LAKE ONTARIO MANAGEMENT UNIT

1994 ANNUAL REPORT

Ontario
Ministry of Natural Resources
Ministère des Richesses naturelles

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Prepared for the
Lake Ontario Committee Meeting
Great Lakes Fishery Commission
Buffalo, New York
March 21-22, 1995

Copies of this report are available from
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Canada

Report ISSN0838-5653

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Introduction

The Lake Ontario Management Unit (LOMU), is part of the Great Lakes Branch, Operations Division, Ontario Ministry of Natural Resources (OMNR). LOMU is OMNR's lead administrative unit for ecosystem management on Lake Ontario and the St. Lawrence River. Responsibility for program delivery is shared with four OMNR Districts fronting Lake Ontario and the St. Lawrence River. LOMU consists of three functional groups: Management, Operations and Assessment. The 1994 Annual Report emphasizes the results of fisheries surveillance programs completed by the Assessment and Operation groups in 1994, and provides a synopsis of major Management programs.

Primary responsibilities of the Management group include lake-wide management planning, fish community management, fishery allocation and regulation, commercial fishery management, fish stocking, native species restoration, habitat management, Remedial Action Plans, First Nations liaison, and public information/communication and compliance. The Operations group provides administrative and technical support for LOMU, and two research groups attached to the Research Science and Technology Branch of OMNR. Administrative support is also provided to the Warmwater Community Ecologist (Aquatic Ecosystems Branch).

The Assessment group plays a lead role in developing and maintaining OMNR's fisheries surveillance programs and shares a responsibility with Lake Ontario's broader scientific community to transfer science to fisheries management policy. Many of the Assessment group's surveillance activities are done in partnership with New York State Department of Environmental Conservation (NYSDEC), and the United States National Biological Service (NBS), formerly the USFWS. Several programs are integrated with research activities conducted by the Lake Ontario Research group (LOR) and the Great Lakes Salmonid Unit (GLSU).

Below is a brief overview of this report and the Assessment group's approach to Lake Ontario fisheries surveillance, including links to research programs. Significant management programs are also described. Included in Appendix A are lists of assessment project titles, Lake Ontario research projects, LOMU staff, and Glenora associates. Results of the St. Lawrence River surveillance programs are reported in a separate report (Ontario Ministry of Natural Resources and New York State Department of Environmental Conservation 1995).

Overview of Surveillance Programs and Related Activities

Lake Ontario surveillance activities, reported in the seven chapters that follow, are grouped under three section titles: Fish Community Indexing, Resource Use, and Additional Topics. The results reported are of a summary nature. The first two sections emphasize 1994 updates of selected fish population, biological, and fishery indices and statistics. In the final section we report on zebra mussel related studies and habitat management activities. The 1994 Annual Report organization reflects our approach to Lake Ontario fisheries surveillance. The highest priority for LOMU Assessment is to develop and maintain indices of fish population abundance and biological attributes to detect long-term fish community changes. We also provide stock-specific information for species requiring rehabilitation such as lake trout, and economically important species such as walleye, whitefish, and yellow perch. Programs that are designed with this intent are grouped under Section I (Fish Community Indexing) and include programs to monitor pelagic planktivores (Chapter 1), pelagic piscivores (Chapter 2), and eastern Lake Ontario and Bay of Quinte fish communities (Chapter 3). Sampling is designed to obtain indices of abundance and measure biological characteristics such as age, sex, weight, diet, and maturity.

Lake Ontario pelagic planktivore abundance and biological attributes (Chapter 1) are monitored through hydroacoustic and mid-water trawling programs carried out in partnership with NYSDEC. The status of pelagic piscivore populations (Chapter 2) is determined by a fall index gillnetting program targeting lake trout, analysis of sport fish harvest rates for rainbow trout and chinook salmon, and stocking records for all salmon and trout. Also, counts of spawning rainbow trout at the Ganaraska River provide direct enumeration of the size of this stock. Growth and condition of chinook salmon and rainbow trout are monitored at selected spawning runs. Wild migratory salmonid recruitment and year-class strength is determined from stream electrofishing surveys.

Fish community indexing is more intensive in eastern Lake Ontario and the Bay of Quinte. Depth-stratified gillnet and bottom trawling surveys are completed during the summer when there is a tendency for stable water temperature regimes and some separation of cold and warmwater fish assemblages. Three major geographic regions are recognized: Northeastern Lake Ontario, the Outlet Basin, and the Bay of Quinte. Walleye abundance is also determined from catch-age analysis of angler harvest data and periodic mark-recapture studies.

The other principal activity of the LOMU Assessment group is to monitor fisheries resource use. Grouped under Section II (Resource Use) are programs which monitor commercial (Chapter 4) and recreational fisheries (Chapter 5). Commercial fish harvest sampling provides data to manage quota allocations. Commercial harvest sampling also has the potential to provide an independent index of abundance of commercial stocks. The collection of biological data from commercial catches will eventually allow us to fully develop this approach. Recreational fisheries monitoring focuses on the Bay of Quinte walleye fishery and the boat fishery for salmon and trout in western Lake Ontario. Other fishery components are surveyed in some years.

Fishing effort statistics are important for gauging public participation in recreational fishing, and provide feedback to managers on the success of stocking programs. Changes in catch and harvest rates reveal temporal and regional differences in fish population abundances and angler preferences. Catch-age analysis of the Bay of Quinte walleye angling data used to refine trend-through-time estimates of the walleye population size (Chapter 3).

The final section of the annual report is titled Additional Topics. In this section we summarize information from programs designed to enhance our understanding of zebra mussel impacts (Chapter 6). The zebra mussel program indexes the distribution and abundance of zebra and quagga mussel, and thereby documents a case history of their invasion. In Chapter 7 we briefly describe some of Lake Ontario habitat features and highlight ongoing and proposed initiatives for habitat evaluation and management.

Research Links

The LOMU Assessment group shares facilities at Glenora with the Lake Ontario Research group (LOR), under the direction of Dr. John Casselman, and the Great Lakes Salmonid Unit (GLSU), under the direction of Dr. Michael Jones. Both Groups are part of the Aquatic Ecosystems Research Section of the Research, Science and Technology Branch. In addition to acting as resource people on scientific and management issues, a number of research projects have direct application to the management of Lake Ontario (Appendix 1). Before 1992, the LOR was responsible for fish community indexing programs in the Bay of Quinte and Outlet Basin. The Lake Ontario Research group retains responsibility for the management of the historic data, and conducts studies to maintain the continuity of the historic data and augment knowledge of fish community dynamics.

In 1994, studies were continued comparing multifilament and monofilament gillnets. The results will allow direct comparison of current and historical indices of abundance. Field sampling for the seasonal fish community indexing program could not be completed in 1994, but analysis of previous data continued. This program provides information on seasonal fish migration and growth. The LOR group also has an age and growth research program. Of particular relevance to the Assessment group is the development and maintenance of the CSAGES computer software that allows for the capture, archival, and analysis of digitized scale and otolith age interpretation data. In 1994, a number of training session were held at Glenora to continue the transfer of CSAGES technology to LOMU and other provincial fisheries staff. Work on discriminating stocks of lake whitefish based on scale and otolith growth characteristics has enhanced our surveillance and management programs specific to the Bay of Quinte and Lake Ontario stocks. Studies of variation in year-class strength based on the examination of archived calcified tissues of pike provided valuable insight into long-term environmental change and its effects on fish community dynamics in the Bay of Quinte and eastern Lake Ontario. Initial work on the micro-chemistry and age interpretation of archived American eel otoliths has potential to provide clues to the recent declines in eel recruitment.

Lake trout research conducted by LOR is important to understanding factors impeding lake trout rehabilitation in Lake Ontario. Research includes assessment of spawning activity at the Yorkshire Bar historical site, in-situ bioassays to investigate early-life history, and studies to identify naturally produced yearling lake trout by examination of their calcified tissue

The GLSU group has several programs integrated with LOMU surveillance programs. Studies at Wilmot creek, examining salmonid early life history, and competition between Atlantic salmon and resident salmonids are useful in the evaluation of Atlantic salmon restoration efforts. The GLSU developed a rapid assessment technique for measuring salmonid densities in streams. The Assessment group routinely applies this technique to estimate rainbow trout smolt production in Ontario streams (Chapter 2). Studies examining the growth and population dynamics of Ganaraska River rainbow trout augment the fishway surveillance program. The studies provide insights into factors determining the size and age composition of the spawning run and the response of rainbow trout populations to ecosystem change. Updates of the computer models resulting from the SIMPLE project, cochaired by Dr. M. Jones and Dr. J. Koonce (Case Western University) and supported by the Great Lakes Fishery Commission (GLFC) were provided in 1994. This modelling tool predicts the impact of varying levels of fish stocking on population characteristics of salmon, trout, and alewife, and continues to be important in managing the predator-prey balance of Lake Ontario.

We also worked cooperatively with external researchers. Dr. Lars Rudsam, Cornell University, New York, is assisting us in re-analysis of hydroacoustic data from 1991-1994. This will result in standard indices of abundance of pelagic prey for that period and more information on the distribution and abundance of *Mysis relicta*. We are working cooperatively with Dr. Robert Bailey, University of Western Ontario, London, to analyze the recent Bay of Quinte mussel surveys and synthesize past mussel survey information.

In 1994, many LOMU staff participated in the OMNR provincial walleye synthesis. LOMU staff contributions and Lake Ontario surveillance data featured prominently in the syntheses. Staff also participated in a number of workshops including: Provincial Fisheries Assessment Unit Design Review Workshop, Ecosystem Assessment Workshop sponsored by the GLFC, and a Catch-age Analysis Workshop sponsored by the Lake Erie Technical Committee.

Management Programs

Fisheries management activities affecting Lake Ontario and the St. Lawrence River are coordinated from the office of the Lake Manager in Napanee. The management programs described below were of particular significance in 1994.

Commercial Fishery Management

The general approach to commercial fisheries management is to support the commercial fishery while conserving the rehabilitating fish stocks. In addition to supporting stock conservation, licence conditions are intended to reduce problems of incidental catch and conflicts with other resource users. Quota management continues to be an essential component of the commercial fishery program. In 1994, significant increases in quotas for lake whitefish reflected substantial recovery of this species in eastern Lake Ontario. There were also small increases in walleye and lake herring quotas. Continued concern about the status of eel and yellow perch stocks resulted in reduced 1994 quotas for these species. In 1994, further expansion of gillnet seasons for lake whitefish was permitted through cooperative "test fishing" programs. A more detailed account of commercial fish management, harvest, and biological characteristics of the harvest can be found in Chapter 4. A royalty of two percent of the value of the commercial fish harvest was implemented on January 1, 1994. Negotiations were initiated with the local industry to establish procedures for introduction of a daily catch reporting (DCR) system in 1995.

Compliance Programs

Compliance activities conducted by LOMU conservation officers are primarily associated with fisheries legislation and regulations. In the commercial fishery, emphasis is placed on ensuring compliance with licence conditions and quota management, promoting ethical fishing practices, and resolving conflicts with other resource users. In 1994, major investigations were conducted into over-quota violations and illegal marketing of eels with elevated contaminant levels. Enforcement of the sport fishing regulations concentrated on the Bay of Quinte walleye fishery, Outlet Basin smallmouth bass fishery, and western Lake Ontario salmon and trout fishery. Compliance directed at shore angling, seasonal spawning runs and nearshore angling in the Bay of Quinte and Niagara area relied on liaison and cooperation with OMNR District and Area Teams.

Review of Eastern Lake Ontario Walleye Angling Regulations

At the request of resource users, LOMU conducted a review of walleye angling regulations for eastern Lake Ontario, with special emphasis on creel limits for the Bay of Quinte. The review included consultation with representatives of the Ontario Federation of Anglers and Hunters, local anglers, commercial fishermen, tourist operators and the Tyendinaga First Nation. In light of the various stresses acting on walleye stocks, including increased harvest by anglers and Tyendinaga Band members, and potential impacts of zebra mussel proliferation, OMNR recommended a cautious approach to changing angling regulations. Based on the consensus achieved through the consultation exercise, there will be no change in the daily catch and possession limit for Bay of Quinte walleye in 1995.

Fish Habitat Management

LOMU is involved in fish habitat management in a broad planning and advisory role. The greatest level of activity is in designated Areas of Concern (AOCs) through the Remedial Action Plan (RAP) process. LOMU staff have provided input on fish habitat for planning exercises of other agencies such as the Canadian Coast Guard, Environment Canada and the NBS. LOMU also contributed to the shoreline management strategy of the Waterfront Regeneration Trust, for the Lake Ontario shoreline from Burlington to Trenton. OMNR District and Area Teams are responsible for review and approval functions relating to shoreline alteration. However, LOMU staff serve in an advisory capacity for large scale proposals and those which have potential offshore or deepwater implications.

Remedial Action Plans (RAPs)

The Lake Ontario Management Unit is responsible for coordinating OMNR's participation in Remedial Action Plans for the Niagara River, Hamilton Harbour, Metro Toronto, the Bay of Quinte and the St. Lawrence River. The focus of OMNR's participation in these RAPs is on restoration of degraded aquatic habitat, with special emphasis on protection and enhancement of fish habitat and the associated fish community. Surveillance programs in support of the Bay of Quinte RAP, are integrated with LOMU's assessment program (Chapter 3 and 7). For most RAPs, OMNR District and Area Offices are directly involved with inter-agency RAP Teams in the planning and delivery of surveillance and remediation activities. Principal areas of involvement include fish community and habitat monitoring, habitat rehabilitation projects and partnerships with other government agencies, non-government organizations, and the public.

Liaison with First Nations

The Unit is involved in fisheries management programs associated with Tyendinaga and Akwesasne First Nations. Fish stock status and resource use information are provided to aboriginal liaison specialists of MNR's Tweed and Kemptville Districts. In 1994, LOMU staff were directly involved with First Nations in information exchange, providing advice and assistance with fisheries projects, and through cooperative RAP projects. The Unit was also involved in deliberations regarding the conservation implications of aboriginal harvest. A cooperative program involving Tyendinaga LOMU and Napanee Area staff monitored the spring walleye harvest by Tyendinaga Band members on Bay of Quinte tributaries in 1994.

Lake Trout Rehabilitation

The Joint Plan for the Rehabilitation of Lake Trout in Lake Ontario provides background and direction for lake trout rehabilitation. In light of recent ecological changes in Lake Ontario and associated reductions in stocking of hatchery-reared lake trout in 1993 and 1994, OMNR, NYSDEC and NBS are committed to a review and update of the joint plan. The cooperative monitoring program of these agencies, which collects data on abundance, survival and population structure of lake trout, is reported in Chapter 2. Several naturally reproduced yearling lake trout were captured in both Canadian and U.S. waters during 1994 monitoring programs.

Atlantic Salmon Restoration

OMNR has been involved in an Atlantic salmon restoration program on Lake Ontario since 1987, with stocking of hatchery-reared fish at Credit River and Wilmot Creek. Adult returns to these sites to date have been disappointing. An OMNR working group, led by LOMU has completed a comprehensive review of the Atlantic salmon program, including an evaluation of ecological feasibility and consultation with a range of stakeholders. As a result of the review, OMNR intends to refocus the program. Emphasis will be placed on learning more about the ability of early life stages of Atlantic salmon to cope with existing stream habitat and inter-specific competition (i.e., rainbow trout). This involves a renewed commitment to the Great Lakes Salmonid Unit (GLSU). Additional research sites are planned for Ganaraska River and Duffins Creek for 1995.

Acknowledgements

The authors gratefully acknowledge the support provided by several individuals and groups that made this report possible. Many studies would not have been complete without the support of our Great Lakes partner agencies. The Operations group at Glenora provided the necessary administrative and technical support required to complete field programs, enter data, move the mail, and keep the facilities functioning. Carol Ward assisted with the editing and Kelly Sarley completed the formatting. Many anglers and commercial fishermen supplied information and fish samples. Field, laboratory, and administrative assistance was provided by individuals participating in the Environmental Youth Corps, Ranger II, Summer Experience, and Co-operative Education Programs. A number of projects were funded by the Canada-Ontario Agreement.

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Pelagic Planktivores

T. Schaner
C.P. Schneider[1]

Overview

Alewife (*Alosa pseudoharengus*) and rainbow smelt (*Osmerus mordax*) are the principal pelagic planktivores in Lake Ontario. They are the main prey of large salmonines, and alewife are also important in the diet of walleye. Over the past decade we have witnessed a slow decline in the numbers of alewife and smelt, which can be attributed to two factors. Firstly, the nutrient loading into the lake has decreased as a result of better sewage treatment, and better land use practices in the watershed. Secondly, the artificial stocking of large salmonines has, until recently, been increasing. As a result, alewife and smelt found themselves squeezed between reduced plankton productivity (the main part of their diet) and increased predatory pressure. The situation has recently been further aggravated by the accidental introduction of the zebra and quagga mussels, which tend to divert the energy flow from the pelagic to the benthic community.

Concern for the declining prey populations has prompted management agencies around the lake to cut down stocking of salmonines starting in 1993. The objective was to reduce the predatory pressure on alewife and smelt by a half. Due to the varying life histories of the stocked salmonines, the reduction in prey demand can only be achieved gradually, and it still remains to be seen whether the stocking reductions were sufficient to allow prey populations to sustain themselves. With the concern for the prey populations on one hand, and a mandate to maintain fishing opportunities on the other, careful management and monitoring of the prey fish is critical.

Ontario Ministry of Natural Resources (OMNR), in cooperation with New York State Department of Environmental Conservation (NYSDEC), conducts hydroacoustic surveys covering both the Ontario and the New York sides of the lake. Most of the information in this chapter comes from these surveys. The U.S. National Biological Survey (NBS) cooperates with NYSDEC to conduct annual bottom trawl surveys to assess alewife and smelt in the U.S. waters of the lake. The results of these surveys form a valuable seventeen year data series that provides an independent assessment, and an historic context for our own observations.

The 1994 hydroacoustic estimate shows a possible further reduction in abundance of pelagic planktivores. Of particular concern is the alewife population, with two consecutive missing year-classes, followed by a year-class of young-of-the-year (YOY) fish that will probably also be reduced by next summer.

Hydroacoustic Surveys

For four years now, the OMNR and NYSDEC have conducted spring, summer, and fall hydroacoustic surveys covering the entire lake. Each survey consists of six cross-lake transects (Fig. 1), during which we collect continuous acoustic data, midwater trawl samples of pelagic prey fish, and temperature profiles.

The acoustic data are collected at night, starting at the 10 m depth at one shore and continuing across the lake until the 10 m depth is reached at the opposite shore. The acoustic equipment is set to process signal down to a depth of 100 m. although few fish are generally found deeper than 50 m. With the present configuration we can measure fish from 1 m off the bottom to within a few metres below the surface. At night when the sampling is done, the bulk of the prey

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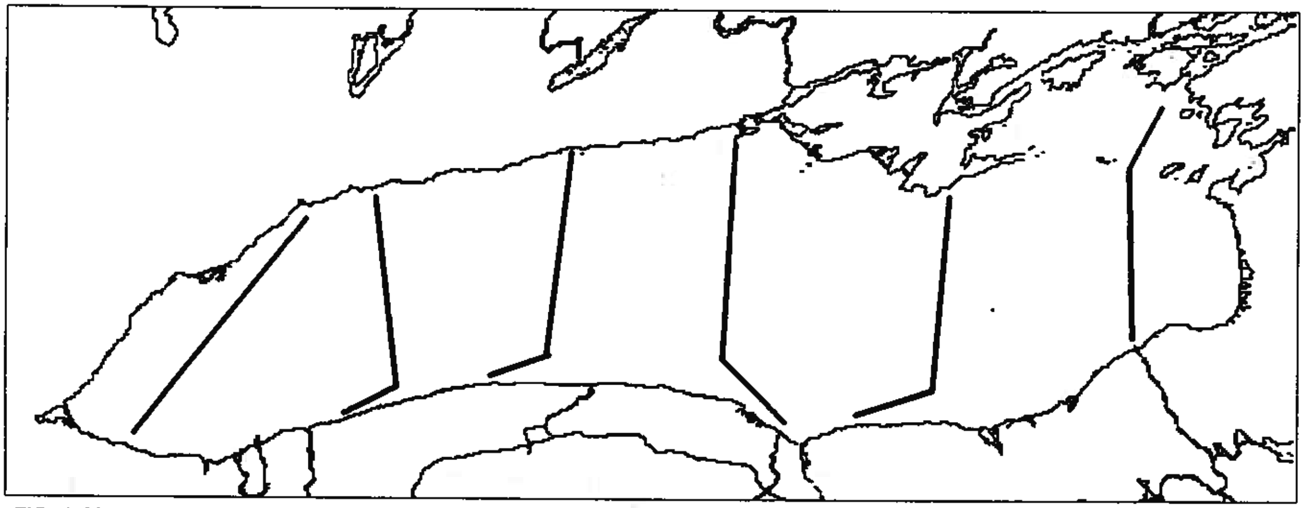

FIG. 1. Map of Lake Ontario showing the hydroacoustic transects sampled in 1994.

fish population is found in the water column, and therefore the lack of coverage near bottom does not present a problem. Our current inability to obtain near-surface data, however, may lead to an underestimate.

A trawler accompanies the hydroacoustic boat, sampling fish from scattering layers detected with the echo sounder. The catches from midwater trawls are used to establish species and size composition of the acoustically detected fish. As a further aid in interpreting the acoustic data, we also measure water column temperature profiles, since both alewife and smelt often exhibit strong temperature preferences.

Previous Hydroacoustic Estimates

In the spring of 1994 we discovered that our 420kHz equipment exhibited a significant attenuation of the sound signal in the water column. Traditionally, signal attenuation in fresh water is considered to be negligible, however, in Lake Ontario, the hydroacoustic estimates are sensitive to small differences in target size between *Mysis* and YOY alewife and smelt. We compensated for attenuation in the 1994 summer and fall estimates, but the echosounder recordings from previous surveys had to be reprocessed, and the new information has not yet been analyzed. Therefore, the 1994 hydroacoustic estimate is reported here without reference or comparison to previous surveys.

Acoustic Estimates

The October 1994 acoustic estimate of pelagic prey-size targets was 4.5 billion. This number breaks down into 3.3 billion YOY-size targets, and 1.2 billion larger targets. However, 74% of the YOY-size targets were detected in the offshore hypolimnetic waters, where YOY alewife and smelt are not normally found. We suspect that some of these targets, possibly a large portion, are *Mysis*, and therefore the estimate of 3.3 billion YOY fish should be reduced. Eliminating all hypolimnetic YOY-size targets gives us an estimate of 2 billion fish, composed of 848 million YOY fish and 1.2 billion older fish. This should be considered as a minimum estimate.

Trawl Catches

The catches made in midwater trawls that accompany the hydroacoustic data collection are used to interpret the acoustic abundance estimates. The catch-per-unit-effort statistics from these trawls should be interpreted with caution, because the trawling schedule is not intended to provide an unbiased index of abundance--we frequently trawl through conspicuous concentrations of fish to establish their size and species composition. Nevertheless, we attempt to represent all depths and areas of the lake, and it appears that the information on relative abundances of various size groups of fish is consistent between successive surveys, and with other sources of information.

