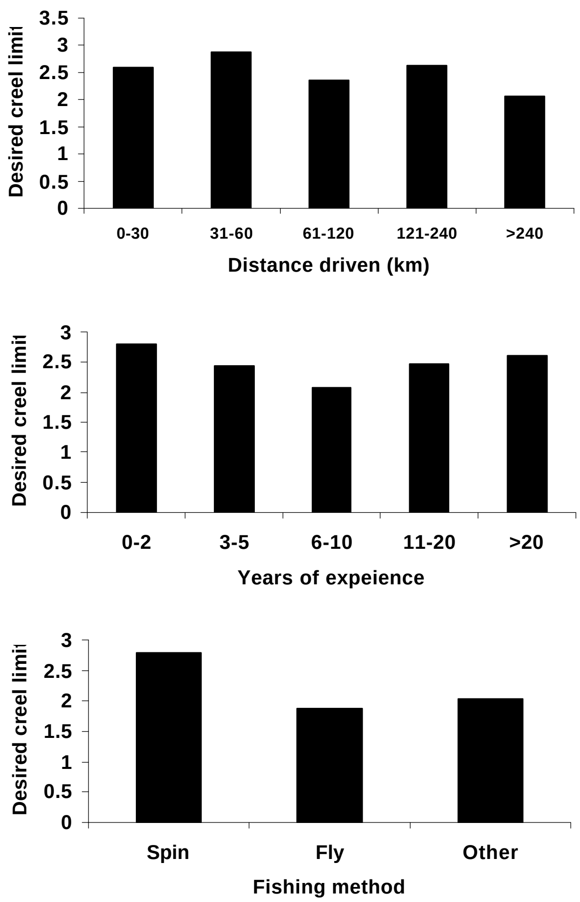

FIG. 3. The effect of distance driven, years of expeience and fishing method on the desired creel limit for rainbow trout by anglers at the Ganaraska River during spring 1999.For fishing method, "Oher" methods were mostly using float rods.

two weeks. After spawning, large numbers of rainbow trout became trapped in the river by low stream flows during spring 1999. Rainbow trout prefer to out migrate on freshets. In mid-May there was sufficient rainfall and the fish out-migrated. Subsequently, in the third season of this survey rainbow trout harvest plummeted (Table 2). During the first season rainbow trout were harvested consistently at all locations (Table 2). After opening weekend most of the harvest was confined to those fish in the upper sector that had become trapped by low flows.

Harvest and exploitation in this fishery may vary from year to year, depending on stream flows and weather. In some years, most of the rainbow trout may spawn and leave the river before the season opens. In 1999, this was not the case, many adult rainbow trout were still in the Ganaraska River when the season opened, and so the exploitation rate in this fishery may have been higher than some other years.

Creel Limit Survey

In answer to our question about what creel limit they would like to see for rainbow trout in Lake Ontario streams, the most common response (given by 418 anglers) was a limit of 2 rainbow trout (Fig. 2). The mean response was a limit of 2.5 rainbow trout. There was also another modal response of 5, corresponding to the existing limit. These results were very consistent among local anglers and those that drove farther, across categories of experience, and even across fishing method (Fig. 3).

The vast majority of anglers harvested no fish (Fig. 4). Since 99% of the anglers harvested 2 rainbow trout or less a creel limit of 2 fish or more would have little impact on anglers or exploitation of rainbow trout in the Ganaraska River.

Management Implications

Considering the river fishery makes up just a portion of the total exploitation of Ganaraska rainbow trout, the exploitation rate of rainbow trout in the Ganaraska River was significant in 1999. Whether this is the case for other years is unclear. Increased levels of exploitation are consistent with recent declines in the size of the spawning run and in the proportion of repeat spawners in the run (Chapter 1 in this report). There is a need to detrmine an appropriate level of exploitation for rainbow trout, especially in light of the management objective (Stewart *et al.* 1999) to encourage wild production of rainbow trout in Lake Ontario. Anglers have shown a desire to reduce creel limits for rainbow trout. However, the creel limits suggested by anglers, here, are unlikely to have a significant impact on exploitation.

Assessment and Research Needs

There are two immediate information needs about the population of rainbow trout in the Ganaraska, that would help manage rainbow trout in Lake Ontario. First, the number of rainbow trout spawning below the fishway at Port Hope has never been counted. Second, the year to year variability of exploitation by the fishery in the Ganaraska River, relative to stream flows and weather is unclear. A tagging program at the mouth of the Ganraraska River would allow us to both estimate this number of rainbow trout spawning below the fishway, and estimate the exploitation rate of Ganaraska rainbow trout by various components of the fishery without the need for angler surveys.