Alewife

The October surveys provide the first look at the new year-class of YOY fish. In October 1994, we saw an unusual size distribution of small alewife (Fig. 2). In the Kingston Basin we caught alewife in the 50 to 90 mm range, while in the rest of the lake, especially in the New York waters, we caught small alewife in the 30 to 50 mm range. The smaller fish were obviously YOYs, but we have some doubts about the age of the larger fish. Our previous experience tells us that in October the size of YOY fish should approximately correspond to the size of the larger group (50-90 mm). Observations on a sample of fish caught by the NBS in the New York waters near Oswego at approximately the same time, suggest that indeed there may have been a bimodal size distribution of the 1994 YOY alewife. On the other hand, assuming that the growth rate of young alewife is decreasing, as we saw the previous year, and taking into account size-selective predation by salmonines, it is conceivable that last October there were yearling alewife less than 90 mm long. Age structures collected during the October survey, but not yet processed, will resolve the question.

The 1993 year-class of alewife appears to have successfully survived the winter of 1993-94, but failed to survive the following spring and summer. Our initial assessment of this group came from the 1993 October survey, when we saw them as YOY fish. They appeared to be abundant but small, and therefore the prognosis for survival through the unusually cold winter was not good. During the 1994 spring survey we were surprised to catch good numbers of these fish, now yearlings, in all parts of the lake. However, during our 1994 summer and fall surveys they were largely missing (with the possible exception of Kingston Basin, see above). We do not know what caused the disappearance of this year-class — the two likely factors would be predation, and loss of fitness caused by their small size in combination with a cold winter.

The bulk of the older fish seen in all three 1994 surveys were 3-yr-olds and older. The absence of 2-yr-olds was marked by the lack of fish in the 110 mm range. This was a further confirmation of observations first made in October 1992, and later in all three 1993 surveys, in which the 1992 year-class was essentially

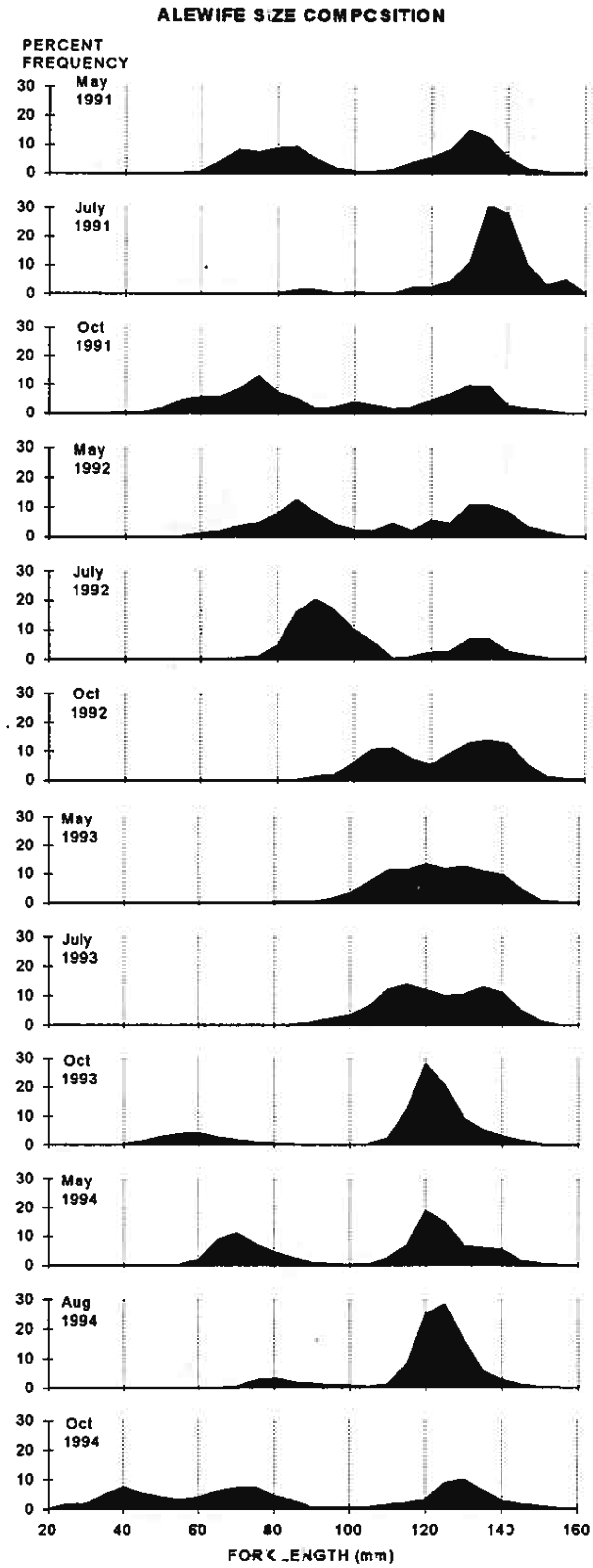

FIG. 2. Length frequency distribution of alewife from midwater trawls.

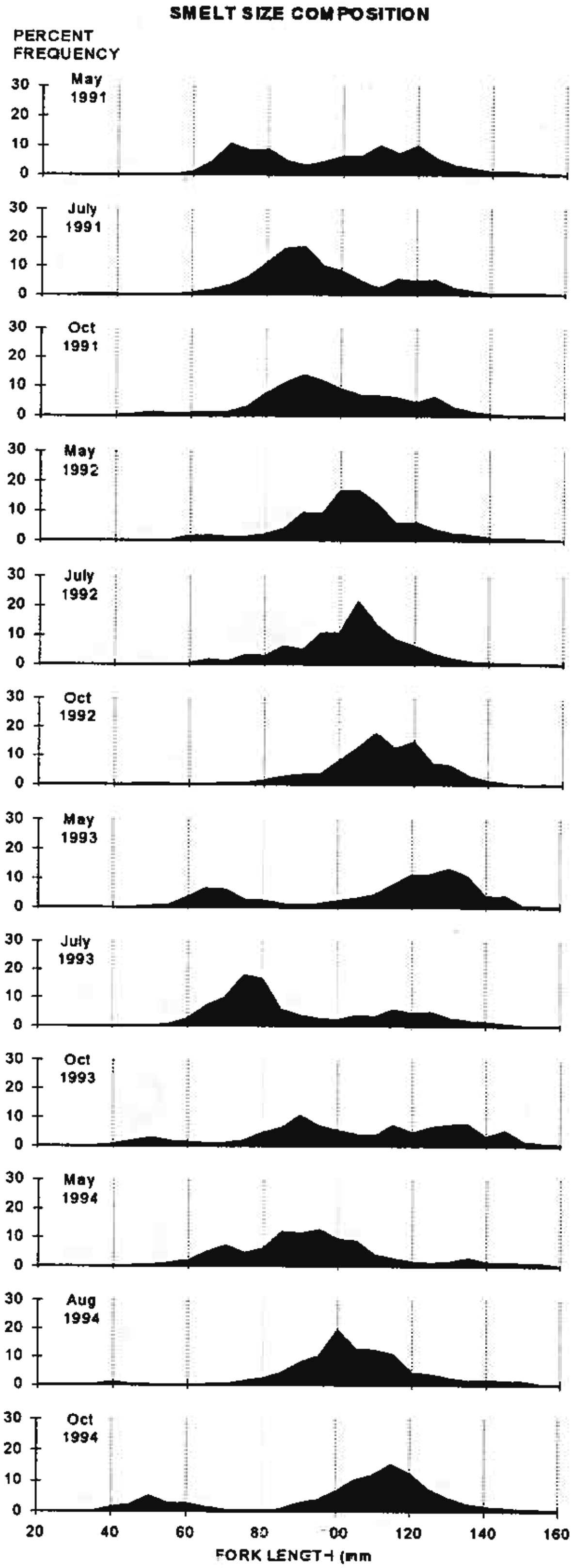

FIG. 3. Length frequency distribution of smelt from midwater trawls.

missing from the catches. We suspect that in 1992 there was a reproductive failure, or high mortality of YOY fish during their first summer.

Smelt

The smelt catches in the 1994 spring survey consisted largely of yearlings and 2-yr-old fish (Fig. 3). In the subsequent summer and fall surveys, however, the yearling smelt disappeared similar to yearling alewife, and the bulk of the summer population of smelt was made up of 2-yr-old fish. In the fall survey we caught relatively good numbers of YOY smelt in the 40 to 60 mm range, suggesting a successful 1994 year-class.

Discussion

Results of the 1994 surveys confirm our continued concern for the state of the pelagic prey stocks. Alewife, the more abundant of the two species, will essentially be missing two year-classes in 1995. The 1992 year-class (3-yr-olds in 1995) was very weak from the onset, and the 1993 year-class (2-yr-olds in 1995) was reduced as yearlings in the early part of 1994. Our first look at the 1994 year-class showed that these YOYs were unusually small, and previous experience indicates that they may suffer high over-winter mortality, since alewife smaller than approximately 50 mm fork length do not normally survive the winter (R. O'Gorman, U.S. Dept. of the Interior, Oswego Biological Station, Oswego, New York 13126, personal communication). The pessimistic scenario for 1995 is that an old population of alewife, 4-yr-olds and older, will bear most of the predation pressure in the summer of 1995. The optimistic scenario is that the 1994 year-class will survive the winter to help shoulder the predation pressure in 1995, but will be reduced in the process, similar to the previous year-class a year earlier. In either case, this will result in a much reduced population of spawning adults in 1995 and beyond.

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Pelagic Piscivores

Michael Rawson
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Overview

This chapter describes the status of the pelagic piscivore community in Lake Ontario. Salmon and trout (salmonines) are the primary members of this community. These species are both ecologically and economically important. They are actively sought by anglers participating in a multi-million dollar recreational fishery. As terminal predators in the Lake Ontario food web, their growth and production are dependent on an adequate supply of alewife and smelt. Currently the status of these prey species is uncertain. Efforts are also underway to rehabilitate lake trout and consideration is being given to the restoration of Atlantic salmon.Therefore, monitoring of the pelagic piscivore community is important to the management of Lake Ontario's aquatic ecosystem. In this chapter we report on the status of the most abundant salmonines, chinook salmon, lake trout and rainbow trout.

Most of the salmonines in Lake Ontario are stocked. Thus, stocking numbers provide a reasonable indicator of recruitment to the pelagic piscivore community. Salmonine stocking in Lake Ontario was reduced substantially in 1993 and 1994 by the Ontario Ministry of Natural Resources (OMNR) and New York State Department of Environmental Conservation (NYSDEC). These actions were taken in response to declines in zooplankton and planktivorous prey fish over the past decade. The stocking reductions are expected to result in a 45-50% reduction in the consumption of prey fish by 1996.

For adult chinook salmon and rainbow trout we have traditionally used angler harvest rates from the boat angler fishery as an index of abundance. A series of fishing derbies drives the boat angler fishery and targets angler effort on chinook salmon and rainbow trout (Chapter 5). The harvest rate of chinook salmon in 1994 was 10% less than in 1993 but 8% higher than the recent 5-yr mean. A decline in the harvest rate of 1-yr-old chinook salmon may have resulted from the stocking reductions of the 1993 year-class.

The harvest rate of rainbow trout in 1994 was unchanged from 1993 but was 19% lower than the recent 5-yr mean. Counts of rainbow trout at the Ganaraska River fishway are monitored in cooperation with OMNR Tweed District (Oak Ridges Moraine Area Team). In 1994, the number of rainbow trout declined only slightly following a 50% decline from the peak in 1989.

The juvenile salmonine stream index program was conducted for a second year. This program is carried out in cooperation with the Great Lakes Salmonid Unit (GLSU). This program indexes year-class strength and recruitment for wild salmonine populations in Lake Ontario. Abundance of young-of-the-year (YOY) rainbow trout was significantly less than in 1993 but yearling abundance was unchanged.

Lake trout populations were monitored to document the progress of the rehabilitation effort based on the Joint Plan for Rehabilitation of Lake Trout in Lake Ontario (Schneider et al. 1983). Most of our information regarding lake trout in Lake Ontario comes from a cooperative gill net program conducted in the fall by the OMNR, NYSDEC, and the United States National Biological Service (NBS). The year 1994 marked the twelfth survey in New York waters, and the tenth survey since OMNR joined the effort. The annual progress report is summarized here. Indices of lake trout status such as catch-per-unit-effort, lamprey wounding rate, and body condition indicate a stable population Survival rate remains above the rehabilitation target level of 60%. Of particular significance in 1994 was the increased number of naturally reproduced lake trout. A detailed discussion of lake trout status is reported by Schneider et al. (1995).

Growth and condition of lake trout, rainbow trout, and chinook salmon were monitored to index the availability of their prey. In 1994, condition of chinook salmon and rainbow trout continued to increase and lake trout remained unchanged following a period of decline in the mid-1980s. In contrast, the mean size of 1-yr-old chinook salmon in the angler harvest suggests that growth rates have been lower in recent years. The mean size of spawning chinook salmon and rainbow trout declined from 1993 to 1994.

Stocking

Changes in Lake Ontario over the past decade have resulted in a situation where the food consumption by salmonines (predator demand) likely exceeds the sustainable supply of their principal prey, alewife and smelt (Anonymous 1992). In response to these changes OMNR and NYSDEC reduced stocking by approximately 50% from 1991 stocking levels. In 1994 OMNR and NYSDEC together stocked a total of 4,635,000 salmonines (Table 1 and 2).Chinook salmon continued to dominate stocking followed by

TABLE 1. Salmon and trout stocked into Province of Ontario waters of Lake Ontario in 1991-94, and target stocking numbers for 1995.

Species	Age	Number of Fish Stocked 1991	1992	1993	1994	Target Number 1995
Atlantic salmon	Yearling	28,495	34,758	42,366	49,502	0
	Fry	0	0	15,000	17,310	160,000
	Subtotal	28,495	34,758	57,366	66,812	160,000
Brown trout	Yearling	380,914	257,366	191,591	227,996	170,000
	Fall Fingerling	145,039	0	25,000	7,500	50,000
	Spring Fingerling	0	0	1,867	0	0
	Subtotal	525,953	257,366	218,458	235,496	220,000
Coho salmon	Yearling	148,006	0	0	0	0
	Fingerling	2,950	0	0	0	0
	Fry	275,511	0	0	0	0
	Subtotal	426,467	0	0	0	0
Chinook salmon	Fingerling	593,631	604,755	500,784	474,981	450,000
Lake trout	Yearling	1,092,196	931,226	567,988	533,131	520,000
	Fingerling	0	195,074	0	0	0
	Adult	0	0	0	1,816	0
	Subtotal	1,092,196	1,126,300	567,988	533,131	520,000
Rainbow trout	Yearling	125,070	64,378	35,850	28,000	100,000
	Fall Fingerling	62,249	226,286	179,839	300,975	200,000
	Subtotal	187,319	290,664	215,689	328,975	300,000
LAKE TOTAL		2,854,061	2,313,843	1,560,285	1,639,395	1,650,000

TABLE 2. Salmon and trout stocked into New York waters of Lake Ontario in 1991-94, and target stocking numbers for 1995.

Species	Age	Number of Fish Stocked 1991	1992	1993	1994	Target Number 1995
Atlantic salmon	Yearling	178,000	169,305	135,280	150,550	162,500
	Fingerling	0	0	30,000	37,500	37,500
	Subtotal	178,000	169,305	165,280	188,050	200,000
Brown trout	Yearling	381,880	415,170	445,350	401,640	425,000
	Fall Fingerling	0	0	0	0	0
	Subtotal	381,880	415,170	445,350	401,640	425,000
Coho salmon	Yearling	97,000	94,100	95,670	91,590	90,000
	Fingerling	131,750	445,000	99,970	223,000	155,000
	Subtotal	228,750	539,100	195,640	314,590	245,000
Chinook salmon	Fingerling	2,835,000	2,798,215	1,603,300	1,000,000	1,000,000
Lake trout	Yearling	818,090	507,580	498,400	507,000	500,000
	Fingerling	160,000	0	0	5,066	0
	Subtotal	978,090	507,580	498,400	512,066	500,000
Rainbow trout:						
Washington Steelhead	Yearling	519,300	430,000	379,930	415,250	431,000
	Fingerling	215,000	0	0	0	0
	Subtotal	734,300	430,000	379,930	415,250	431,000
Domestic	Yearling	81,550	84,850	88,020	92,000	100,000
	Fingerling	28,900	0	0	0	0
	Subtotal	110,450	84,850	88,020	92,000	100,000
Skamania	Yearling	32,000	84,780	74,000	72,150	82,000
Rainbow trout	Subtotal	876,750	599,630	541,950	579,400	613,000
LAKE TOTAL		5,478,470	5,029,000	3,449,920	2,995,746	2,983,000

lake trout, rainbow trout, and brown trout (Fig. 1). Detailed information about stocking in 1994 by OMNR appears in Appendix B.

The purpose of the stocking reductions was to decrease predator demand by 45-50% by 1996. Due to the effect of fish stocked in earlier years, the reduction in predator demand lags behind the reductions in stocking. The stocking reductions in 1993 and 1994 were expected to reduce predator demand by 10% in 1994, 29% in 1995, but the full effect will not occur until 1996 (Fig. 2). Predator demand will be managed at this level for the immediate future unless observations of prey population status suggest that a change is required.

A target stocking number for each species was identified by OMNR for 1994. The target was based on

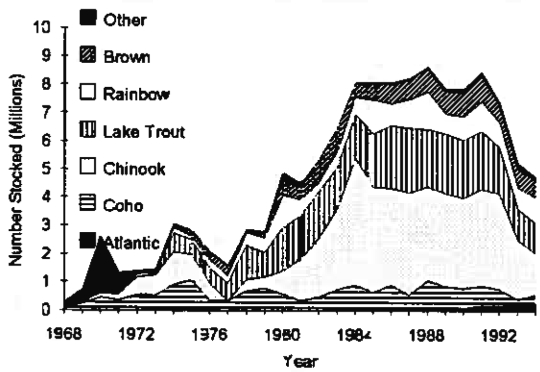

FIG. 1. Lake Ontario stocking trends by species.

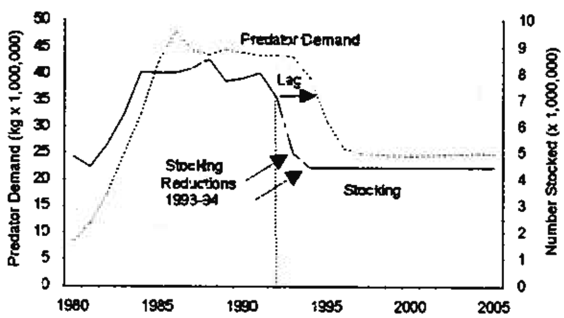

FIG. 2. Number of salmon and trout stocked by Ontario and New York combined and the estimated predator demand of all salmon and trout in Lake Ontario by year. Predator demand was estimated using the SIMPLE model (Jones et al. 1993).

the desired reduction in predator demand, species preferences by anglers, and a continued commitment to lake trout rehabilitation and maintenance of an Atlantic salmon program. Extensive public consultation in 1992-93 indicated that anglers had the greatest interest in chinook salmon but there was considerable support for a diverse salmonine community including rainbow trout, brown trout, lake trout, and Atlantic salmon.

Stocking of chinook salmon by OMNR in 1994 was 5% above the target level of 450,000 fingerlings. Chinook salmon were stocked at 10 locations along the Lake Ontario waterfront to support fisheries from Port Dalhousie to Wellington. The largest number of chinook salmon was stocked into the Credit River to ensure adequate returns of mature fish for spawn collection.

OMNR stocked 534,000 yearling lake trout in 1994 which was only 3% above the target of 520,000 yearlings. Despite a 50% reduction from 1991 stocking levels, OMNR remains committed to lake trout rehabilitation in Lake Ontario. Lake trout stocking was concentrated in eastern Lake Ontario where much of the potential spawning habitat for lake trout exists. Lake trout were also stocked at Fifty Mile Point and Cobourg Harbour because of the proximity to historical nearshore spawning shoals.

OMNR is shifting the genetic strain composition of lake trout stocked into Lake Ontario. Historically, Slate Island (Lake Superior) was the most readily available strain from OMNR's fish culture system. Preliminary evidence suggested that the Seneca Lake strain was a principal contributor to the limited natural reproduction in Lake Ontario, and in future this strain will be emphasized. In 1994, nearly 8% of the fish stocked were from the Seneca Lake strain with the remainder being Slate Island strain. The proportion of Senecas stocked into Lake Ontario are expected to increase as brood stock is further developed and managed for greater production. By 1997, approximately 50% of lake trout will be Seneca Lake strain with the remainder being equal proportions of Slate Island, Michipicoten, and Mishibishu strains.

The stocking target for rainbow trout was 135,000 yearlings in 1994. Fish culture production supplied 28,000 yearlings and 301,000 fall fingerlings. Because of lower survival for fall fingerlings, the total stocking was equivalent to an estimated 76,000 yearlings. The fall fingerlings and spring yearlings were stocked in paired experimental releases to determine their relative survival rates. Stocking locations were primarily at the west end of the lake. Rainbow trout stocking into the Humber and Rouge Rivers was strategically located in the watersheds to support OMNR's District Watershed Management Plans. Much of the rainbow trout fishery east of Toronto is supported by wild populations that reproduce naturally in Lake Ontario tributaries. Rainbow trout are not stocked in these tributaries in order to avoid the negative impacts of stocking on top of naturally reproducing populations.

OMNR stocked 179,500 yearling brown trout which was only 500 fish below the 1994 target. In addition, 56,000 fall fingerlings were stocked in a paired experimental release to determine the relative survival rate of spring yearlings and fall fingerlings. Brown trout were stocked at 11 locations from Port

Dalhousie to Collins Bay. The largest proportion of brown trout was stocked into the west end of the lake to support the areas that have shown the best returns to the angler harvest.

The 1994 Atlantic salmon target number of 50,000 yearlings was stocked Yearling Atlantic salmon were stocked into the Credit River and Wilmot Creek in an attempt to develop spawning runs for egg collection. A review of the Lake Ontario Atlantic salmon program by OMNR determined that the yearling stocking program was not successful and will not continue after 1995. Over the next several years stocking will support an experimental approach to determine the potential of successfully restoring Atlantic salmon into Lake Ontario. In 1994, 17,000 fry were stocked into Wilmot Creek for these experiments.

Chinook Salmon Status

Abundance Trends

The harvest rate of chinook salmon in the boat angler fishery was 10% lower in 1994 than in 1993, but was 8% higher than the recent 5-yr mean. Harvest rate peaked in 1986 because of stocking increases in the early 1980s, but declined through the late 1980s despite continued high stocking numbers. Analysis of harvest-at-age suggests that survival of stocked fish to recruitment has declined during the period of high abundance in the late 1980s (Bowlby et al. 1994).

The total harvest rate was separated into components for 1- and 2-yr-old and older fish to examine the effect of stocking reductions in 1993. The harvest rate of 1-yr-old fish declined by 42% from 1993 but was comparable to values seen in the early 1990s (Fig. 3). The proportion of 1-yr-old fish in the harvest declined as well. While these declines are consistent with reduced stocking, they may have been affected by other factors influencing angler selectivity or catchability. Stocking reductions have not affected the abundance of 2-yr-old and older fish in 1994. Their harvest rate increased by 24% over the 1993 value. A decline in the harvest rate of 2-yr-old and older chinook salmon resulting from reduced stocking is not anticipated until 1995 at the earliest.

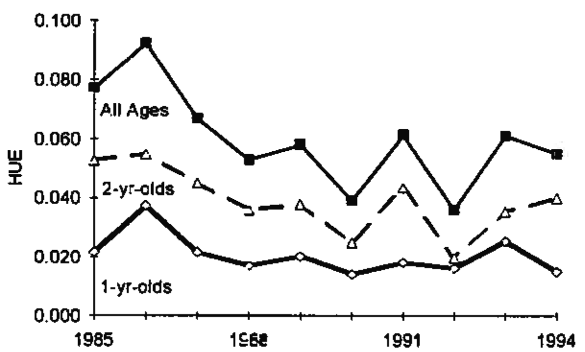

FIG. 3. Age-specific harvest rate of chinook salmon by boat anglers in the Ontario waters of Lake Ontario. The 2-yr-old category includes all fish 2-yr-old and older.

Growth and Condition Trends

In recent years, the mean size of 1-yr-old chinook salmon in the boat angler harvest has declined (Fig. 4). The mean length of 1-yr-old chinook salmon was estimated from the August and September harvest size distributions using MIX software (MIX 1988). Mean lengths in 1990, 1993, and 1994 were below the historical values. Reduced growth was also reported by Bishop (1994a) for 1-yr-old male chinook salmon returning to the Salmon River in 1990 and 1993.

The chinook salmon spawning run was monitored in the Credit River at the Streetsville Dam. The length and weight of male and female chinook salmon were monitored for those fish selected for the Ringwood Fish Culture Station spawn collection. The mean length and weight of 2-year-old and older fish in 1994 were slightly smaller than in recent years. Mean weight of males declined by 13% and females declined by 7%. Body condition was determined as the mean weight after adjusting for length using analysis of covariance as outlined by Dimond and Bowlby (1992). Condition was highest in the early 1980s and then

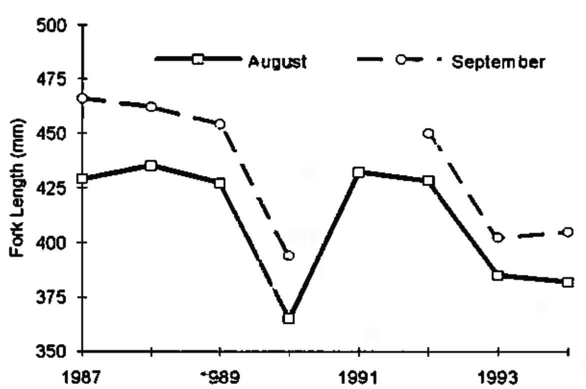

FIG. 4. Mean length of 1-yr-old chinook salmon harvested by boat anglers in the Ontario waters of Lake Ontario.

declined to a relatively stable level since 1989 (Fig. 5). In 1994, condition increased significantly from 1993 for males but did not differ for females.

Rainbow Trout Status

Abundance Trends

The harvest rate of rainbow trout in the boat angler fishery did not differ significantly from 1993 but it remained low relative to the harvest rates prior to 1991. Since the large majority of the harvest occurs east of Toronto, harvest rate primarily reflects the dynamics of the fishery in that area. Counts of spawning rainbow trout at the Ganaraska River fishway also index abundance trends. In 1994 these counts declined to 7700 fish. Both the boat angler harvest rate and the fish counts at the Ganaraska River fishway suggest a decline in the abundance of rainbow trout in recent years (Fig. 6) although the close correspondence of the two indices may be spurious.

Rainbow trout seasonal and areal distribution patterns are not well understood in Lake Ontario and may differ considerably between years. For example, in 1994 the harvest rate declined by 62% in the areas west of Toronto and increased by 58% east of Toronto, compared to 1993 values. The harvest in Ontario waters consists of naturally reproduced fish as well as fish stocked by both OMNR and NYSDEC, although fish with OMNR clips have been less than 5% of the harvest in recent years. Results from a recent tagging survey indicate that fish stocked in eastern New York tributaries contribute to the open-water harvest in Ontario waters east of Toronto (Bishop 1994b). While rainbow abundance measures have declined in Ontario recently, harvest rates in New York waters have reached record high levels in three consecutive years (Eckert 1995).

Growth and Condition Trends

Biological attributes of the rainbow trout spawning run were also monitored at the Ganaraska River fishway. The mean length and weight of fish in the spawning run declined in 1994. Body condition was highest in the early 1980s and has declined to a relatively stable level since 1989 (Fig. 7). Body condition increased significantly from 1993 to 1994 for males but did not differ for females.

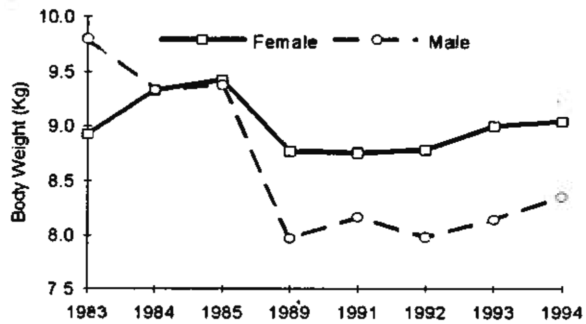

FIG. 5. Body condition of chinook salmon during the fall spawning run in the Credit River. Body condition was determined as the mean weight after adjusting for differences in length, using analysis of covariance.

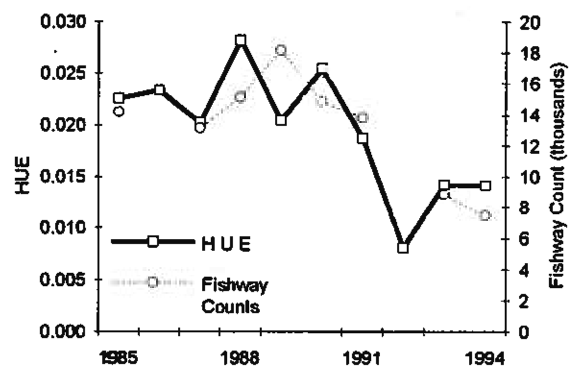

FIG. 6. Harvest rate of rainbow trout by boat anglers in Ontario waters of Lake Ontario and the number of rainbow trout passing through the fishway on the Ganaraska River during April and May.

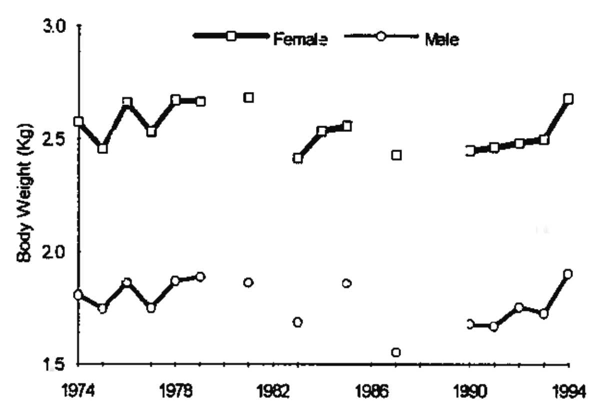

FIG. 7. Body condition of rainbow trout during the spring spawning run in the Ganaraska River. Body condition was determined as the mean weight after adjusting for differences in length, using analysis of covariance.

Stream Recruitment Index

In 1994, we sampled 39 of the 40 sites established in 1993 on streams along the northern shore of Lake Ontario. Field and analytical methods remained the same as in 1993 (Bowlby et al. 1994). In addition, in 1994 nine sites were sampled with the 3-pass removal method (DeLury 1947). Pair-wise t-tests indicated no significant differences in population estimates between the Jones and Stockwell (1995) method for a single pass and the Delury method for three passes for yearling and older rainbow trout (P=0.513). However, the Jones and Stockwell method estimated 37% fewer young-of-the-year (YOY) rainbow trout than the Delury method (P=0.057). Accordingly, we will attempt to recalibrate the Jones and Stockwell expansion equation for YOY when we have a larger number of samples. Until then we recognize that our estimates of YOY may be biased low.

We estimated 625,240 wild rainbow trout juveniles in Lake Ontario tributary streams. This was 73% of the estimate for 1993 (Fig. 8). Pair-wise t-tests indicated significant declines in YOY, 2-yr-old, and 3-yr-old rainbow trout. Yearlings did not change significantly between years. Wild rainbow trout were found at almost all sites except three sites in the Credit River tributaries and one on Graham Creek. One stocked rainbow trout was observed at Black Creek.

One or two fin-clipped Atlantic salmon yearlings were observed at each of Black Creek, Silver Creek and Orono Creek. Eighteen unclipped Atlantic salmon YOY were observed at Wilmot, but these were presumed to be stocked as part of an experimental fry stocking.

Coho salmon were found in the Ganaraska River, Shelter Valley Creek, Orono Creek, and Wilmot Creek. We estimated 2593 wild coho salmon in Ontario streams, which was quite similar to 1993. We believe these estimates are low. Coho salmon are habitat specialists and their distribution may be more patchy than rainbow trout. However, the coho estimates on a basin-wide basis are probably in the right order of magnitude relative to rainbow trout.

No chinook salmon were observed in 1994. Brown trout and brook trout were also observed at about 9% of the number of rainbow trout at the survey sites. However, their numbers are not presented here since we feel that they do not make a significant contribution to the Lake Ontario fish community. Although brown trout make up a significant part of the Lake Ontario fish community they are virtually all stocked fish. The strain stocked in Ontario does not have a strong migratory tendency (Bowlby 1991).

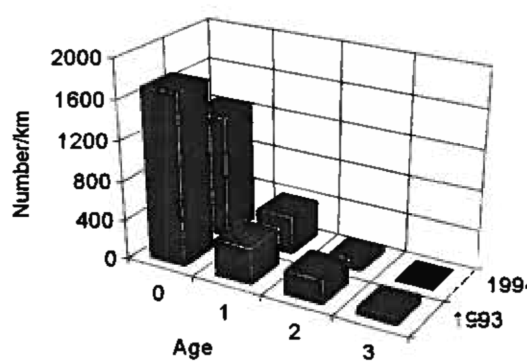

FIG. 8. Estimated number of juvenile rainbow trout by age in Lake Ontario tributaries in Ontario.

Lake Trout Status

Assessment of Stocked Lake Trout

The overall abundance of mature lake trout, measured from catches in standard gill net sets (CUE), remained relatively stable in 1994 (Fig. 9). Abundance

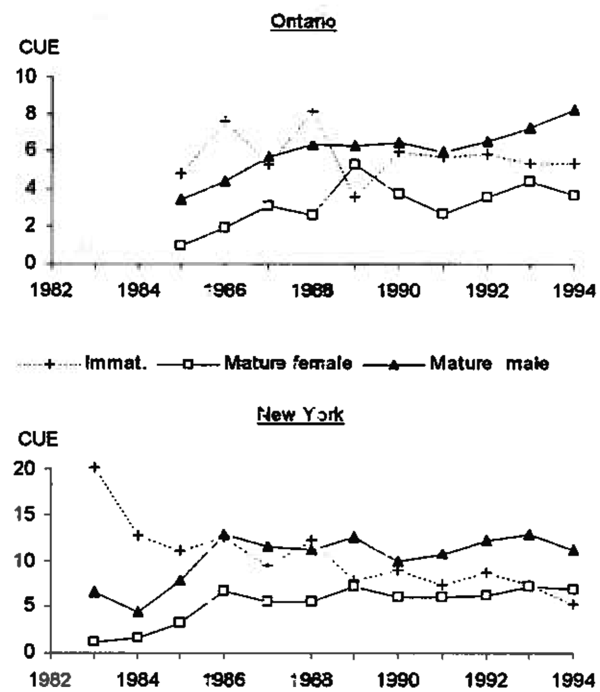

FIG. 9. Lake trout catch per standard gill net set during September in Ontario and New York waters of Lake Ontario.

trends in Ontario and New York waters have been consistent with the stocking levels. In Ontario waters abundance levels have been relatively stable since 1990 although it appears that the abundance of mature males may still be increasing. In New York waters, abundance levels have been relatively stable since the mid-1980s.

Abundance of immature lake trout remained stable in Ontario waters but decreased in New York waters. This is consistent with the decline in the number of yearling lake trout stocked by New York beginning in 1992, since lake trout are large enough to be captured in the gill net survey as 3-yr-old fish. We expect the stocking reduction by OMNR to result in lowered immature abundance of mature fish in Ontario waters in 1995.

Sea lamprey induced mortality in lake trout is assessed by measuring the incidence of A1 lamprey wounds. Wounding rates have decreased in both Ontario and New York waters since the mid-1980s. In Ontario, the 1994 rate of 0.004 wounds per fish was the lowest rate observed, while in New York the 1994 rate of 0.011 did not differ from the record low observed in 1993 (Fig. 10).

Angler harvest is the other major source of mortality. We estimate that the open-water boat fishery in Ontario waters harvests approximately 15,000 lake trout. In 1994, the central and western Lake Ontario harvest was 4,563 lake trout, a nearly two-fold increase since 1993 (Chapter 5). Harvest of an additional 10,000 lake trout may be attributed to the boat angler fishery in the Kingston Basin (Bowlby and Mathers 1995). Lake trout harvest in the New York waters has traditionally been much higher than in Ontario, although harvest declined in 1993 and 1994 to approximately 22,000 fish.

Survival of adult lake trout continued to improve, reflecting low losses to lamprey predation and to angling fishery. Cohort-based survival rates are estimated by following the decline of a year-class after they reach age-7. Survival for the 1984 and 1985 year-classes exceeded the rehabilitation target of 60% per year.

The body condition of adult lake trout in 1994 did not differ from 1993 (Fig. 11). Condition was determined by calculating the predicted weight of a 700 mm lake trout using the length-weight regression. Predicted weight declined from 1983 to 1986, followed by an increase and levelling off in the early 1990s.

Natural Reproduction

The occurrence of natural reproduction of lake trout in Lake Ontario has now been documented for several years. Fry traps placed on spawning shoals in eastern Lake Ontario have been catching naturally produced emergent fry in increasing numbers since 1987. There were also the rare instances where examination of calcified structures of older unmarked lake trout suggested that the fish were of wild origin. Unmarked juvenile lake trout were also caught in trawls in the past but their numbers did not exceed levels that could be explained by rates of clip regeneration and loss of coded wire tags (Elrod et al. 1995).

The year 1994 was the first time that very young, unquestionably wild lake trout showed up in trawls. In addition to not being marked, these fish had distinct colouration, and were smaller than their hatchery counterparts. A total of three YOY and eight wild yearling lake trout were caught in various trawling

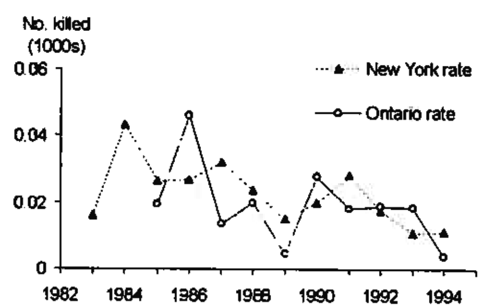

FIG. 10. Number of A1 lamprey wounds per lake trout captured during September gill net surveys in Lake Ontario.

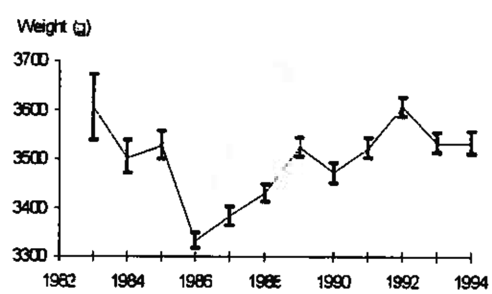

FIG. 11. Predicted weight (± 95% CI) of a 700 mm (total length) lake trout during September in Lake Ontario.

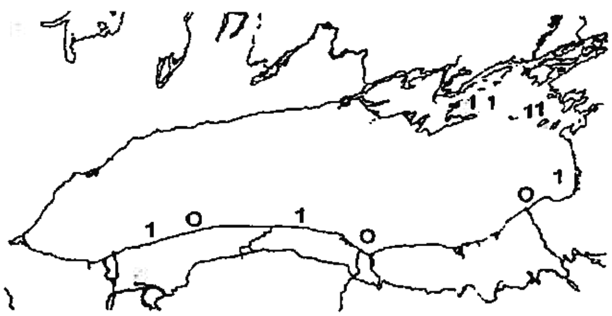

FIG. 12. Locations of trawl captures of suspected naturally produced young-of-year (0) and yearling (1) lake trout in Lake Ontario in 1994. Each symbol represents one fish.

programs conducted by OMNR, NYSDEC and NBS (Fig. 12). They were caught in every area of the lake where trawling occurred, suggesting that successful natural reproduction, and survival in the early stages occurred lake-wide in 1993-1994.

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3

Eastern Lake Ontario and Bay of Quinte

Jim Hoyle
Jim Bowlby

Overview

Changes in the Lake Ontario fish community from the turn of the century to 1970 were reviewed by Christie (1973), and from 1970 to 1985 by Christie et al. (1987). The fish community changed tremendously during these years. For example, by the 1960s, populations of the lake's commercially premium species, including lake trout, lake herring, the deep-water ciscoes, lake whitefish, and walleye, had collapsed. These species were largely replaced by alewife, smelt, yellow perch and, in the Bay of Quinte, white perch.

In eastern Lake Ontario and the Bay of Quinte (Fig. 1), another dramatic turn of events has occurred in the fish community in the last fifteen years. Lake trout, lake whitefish and walleye once again have risen to dominance while alewife, smelt, yellow perch and white perch, although numerically still abundant, are now at much reduced levels. In the case of lake trout, the large populations now residing in eastern Lake Ontario have, to date, been supported by stocking. However, the encouraging observation in 1994 of naturally reproduced lake trout surviving to the yearling stage, bodes well for this species in the future.

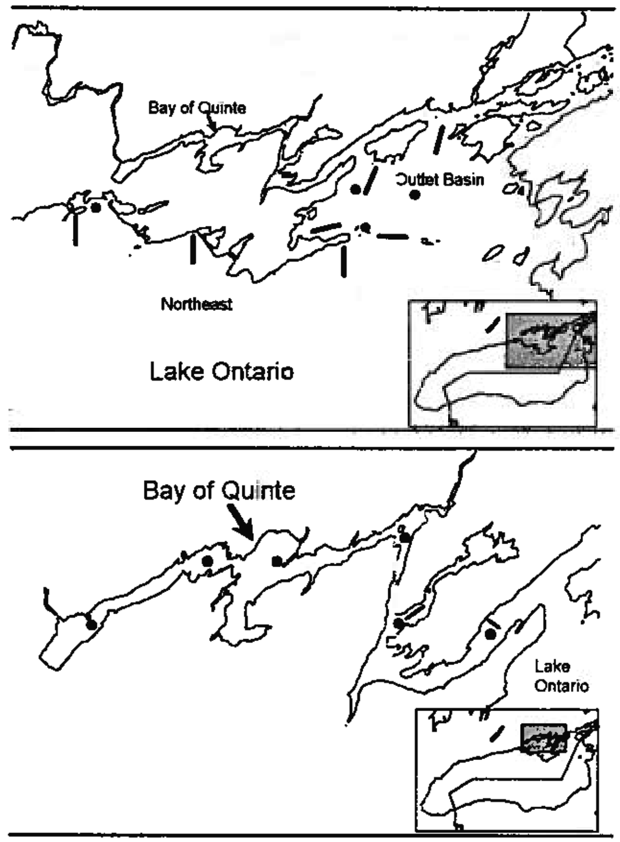

FIG. 1. Maps of eastern Lake Ontario (upper panel) and the Bay of Quinte (lower panel) showing fish community index gillnetting and trawling locations. Depth-stratified gillnetting locations are shown as bars; single depth gillnetting and trawling locations are represented by circles.

Fish Community Assessment Programs

To help maintain a balanced fish community and thereby avoid catastrophic swings in species abundance, monitoring current fish population status and trends in species relative abundance is essential. Such information provides a sound and scientific basis for taking appropriate fisheries management action. The Lake Ontario Management Unit uses annual summer index gillnetting and bottom trawling programs to detect long-term changes in the eastern Lake Ontario and Bay of Quinte fish communities. By providing trend-through-time indices of species population abundance, these programs also routinely deliver timely, stock-specific information to fisheries managers. For the deep waters of Lake Ontario's Outlet Basin and the Bay of Quinte, the gillnetting program has run for over 30 years, the trawling program for 20 years (Casselman and Scott 1992; Hurley 1992). More recently, gillnetting operations were initiated in the nearshore waters of eastern Lake Ontario as far west as Brighton. The latter studies initially focused on yellow perch, an important commercial species at the time, but expanded in 1986 to a wide range of depths and thereby sampled a diverse assemblage of warm- and cold-water species (Hoyle 1992).

In 1992, fish community studies on eastern lake Ontario underwent a major program overhaul to facilitate gear standardization, improved experimental design, elimination of sampling redundancies, and better program coordination, while preserving the continuity and integrity of the historic data series (Hoyle 1992; Casselman and Scott 1992). Also in 1992, multifilament gillnets were replaced with monofilament nets. Comparative netting studies have been completed but gear/species conversion factors have not been finalized. Hence, the trend-through-time gillnet results presented here have not been adjusted to reflect this gear change and must be interpreted accordingly.

In addition to determination of relative fish abundance in the fish community index gillnetting and trawling programs described above, we have also traditionally estimated absolute abundance for walleye. A walleye mark/recapture program was conducted periodically from 1985 to 1992. The mark/recapture program provided direct walleye population estimates to ground-truth the index netting results. We also employed a young-of-the-year (YOY) walleye index of abundance based on Bay of Quinte bottom trawling, to project walleye population estimates into the future (Mathers 1993). Beginning in 1992, we supplemented this approach to walleye management with a catch-age model (CAGEAN, Deriso et al. 1985) which calculates walleye population estimates using Bay of Quinte angler harvest data. Although the CAGEAN model has been calibrated to the walleye mark/recapture results, CAGEAN has the advantage that it can be updated on an annual basis with only angler harvest data. In this chapter we provide CAGEAN estimates of walleye population size from 1979 to 1994. We also provide a projected estimate for 1995 based on CAGEAN estimates of population size and mortality during 1994 for 3-yr-olds and older, and, for 2-yr-olds, a new walleye index of year-class strength in Bay of Quinte

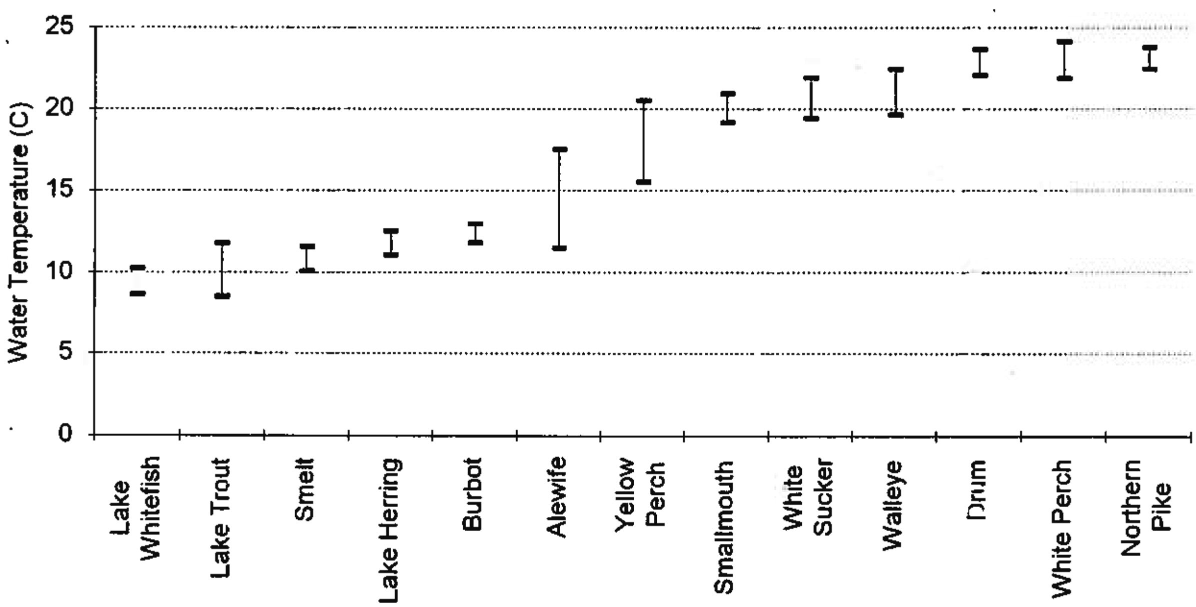

FIG. 2. Mean (+/- 2 SE) water temperatures at which eastern Lake Ontario and Bay of Quinte fish community members were captured in gillnets. These "preferred" water temperatures may be biased high for the warm-water species because, in much of the Bay of Quinte, water temperatures are isothermal, and opportunities for fish to actively select "preferred" temperatures are scarce.

bottom trawls.