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Appendix A: Fish stocked in the province of Ontario waters of Lake Ontario in 1999

SITE NAME	MONTH STCKED	YEAR SPAWNED	HATCHERY/ SOURCE	STRAIN/ EGG SOURCE	AGE (MO.)	MEAN WT (G)	MARKS	NUMBER STOCKED
			ATLANTIC SALMON - EGGS					
SHELTER VALLEY CREEK								
West Branch	12	1999	Partnership	LaHave/Normandale	0		None	**12,036**
			ATLANTIC SALMON - EARLY FRY					
COBOURG CREEK								
Ball's Mill	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	20,000
Cobourg Cr Dale Rd	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	4,100
								24,100
CREDIT RIVER								
Belfountain-Upstream	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	10,000
Black Cr 17th Line	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	6,500
Black Cr Limehouse	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	12,500
Dominion Street Bridge	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	15,352
Forks to Meadow	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	10,000
Glen Williams	5	1998	Partnership	LaHave/Normandale	2	0.2	None	200
								54,552
DUFFIN CREEK								
Highway 7	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	**3,300**
GANARASKA RIVER								
Canton Br at Hydro	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	4,000
Canton Cr Cascades	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	4,100
								8,100
HUMBER RIVER								
Purpleville Cr - Evans Farm	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	**5,000**
WILMOT CREEK								
4th Concession	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	20,000
Above Nursery Bridge	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	4,500
Below 5th	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	3,700
Hwy 35/115-Twin Tnnl	5	1998	Ringwood	LaHave/Normandale	4	0.2	None	8,000
								36,200
			ATLANTIC SALMON - ADVANCED FRY					
BARNUM HOUSE CREEK								
Barnum House	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	4,100
S of Spillway	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	8,361
								12,461
BRONTE CREEK								
Bronte Cr	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	8,800
Cedar Spr Trib	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	4,500
Cedar Springs Pk	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	7,200
								20,500
CREDIT RIVER								
Terra Cotta Bridge	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	40,000
Black Cr above Stewarttown	5	1998	Partnership	LaHave/Normandale	2	0.2	None	5,333
								45,333
DUFFIN CREEK								
6th Conc	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	**4,500**
GANARASKA RIVER								
Canton Br S Hydro	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	**3,400**
HUMBER RIVER								
Purpleville Cr - Teston Rd	2	1998	Ringwood	LaHave/Normandale	2	0.2	None	5,333
Purpleville Cr - Evans Farm	2	1998	Ringwood	LaHave/Normandale	2	0.2	None	5,333
								10,666

Appendix A: Fish stocked in the province of Ontario waters of Lake Ontario in 1999

SITE NAME	MONTH STCKED	YEAR SPAWNED	HATCHERY/ SOURCE	STRAIN/ EGG SOURCE	AGE (MO.)	MEAN WT (G)	MARKS	NUMBER STOCKED
				ATLANTIC SALMON - ADVANCED FRY (CONT'D)				
PROCTORS CREEK								
Proctors Cr	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	2,350
Up-Downlake	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	5,328
								7,678
SHELTER VALLEY CREEK								
Shelter Valley Chnl	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	5,175
Shelter Valley Park	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	2,700
								7,875
WILMOT CREEK								
Pisany Property	4	1998	Ringwood	LaHave/Normandale	4	0.8	None	**4,900**
				ATLANTIC SALMON YEARLINGS				
CREDIT RIVER								
Norval	4	1997	U. of Guelph	LaHave/Normandale	16	15.0	None	1,000
Rogers Creek	4	1997	U. of Guelph	LaHave/Normandale	16	15.0	None	200
Terra Cotta	10	1998	U. of Guelph	LaHave/Normandale	18	130.0	None	1,125
								2,325
				ATLANTIC SALMON - ADULTS				
CREDIT RIVER								
Dr Kauk Property	10	1993	Codrington	LaHave River	60	3058.0	Tag*	43
McLaughlin Rd Bridge	10	1993	Codrington	LaHave River	60	3058.0	Tag*	41
Stuart Horne Property	10	1993	Codrington	LaHave River	60	3058.0	Tag*	41
Trout Unlimited	10	1993	Codrington	LaHave River	60	3058.0	Tag*	40
Whillans	10	1993	Codrington	LaHave River	60	3058.0	Tag*	39
Norval	12	1995	Normandale	LaHave/Normandale	48	1722.5	None	86
								290

TOTAL - ATLANTIC SALMON EGGS	**12,036**
TOTAL - ATLANTIC SALMON EARLY FRY	**131,252**
TOTAL - ATLANTIC SALMON ADVANCED FRY	**117,313**
TOTAL - ATLANTIC SALMON YEARLINGS	**2,325**
TOTAL - ATLANTIC SALMON ADULTS	**290**
TOTAL - ATLANTIC SALMON	**263,216**

* some fish also carried internal radio transmitters

Appendix A: Fish stocked in the province of Ontario waters of Lake Ontario in 1999