For a summary of standardized gillnet/trawl catch-per-unit-effort for 1994, organized by geographic area (Northeast, Outlet Basin, and the Bay of Quinte), see Appendix C. In this chapter, we report on the current make-up of the eastern Lake Ontario and Bay of Quinte fish communities, and provide updated trends in abundance for several fish species of local management interest including lake whitefish, lake herring, smallmouth bass, yellow perch, and walleye.

Gillnets

We used gillnets to index the abundance of the larger, active, bottom dwelling fish species. Analysis of gillnet catches relative to water temperatures at depth of the gear indicates that the eastern Lake Ontario and Bay of Quinte fish communities separate neatly into cold- and warm-water inhabitants, except for alewife and yellow perch which occupy a very wide range of water temperatures (Fig. 2).

Alewife and yellow perch numerically dominate in both cold- and warm-water gillnet catches, except in the deepest areas of the Outlet Basin (Table 1). The cold-water fish community was very similar in all geographic areas sampled, with lake trout and lake whitefish being the most abundant. Lake herring and burbot are currently at low levels of abundance. The warm-water community is highly variable among geographic areas. Warm-water species catches are very low in the Northeast with largest catches being near the eastern most part of this area. Here, walleye and smallmouth bass are caught in moderate numbers at the edge of the range of larger populations occupying the Outlet Basin. Walleye catches in the Outlet Basin rival midsummer catches in the Bay of Quinte. The Bay of Quinte community also has large populations of white perch, white sucker and freshwater drum.

Trawls

Bottom trawling, conducted in the deepest waters of the Outlet Basin (cold-water community) and in the Bay of Quinte (mainly a warm-water

TABLE 1. Eastern Lake Ontario cold- and warm-water fish communities for three major geographic areas. Only the most abundant species are included. Numbers represent mean catches-per-standard gillnet lift for the last three years (1992, 1993 and 1994). A standard gillnet lift represents the sum of catches in ten mesh sizes (1 1/2" to 6" at 1/2" intervals) with catches adjusted to represent 100 m of net for each mesh size. The Outlet Basin "Deep" gillnet sets include all nets set at stations EB02 and EB06. Otherwise, for the cold-water fish community all gillnets set at water temperatures <15 C were included. The warm-water fish community included gillnets set at water temperatures >= 15 C. The Northeast includes nets set at Brighton, Wellington and Rocky Point; the Outlet Basin includes nets set at Flatt Point, Grape Island and Melville Shoal; and the Bay of Quinte include nets set at Conway, Hay Bay and Big Bay. Species "preferred" (see Fig. 1) temperatures are indicated as are the mean bottom temperatures (C) at which gillnets were set in the three geographic areas.

	Preferred temperature	Northeast		Outlet Basin			Bay of Quinte	
		Cold	Warm	Deep	Cold	Warm	Cold	Warm
Lake whitefish	9	13	1	51	45	3	23	0
Lake trout	10	110	22	243	106	5	40	1
Rainbow smelt	11	1	1	8	3	0	5	0
Lake herring	12	2	1	2	7	0	9	2
Burbot	12	2	0	0	0	0	0	1
Alewife	14	205	227	178	492	541	224	239
Yellow perch	18	50	233	0	180	338	651	778
Smallmouth bass	20	0	7	0	2	7	0	3
White sucker	21	1	4	0	1	7	29	33
Walleye	21	1	9	0	10	101	10	130
Freshwater drum	23	0	3	0	1	5	0	29
White perch	23	0	0	0	1	5	10	440
Northern pike	23	0	1	0	0	2	4	6
Mean bottom temperature		10	18	9	11	17	12	20

community except in the lower portion), is most effective for catching the smaller bottom dwelling species and the young individuals of larger species. Therefore, this gear provides useful information on forage species and indicators of year-class strength for larger species.

Alewife, smelt and trout-perch are the most abundant species in the deep waters of the Outlet Basin (Table 2). Young lake whitefish are also abundant. Bottom trawling in the Bay of Quinte indicates a more diverse community. Most abundant species include alewife, trout-perch, white perch, yellow perch, gizzard shad and spottail shiner. Moderate numbers of young walleye and freshwater drum are also caught as are the bottom dwelling brown bullhead and white sucker. Cold-water species, including young lake whitefish and lake herring as well as smelt, are found in the deeper waters of the lower Bay of Quinte.

TABLE 2. Fish communities in the "Deep" waters of the Outlet Basin and in the Bay of Quinte as measured by bottom trawls. Only the most abundant species are included. Numbers represent mean catches-per-trawl for the last three years (1992, 1993 and 1994). Trawls are of 1/2 mile in length for the Outlet Basin and 1/4 mile in length for the Bay of Quinte. Bay of Quinte trawl catches are divided into three regions, upper (Trenton, Belleville, Big Bay and Deseronto sites), middle (Hay Bay), and lower (Conway), and representing a progression from shallow, warm-water, eutrophic conditions in the upper bay to deep, cold-water, more oligotrophic conditions in the lower bay.

	Outlet Basin	Bay of Quinte		
	Deep	Upper	Middle	Lower
Alewife	1025	142	76	149
Gizzard shad	0	104	1	0
Lake whitefish	15	0	0	25
Lake herring	1	0	0	6
Rainbow smelt	623	0	1	13
White sucker	0	4	6	7
Spottail shiner	42	61	12	0
Brown bullhead	0	30	9	0
Trout-perch	520	87	79	276
White perch	0	142	49	16
Pumpkinseed	0	6	1	0
Yellow perch	0	103	24	13
Walleye	0	24	13	14
Freshwater drum	0	14	5	0

Species Population Trends

Here we provide an update on the population status of several species of current management interest including lake whitefish, lake herring, smallmouth bass, yellow perch and walleye. Also we note the catch of three yearling, naturally reproduced lake trout in our bottom trawls.

Population trends for some species are assessed in other, more targeted, programs and reported elsewhere. Alewife and smelt are assessed in a lake-wide hydroacoustic/mid-water trawling program (Chapter 1 in this report). Adult lake trout are monitored in a lake-wide index gillnetting program (Chapter 2 in this report). The current status of salmon and trout inhabiting the open waters of Lake Ontario is also reported in Chapter 2. Additional stock status information for commercially important species can be found in Chapter 4.

Lake Whitefish

Lake whitefish are the most important commercial fish in Lake Ontario (Chapter 4 in this report). There are two large spawning stocks of lake whitefish in eastern Lake Ontario; one spawning in Lake Ontario proper along the south shore of Prince Edward County, the other spawning in the Bay of Quinte.

YOY whitefish are monitored in bottom trawls at Timber Island and Conway for lake and bay whitefish stocks, respectively (Fig. 3). Small year-classes were observed, sporadically, throughout the 1970s and early 1980s. Since the mid-1980s, moderate to large year-classes have frequently been produced, especially for the bay stock. Very large year-classes, associated with extremely cold over-wintering conditions, were observed for both lake whitefish stocks in 1994.

The two whitefish stocks intermix as adults during midsummer in the deep waters of the Outlet Basin. Here, their collective abundance is monitored in gillnets (Fig. 3). Catches were down in 1994. We interpret the decline as being related to a reduction in the number of small-sized fish (29% of the catch in 1994 were 1- and 2-yr-old fish compared with 44% and 57% in 1992 and 1993, respectively), and to increased variability in our index of abundance associated with reducing the number of index netting locations, beginning in 1991. The low gillnet catches of small whitefish are associated with poor year-

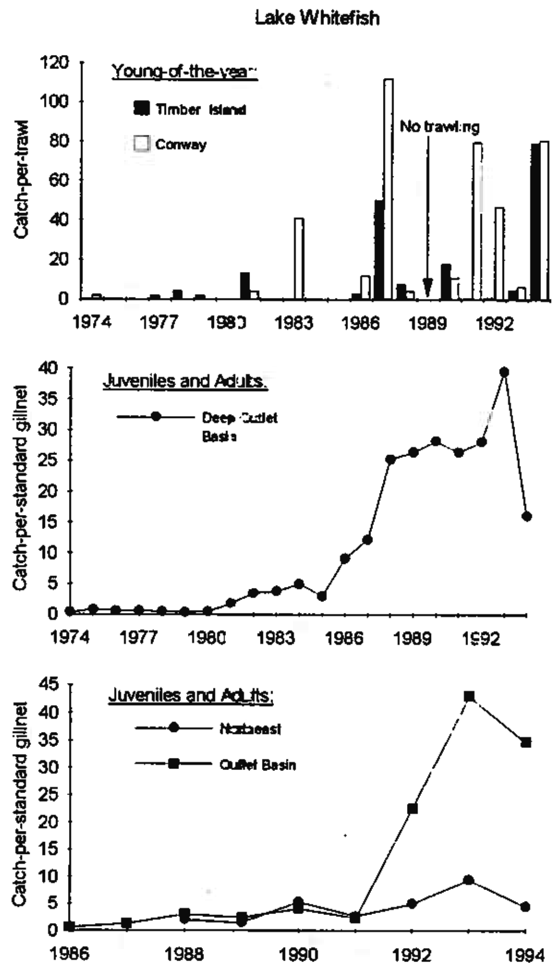

FIG. 3. Lake whitefish indices of abundance. Upper panel shows year-class strength of Lake Ontario and Bay of Quinte stocks as represented by YOY catch-per-trawl (adjusted to 12 min duration), at Timber Island and Conway, respectively, 1974 to 1994. No trawling was conducted in 1989. Middle panel shows catch-per-standard gillnet lift for juvenile and adult lake whitefish from deep-water gillnetting locations in the Outlet Basin, Lake Ontario, 1974 to 1994. Catches were calculated as the sum of the catch of eight gillnet panels (1 1/2" to 5" with 1/2" intervals), each of which were 50 ft in length. There were six netting locations prior to 1991, three in 1991 and two since 1991, therefore catches in later years were weighted based on the relative proportion of the catches at each site in previous years. Lower panel shows catch-per-standard gillnet lift for juvenile and adult lake whitefish from Northeast (1988 to 1994) and Outlet Basin (1986 to 1994) gillnet sampling locations. A standard gillnet lift represents the sum of catches in eight mesh sizes (1 1/2" to 5 " at 1/2" intervals) with catches adjusted to represent 100 m of net for each mesh size. The Northeast includes nets set at Brighton, Wellington and Rocky Point; and the Outlet Basin includes nets set at Flatt Point, Grape Island and Melville Shoal.

classes of both stocks in 1993 and of the lake stock since 1991 (Fig. 3). Larger catches of small whitefish are anticipated in 1995 as the very strong 1994 year-classes recruit to the gillnets.

Lake whitefish catches are also monitored in the nearshore waters of the Outlet Basin and in the Northeast but only in more recent years (Fig. 3). Catches were also down in these two areas.

Lake Herring

Historically, lake herring supported an important commercial fishery in Lake Ontario but this fishery collapsed during the 1940s. We anticipated that lake herring, like lake whitefish, would increase in abundance following declines in alewife and smelt in the late 1970s. To date, this has not happened. There was an increase in herring abundance in a localized area of the Outlet Basin (Prince Edward Bay) in the late 1980s but catches declined after peaking in 1990 (Fig. 4). Ages were interpreted for a small number of fish caught in this area during the peak years of 1990 and 1991—eight of twelve fish were from the 1987 year-class. It appears that a locally strong year-class of lake herring was produced in 1987 but these did not show up in bottom trawling in the Outlet Basin (Fig. 4). Note that large year-classes of lake whitefish were also produced in 1987 (Fig. 3).

Prior to 1990, lake herring had not been observed in bottom trawls. Small numbers have been observed in 1990, 1991 and 1993 at the Conway site in the lower Bay of Quinte (Fig. 4). In 1994, a significant number of YOY lake herring were caught, along with large numbers of YOY lake whitefish, at the Conway site. Relative to the large year-classes of lake whitefish observed since the mid-1980s, the 1994 lake herring year-class could be considered of moderate size.

We expect to see more lake herring in the near future.

Smallmouth Bass

Smallmouth bass populations, along with lake trout, provide an important recreational fishery in the Outlet Basin. Their abundance in gillnets has decreased since 1991 (Fig. 5). The reason for the decline is not clear. Smallmouth bass abundance has remained steady in the Northeast but at lower levels than in the Outlet Basin (Fig. 5).

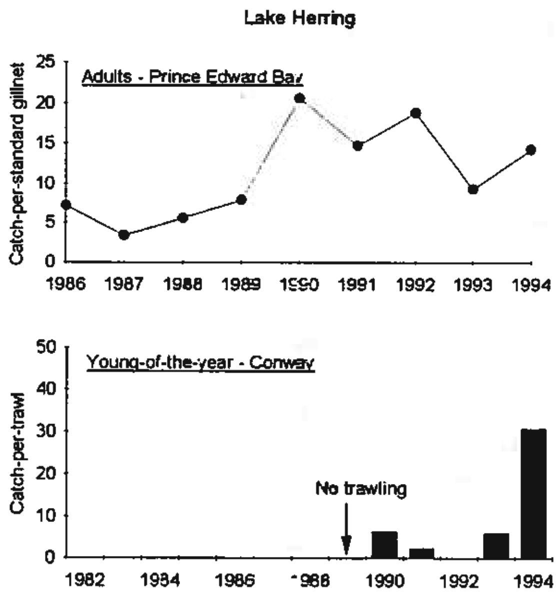

FIG. 4. Lake herring indices of abundance. Upper panel shows catch-per-standard gillnet lift for adult lake herring from the Flatt Point gillnet sampling location in Prince Edward Bay, Lake Ontario (1986 to 1994). A standard gillnet lift represents the sum of catches in eight mesh sizes (1 1/2" to 5 " at 1/2" intervals) with catches adjusted to represent 100 m of net for each mesh size. Lower panel shows year-class strength of lake herring as represented by YOY catch-per-trawl (adjusted to 12 min duration), at Conway in the lower Bay of Quinte, 1982 to 1994. No trawling was conducted in 1989.

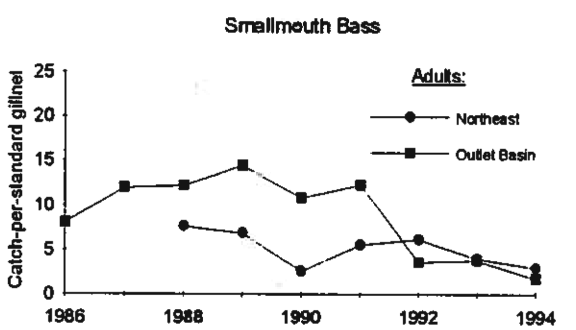

FIG. 5. Catch-per-standard gillnet lift for adult smallmouth bass from Northeast and Outlet Basin gillnet sampling locations. A standard gillnet lift represents the sum of catches in eight mesh sizes (1 1/2" to 5 " at 1/2" intervals) with catches adjusted to represent 100 m of net for each mesh size. The Northeast includes nets set at Brighton, Wellington and Rocky Point; and the Outlet Basin includes nets set at Flatt Point, Grape Island and Melville Shoal.

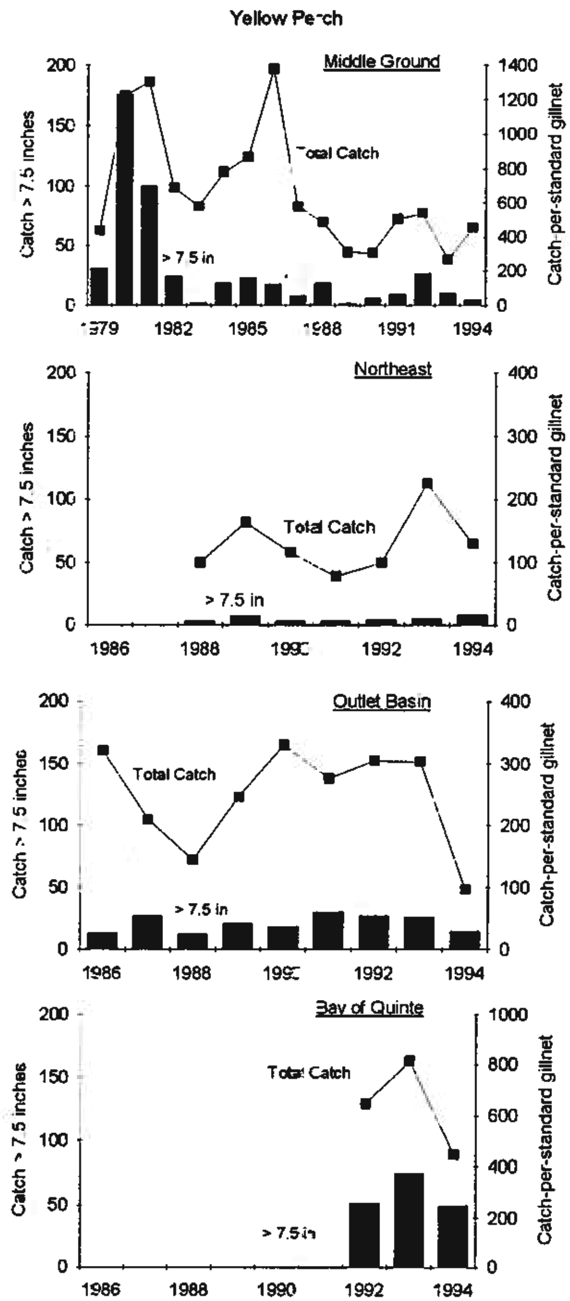

FIG. 6. Yellow perch indices of abundance for fish greater than 7.5 inches fork length (index of commercially marketable-sized fish) and for total catches. Upper panel, Middle Ground, 1979 to 1994; second panel, Northeast, 1988 to 1994; third panel, Outlet Basin 1986 to 1994; and Bay of Quinte 1992 to 1994.

Yellow Perch

Yellow perch are found throughout eastern Lake Ontario and the Bay of Quinte. Their abundance, which declined dramatically in the early 1980s after peaking at historically high levels, now remains at comparatively low levels.

In the Northeast, yellow perch abundance has been monitored in gillnets for many years at Middle Ground, and since 1988 at several additional sites (Fig. 6). Commercially marketable-sized yellow perch (>7.5 inches) are particularly scarce, even though large numbers of small fish have been observed in some years. Gillnet catches in the Outlet Basin have been fairly steady since 1986 but lowest catches occurred in 1994 (Fig. 5). Largest catches of yellow perch now come from the Bay of Quinte, but even here marketable-sized fish do not make up a large portion of the total catch (Fig. 5).

Walleye

Bay of Quinte walleye are the target of one of Lake Ontario's largest recreational fisheries (see Chapter 5 in this report). The walleye population is unique in that adult fish migrate to Lake Ontario immediately following spawning in the Bay of Quinte. The adult fish move back into the bay in the fall to overwinter.

Walleye population size increased sharply in 1980, with recruitment of the 1978 year-class, and has remained stable in recent years (Fig. 7). The 2-yr-old component of the 1995 projected population estimate was based on an index of walleye year-class strength, for the 1993 year-class, as measured in Bay of Quinte bottom trawls. Traditionally the index of year-class strength was based on YOY fish only. For 1994, we introduce a new index that is based on tracking walleye year-classes, in the bottom trawls, for a number of years (up to 4-yr-olds, Fig. 7). Thus, the projected population estimate for 2-yr-old walleye in 1995 was based on an index of year-class strength for the 1993 year-class that was observed, in bottom trawls, as YOY in 1993 and as yearlings in 1994. This index should more accurately reflect recruitment to the population than an observation of YOY alone.

The new index of walleye year-class strength suggests more stable recruitment in recent years than the YOY index that we have traditionally used, and is more consistent with the amount of year-class variation in the CAGEAN population estimates (Fig. 7.). Moreover, it was significantly correlated with our Jolly-Seber mark-recapture population estimates ($p=0.01$).

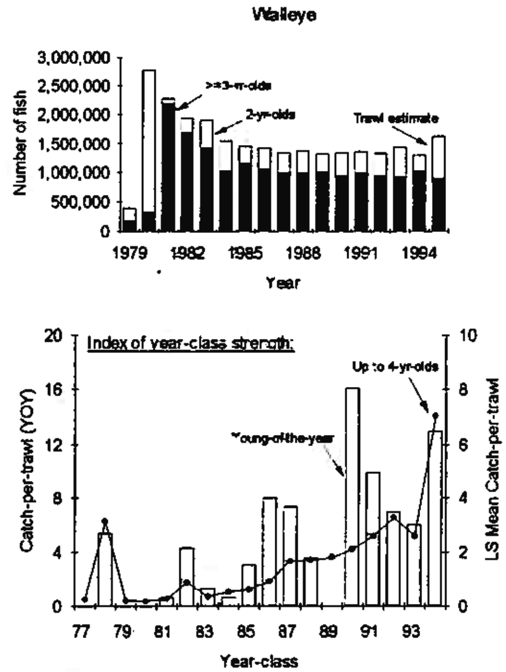

FIG. 7. Bay of Quinte walleye population estimates for 2-yr-olds, representing fish about to recruit to the recreational fishery, and for 3-yr-old and older fish, representing the fishable population (upper panel). The population estimates were based on catch-at-age analysis and calibrated with mark/recapture results. Lower panel shows two indices of walleye year-class strength: the first is mean YOY catch-per-trawl (6 min duration) at three Bay of Quinte sites, Big Bay, Hay Bay and Conway, 1978 to 1994 (no trawling was conducted in 1989); and the second is based on tracking the mean catch-per trawl (least-squares means) of each year-class from young-of-the-year up to 4-yr-olds (1977 to 1994). The latter index was used to project walleye population estimates for 1995.

Note that our CAGEAN population estimate and our new index of year-class strength, for a particular year-class, improve with the number of years a year-class has been observed in the fishery/bottom trawls. Therefore, our Bay of Quinte walleye population estimates for the more recent years/year-classes will fluctuate as additional years of harvest/bottom trawl data are added. This sort of fluctuation accounts for some of the minor differences between walleye population size estimates presented this year compared with last year (Hoyle and Rawson 1994).

Lake Trout

In an effort to rehabilitate lake trout in Lake Ontario, about 1/2 million yearling lake trout are stocked into the Canadian waters of eastern Lake Ontario annually (see Chapter 2 and Appendix B). Bottom trawling in the deep-waters of the Outlet Basin revealed that, of 56 yearling lake trout captured, three were of native origin. The three fish were identified as being of native origin based on their lack of coded wire nose tags and fin clips, and based on a variety of morphological features. The three native lake trout were caught during three separate netting occasions (June 28, July 20 and September 7) but all at the same sampling location. Only one other yearling lake trout (hatchery origin) was caught at this same site.

The three native lake trout had fork lengths of 116, 101 and 142 mm, and weights of 14, 9 and 30 g. The naturally reproduced lake trout were much smaller than stocked fish of the same age (Fig. 8), and may therefore be at a competitive disadvantage.

Also in the summer of 1994, fisheries agencies in New York State reported the capture of seven yearling and two YOY native lake trout. The fish were widely distributed across the New York waters of Lake Ontario.

These naturally reproduced fish, although caught in small numbers, represent by far the most significant occurrence of lake trout natural reproduction in Lake Ontario since rehabilitative efforts began.

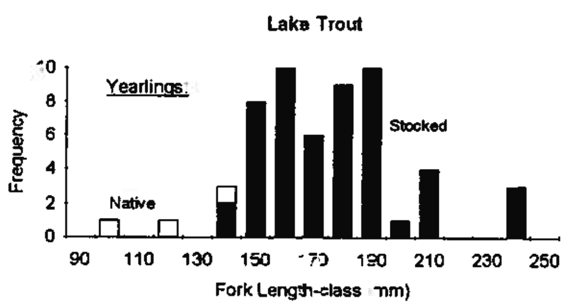

FIG. 8. Frequency distribution of yearling lake trout fork length-classes (mm) caught in Outlet Basin bottom trawls. Naturally reproduced fish are contrasted with stocked fish.

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4

Commercial Fisheries

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Overview

The commercial fishing industry on the Canadian waters of Lake Ontario harvests about $1,000,000 worth of fish annually, small relative to the other Great Lakes, but locally significant since it is confined mainly to the northeast corner of the lake. Records of commercial fish harvest on Lake Ontario date back to 1867 (Baldwin et al. 1979). The provincial commercial fisheries modernization program was introduced in 1984. The principal feature of this program, as it affected the Lake Ontario commercial fishery, was individual species harvest quotas.

This chapter on Lake Ontario's 1994 commercial fishery deals with three areas: i) management and licencing, ii) commercial harvest summary, and iii) biological characteristics of the harvest. Our approach to commercial fish management and licencing in recent years on Lake Ontario, including quota setting, fishing seasons, gear restrictions, size limits, and harvest reporting, was documented by Hoyle et al. (1994). In the present report we focus on regulation changes in the commercial fishery pertinent to 1994. We also report the 1994 commercial harvest (weight and value) by species, and provide length and age distributions for lake whitefish, eel, yellow perch and walleye harvests--four of the most important quota species.

Management and Licencing

The overall management direction of commercial fish management on Lake Ontario 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.

Quota Management

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 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 1994, the commercial allocation for lake whitefish was again increased, in light of continued recovery of this species. Walleye quotas were also increased, primarily to allow marketing of walleye caught incidentally during the gillnet fisheries for lake whitefish and white perch in Quota Zones 2 and 4.

Continued concerns about the status of yellow perch and eel stocks resulted in reduced commercial quotas for these two species in 1994. Quotas for both species were reduced approximately 10% from 1993

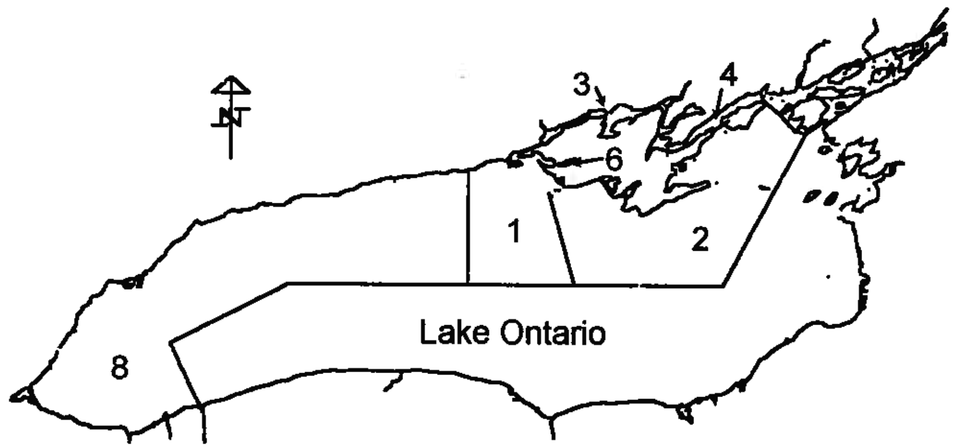

FIG. 1. Commercial fish quota zones on the Canadian waters of Lake Ontario.

TABLE 1. Commercial harvest quotas (lb) for the Canadian waters of Lake Ontario, 1994. For Quota Zone 1 eel and black crappie include quota from Consecon Lake, Quota Zone 6. 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, Wellers Bay) are not given here but their 1994 harvest totals are included in Table 3.

	Quota (lb) by quota zone					
	1	2	3	4	8	Total
Lake whitefish	34,800	384,390	76,300	102,500	800	598,790
Lake herring	11,480	14,200	4,800	3,700	0	34,180
Round whitefish	8,000	0	0	0	0	8,000
Eel	45,830	247,320	72,370	40,830	3,600	410,650
Black crappie	3,940	15,450	11,250	800	2,400	34,140
Yellow perch	48,830	148,910	99,580	67,250	11,500	376,070
Walleye	4,620	47,760	0	13,890	300	66,570

allocations.

Round whitefish was placed under quota management for the first time in 1994. A total of 8,000 lb was allocated to Quota Zone 1 licences.

Fishing Seasons

Most season restrictions for the commercial fishery are applied to gear rather than on fish species. These seasons are intended primarily to reduce problems of incidental catch and to minimize gear conflicts with other resource users (e.g., anglers and boaters). Walleye is the only commercial fish species with a closed season.

In response to requests from the industry, where cooperative *test fishing* demonstrated low incidental catch rates, some expansion of gillnet seasons was authorized in 1994 (Table 2). Commercial seasons for impounding gear in 1994 were generally consistent with those of 1993 (see Table 3 by Hoyle et al. 1994).

Gear Restrictions

Generally, no additional commercial gear is being licenced on Lake Ontario. Some fishermen in the impounding gear fishery exchanged hoopnets for trapnets (at a ratio of 3:1) to better access lake whitefish during fall spawning runs. An experimental electrofishing permit for eels was authorized for Quota Zone 2 for the period May 5 to July 31, 1994.

Size Limits

Size limits are placed on some commercial species to ensure conservation of fish stocks, to prevent the harvest of fish having high contaminant levels or to assist in allocation among user groups.

In 1994, the maximum size limit for walleye remained at 24 inches. The minimum size limit was standardized at 16 inches for both the gillnet and impoundment gear fisheries.

Commercial Harvest Summary

The 1994 Lake Ontario commercial fishing season was much improved over the 1993 season in terms of both total landings and dollar value of the fishery.

The total harvest of all species exceeded 1.2 million lb (Table 3). The total landed value of the harvest rebounded from the very low level realized in 1993 to over $1.2 million, the highest level in several years. This increase can be attributed to strong markets, high fish prices, and significant increases in

TABLE 2. Commercial harvest fishing seasons for gillnet licences on the Canadian waters of Lake Ontario, 1994. For impoundment gear, see Table 3 in Hoyle et al. (1994).

Mesh Size mm (in)			
Minimum	Maximum	Time period	Fish species
Quota Zone 1:			
57 (2 1/4)	66 (2 5/8)	July 25 to Aug 31	Any species for which the licence is valid other than lake whitefish, lake herring, walleye and carp.
76 (3)	83 (3 1/4)	Dec 1 to Dec 20	Any species for which the licence is valid other than walleye.
114 (4 1/2)	114 (4 1/2)	Oct 28 to Nov 30	Any species for which the licence is valid.
203 (8)	unlimited	Jan 1 to Dec 31 except Weller's Bay	Carp
Quota Zone 2:			
57 (2 1/4)	83 (3 1/4)	Jan 1 to Apr 30 Jul 1 to Dec 31	Any species for which the licence is valid other than lake whitefish, walleye and carp.
114 (4 1/2)	127 (5)	Jan 1 to Jan 20	Any species for which the licence is valid other than walleye.
		Nov 1 to Dec 20	Any species for which the licence is valid.
203 (8)	unlimited	Jan 1 to Dec 31 except West Lake	Carp
Quota Zone 4:			
57 (2 1/4)	66 (2 5/8)	Jan 1 to May 12	Any species for which the licence is valid other than lake whitefish, lake herring, walleye and carp.
76 (3)	83 (3 1/4)	Jan 1to Mar 20 Dec 1 to Dec 31	Any species for which the licence is valid.
		Oct 11 to Oct 31 Mar 21 to Apr 30	Any species for which the licence is valid other than walleye.
114 (4 1/2)	114 (4 1/2)	Jan 1 to Mar 20 Dec 1 to Dec 31	Any species for which the licence is valid.
		Aug 23 to Sep 10	Any species for which the licence is valid other than walleye.
203 (8)	unlimited	Jan 1 to Dec 31	Carp
Quota Zone 8:			
66 (2 5/8)	83 (3 1/4)	Jan 1 to Sep 30 Nov 1 to Dec 31	Any species for which the licence is valid.

the commercial harvest of premium species such as lake whitefish and yellow perch. Even the lower value species, such as sunfish, white perch and bullheads, experienced seasonally strong prices, with associated increases in harvest.

Again in 1994, lake whitefish was the most important commercial species on Lake Ontario, both in terms of harvest weight and total dollar value. While yellow perch harvest continued to be at a low level relative to levels observed through the 1980s, the high prices paid to fishermen for this species in 1994 meant that yellow perch remained an important component of the fishery. Eel was the third most important species in terms of landed value, in spite of the fact that eel harvest declined in all quota zones in eastern Lake Ontario.

Biological Characteristics of the Harvest

Biological characteristics of the harvest were monitored for four important quota species: lake whitefish, eel, yellow perch and walleye. Sampling activities focused on those quota zones, seasons and gear types where harvest was greatest for each species. As such our surveys covered the majority of the total annual harvest for the four species--lake whitefish (85% of the harvest), eel (65%), yellow perch (67%), and walleye (61%).

Lake Whitefish

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 have recovered in recent years thanks to good recruitment of both major spawning stocks (Lake Ontario and Bay of Quinte spawning stocks, Chapter 3 in this report).

The 1994 lake whitefish harvest was 452,601 lb, representing 76% of the 598,790 lb quota. Much of the total harvest (54%) comes from Quota Zone 2 during the lake whitefish spawning run in November and December (Fig. 2). The main gear type used in this fishery is 4 1/2 inch gillnets. The fact that the fishery focuses on the spawning population, using a

TABLE 3. Commercial fish harvest (lb) and value ($) for fish species in the Canadian waters of Lake Ontario, 1994.

	Commercial harvest (lb) by quota zone							Price	
Species	1	2	3	4	6	8	Total	per lb	Value
Black crappie	512	5,307	3,059	35	44	49	9,006	2.16	$19,423
Bowfin	4,721	3,001	6,480	0	1,343	0	15,545	0.24	$3,680
Brown bullhead	31,122	23,556	151,580	4,573	5,087	435	216,353	0.37	$79,047
Carp	4,473	2,471	11,408	58	48	0	18,458	0.23	$4,329
Channel catfish	80	2,789	2,352	192	0	383	5,796	0.30	$1,752
Eel	11,186	104,273	22,136	13,502	264	4,129	155,430	1.55	$240,854
Freshwater drum	767	7,974	10,567	5,728	0	173	25,209	0.14	$3,552
Lake herring	3,083	5,399	1,797	2,727	0	0	13,006	0.52	$6,758
Lake whitefish	25,134	283,857	66,041	77,569	0	0	452,601	0.91	$413,541
Rock bass	2,835	7,335	3,986	231	327	1,438	16,152	0.34	$5,424
Round whitefish	0	3	0	0	0	0	3		
Suckers	36	4,204	8,608	705	0	475	14,028	0.10	$1,356
Sunfish sp	13,376	18,489	17,829	277	6,980	0	56,951	0.56	$31,994
Walleye	3,451	28,200	0	3,420	0	17	35,088	1.54	$54,130
White bass	1	7	211	718	0	325	1,262	0.90	$1,138
White perch	431	3,071	19,815	29,671	0	3,820	56,808	0.56	$32,024
Yellow perch	6,134	47,298	53,806	42,508	0	1,595	151,341	2.50	$378,259
Scrap	0	0	1,095	0	0	455	1,550	0.00	$0
Total							1,243,097		$1,277,262

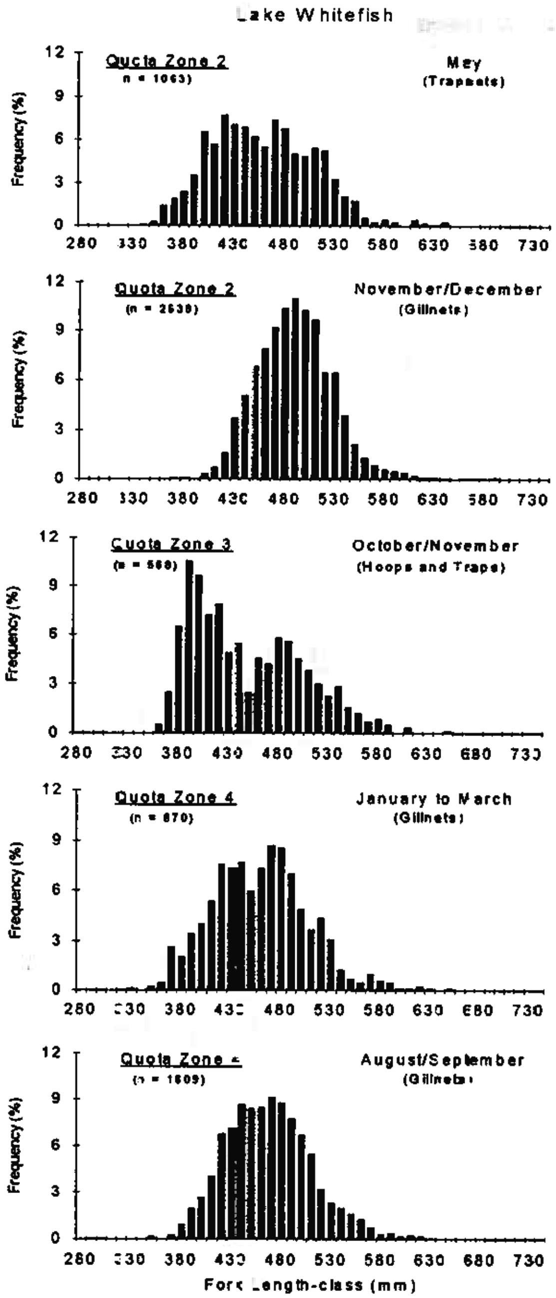

FIG. 2. Lake whitefish size distributions of the 1994 commercial harvest from Quota Zones 2, 3 and 4 for the seasons and gear types indicated. The y-axis represents the percent of the sample (sample size indicated in parentheses) for the season and gear type indicated. Eighty-five percent of the annual lake whitefish harvest occurred in the seasons and gear types shown.

highly selective gear type, results in the harvest of a relatively narrow size range of fish (Fig. 2) consisting of relatively few age-classes (4- to 7-yr-olds, Fig. 3).

Differences in size and age distributions for the other major lake whitefish fisheries (Fig. 2 and 3) can be accounted for by differences in geographic area (and therefore the stock exploited), season (and therefore whether only spawning fish or the entire population is exploited), and gear type used. Some highlights for these other fisheries include the following. The trapnet and hoopnet fisheries of Quota Zones 2 (May) and 3 (October/November) harvested a wider size range of fish than the gillnet fisheries. The widest size of fish came from Quota Zone 3 (Bay of Quinte, Fig. 2) where large numbers of 3-yr-old fish were included in the harvest (Fig. 3). The 1989 year-class was poorly represented in all fisheries.

Mean age of the 1994 harvest in the Quota Zone 2 gillnet fishery (5.9 yr) is less now than for the 1988 harvest (7.0 yr) but similar to the 1990 harvest (5.7 yr) as reported by Brown and Casselman (1992). The mean age of the 1994 Quota Zone 3 harvest (5.2 yr) is somewhat older than that of 1988 (4.9 yr) and 1990 (4.6 yr).

Most of the Ontario lake whitefish harvest occurs at, or near, spawning time. Therefore, depending on the location, the harvest exploits mainly Lake Ontario (Quota Zones 1 and 2) or Bay of Quinte (Quota Zone 3 and Quota Zone 4 in the August/September fishery) spawning stocks. A low rate of mixing between the two stocks occurs at spawning time (12% for both major spawning areas, Brown and Casselman 1992). The exception is the winter harvest from Quota Zone 4. Using the technique described by Brown and Casselman (1992), we measured a mixture of 75% Bay of Quinte stock and 25% Lake Ontario stock for this fishery in 1994.

Mean length-at-otolith-age (calender) of the harvest is somewhat larger in Quota Zone 2 (Lake Ontario stock) than for the other fisheries (mainly Bay of Quinte stock, Fig. 4).

Eel

The 1994 eel harvest was 155,490 lb, representing 38% of the 409,952 lb quota. The largest eel harvest was taken from the Quota Zone 2 hookline fishery from June to September (60% of the total annual harvest). The harvest consisted of large adult eels, with an average size of 800 mm total length (Fig. 5).

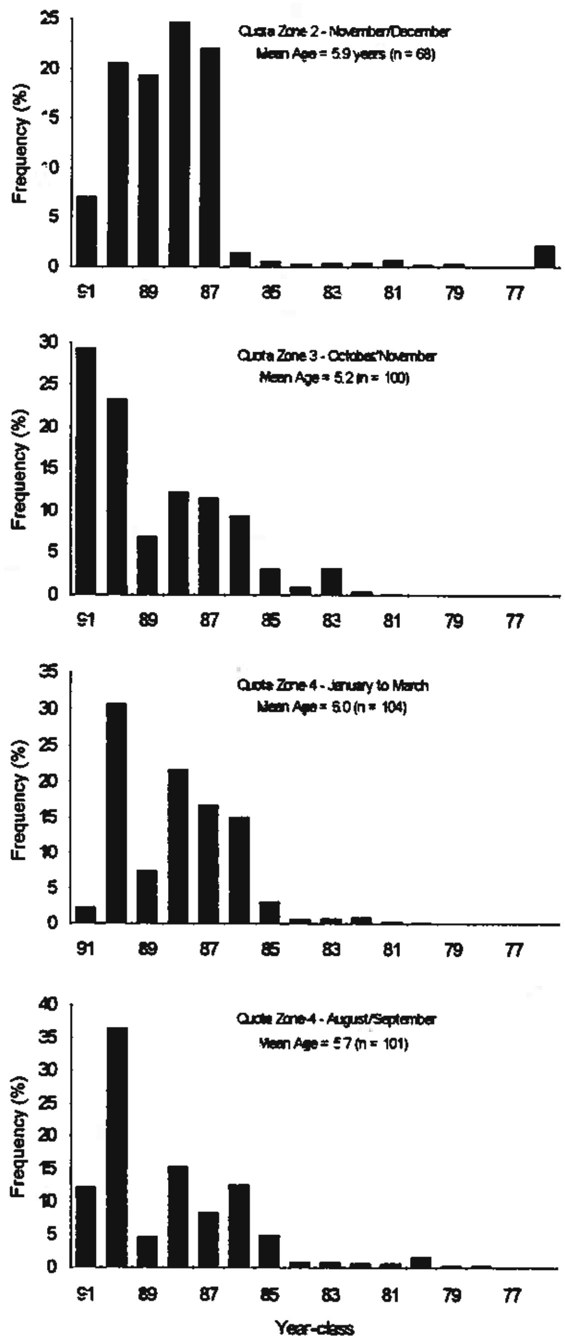

FIG. 3. Lake whitefish age distributions of the 1994 commercial harvest from Quota Zones 2, 3 and 4 for the seasons and gear types indicated. The y-axis represents the percent of the sample for the season and gear type indicated. Sample sizes, indicated in parentheses, are the number of fish sub-sampled for age interpretation (otoliths), from the larger size distribution samples given in Fig. 2. Mean ages are also shown.

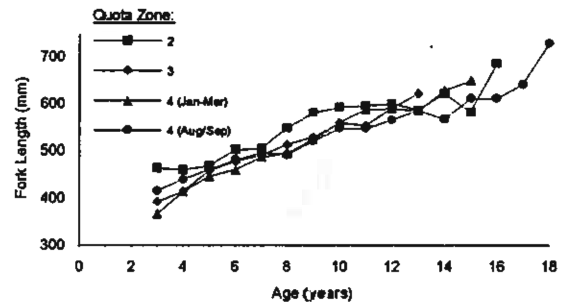

FIG. 4. Lake whitefish fork length-at-age for the quota zones and seasons indicated.

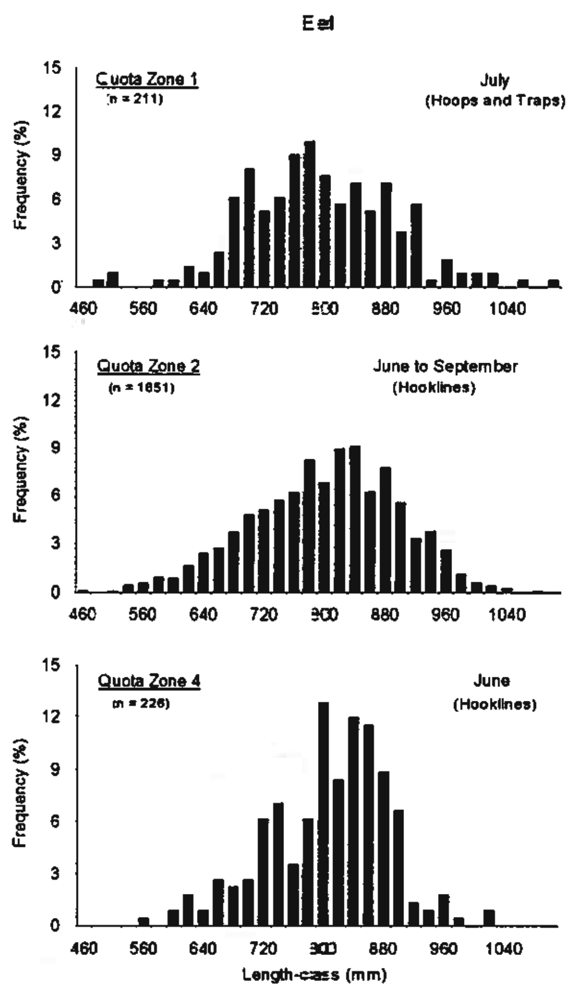

FIG. 5. Eel size distributions of the 1994 commercial harvest from Quota Zones 1, 2 and 4 for the seasons and gear types indicated. The y-axis represents the percent of the sample (sample size indicated in parentheses) for the season and gear type indicated. Sixty-five percent of the annual eel harvest occurred in the seasons and gear types shown.

New eel recruits to the Lake Ontario fishery must come from the Atlantic Ocean via the St. Lawrence River. Their abundance is monitored at the R.H. Saunders Generating Station eel ladder. Eel counts at the ladder declined tremendously from 1983 up to 1993. The 1994 eel count (163,521 fish, mean total length = 493 mm), being the highest for several years (Kentell 1995), provides some encouragement for an otherwise declining fishery.