SITE NAME	MONTH STCKED	YEAR SPAWNED	HATCHERY/ SOURCE	STRAIN/ EGG SOURCE	AGE (MO.)	MEAN WT (G)	MARKS	NUMBER STOCKED
			BROWN TROUT YEARLINGS					
BRONTE CREEK								
Bronte Beach Park	4	1997	Normandale	Ganaraska/Normandale	17	41.4	RV	**15,021**
DUFFIN CREEK								
401 Bridge	5	1997	Harwood	Ganaraska/Normandale	18	66.0	RV	**9,878**
LAKE ONTARIO								
Ashbridge's Bay Ramp	3	1997	Harwood	Ganaraska/Normandale	16	47.0	RV	7,796
	5	1997	Harwood	Ganaraska/Normandale	18	59.1	RV	7,736
Bluffer's Park	3	1997	Harwood	Ganaraska/Normandale	16	38.1	RV	8,300
	5	1997	Harwood	Ganaraska/Normandale	18	53.0	RV	4,837
Burlington Canal	4	1997	Normandale	Ganaraska/Normandale	17	46.3	RV	15,000
Fifty Point CA	4	1997	Normandale	Ganaraska/Normandale	17	40.1	RV	7,476
Jordan Harbour	4	1997	Normandale	Ganaraska/Normandale	17	39.4	RV	10,005
Lakefront Promenade	4	1997	Normandale	Ganaraska/Normandale	17	41.0	RV	10,009
Lakeport	5	1997	Harwood	Ganaraska/Normandale	18	53.9	RV	9,002
Millhaven Wharf	3	1997	Harwood	Ganaraska/Normandale	16	40.2	RV	8,303
	5	1997	Harwood	Ganaraska/Normandale	18	59.9	RV	5,532
Oshawa Harbour	5	1997	Harwood	Ganaraska/Normandale	18	62.2	RV	9,498
Port Dalhousie East	4	1997	Normandale	Ganaraska/Normandale	17	46.2	RV	13,000
	5	1997	Normandale	Ganaraska/Normandale	18	40.6	RV	14,149
								130,643
TOTAL - BROWN TROUT								**155,542**

Appendix A: Fish stocked in the province of Ontario waters of Lake Ontario in 1999

SITE NAME	MONTH STCKED	YEAR SPAWNED	HATCHERY/ SOURCE	STRAIN/ EGG SOURCE	AGE (MO.)	MEAN WT (G)	MARKS	NUMBER STOCKED
				CHINOOK - SPRING FINGERLINGS				
BOWMANVILLE CREEK								
CLOCA Ramp	4	1998	Ringwood	Lake Ontario	4	3.8	None	**16,999**
BRONTE CREEK								
2nd Side Rd Bridge	4	1998	Ringwood	Lake Ontario	4	4.1	None	17,002
5th Side Rd Bridge	4	1998	Ringwood	Lake Ontario	4	4.1	None	17,000
								34,002
COBOURG BROOK								
South of King St	4	1998	Partnership	Wild - Cobourg Br.	5	8.7	None	1,200
	5	1998	Ringwood	Lake Ontario	5	5.9	None	10,000
								11,200
CREDIT RIVER								
Eldorado Park	4	1998	Ringwood	Lake Ontario	4	3.7	None	33,281
Huttonville	4	1998	Ringwood	Lake Ontario	4	4.1	None	33,332
Norval	4	1998	Ringwood	Lake Ontario	4	4.4	None	33,219
								99,832
LAKE ONTARIO								
Ashbridge's Bay Ramp	4	1998	Ringwood	Lake Ontario	4	3.8	None	17,000
Barcovan Beach	5	1998	Ringwood	Lake Ontario	5	5.9	None	17,000
Bluffer's Park	4	1998	Ringwood	Lake Ontario	4	3.8	None	33,976
Jordan Harbour	5	1998	Ringwood	Lake Ontario	5	5.5	None	17,764
Oshawa Harbour	4	1998	Ringwood	Lake Ontario	4	3.8	None	17,000
Port Dalhousie East	4	1998	Ringwood	Lake Ontario	4	3.8	None	49,969
	5	1998	Ringwood	Lake Ontario	5	5.5	None	17,000
Wellington Channel	5	1998	Ringwood	Lake Ontario	5	5.9	None	16,963
Whitby Harbour	4	1998	Ringwood	Lake Ontario	4	3.8	None	17,000
								203,672
TOTAL - CHINOOK SALMON								**365,705**

Appendix A: Fish stocked in the province of Ontario waters of Lake Ontario in 1999

SITE NAME	MONTH STCKED	YEAR SPAWNED	HATCHERY/ SOURCE	STRAIN/ EGG SOURCE	AGE (MO.)	MEAN WT (G)	MARKS	NUMBER STOCKED
				COHO - FALL FINGERLINGS				
CREDIT RIVER								
Eldorado Park	11	1998	Ringwood	Wild - Salmon R.	12	22.6	AdRV	7,873
Huttonville	11	1998	Ringwood	Wild - Root R.	11	14.5	AdLV	12,989
	11	1998	Ringwood	Wild - Salmon R.	12	20.8	AdRV	17,607
Norval	11	1998	Ringwood	Wild - Salmon R.	12	20.8	AdRV	23,016
								61,485
				COHO - SPRING YEARLINGS				
CREDIT RIVER								
Eldorado Park	2	1997	Ringwood	Wild - Kewaunee R.	11	21.3	LV	14,959
	2	1997	Ringwood	Wild - Salmon R.	16	21.2	RV	8,041
Huttonville	2	1997	Ringwood	Wild - Blue Jay Cr.	14	21.7	Ad	7,893
	2	1997	Ringwood	Wild - Salmon R.	15	21.1	RV	8,094
	3	1997	Ringwood	Wild - Salmon R.	16	20.5	RV	12,325
Norval	2	1997	Ringwood	Wild - Kewaunee R.	11	19.6	LV	11,894
	2	1997	Ringwood	Wild - Salmon R.	15	19.6	RV	4,465
	2	1997	Ringwood	Wild - Salmon R.	16	21.2	RV	5,741
								73,412
TOTAL - COHO FALL FINGERLINGS								**61,485**
TOTAL - COHO SPRING YEARLINGS								**73,412**
TOTAL - COHO SALMON								**134,897**