Yellow Perch

Historic trends in yellow perch commercial harvest were recently described by Hoyle (1993). Yellow perch commercial harvest fluctuated around 125,000 lb from the early 1900s to the mid-1960s when a tremendous increase in harvest occurred, and was sustained until the early 1980s. Yellow perch harvest declined through the mid-1980s. The 1994 harvest was 151,341 lb, representing only 40% of available quota (376,060 lb) for this species. Although the 1994 harvest was 40% higher than 1993, we attribute this to increased fishing effort associated with the much higher market value (about $2.50/lb) in 1994 compared to 1993 ($1.01/lb).

For the first time in many years yellow perch harvest from Quota Zone 2 (47,298 lb) was not the largest for all quota zones. The largest harvest (53,806 lb) came from the Bay of Quinte (Quota Zone 3), while the highest harvest relative to quota occurred in Quota Zone 4 (63%). Yellow perch harvest (6,134 lb) was especially low in Quota Zone 1 relative to quota (48,830 lb).

The size structures of the yellow perch harvest were similar for Quota Zones 2 and 4 with mean sizes of just under 200 mm fork length (Fig. 6). Quota Zone 1 harvested very small fish (mean size less than 190 mm). The widest range of sizes and the largest fish came from Quota Zone 3 (Bay of Quinte).

We feel that lower productivity, compared with the 1970s and early 1980s, is currently the primary factor limiting the abundance of commercially marketable-sized yellow perch in the main lake. It appears that the large annual yellow perch gillnet harvests of the late 1970s and early 1980s can no longer be supported in the open-waters of Lake Ontario.

Walleye

Like lake whitefish, walleye commercial harvest declined during the 1960s. The annual harvest remained very low until their resurgence beginning in

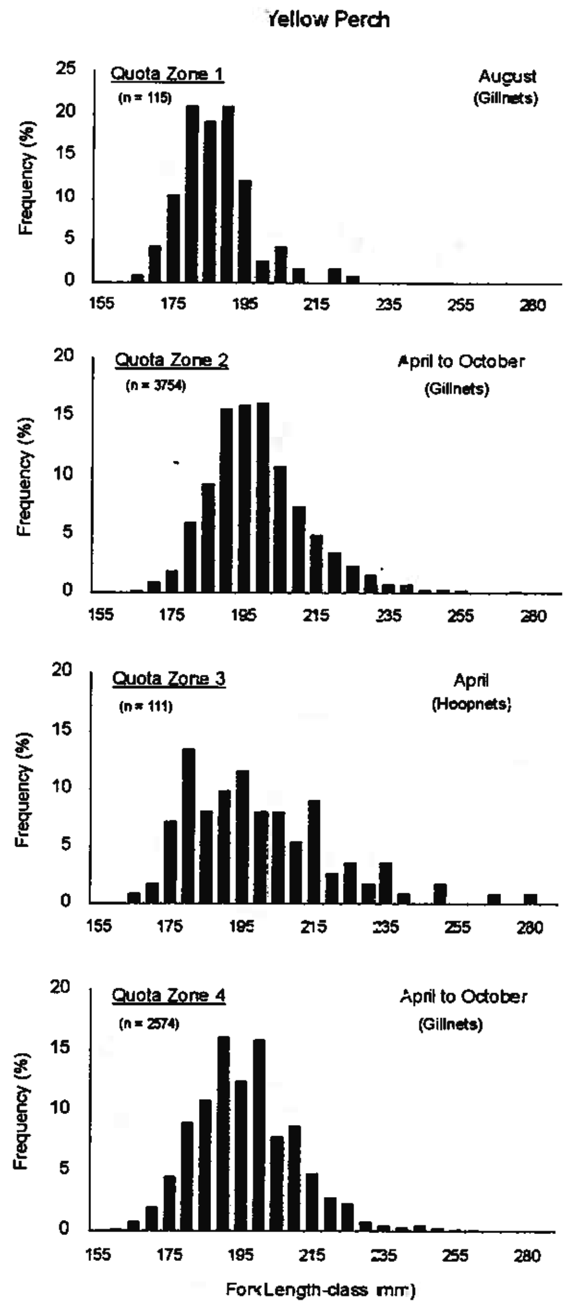

FIG. 6. Yellow perch size distributions of the 1994 commercial harvest from Quota Zones 1, 2, 3 and 4 for the seasons and gear types indicated. The y-axis represents the percent of the sample (sample size indicated in parentheses) for the season and gear type indicated. Sixty-seven percent of the annual yellow perch harvest occurred in the seasons and gear types shown.

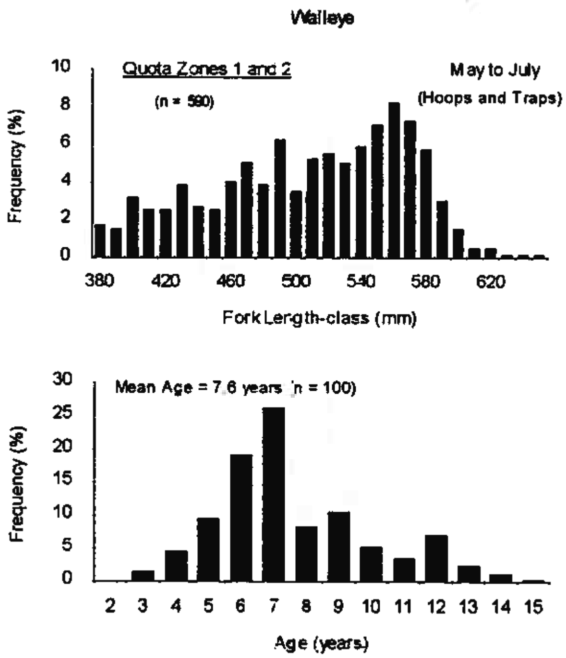

FIG. 7. Upper panel, walleye size distribution of the 1994 commercial harvest from Quota Zones 1 and 2 hoopnets and trapnets for the May to July season. The y-axis represents the percent of the sample (sample size indicated in parentheses) for the season and gear type indicated. Sixty-one percent of the annual walleye harvest occurred from May to July in hoopnets and trapnets. Lower panel, walleye age distribution corresponding to the size distribution in upper panel. Sample size, indicated in parenthesis, is the number of fish sub-sampled for age interpretation (scales).

1978. Tight commercial harvest controls were introduced in 1981, with a complete prohibition on harvest for the years 1984 to 1988 inclusive. A small walleye commercial harvest was re-instituted in 1989.

In 1994, the harvest was 35,088 lb, 53% of the available quota (66,570 lb), and was taken mainly by the trapnet/hoopnet fishery in Quota Zones 1 and 2, and an incidental catch allowance taken during the various lake whitefish gillnet fisheries. The walleye harvested from the trapnet/hoopnet fishery in Quota Zones 1 and 2 were larger and older (Fig. 7) than those observed in the last two years (Hoyle et al. 1994).

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5

Recreational Fisheries

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Jim Hoyle
Mike Rawson

Overview

Surveys of recreational fisheries are used to monitor trends in fishing effort and catch. They are useful in gathering demographic, socioeconomic, and angler behavioral information valuable in resource management decision making. Fisheries managers rely on recreational fishing survey information to detect changes in fish distribution and species composition that can be used to refine stocking policies or update fishing regulations. By measuring changes in catch and harvest rates, and biological characteristics of the fish harvested, angler surveys provide information on the status of fish populations. These surveys monitor fish abundance, growth, and levels of natural production, that supplements information from other surveillance programs.

There are two major recreational fisheries in Canadian waters of Lake Ontario: the Bay of Quinte walleye fishery, and the lake and tributary salmonine (salmon and trout) fishery.

Angler surveys have been conducted on the Bay of Quinte periodically since 1957 (Fig. 1). There is a winter ice fishery and a three season, open-water fishery on the bay. The ice fishery in the Bay of Quinte has been monitored biennially from 1982 to 1988 and annually since 1988. The open-water fishery has been monitored annually since 1979. Traditionally, walleye make up the bulk of the angling harvest. Fishing pressure was minimal on the Bay of Quinte when walleye populations were very low in the

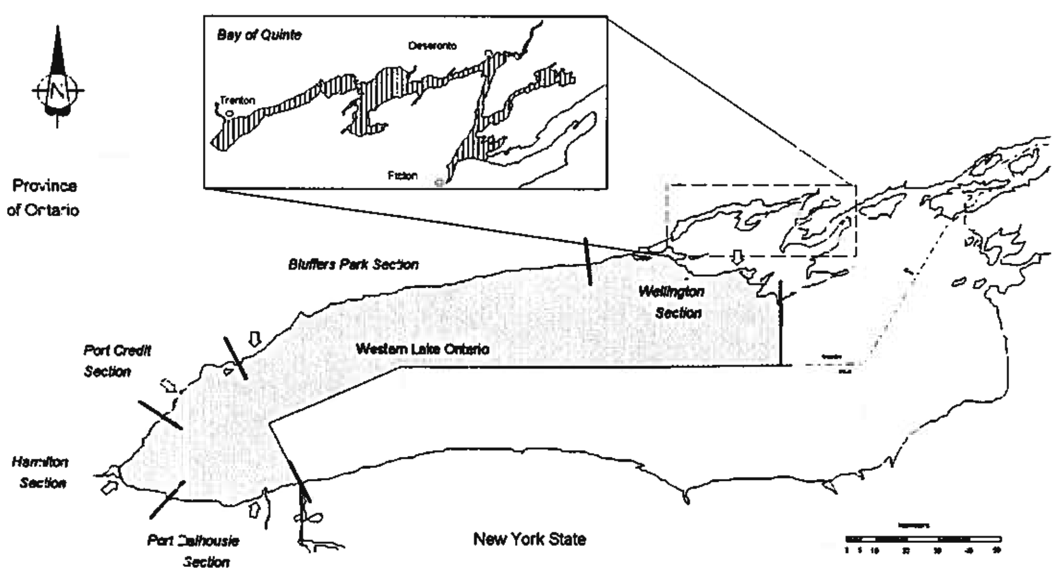

Fig. 1. Geographic areas covered by the Bay of Quinte and western Lake Ontario angler surveys in 1994 (the 5 western Lake Ontario angler interview sites are indicated by arrows).

late 1960s and 1970s, and no angling surveys were conducted at that time. With the resurgence of walleye since 1978, a large sport fishery has developed. Results of the 1994 angler surveys on the Bay of Quinte indicate that total walleye angler effort continues to grow annually (over 1 million hours of fishing effort in 1994) while the numbers of walleye harvested appears to have levelled off at about 150,000 fish.

Monitoring of the lake salmonine fishery is centred around western Lake Ontario, launch daily, boat angler surveys (Fig. 1). These surveys began in 1977, and are restricted to anglers who trailer their boats to launch ramps. Early surveys were confined to specific fishing derbies and regions. Annual surveys (April to September, inclusive) were first implemented in 1987. In 1989 this launch daily boat fishery was estimated to represent 25% of the salmonine angling effort in Canadian waters of Lake Ontario and the lower reaches of its tributaries (Savoie and Bowlby, 1991). Since 1987, the western Lake Ontario angling effort of affiliated charter boat operators has been indexed by a mail-in questionnaire. Other components of the shore and marina-based fisheries, including the eastern Outlet Basin, are scheduled to be sampled on a 5-year rotation and are not reported here.

Boat anglers enjoyed an excellent spring fishery and a good fishing season overall. With the exception of a 1992 low (attributed to poor weather conditions), the combined salmonine harvest rates have not changed significantly since 1987. The western Lake Ontario quality of fishing has remained relatively constant over the past 8 years. The international stocking cutbacks of 1993 and 1994 have not yet significantly affected the fishery. Despite these facts, the western Lake Ontario harvest continues to decline in response to decreasing angler effort.

Chinook salmon continued to dominate this fishery. Rainbow trout, lake trout, brown trout and coho salmon all contributed significantly to a fishery which varied considerably on a seasonal and regional basis. The St. Catharines and Hamilton sections were the only areas of the lake where angling effort and, coho salmon catch and harvest, increased from 1993. The loss of the Toronto Star Great Salmon Hunt resulted in a significant reduction in fishing effort particularly in the Bluffers Park and Port Credit sections. In 1994 there were some significant improvements in brown trout harvest rates in the Wellington, St. Catharines and Hamilton sections of the lake. Of the five sections monitored Wellington had the best harvest rates by far for lake trout, brown trout and chinook salmon. The Bluffers Park section had the best harvest rates for rainbow trout, with Wellington a very close second. More changes are expected in the near future as the Lake Ontario fishery adjusts to ecological and socioeconomic changes and the recent international stocking reductions.

A summary of the 1994 survey results for the Bay of Quinte walleye and the western Lake Ontario salmonine fisheries is presented below.

Bay of Quinte Walleye Fishery

Bay of Quinte recreational angling surveys are conducted annually 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. In 1994, as in most recent years, the on-ice/on-water interviews component of the angler surveys consisted of index surveys based on the geographic (ice fishing survey) or seasonal (open-water survey) patterns of fishing effort and catch/harvest rates observed during full surveys. Full surveys are scheduled every 5 years. The last full surveys were completed in the summer of 1988, winter 1989, and winter and summer 1993). Ice angler interviews are conducted in one geographic area, and results are extrapolated to represent the whole Bay of Quinte. Open-water angler interviews are conducted in May and July, and the results are extrapolated to represent the entire open-water walleye fishing season. Aerial counts, to estimate total angling effort, are conducted across all geographic areas, and in all seasons, every year. Detailed survey designs are reported by Mathers (1994a), and Hoyle (1994) for on-ice and on-water surveys, respectively.

Ice Fishery

Ice angling effort was estimated to be 355,858 rod-hours (Table 1). This level of effort is about the average observed in the two previous years, suggesting that ice angling effort may have peaked after having increased since 1982 (Fig. 2) An estimated 31,060

*Table 1. The seasonal distribution of angling effort and walleye catch and harvest for Bay of Quinte ice and open-water recreational fisheries, 1994. *Ice fishing walleye catch and harvest totals represent extrapolations from a partial geographic on-ice survey to the whole Bay of Quinte (note that aerial counts to determine fishing effort encompassed the whole Bay of Quinte), and are based on the geographic distribution of fishing success observed in 1993. **Open-water fishing effort and walleye catch and harvest for June, August and fall seasons represent extrapolations based on the seasonal pattern of fishing effort and success observed in 1993.*

Season	Effort (rod-hours)	Catch	Harvest
Ice fishery:			
Ice fishing-total*	355,858	31,060	8,557
Open-water fishery:			
Opening weekend	106,116	22,591	13,918
May	293,560	138,100	75,600
June**	75,531	23,197	12,585
July	56,037	38,540	18,944
August**	91,581	28,086	20,223
Fall**	58,232	7,018	2,858
Open-water total	681,058	257,531	144,128
Annual total	1,036,916	288,591	152,685

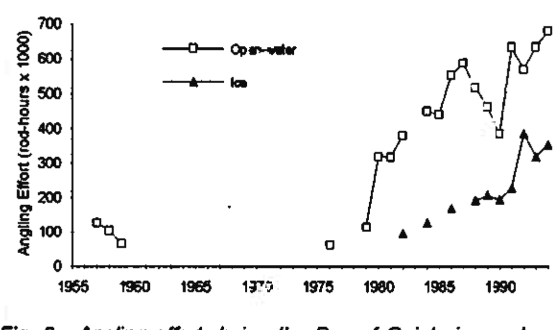

Fig. 2. Angling effort during the Bay of Quinte ice and open-water recreational fisheries 1957 to 1994.

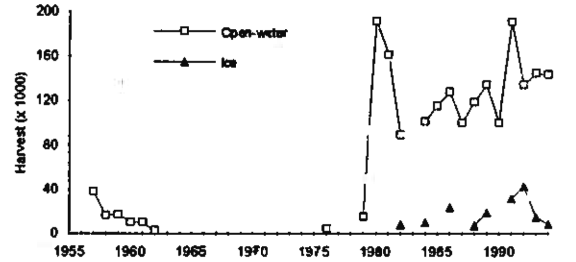

Fig. 3. Walleye harvest during the Bay of Quinte ice and open-water recreational fisheries, 1957 to 1994.

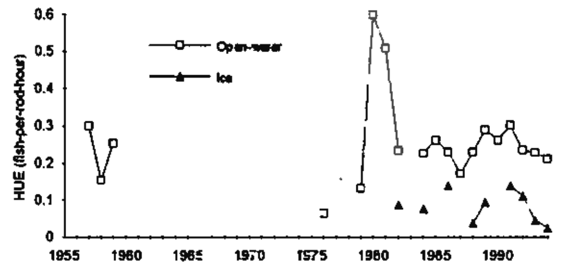

Fig. 4. Walleye harvest-per-unit-effort (HUE) during the Bay of Quinte ice and open-water recreational fisheries, 1957 to 1994.

walleye were caught of which 8557 were harvested (Table 1). This level of harvest, and the harvest-per-unit-effort (HUE) of 0.024 walleye-per-rod-hour are the lowest observed since 1988 (Fig. 3 and 4). The average walleye harvested during the ice fishery was 553 mm fork length, weighed 2.2 kg and was 6-yrs-old.

Extrapolation of on-ice angler interview results from one geographic area, to the entire Bay of Quinte assumes that fishing success (and biological characteristics of the walleye harvest) in the index area, relative to the rest of the Bay of Quinte, remains constant from year-to-year. The shift in angler distribution from 1989 to 1994, as measured by aerial angler count data (Fig. 5), suggests that this assumption may not hold true. A comparison of angler success rates in the winter of 1989 (Mathers and Bowlby 1990) with those of 1993 (Mathers 1994b), indicates that the geographic pattern of walleye fishing success is highly variable. Hence, extrapolations of the 1994 winter walleye catch and

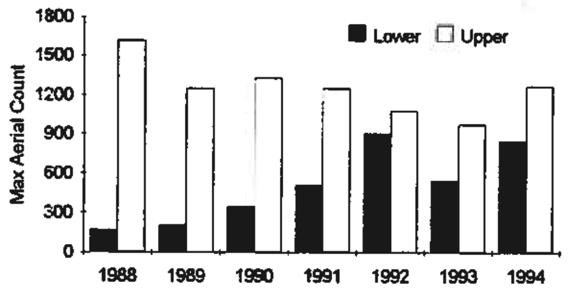

Fig 5. Maximum aerial counts (huts plus on-ice anglers) during ice angling surveys for the lower (Deseronto to Picton) and upper (Trenton to Deseronto) Bay of Quinte (Fig. 1, inset), 1988 to 1994.

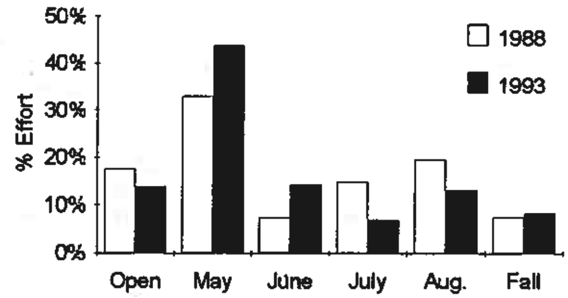

Fig. 7. Comparison of the seasonal distribution of angler effort for the open-water recreational fishery in 1988 and 1993

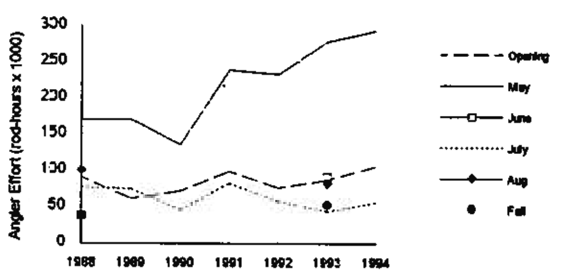

Fig. 6. Trends in the seasonal distribution of angling effort for the Bay of Quinte open-water recreational fishery, 1988 to 1994. The opening weekend, May and July were surveyed in all years; June, August and the fall were surveyed in 1988 and 1993 only.

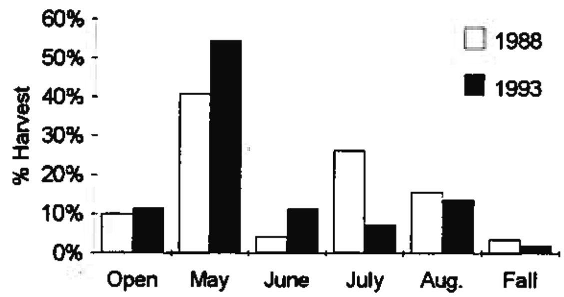

Fig. 8. Comparison of the seasonal distribution of walleye harvest for the open-water recreational fishery in 1988 and 1993.

harvest to the whole Bay of Quinte must be viewed with caution. Future on-ice surveys must include wider geographic coverage to obtain accurate walleye harvest estimates for the whole Bay of Quinte.

Open-water fishery

Open-water fishing effort was estimated at 681,058 rod-hours, the highest ever observed (Table 1). The trend in angling effort (Fig. 2) suggests that the open-water walleye fishery continues to grow. The increase in angling effort, over the last several years, can be accounted for by fishing effort in May alone (Fig. 6). Walleye catch was estimated at 257,531 fish of which 144,128 were harvested. This level of harvest has been steady over the last three years (Fig. 3). Because angler effort has increased and walleye harvest has remained steady, walleye HUE has declined. The HUE of 0.212 walleye-per-rod-hour observed in 1994 is the lowest observed since 1987 (Fig. 4). The average walleye harvested during the open-water fishery was 397 mm fork length, weighed 0.8 kg and was 4-yrs-old.

Although most of June was not surveyed directly in 1994, anecdotal evidence suggests that walleye catch rates were high. Angler effort and walleye harvest for June were higher in 1993 than in 1988 (Fig. 7 and 8). These results suggest a trend of increasing angler effort and walleye harvest in June. Consideration should be given to including June in our annual open-water angling surveys.

Western Lake Ontario Boat Fishery

The 1994 survey of the salmonine fishery focused primarily on the launch daily boat anglers in Canadian waters of western Lake Ontario. This survey was based on completed trip angler interviews from April to September at five boat launching ramps: Port Dalhousie, Hamilton, Port Credit, Bluffers Park and Wellington. As a cost saving measure, the Port

Darlington site (surveyed by angler interviews in 1993) was monitored by boat trailer count only in 1994. In order to capture regional differences in the character of this fishery the lake was divided into 5 sections, the boundaries of which are indicated in Fig.1. Counts of parked boat trailers at the five surveyed ramps, and an additional 34 ramps, from Queenston (Niagara River) to Wellington (Prince Edward County), were used to determine the relative distribution of fishing effort, and to expand catch and harvest statistics indexed by the five surveyed sites. In 1994 , the five angler interview sites represented an estimated 40% of the launch daily boat angling effort for western Lake Ontario. This survey was also divided into five temporal strata in order to compare seasonal differences in the fishery. Detailed survey protocols were reported by Savoie (1994a, 1994b, 1994c). In 1994, the western Lake Ontario angling effort of affiliated charter boat operators continued to be indexed by a mail-in questionnaire. Affiliated charter captains were asked to report the number of fishing trips conducted by month and port.

Lake-Wide Results

The 1994 western Lake Ontario launch daily boat angling effort was estimated at 406,898 rod-hours. The salmonine catch was estimated at 70,750 fish with a catch-per-unit-effort (CUE) of 0.174 fish-per-rod-hour of effort (Table 2). Salmonine release rates averaged 48% in 1994. The harvest was estimated at 36,810 fish with an HUE of 0.091 fish-per rod-hour of fishing effort. Chinook salmon continued to dominate the western Lake Ontario launch daily boat fishery, comprising 61% of the harvest (Fig. 9). Rainbow and lake trout represented 16% and 12% of the harvest, respectively. Brown trout comprised 7% of the harvest while coho salmon accounted for only 4% of the western Lake Ontario harvest. Atlantic salmon did not significantly contribute to the harvest. In 1994, there were a few non-salmonine incidentally harvested, mostly walleye and white bass (Table 2).

In 1994, 134 affiliated charter boat operators conducted an estimated 2986 fishing trips in western Lake Ontario.

Seasonal Comparisons

There were significant differences in the geographic and temporal distribution of salmonine boat fishing effort. In 1994, 29% of the launch daily boat angler effort was along the Bluffers Park section

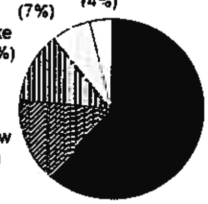

Fig. 9. Lake-wide harvested species mix, from the 1994 western Lake Ontario launch daily boat fishery.

TABLE 2. Launch daily boat angler catch and harvest statistics for western Lake Ontario, 1994, based on 1,973 completed trip interviews. Catch-per-unit-effort (CUE) and harvest-per-unit-effort (HUE) are reported as number of fish caught or harvested-per-rod-hour of fishing effort. Release rates are given in percentages.

Species	Catch	Harvest	CUE	HUE	Release Rate (%)
Chinook salmon	43,003	22,410	0.1057	0.0551	48
Rainbow trout	10,895	5,747	0.0268	0.0141	47
Lake trout	10,411	4,563	0.0256	0.0112	56
Brown trout	4,019	2,492	0.0099	0.0061	38
Coho salmon	1,819	1,383	0.0045	0.0034	24
Atlantic salmon	157	134	0.0004	0.0003	15
Unknown salmonine	446	81	0.0011	0.0002	n/a
Total salmonine	70,750	36,810	0.1739	0.0905	48
Total non-salmonine	5,088	438	0.0125	0.0011	91

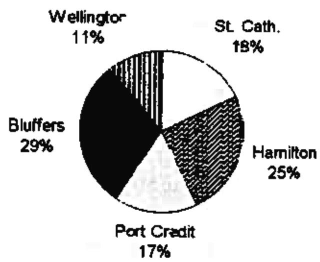

Fig 10. Regional distribution of fishing effort, from the 1994 western Lake Ontario launch daily boat fishery.

(Fig. 1 and 10). The Hamilton section was a close second at 25%, followed by St. Catharines (18%), Port Credit (17%) and Wellington (11%). The period from mid-July to September 30, accounted for 59% of the western Lake Ontario launch daily boat angler effort and 68% of the harvest in 1994 (Fig. 11A). There was a lake-wide lull in fishing effort and harvest from early June to mid-July.

St. Catharines Section

The fishery in this section of the lake was characterized by a strong spring component, dominated by chinook salmon with a mix of lake trout, coho salmon and brown trout (Fig. 11B). Lake trout and coho salmon harvest in the St Catharines section was largely confined to April and May. There was almost no harvest for the period from mid-June to mid-August. From mid-August to the end of September there was a chinook salmon and brown trout fishery. The brown trout fishery in this section of the lake was largely confined to April and September.

Hamilton Section

The April to early June fishery in this section of the lake had a mix of lake trout, chinook salmon, coho salmon and brown trout (Fig. 11C). Unique to this area is the fact that coho salmon remained available into August. The latter part of the fishing season was dominated by a chinook salmon fishery. Similar to St. Catharines, the brown trout fishery was largely confined to April, May and September.

Port Credit Section

Ninety percent of the launch daily salmonine harvest in this area occurred from mid-July to the end of September, and was confined largely to chinook salmon and rainbow trout (Fig. 11D). The termination of the Toronto Star Great Salmon Hunt in 1994 was a contributing factor in the reduction of fishing effort in the Port Credit section.

Bluffers Park Section

The relatively small spring component of the fishery that exists in the Bluffers Park section was confined to brown trout (Fig. 11E). Rainbow trout show up earlier and in larger numbers in this section of the lake than any other. Chinook salmon still make up the bulk of the harvest from mid-June onwards. The period from mid-July to the end of September accounted for 88% of the harvest in the Bluffers Park section. The chinook salmon fishery drops off earlier at Bluffers Park compared to Port Credit, as the salmon stage near the Credit River mouth prior to the spawning run (Fig. 11D, 11E). With Port Darlington having been dropped as an angler interview site in 1994, we believe that the mid-season rainbow trout harvest in this section may have been underestimated. Past surveys indicated that the Bluffers Park and Port Darlington sites had virtually identical harvested species mix. However, the seasonal character of the Port Darlington fishery differed significantly, in that a higher proportion of rainbow trout were harvested from mid-June to mid-July. We recommend that future surveys include an angler interview site in the Port Darlington to Port Hope area.

Wellington Section

The first 3 months of the fishing season in the Wellington sector revolves exclusively around lake trout (Fig. 11F). In 1994, the 5-week period from July 16 to August 19, accounted for 65% of the salmonine harvest which included very few lake trout. The balance of the fishing harvest was evenly spread among the rest of the season. The Wellington area was unique in that brown trout were harvested almost exclusively from mid-July to mid-August.

Regional Comparisons

Chinook Salmon

The Bluffers Park and Hamilton sections of the lake together, accounted for 54% of the chinook harvest (Fig. 12A). The Port Credit section had the lowest chinook HUE. The earlier timing of a new fishing derby (The Salmon Masters Tournament) combined with later staging of chinook salmon at the Credit River mouth (due to colder than average water temperatures) may account for the relatively low HUE in the Port Credit section. By far the best chinook

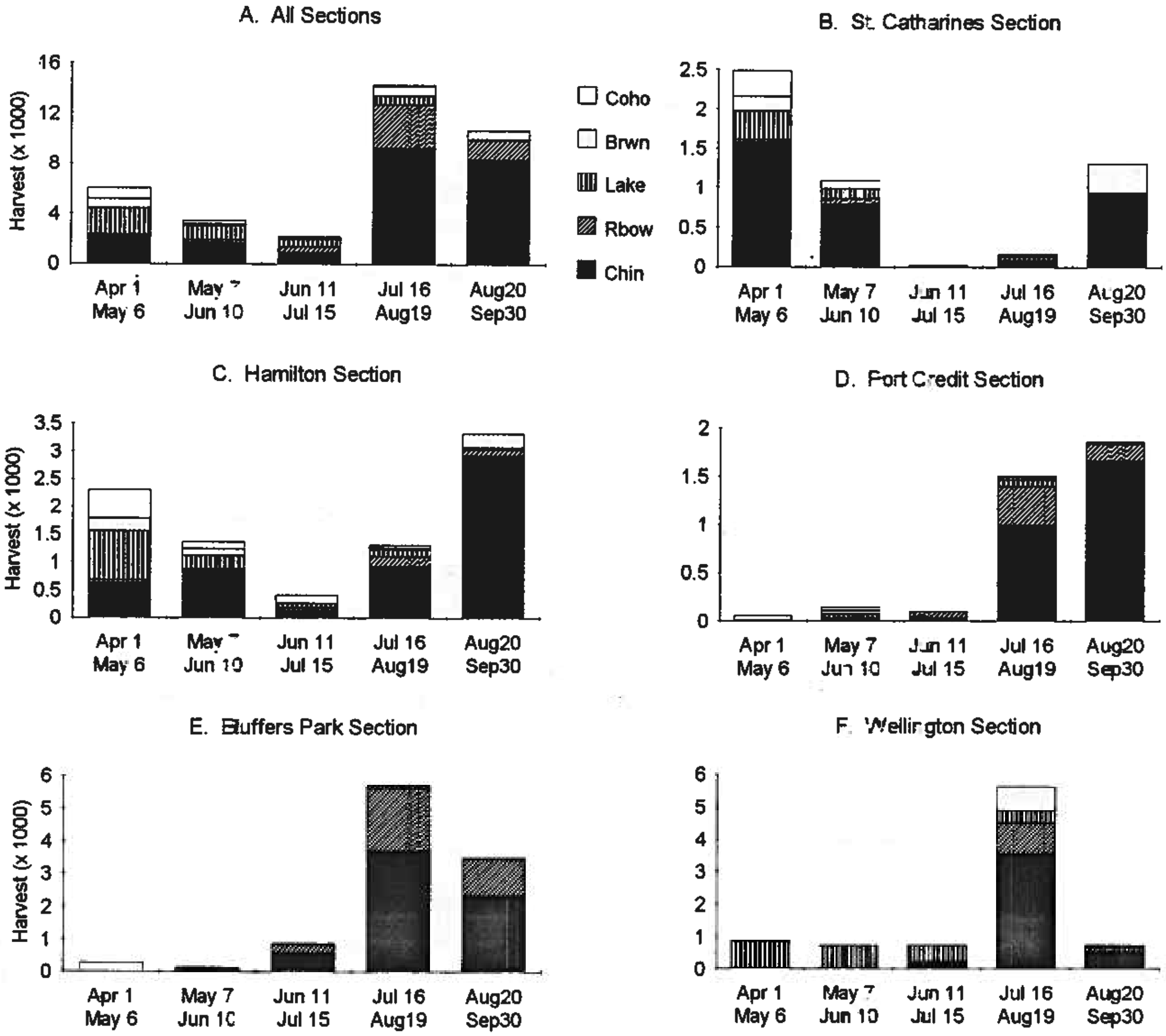

Fig. 11. Seasonal comparisons of harvest by lake section, from the 1994 western Lake Ontario launch daily boat fishery.

fishing was in the Wellington section, where the HUE was at least 42% higher than the remainder of the lake, although it was largely confined to a 5-week period from mid-July to mid-August (Fig. 11F).

Rainbow Trout

The Bluffers Park section took 59% of the rainbow trout harvest and had the highest HUE (Fig. 12B). Wellington was a distant second for rainbow trout harvest (20%), but enjoyed an HUE only slightly lower than Bluffers Park. The St. Catharines, Hamilton and Port Credit sections combined, only accounted for 21% of the lake-wide rainbow trout harvest.

Lake Trout

The Wellington section alone accounted for 55% of the lake trout harvest, with Hamilton second at 29% (Fig. 12C). The lake trout HUE at Wellington was 3.3 times higher than Hamilton. The St. Catharines, Bluffers Park and Port Credit sections combined, accounted for only 16% of the western Lake Ontario lake trout harvest.

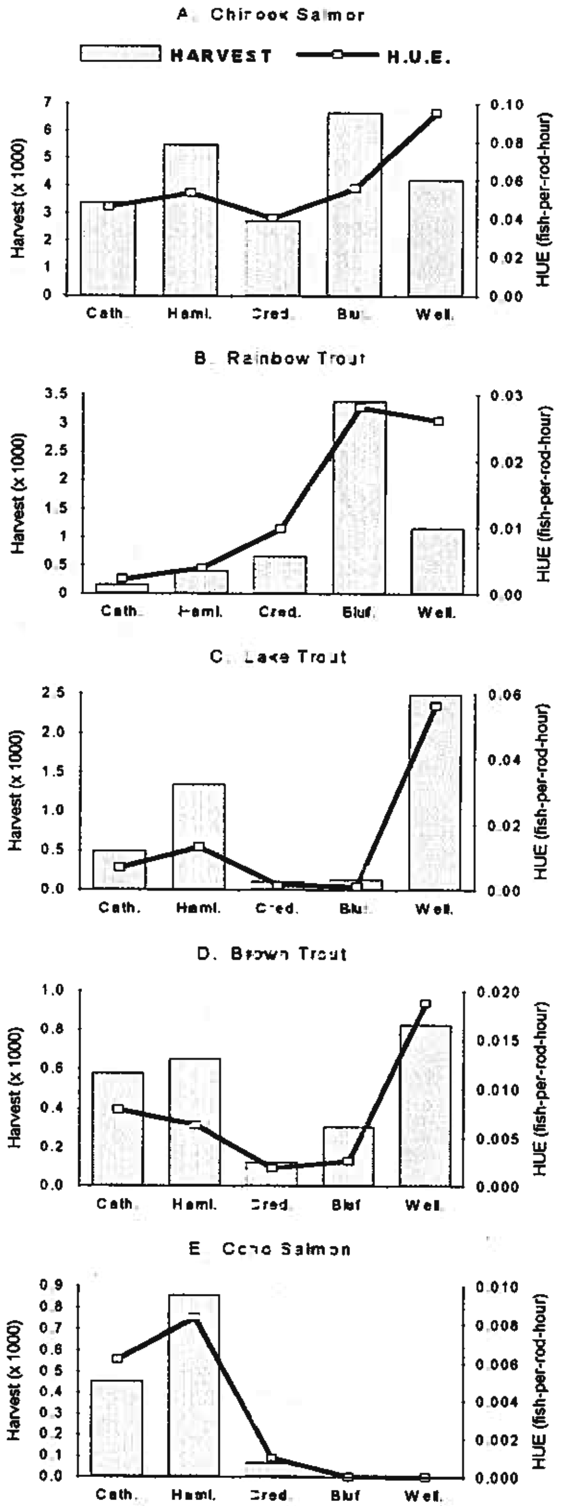

Fig. 12. Regional comparisons of the harvest and HUE by species, from the 1994 western Lake Ontario launch daily boat fishery.

Brown Trout

The Wellington section accounted for 33% of the brown trout harvest and HUE was almost 1.4 times higher than the second place, St. Catharines section (Fig. 12D). The St. Catharines and Hamilton sections combined, accounted for 49% of the lake-wide brown trout harvest.

Coho Salmon

The Hamilton and St. Catharines sections together accounted for 95% of the coho salmon harvest (Fig. 12E). The Hamilton section also had the highest HUE for coho salmon. No coho salmon were observed in the harvest in either, the Bluffers Park, or Wellington sections. This was the first time, in the 8-year history of surveys in these areas, that coho salmon were absent from the harvest. With the discontinuation of the Canadian coho stocking program in 1992 (Chapter 2) and decreased fishing effort, it may be that our reduced survey effort of recent years can no longer detect the low incidence of coho harvest. Experienced anglers fishing the area from Wellington to Colborne did acknowledge that coho salmon were very rare in 1994. The results of the 1995 survey may help to clarify this situation.

Recent Trends

Effort

The 1994 salmonine boat fishing effort declined by 23% compared to 1993, the lowest in 10 years (Fig. 13). Effort decreased from 1982 to 1984 and was followed by a dramatic rise from 1984 to 1986, coincident with increased stocking of salmon and trout. Effort peaked in 1989, and has declined since. Lake-wide stocking levels have hovered around 8.2 million (+/- 5%) fish from 1984 to 1991 and were cut

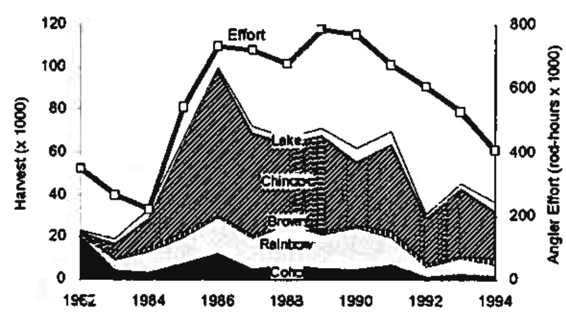

Fig. 13. Western Lake Ontario launch daily boat angler effort and salmonine harvest trends from 1982 to 1994.

to nearly half that level by 1994 (Chapter 2). It will take several years (depending on age at stocking and longevity of a given species) for fish stocked at reduced levels in 1993 and 1994 , to enter the fishery and potentially impact CUE and HUE. The discontinuation of the Toronto Star Great Salmon Hunt resulted in reduced fishing effort in 1994. The declining trend in angling effort may be due to a general decline in the economy, the false perception that recent stocking cuts have already had a negative impact on the fishery, and concern over contaminants in fish. Some anglers in the Hamilton to St. Catharines area may be shifting their effort to the improving walleye fishery in eastern Lake Erie.

The 1994 western Lake Ontario affiliated charter boat effort declined by 4% compared to 1993. This decline in effort was despite a 24% increase in membership from 1993 (Fig. 14). Anecdotal information suggested that the 1994 decline in the charter boat business was largely due to the termination of the Toronto Star Great Salmon Hunt. The 1994 level of effort was the lowest observed in the 8-year history of our survey. The charter boat component of the fishery has been particularly sensitive to the decline in the economy. The longer-term decline in charter boat effort was related to a declining trend in association membership. Charter boat effort increased from 1987 to 1989. At that time there were four associations in existence. Effort has declined since, with the Scarborough Charterboat Association (SCBA) disbanding in 1990 and the Eastern Ontario Charterboat Association (EOCBA) disbanding by 1992, leaving only the Independent Sportfishing Association (ISA) and the Ontario Sportfishing Guides' Association (OSGA) to continue to the present (Fig. 14).

Catch, Harvest, and HUE

The 1994 catch and catch rates decreased by 25% and 3% , respectively, compared to 1993 (Savoie and Mathers, 1994). Salmonine release rates averaged 48% in 1994 as compared to 52% in 1993. The 1994 harvest declined by 20% compared to the previous year (Fig. 13). The magnitude and species mix of the harvest has varied considerably since 1982. In the early 1980s the harvest was smaller and dominated by coho salmon. In response to changes in stocking

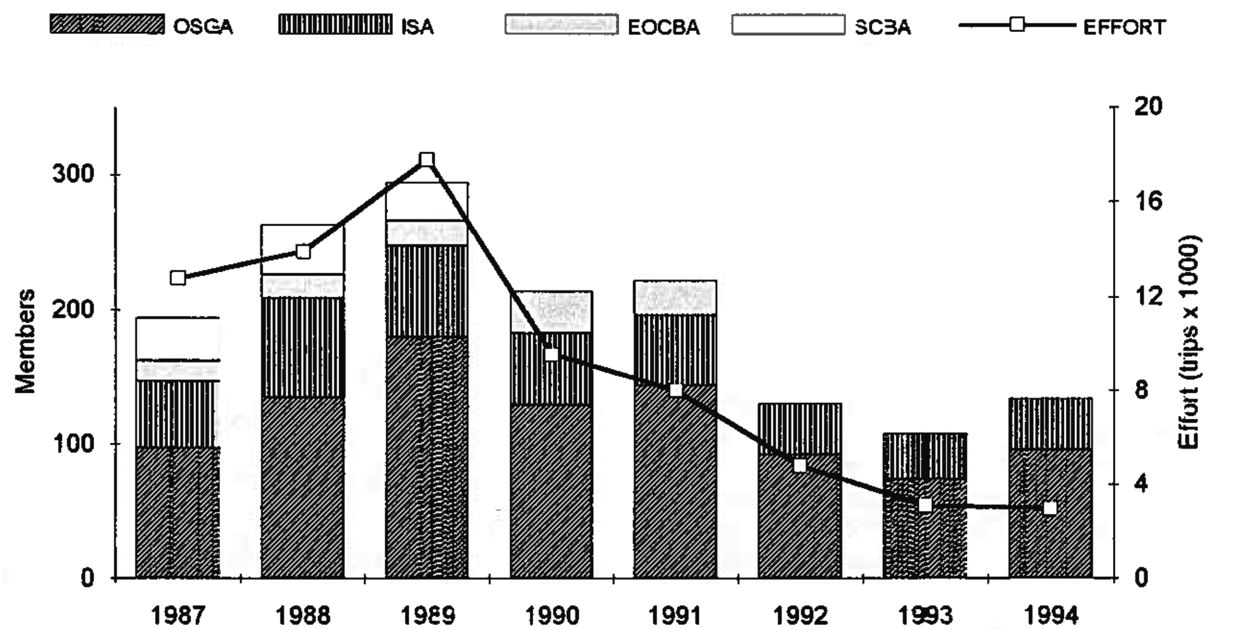

Fig. 14. Western Lake Ontario affiliated charter boat membership and effort trends, 1987 to 1994 (Scarborough Charterboat Association (SCBA-disbanded 1990), Eastern Ontario Charterboat Association (EOCBA-disbanded 1992), Independent Sportfishing Association (ISA), Ontario Sportfishing Guides' Association (OSGA)).

strategies, harvest increased dramatically by the mid-1980s (Fig. 13). Harvest was relatively stable from 1987 to 1991, then began to decline in 1992, a trend which continued to the present.

By the mid 1980s chinook salmon clearly dominated the fishery (Fig. 13). Chinook salmon harvest decreased by 30% from 1993 to 1994. The 1994 lake trout harvest almost doubled compared to 1993. Rainbow trout harvest decreased by 23% from 1993 to 1994. Brown trout harvest increased by 130% from 1993 to 1994. The 1994 coho salmon harvest declined by 43% from the previous year.

The 1994 salmon and trout HUE increased by 4% compared to 1993 (Fig. 15). The quality of the western Lake Ontario salmonine fishery, as measured by HUE, peaked in 1984 but has remained relatively stable since 1987, with the exception of a low in 1992 which was attributed to inclement weather (Fig. 15). The decline in harvest since 1991 is therefore related to decreased angler effort and not to any significant decline in the quality of fishing (Fig. 13).

While the total salmonine HUE has been relatively stable in recent years, there have been some species-specific changes. The chinook salmon HUE decreased by 10% from 1993 to 1994 (Fig. 16). Chinook salmon HUE has fluctuated about a fixed level since 1988. The 1994 chinook salmon harvest rate is higher than observed in 1988 (Fig. 16). The 1994 rainbow trout HUE was the same as the previous year. Rainbow trout HUE increased dramatically from 1982 to a peak in 1984, dropped significantly the following year, remained relatively constant until 1991, and then declined further to the present level (Fig. 16). The coho salmon HUE declined by 27% from 1993 to 1994 The 1994 coho salmon HUE was the second lowest observed in our 13-year data series, only 1992 was lower. Coho salmon HUE was highest in 1982, then declined sharply the following year as Pacific salmon stocking shifted to chinook (Fig. 16). Coho salmon HUE has gradually declined from 1983 to the present. The Ontario Ministry of Natural Resources discontinued coho salmon stocking in Canadian waters of Lake Ontario in 1992. The 1994 lake trout HUE was 1.5 times that of 1993 (Fig. 17). The 1994 lake trout HUE was the second highest observed in our 13-year data series, only 1984 was higher. The brown trout HUE almost doubled from 1993 to 1994 (Fig. 17). The 1994 brown trout HUE was the second highest observed in our 13-year data series, only 1984 was higher. The cold spring and late fall may have been the primary factors contributing to the improved HUE for both the brown and lake trout fisheries, which are concentrated in April and September.

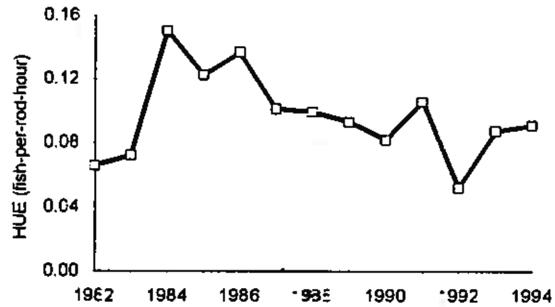

Fig. 15. Salmonine HUE trends for the western Lake Ontario launch daily boat angler fishery, 1982 to 1994.

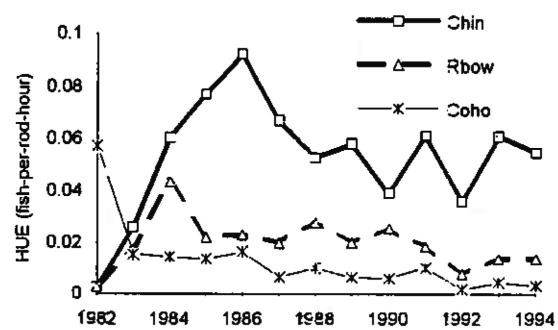

Fig. 16. Western Lake Ontario launch daily boat angler HUE trends for, chinook salmon, rainbow trout and coho salmon, 1982 to 1994.