Appendix A: Fish stocked in the province of Ontario waters of Lake Ontario in 1999

SITE NAME	MONTH STOCKED	YEAR SPAWNED	HATCHERY/ SOURCE	STRAIN/ EGG SOURCE	AGE ((MO.)	MEAN WT (G)	MARKS	NUMBER STOCKED
				LAKE TROUT - YEARLINGS				
LAKE ONTARIO								
Cobourg Harbour Pier	3	1997	Harwood	Slate Islands/Dorion	16	25.2	AdRV	30,477
Fifty Point CA	3	1997	Harwood	Slate Islands/Dorion	16	26.7	AdRV	10,476
	3	1997	Harwood	Seneca Lake/Harwood	15	20.4	AdRV	30,051
	5	1997	Harwood	Slate Islands/Dorion	18	30.7	AdRV	18,222
N of Main Duck Sill	4	1997	Harwood	Michipicoten Island/Dorion	18	42.2	AdRV	33,937
	4	1997	Harwood	Mishibishu Lakes/Tarentorus	17	30.1	AdRV	35,254
	4	1997	Harwood	Seneca Lake/Harwood	16	28.4	AdRV	115,865
Pigeon Island	4	1997	Harwood	Seneca Lake/Harwood	16	28.3	AdRV	15,932
S of Long Point	4	1997	Harwood	Michipicoten Island/Dorion	18	41.7	AdRV	23,957
	4	1997	Harwood	Mishibishu Lakes/Tarentorus	17	30.5	AdRV	35,005
	4	1997	Harwood	Seneca Lake/Harwood	16	29.0	AdRV	114,038
TOTAL - LAKE TROUT								**463,214**

Appendix A: Fish stocked in the province of Ontario waters of Lake Ontario in 1999

SITE NAME	MONTH STOCKED	YEAR SPAWNED	HATCHERY/ SOURCE	STRAIN/ EGG SOURCE	AGE (MO.)	MEAN WT (G)	MARKS	NUMBER STOCKED
			RAINBOW TROUT - FRY					
CREDIT RIVER								
Black Creek	6	1999	Partnership	Ganaraska			None	15,000
Papermill Dam	7	1999	Partnership	Ganaraska			None	80,000
Silver Creek	6	1999	Partnership	Ganaraska			None	60,000
								155,000
EAST DON RIVER								
16th Avenue	6	1999	Partnership	Wild - Rouge R.	3	0.2	None	**2,232**
EAST HUMBER RIVER								
King City	6	1999	Partnership		3	0.3	None	2,500
King Creek	6	1999	Partnership		3	0.3	None	2,500
Laskay	6	1999	Partnership		3	0.3	None	2,500
Purpleville Creek	6	1999	Partnership		3	0.3	None	12,500
Silver Creek	6	1999	Partnership		3	0.3	None	2,500
								22,500
ROUGE RIVER								
Burndenette Creek	6	1999	Partnership	Wild - Rouge R.	3	0.2	None	3,000
Carlton Creek	6	1999	Partnership	Wild - Rouge R.	3	0.2	None	7,144
Leno Creek	6	1999	Partnership	Wild - Rouge R.	3	0.2	None	5,000
Morningside Creek	6	1999	Partnership	Wild - Rouge R.	3	0.2	None	5,000
Robinson Creek	6	1999	Partnership	Wild - Rouge R.	3	0.2	None	5,000
								25,144
			RAINBOW TROUT - FINGERLINGS					
CREDIT RIVER								
Papermill Dam	9	1999	Partnership	Ganaraska			None	**5,000**
			RAINBOW TROUT - YEARLINGS					
BRONTE CREEK								
5th Side Rd Bridge	4	1998	Normandale	Ganaraska/Normandale	13	20.4	AdRV	10,018
Lowville Park	4	1998	Normandale	Ganaraska/Normandale	13	20.4	AdRV	10,023
								20,041
CREDIT RIVER								
Huttonville	5	1998	Normandale	Ganaraska/Normandale	14	17.9	AdRV	10,031
Norval	5	1998	Normandale	Ganaraska/Normandale	14	17.8	AdRV	10,036
								20,067
HUMBER RIVER								
E B Rutherford	4	1998	Normandale	Ganaraska/Normandale	13	17.6	AdRV	10,423
King Vaughan Line	4	1998	Normandale	Ganaraska/Normandale	13	19.6	AdRV	10,016
								20,439
LAKE ONTARIO								
Glenora	4	1998	Normandale	Ganaraska/Normandale	13	18.1	AdRV	7,514
Jordan Harbour	5	1998	Normandale	Ganaraska/Normandale	14	17.0	AdRV	19,986
Long Pt - P.E. Bay	4	1998	Normandale	Ganaraska/Normandale	13	19.1	AdRV	5,014
Millhaven Wharf	4	1998	Normandale	Ganaraska/Normandale	13	17.0	AdRV	7,528
Port Dalhousie East	5	1998	Normandale	Ganaraska/Normandale	14	18.2	AdRV	24,709
								64,751
ROUGE RIVER								
Bruce Creek	4	1998	Normandale	Ganaraska/Normandale	13	17.0	AdRV	6,677
Robinson Creek	4	1998	Normandale	Ganaraska/Normandale	13	17.0	AdRV	6,678
Silver Spring Farms	5	1998	Normandale	Ganaraska/Normandale	14	18.5	AdRV	6,711
								20,066
TOTAL - RAINBOW TROUT FRY								**204,876**
TOTAL - RAINBOW TROUT FINGERLINGS								**5,000**
TOTAL - RAINBOW TROUT YEARLINGS								**145,364**
TOTAL - RAINBOW TROUT								**355,240**

Appendix A: Fish stocked in the province of Ontario waters of Lake Ontario in 1999

SITE NAME	MONTH STOCKED	YEAR SPAWNED	HATCHERY/ SOURCE	STRAIN/ EGG SOURCE	AGE (MO.)	MEAN WT (G)	MARKS	NUMBER STOCKED
			WALLEYE - FINGERLINGS					
HAMILTON HARBOUR								
Cootes Paradise	7	1999	White Lake	Napanee River (Wild)	3	0.5	None	**6,000**

Appendix B: Catches in the index netting program in eastern Lake Ontario and the Bay of Quinte in 1999.

Species-specific catch-per-standard-gillnet lift, Northeast Lake Ontario, 1999.

	Brighton					Middle Ground	Rocky Point				
Species / Depth (m)	8	13	18	23	28	5	8	13	18	23	28
Alewife	43.5	50.1	32.6	79.4	618.6	-	210.9	685.6	1,167.1	1,408.0	2,972.5
Chinook salmon	-	-	-	9.9	-	-	-	-	-	-	-
Brown trout	-	-	-	3.3	-	3.3	-	-	-	-	-
Lake trout	-	-	6.6	6.6	6.6	-	-	-	-	3.3	95.4
Lake whitefish	-	-	-	-	-	-	-	-	-	-	-
Lake herring	-	-	-	-	-	-	-	-	-	-	-
Rainbow smelt	-	-	-	-	-	-	-	-	-	-	-
White sucker	-	-	-	-	-	23.0	1.6	-	-	-	-
Common carp	-	-	-	-	-	6.6	-	-	-	-	-
Brown bullhead	3.3	-	-	-	-	13.2	-	-	-	-	-
Burbot	-	-	-	-	-	-	-	-	-	-	-
Rock bass	-	-	-	-	-	32.6	3.3	12.0	1.6	-	-
Pumpkinseed sunfish	-	-	-	-	-	10.9	-	-	-	-	-
Smallmouth bass	-	-	-	-	-	-	11.5	29.6	1.6	-	-
Yellow perch	65.2	-	3.3	-	-	419.9	-	1.6	-	-	-
Walleye	3.3	-	-	-	-	6.6	6.6	4.9	4.9	-	-
Freshwater drum	-	-	-	-	-	-	9.9	1.6	-	-	-

Species-specific catch-per-standard-gillnet lift, Northeast Lake Ontario, 1999 (continued).

	Rocky Point				Wellington				
Species / Depth (m)	40	60	80	100	08	13	18	23	28
Alewife	-	11.5	11.5	1.6	-	46.8	126.1	119.6	28.3
Chinook salmon	-	-	-	-	-	-	-	-	-
Brown trout	-	-	-	-	-	-	-	-	-
Lake trout	6.6	78.9	34.5	23.0	-	-	-	6.6	26.3
Lake whitefish	-	16.4	-	-	-	-	-	-	-
Lake herring	-	-	-	1.6	-	-	3.3	-	-
Rainbow smelt	-	1.6	6.6	3.3	-	-	-	-	-
White sucker	-	-	-	-	-	-	-	-	-
Common carp	-	-	-	-	-	-	-	-	-
Brown bullhead	-	-	-	-	-	-	-	-	-
Burbot	-	1.6	1.6	-	-	-	-	-	-
Rock bass	-	-	-	-	-	20.7	19.7	-	-
Pumpkinseed sunfish	-	-	-	-	-	-	-	-	-
Smallmouth bass	-	-	-	-	-	-	-	-	-
Yellow perch	-	-	-	-	302.9	306.6	130.7	13.2	-
Walleye	-	-	-	-	3.3	-	3.3	-	-
Freshwater drum	-	-	-	-	3.3	-	-	-	-

Appendix B: Catches in the index netting program in eastern Lake Ontario and the Bay of Quinte in 1999.

Species-specific catch-per-standard-gillnet lift, Outlet Basin Lake Ontario, 1999.

	Eastern Basin		Flatt Point				
Species / Depth (m)	30 (02)	30 (06)	8	13	18	23	28
Lake sturgeon	-	-	-	-	-	-	3.3
Alewife	582.8	676.0	282.6	880.4	195.7	1,158.8	1,152.2
Chinook salmon	-	0.5	-	-	-	-	3.3
Brown trout	-	-	-	-	3.3	-	-
Lake trout	38.4	44.4	-	-	9.9	-	42.8
Lake whitefish	7.7	25.2	-	-	-	-	16.4
White sucker	-	-	3.3	3.3	-	-	-
Moxostoma sp.	-	-	-	-	-	-	-
Channel catchfish	-	-	-	-	-	-	-
Stonecat	-	-	-	-	-	-	-
Burbot	-	0.5	-	-	-	-	-
3-Spine stickleback	-	-	-	-	-	-	-
Rock bass	-	-	37.2	3.3	-	-	-
Smallmouth bass	-	-	-	-	-	-	-
Yellow perch	0.5	-	227.8	-	10.9	-	-
Walleye	-	-	-	6.6	-	-	-
Freshwater drum	-	-	-	-	-	-	-

Species-specific catch-per-standard-gillnet lift, Outlet Basin Lake Ontario, 1999 (continued).

	Grape Island					Melville Shoal				
Species / Depth (m)	8	13	18	23	28	8	13	18	23	28
Lake sturgeon	-	-	1.6	-	-	-	-	1.6	-	-
Alewife	580.0	553.3	1,504.9	1,167.6	407.9	96.8	99.5	176.7	122.9	135.9
Chinook salmon	-	-	-	-	-	-	-	-	-	-
Brown trout	-	-	-	3.3	-	-	-	-	-	-
Lake trout	-	-	1.6	3.3	19.7	-	-	-	-	-
Lake whitefish	-	-	-	-	13.2	-	-	-	-	6.6
White sucker	-	-	-	-	-	-	-	-	-	-
Moxostoma sp.	-	-	-	-	-	1.6	1.6	-	-	-
Channel catchfish	-	1.6	-	-	-	1.6	1.6	-	-	-
Stonecat	4.9	-	-	-	-	-	-	-	-	-
Burbot	-	-	1.6	3.3	-	-	-	-	-	-
3-Spine stickleback	-	-	5.4	-	-	-	-	-	-	-
Rock bass	43.6	13.7	10.4	-	-	19.1	16.9	25.2	17.4	3.3
Smallmouth bass	14.8	6.6	-	-	-	4.9	5.4	14.2	-	-
Yellow perch	17.4	280.3	107.0	104.4	-	26.2	199.7	257.2	286.5	23.0
Walleye	23.0	13.2	6.6	-	-	121.7	118.4	47.7	26.3	9.9
Freshwater drum	6.6	-	-	-	-	-	1.6	-	-	-

Appendix B: Catches in the index netting program in eastern Lake Ontario and the Bay of Quinte in 1999.

Species-specific catch-per-standard-gillnet lift, Bay of Quinte, 1999.

	Big Bay	Hay Bay		Conway				
Species / Depth (m)	5	8	13	8	13	20	30	45
Longnose gar	44.4	-	-	1.6	-	-	-	-
Alewife	-	13.2	28.0	3.3	8.2	8.2	4.9	-
Gizzard shad	162.8	13.2	-	-	-	-	-	-
Lake whitefish	-	-	-	-	-	-	16.4	-
Rainbow smelt	-	-	-	-	-	-	-	11.0
Northern pike	3.3	3.3	3.3	-	-	-	-	-
White Sucker	24.7	18.1	34.5	36.2	19.7	37.8	13.2	-
Brown bullhead	70.7	9.9	1.6	-	-	-	-	-
White perch	404.6	342.1	8.2	11.5	11.5	4.9	-	-
Rock bass	-	-	-	77.3	8.2	-	-	-
Pumpkinseed sunfish	37.8	103.6	-	-	-	-	-	-
Bluegill sunfish	8.2	-	-	-	-	-	-	-
Smallmouth bass	3.3	3.3	-	16.4	11.5	-	-	-
Yellow perch	842.1	1,343.8	1,523.0	1,090.5	934.2	952.3	254.9	11.0
Walleye	60.9	80.6	6.6	42.8	34.5	3.3	-	-
Freshwater drum	70.7	23.0	-	6.6	1.6	-	-	-

Seasonal species-specific catch-per-standard-gillnet lift, Bay of Quinte, 1999.

	Big Bay			Hay Bay			Conway		
Species / Season	May/Jun	Jun/Jul	Summer	May/Jun	Jun/Jul	Summer	May/Jun	Jun/Jul	Summer
Longnose gar	3.3	-	44.4	-	-	-	-	-	0.3
Alewife	-	-	-	-	60.9	20.6	-	518.4	5.2
Gizzard shad	-	-	162.8	-	-	6.6	-	-	-
Lake trout	-	-	-	-	-	-	1.5	11.8	1.0
Lake whitefish	-	-	-	-	-	-	5.1	6.6	3.5
Lake herring	-	-	-	-	42.8	1.6	-	0.7	0.7
Northern pike	23.0	6.6	3.3	3.3	13.2	3.3	-	-	-
White sucker	13.2	19.7	24.7	4.9	75.7	26.3	3.7	25.0	22.5
Brown bullhead	9.9	9.9	70.7	-	-	5.8	-	-	-
White perch	171.1	161.2	404.6	1.6	9.9	175.2	-	0.7	5.9
Rock bass	3.3	-	-	1.6	-	-	0.7	6.6	18.0
Pumpkinseed sunfish	3.3	29.6	37.8	-	-	51.8	-	-	-
Yellow perch	2,003.3	1,944.1	842.1	549.3	1,322.4	1,433.4	302.6	483.6	682.1
Walleye	121.7	46.1	60.9	4.9	9.9	43.6	-	11.2	17.0
Freshwater drum	26.3	98.7	70.7	-	-	11.5	-	-	1.7

Appendix B: Catches in the index netting program in eastern Lake Ontario and the Bay of Quinte in 1999.

Species-specific catch-per-trawl, Bay of Quinte, 1999.

	Bay of Quinte					
Species	Trenton	Belleville	Big Bay	Deseronto	Hay Bay	Conway
Alewife	246.1	11.3	19.6	23.5	1,051.3	-
Gizzard shad	131.8	245.9	337.5	36.1	0.8	-
Lake whitefish	-	-	-	-	-	-
Rainbow smelt	-	0.1	-	-	0.1	-
Northern pike	-	-	-	-	-	-
White sucker	1.9	0.8	3.3	0.3	4.7	0.8
Common carp	0.1	0.5	0.1	-	0.1	-
Emerald shiner	-	-	0.4	-	-	-
Spottail shiner	104.5	103.2	26.6	29.7	134.7	-
Brown bullhead	61.3	25.0	61.5	21.9	22.3	-
Channel catfish	-	-	-	-	-	-
American eel	0.1	-	-	-	0.1	-
3-spine stickleback	-	-	-	-	-	-
Trout-perch	0.5	1.2	30.8	0.9	18.5	1.8
White perch	126.3	251.0	329.6	544.6	565.2	-
White bass	0.1	0.4	0.4	-	-	-
Sunfish Family	25.1	18.1	15.4	0.9	-	-
Rock bass	-	-	-	-	0.1	-
Pumpkinseed	113.3	13.8	2.0	17.2	76.9	-
Bluegill	0.4	-	0.1	0.1	-	-
Smallmouth bass	0.3	-	-	1.6	-	-
Largemouth bass	5.4	-	-	0.1	-	-
Black crappie	-	0.5	0.3	0.3	-	-
Yellow perch	101.6	29.0	16.5	803.7	1,488.6	41.4
Walleye	1.7	0.8	3.1	3.3	12.2	0.1
Johnny darter	0.1	-	-	-	-	-
Logperch	0.1	-	-	-	0.3	-
Brook silverside	-	1.3	0.7	2.7	-	-
Freshwater drum	5.4	25.0	9.5	1.3	1.4	-
Slimy sculpin	-	-	-	-	-	-

Appendix B: Catches in the index netting program in eastern Lake Ontario and the Bay of Quinte in 1999.

Species-specific catch-per-trawl, Lake Ontario, 1999.

	Lake Ontario			
Species	EB02	EB03	EB06	Rocky Point
Alewife	60.7	-	24.8	-
Gizzard shad	-	-	-	-
Lake whitefish	0.2	-	0.1	-
Rainbow smelt	4.4	0.9	346.6	161.3
Northern pike	-	-	-	-
White sucker	-	-	-	-
Common carp	-	-	-	-
Emerald shiner	-	-	-	-
Spottail shiner	-	-	-	-
Brown bullhead	-	-	-	-
Channel catfish	-	-	-	-
American eel	-	-	-	-
3-spine stickleback	25.2	37.0	59.5	-
Trout-perch	0.6	3.1	-	-
White perch	-	-	-	-
White bass	-	-	-	-
Sunfish Family	-	-	-	-
Rock bass	-	-	-	-
Pumpkinseed	-	-	-	-
Bluegill	-	-	-	-
Smallmouth bass	-	-	-	-
Largemouth bass	-	-	-	-
Black crappie	-	-	-	-
Yellow perch	-	-	-	-
Walleye	-	-	-	-
Johnny darter	0.1	-	-	-
Logperch	-	-	-	-
Brook silverside	-	-	-	-
Freshwater drum	-	-	-	-
Slimy sculpin	4.1	-	0.1	7.3

Appendix B: Catches in the index netting program in eastern Lake Ontario and the Bay of Quinte in 1999.

Seasonal species-specific catch-per-trawl, Bay of Quinte, 1999.

	Big Bay			Hay Bay		
Species / Season	May/Jun	Jun/Jul	Summer	May/Jun	Jun/Jul	Summer
Alewife	-	-	19.6	0.5	35.5	1,051.3
Gizzard shad	-	-	337.5	-	-	0.8
Lake whitefish	-	-	-	-	-	-
Rainbow smelt	0.2	-	-	1.3	84.7	0.1
Northern pike	0.5	0.2	-	-	-	-
White sucker	0.5	0.2	3.3	1.5	2.5	4.7
Common carp	-	-	0.1	-	-	0.1
Emerald shiner	-	-	0.4	-	-	-
Spottail shiner	1.0	-	26.6	23.0	14.3	134.7
Brown bullhead	-	15.8	61.5	-	0.2	22.3
Channel catfish	0.2	0.2	-	-	-	-
American eel	0.2	1.3	-	-	-	0.1
3-spine stickleback	-	-	-	-	-	-
Trout-perch	0.5	0.5	30.8	107.7	77.7	18.5
White perch	12.3	27.0	329.6	6.5	0.5	565.2
White bass	-	-	0.4	-	-	-
Sunfish Family	-	-	15.4	-	-	-
Rock bass	-	-	-	5.2	0.5	0.1
Pumpkinseed	4.7	63.2	2.0	5.2	-	76.9
Bluegill	-	-	0.1	-	-	-
Smallmouth bass	-	-	-	-	-	-
Largemouth bass	-	-	-	-	-	-
Black crappie	-	-	0.3	-	-	-
Yellow perch	131.0	503.2	16.5	958.3	202.8	1,488.6
Walleye	2.5	4.0	3.1	1.0	-	12.2
Johnny darter	-	-	-	-	-	-
Logperch	-	-	-	-	-	0.3
Brook silverside	-	-	0.7	-	-	-
Freshwater drum	0.2	8.0	9.5	1.3	0.8	1.4
Slimy sculpin	0.2	-	-	-	-	-

Appendix B: Catches in the index netting program in eastern Lake Ontario and the Bay of Quinte in 1999.

Seasonal species-specific catch-per-trawl, Bay of Quinte, 1999 (continued).

		Conway	
Species / Season	May/Jun	Jun/Jul	Summer
Alewife	-	283.0	-
Gizzard shad	-	-	-
Lake whitefish	-	5.2	-
Rainbow smelt	0.2	451.5	-
Northern pike	-	-	-
White sucker	-	0.5	0.8
Common carp	-	-	-
Emerald shiner	-	-	-
Spottail shiner	0.2	-	-
Brown bullhead	-	-	-
Channel catfish	-	-	-
American eel	-	-	-
3-spine stickleback	0.2	-	-
Trout-perch	0.2	137.8	1.8
White perch	-	-	-
White bass	-	-	-
Sunfish Family	-	-	-
Rock bass	-	-	-
Pumpkinseed	-	-	-
Bluegill	-	-	-
Smallmouth bass	-	-	-
Largemouth bass	-	-	-
Black crappie	-	-	-
Yellow perch	-	1.0	41.4
Walleye	-	-	0.1
Johnny darter	0.2	-	-
Logperch	-	-	-
Brook silverside	-	-	-
Freshwater drum	-	-	-
Slimy sculpin	-	-	-

Appendix C: Catches in the index netting program in the Thousand Islands area of the St.Lawrence River 1987 to 1999

Species-specific catch-per-standard-gillnet lift, Thousand Islands area, St. Lawrence River 1987 to 1999.

	1987	1989	1991	1993	1995	1997	1999
Lake Sturgeon	-	-	-	-	-	-	0.02
Longnose gar	-	-	0.02	-	-	0.02	-
Bowfin	0.05	0.06	-	0.04	0.02	0.04	-
Alewife	0.31	-	0.06	0.02	0.02	-	-
Gizzard shad	-	0.23	0.29	-	-	-	0.02
Chinook salmon	-	-	0.02	-	-	-	0.02
Brown trout	-	0.02	-	-	-	-	-
Rainbow trout	-	-	-	-	-	0.02	-
Lake trout	-	0.10	-	0.10	0.08	0.08	-
Lake herring	-	0.02	-	-	0.04	-	-
Northern pike	2.82	3.96	2.75	2.29	1.65	1.52	1.35
Muskellunge	-	-	0.02	-	-	-	-
Esocidae hybrids	-	-	-	-	0.02	-	-
Mooneye	0.03	-	-	-	-	-	-
White sucker	0.69	1.29	0.88	0.94	0.87	0.79	1.13
Moxostoma sp.	-	0.08	0.04	0.08	0.21	-	0.15
Common carp	0.03	0.06	0.06	0.02	0.06	0.23	0.08
Chub	-	0.02	-	-	-	-	-
Golden shiner	0.03	0.02	-	0.04	0.02	-	0.02
Brown bullhead	1.62	1.13	1.56	0.67	0.60	1.21	2.44
Channel catfish	0.51	0.08	0.35	0.10	0.19	0.19	0.35
White perch	0.05	-	0.23	0.02	0.04	-	0.04
White bass	0.03	0.46	0.27	0.15	-	0.04	-
Rock bass	2.62	3.08	3.44	3.02	3.52	3.08	4.77
Pumpkinseed	2.92	3.67	3.68	2.46	1.77	1.52	2.04
Bluegill	0.41	0.48	0.27	0.04	-	0.10	0.04
Smallmouth bass	2.00	3.44	2.73	1.48	0.98	0.94	2.02
Largemouth bass	0.08	0.25	0.08	0.10	0.10	0.02	0.15
White crappie	-	0.04	-	-	-	-	-
Black crappie	0.08	0.08	0.06	0.04	0.02	0.02	0.06
Yellow perch	17.59	10.77	9.75	10.27	14.35	13.50	14.06
Walleye	0.13	0.35	0.21	0.21	0.17	0.38	0.04
Freshwater drum	-	0.02	0.06	-	0.02	0.06	-
Total Catch	32.00	29.71	26.83	22.09	24.75	23.77	28.79