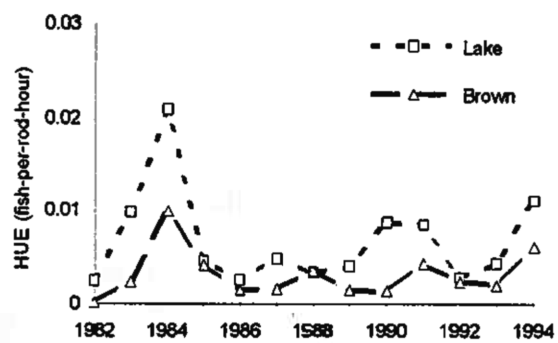

Fig. 17. Western Lake Ontario launch daily boat angler HUE trends for lake trout and brown trout, 1982 to 1994.

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6

Zebra and Quagga Mussel Studies

Ted Schaner
Tom Stewart

Overview

Lake Ontario fisheries surveillance programs are designed to detect changes in fish communities and associated fisheries over time, including changes that may result from invasion of zebra and quagga mussel (*Dreissena polymorpha and D. bugensis*). To increase our ability to relate potential changes to the effects of *Dreissena* we implemented studies documenting the mussels' abundance, and their effect on the early life history of lake whitefish.

The density studies have been ongoing since 1990, the year following the discovery of the first *Dreissena* in Lake Ontario. The program evolved from surveys of planktonic *Dreissena* larvae (veliger larvae), to diving surveys measuring densities of settled mussels in western Lake Ontario, and later as the colonization progressed, to diving surveys of the whole lake (Schaner 1991, 1992a, 1992b; Stewart et al. 1994). In 1994 we surveyed mussel populations in the Bay of Quinte. The surveys documented the overall increase in abundance of the mussels since 1990, the spread of the mussels from the densely colonized eastern and western extremes of the lake to the north-central shore, the late but rapid colonization of the Bay of Quinte, and the presence of quagga mussel.

The studies examining effects of *Dreissena* on the fish community focused on the mussels' interaction with larval lake whitefish (Hoyle 1992, Stewart et al. 1994). This choice was based on the strength of existing research and surveillance programs, the opportunity to contrast the response of Bay of Quinte whitefish stocks to those of Lake Ontario, and the fact that whitefish are a species of provincial significance that are not being extensively studied outside of Lake Ontario. Three years of data have been accumulated since 1991 (Stewart et al. 1994) We did not make direct observations of whitefish larvae in 1994, and thus no results are reported in this chapter. We did, however, keep up the collection of background data on lake whitefish egg densities as part of the mussel density studies, and we hope to continue larval whitefish observations in the future.

Colonization of Lake Ontario, 1990-1993

Extensive areas of Lake Ontario were colonized by *Dreissena* within a relatively short time. The first mussel was sighted in Port Weller in November 1989, and the following summer there were numerous sightings of *Dreissena* from areas throughout the lake. Most reports, as well as the highest densities observed at the time, came from U.S. sources. They spanned most of the south shore of the lake, from Niagara in the west all the way to Oswego in the east. On the Canadian side, sightings were concentrated in the western basin between Niagara and Toronto, but mussels were also reported from the Kingston Basin and the Bay of Quinte. The 1990 OMNR survey of *Dreissena* veliger larvae in Canadian waters confirmed the presence of mussels in the western basin, though only a single veliger was found in the Kingston Basin and none in the Bay of Quinte. In the two following years, 1991 and 1992, the general distribution pattern in Canadian waters remained the same, but the densities were increasing. Both, the 1991 veliger surveys, and the 1991 and 1993 diving surveys suggested that the highest mussel densities were found in the Toronto-Niagara area in the west, and somewhat lower concentrations were found in the Kingston Basin area in the east. Colonization of the intervening areas along the north shore of the lake was delayed, and densities there were lower. It appears that

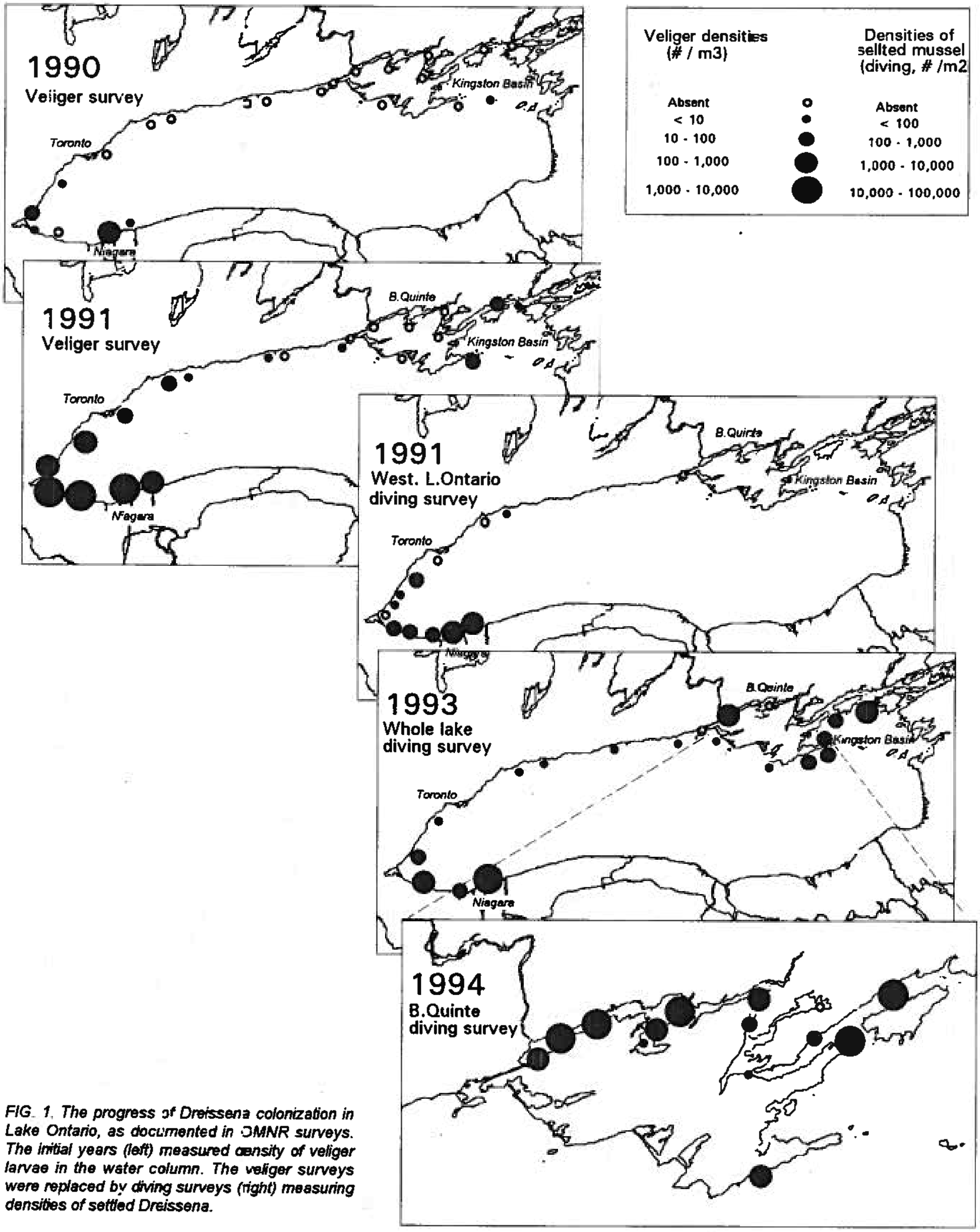

FIG. 1. The progress of Dreissena colonization in Lake Ontario, as documented in OMNR surveys. The initial years (left) measured density of veliger larvae in the water column. The veliger surveys were replaced by diving surveys (right) measuring densities of settled Dreissena.

the Bay of Quinte remained free of *Dreissena* until 1993.

The colonization pattern can be readily interpreted in terms of prevailing lake currents. The Niagara River, carrying Lake Erie water, was probably the major original source of *Dreissena* veligers. The river discharge into Lake Ontario is generally deflected eastward along the south shore, but wind-generated lake currents can at times carry it to the west (Anonymous 1985). The rapid spread of *Dreissena* along the U.S. south shore, and in the Niagara-Toronto area is consistent with these currents. The early concentrations of *Dreissena* in the Kingston Basin could have been due to contamination by the heavy shipping traffic in the area, or to veligers carried by currents along the south shore. The north-central shore of the lake is the least likely to receive water from the heavily colonized southwest region, and prevailing currents indicate that it should be colonized from the northeast and Kingston Basin regions. Accordingly, the north-central shore lagged behind the rest of the lake.

Bay of Quinte Survey, 1994

The delay in colonization of the Bay of Quinte was unexpected. The bay is highly productive, and a prime candidate for zebra mussel colonization. A single settled *Dreissena*, as well as veliger larvae were found in the Picton area (lower bay) as early as 1990. The bay empties into the Kingston Basin, which had significant populations of *Dreissena* since 1991, and there is intensive boat traffic between the two areas. In spite of the favourable conditions, it was not until the fall of 1993 that we received the first reports of major *Dreissena* colonies in the bay.

In the fall of 1994 OMNR conducted a diving survey of *Dreissena* densities in the bay and surrounding areas. Processing of materials collected during this survey has not been completed, but data from divers' reports provide us with provisional density estimates. The highest densities were found in the upper bay in the Trenton to Belleville area. The densities here exceeded 100,000 individuals.m^{-2}, the highest densities measured during any of our diving surveys on Lake Ontario so far. The densities in the middle and lower bay were lower, on the order of 10,000's individuals.m^{-2}. In the Bay of Quinte, *Dreissena* reached high densities very rapidly, and we should expect to start observing significant effects of the mussel soon.

Zebra vs Quagga

The distinction between zebra mussel (*Dreissena polymorpha*) and quagga mussel (*D. bugensis*) became known in 1992 (May and Marsden 1992). Life history studies made since the discovery revealed two major differences between the two species: quagga mussel tend to inhabit deeper and cooler waters, and unlike the zebra mussel, the quagga mussel will readily colonize soft substrate.

We now know that quaggas were present in Lake Ontario alongside the zebra mussel since the start. The first quagga in our survey series was found in a 1990 sample from the Niagara area. Re-examination of materials collected a year later, during the 1991 western basin survey, revealed that less than 1% of the collected *Dreissena* were quaggas. The 1993 survey encompassed the entire lake, and showed that the proportion of quaggas in the western basin remained below 1%, but proportions in the Kingston Basin reached up to 30%. In citing these numbers, it should be noted that based on the best information available at the time, we restricted the sampling depths and favoured hard substrate, thereby biasing the survey against finding quaggas.

The presence of quagga mussel changes the predictions for ecosystem impacts of *Dreissena*. In the past we felt that the mussel's population in Lake Ontario was going to be limited to a relatively narrow band around the perimeter of the lake through a general lack of suitable hard substrates at depths beyond 20 m. Quaggas ability to colonize deep unconsolidated substrates increases the potential biomass and impact of the invader.

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7

Habitat

Alastair Mathers

Overview

The structure and function of fish communities is influenced by the quantity and quality of fish habitat. Ecosystem management requires that we evaluate and manage fish habitat. Open lake and nearshore habitats in Lake Ontario's ecosystem can be classified by physical structure, water quality, and temperature. The open lake habitat of Lake Ontario is important for primary production and zooplankton grazing. In addition, planktonic and piscivorous fish feed in this region during many times of the year. The nearshore of the lake, which includes both exposed and sheltered zones, serves several important habitat functions. The substrate in the exposed nearshore zone provides spawning grounds for important cold-water fish species including lake trout and lake whitefish. Sheltered nearshore zones provide spawning grounds for a variety of warm-, cool- and cold-water fish species. All nearshore zones contribute greatly to the primary production of the lake and many fish utilize the nearshore benthic and planktonic habitats as nursery, refuge and feeding habitats.

This chapter provides background information and status of each of these habitat categories. In addition, new and ongoing initiatives for habitat evaluation and management will be described.

Water Quality

Lake Ontario, the lowermost of the Great Lakes, receives inputs of toxic substances and nutrients from upstream sources. Water quality is also affected by local industry, urban development, agriculture, and landfill leachate.

Eutrophication has been one of the most obvious forms of degradation of the aquatic habitat of Lake Ontario in the past (Christie 1972). In particular, the water quality of most of the sheltered nearshore zones has been strongly affected by cultural eutrophication since the 1940s and possibly earlier. Nuisance algae blooms have resulted in decreased water clarity and reduced the abundance of beds of rooted aquatic plants in many sheltered nearshore zones, such as the Bay of Quinte. Consequently there has been a decline in the abundance of piscivorous fish species associated with weed beds such as largemouth bass and northern pike (Hurley and Christie 1977).

Some improvements to water quality have been observed since the implementation of secondary and tertiary sewage treatment during the early 1970s in many sheltered nearshore zones such as the Bay of Quinte. However, in most of these zones clear waters, rooted aquatic macrophytes, and a diverse fish community have not returned. In Hamilton Harbour hypolimnetic waters are anoxic during the summer months (Victor Cairns, Department of Fisheries and Oceans, Canada Centre for Inland Waters, P.O. Box 5050, Burlington. Ontario. L7R 4A6, personal communication - 1995). It is to be hoped that future management actions, such as further reductions in the inputs of phosphorus, will restore a more natural balance to these systems. Remedial Action Plans are actively pursuing reductions in phosphorus input in the Hamilton Harbour, Toronto waterfront, and the Bay of Quinte.

The signs of eutrophication of the open lake and exposed nearshore zones are not as obvious as in the sheltered nearshore zones. One specific example is the spawning beds in the exposed nearshore zones have been degraded by dense mats of *Cladophora*, a nuisance algal typical of eutrophic systems (Whillans 1980). Also, steady changes in the nutrient levels and lower trophic levels during the past decade suggest that the trophic status of the open lake and exposed nearshore zones is changing towards a more oligotrophic state (Anonymous 1992). Total phosphorus levels have declined by 25% during the past decade and there have also been declines in both particulate organic carbon and particulate organic nitrogen. The algal community composition has changed in both the nearshore and offshore zones and coincident with this change there has been an 18% reduction in the annual rate of photosynthesis during the 1980s. Chlorophyll *a* concentrations have decreased in recent years, and Secchi depths (a measure of water clarity) have increased by 20%. Zooplankton production is thought to have been reduced by 50% (Anonymous 1992). The trend towards reduced nutrients in Lake Ontario has significant implications for the future levels of fish production in the open lake, especially terminal predators that are sport fish (IJC 1988; Flint 1989; Hartig et al. 1991; Anonymous 1992; Jones et al. 1993).

Thermal Habitat

Water temperature is one of the most important factors determining the distribution of fish and other aquatic organisms. The thermal habitat of Lake Ontario is not uniform. During the spring vertical thermal bars of relatively warm water develop in the exposed nearshore areas. This concentrates the spring runoff with associated contaminants, turbidity, and increased nutrient levels in the nearshore zone during a period of high biological productivity (Allen 1977).

Summer surface water temperatures in Lake Ontario warm in either a south or east direction, and the warmest temperatures are found along the shallow south shore zones and in the eastern outlet basin (Stewart 1990). The coolest water is found in the shallow zones of the north shore of central and western Lake Ontario and in the deep waters in the extreme western Lake Ontario. Cooler areas are associated with higher variation in temperature and shallower thermoclines. The corresponding link to differing fish community structure has not been firmly established for Lake Ontario, however, the limited evidence is supportive (Stewart 1991).

Mazumder and Taylor (1994) found a relationship between Secchi depth and the depth of the epilimnion for Great Lakes. As discussed above, increases in water clarity have already been detected in Lake Ontario and future increases appear likely. Therefore is seems likely that the thermal habitat may be affected by the future changes in the nutrient levels in Lake Ontario. Warm water outflows from hydro-electric generation plants, and deepwater cooling proposals have the potential to influence the thermal regime of the lake. However, the physical impacts of deepwater cooling at the scale currently proposed are currently thought to be small (Boyce et al. 1993).

Physical Habitat

Although Lake Ontario is the smallest of the Laurentian Great Lakes, based on volume it is the twelfth largest lake in the world, it has the largest drainage basin relative to its size of all the Great Lakes, and is second only to Lake Superior in terms of depth relative to size. The bottom topography of the lake is relatively smooth with the exception of the Duck-Galoo Sill which results in a distinct separation between the Kingston Basin and the remainder of the lake. This separation results in unique water quality characteristics in the Kingston Basin (Kerr and LeTendre 1991).

Eighty-five percent of the lake perimeter is characterized by regular (nearly linear) shorelines sloping rapidly into deep water (Whillans 1980). This shoreline configuration tends to lead to a relatively low biological productivity (Ryder 1965). In the majority of the lake (excluding the Kingston Basin) the nearshore zone (0 to 10 m depth) is found in a narrow 0.5 to 1.5 km wide band. This represents only 7% of the total surface area. Most of this zone is unsuitable for rooted aquatic plants because of exposure to wave action and large-scale shifts in sediments during storm events (Whillans 1980). Embayments which are a notable exceptions to this include Hamilton Harbour, Toronto waterfront, Presqu'ile Bay/Wellers Bay, East Lake, and West Lake which are all sheltered by barrier beaches or islands.

In contrast, the shoreline in the Kingston Basin is highly irregular and the nearshore zone (0 to 10 m depth) represents 31% of the basin's surface area. The largest areas of shallow water in the Kingston Basin include the Bay of Quinte, and Prince Edward Bay. The sheltered nearshore zones in all areas of the lake tend to support aquatic macrophytes and relatively diverse warm-water aquatic communities.

The nearshore substrate of Lake Ontario consists of extensive glacial sediment and bedrock overlaid with relatively small, discrete deposits of post-glacial sediment. The nearshore between Niagara and Whitby is a mosaic of glacial drift (39%), bedrock (23%), gravel (9%), sand (12%), silt-sand (10%), and silt-clay (7%) (Rukavina 1969). The substrate along the north shore, from Whitby to Wellington, is comprised primarily of glacial sediments (55%), sand (25%), and bedrock (20%). Sand accumulation is most extensive in the vicinity of the Presqu'ile Peninsula, the areas fronting East and West Lakes, and at stream mouths (Rukavina 1970). The substrate from Wellington to Kingston is generally bedrock (80%) with occasional deposits of fines in protected areas (Balesic 1979).

The status of the physical habitat is difficult to assess since little historical data are available. However, several specific examples of habitat degradation are known. Areas where fractured bedrock and glacial drift are swept clean of fine materials were historically used as spawning sites for several offshore fish species including lake whitefish, lake herring, and lake trout (Whillans 1980). Much of the nearshore habitat in the Toronto area has been destroyed by mining for construction aggregate and filling or armouring of the shoreline. This has occurred in the rest of the lake, primarily where urbanization has occurred along the shoreline. Agricultural land-clearing was widespread in the Lake Ontario watershed during the early nineteenth century. This led to extensive soil erosion and siltation of stream and nearshore spawning grounds. Several of the fish species, including lake sturgeon, Atlantic salmon and walleye, which historically inhabited Lake Ontario, migrated up streams to spawn. Numerous dams for saw and grist mills were constructed blocking upstream migrations of fish (Bridger and Oster 1981) and contributed to the decline of these important fish populations.

Habitat Initiatives

Recent initiatives to describe the Lake Ontario habitats include the North Shore Descriptive Model which is being developed by the Waterfront Regeneration Trust. This model will describe geo-physical characteristics which control the long-term, large-scale evolution of the north shore. Nine shoreline units were identified when this model was used in a preliminary characterization of the Lake Ontario shoreline between Burlington Beach and Wellers Bay. Biological characteristics and processes will be linked to these units, however, these data are extremely limited. Management strategies for each of the shoreline units will also be described.

The Environmental Sensitivity Atlas for Lake Ontario's Canadian Shoreline was published by Environment Canada (Conservation and Protection Branch, Environmental Protection Ontario Region) for use in response to spills of oil and other hazardous materials. The atlas described areas of fish migration and spawning, as well as other important habitats. However, the sensitivity ranking of the shoreline is based on factors such as oil residence time, cleaning potential, and exposure. It does not consider the relative importance of these habitats to fish or wildlife.

Others initiatives include, draft Guidelines for Collecting Baseline Aquatic Habitat Data in Great Lakes Areas of Concern which have been developed as part of the Remedial Action Plan (RAP) process. Aquatic habitat mapping has already been undertaken in the Bay of Quinte and the Metro Toronto Areas of Concern (AOC). Habitat rehabilitation projects have been initiated in all five Lake Ontario AOC's (see Management Programs in the Introduction of this Report).

Discussion

The Lake Ontario watershed is home to the largest concentration of people in all of Canada. Human activities along the shoreline and upland areas have already profoundly changed aquatic habitats along parts of Lake Ontario. In addition, there continues to be tremendous pressure for the development of remaining aquatic resources. Changes to aquatic habitats have the potential to affect both the varieties of organisms which will inhabit these habitats and their productivity.

The habitat initiatives described above will improve our ability to protect and rehabilitate the aquatic resources of Lake Ontario, but additional information is required. The Lake Ontario Management Unit has an important role to play in this regard and we hope to develop partnerships to enhance ongoing initiatives. For example, one approach would be to expand upon the North Shore Descriptive Model to include the entire Canadian shoreline of Lake Ontario. It is important to establish standard methodologies for collection of habitat evaluation and habitat use data, particularily for the nearshore zone. Our knowledge of Lake Ontario fish communities and survey methodologies could contribute to development of these data. We see a need to promote mechanisms that ensure that current information is readily available, and will accumulate over time. Establishment of standard methodologies for collection, storage, and retrieval of habitat and associated fish community data would be a first step.

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Appendices

APPENDIX A1. Assessment programs conducted by the Lake Ontario Management Unit and the Research, Science and Technology Branch at Glenora between April 1, 1994 and April 1, 1995.

Assessment Programs

Hydroacoustics and trawling survey (NYSDEC/OMNR)
Project Leader: Ted Schaner

Eastern Lake Ontario and Bay of Quinte fish community index netting program
Project Leader: Jim Hoyle

Cooperative lake trout gillnetting (NYSDEC/OMNR/NBS)
Project Leader: Ted Schaner

Salmonid recruitment index
Project Leader: Jim Bowlby

Salmonid recreational boat angler survey
Project Leader: Paul Savoie

Charter boat survey
Project Leader: Mike Rawson

Credit River coho/chinook monitoring
Project Leader: Mike Rawson

Ganaraska River rainbow trout monitoring
Project Leader: Jim Bowlby

Bay of Quinte recreational angling survey
Project Leader: Jim Hoyle

Commercial harvest sampling
Project Leader: Jim Hoyle

Bay of Quinte zebra mussel density index
Project Leader: Tom Stewart

Cooperative angler sportfish contaminant sampling
Project Leader: Mike Rawson

St. Lawrence River Projects

St. Lawrence River fish community indexing
Project Leader: Anne Bendig

Appendix A

St. Lawrence River muskellunge nursery and spawning habitat assessment
Project Leader: Anne Bendig

Cornwall eel ladder monitoring
Project Leader: Anne Bendig

St. Lawrence River boat fishing effort survey
Project Leader: Anne Bendig

Thousand Islands creel survey
Project Leader: Anne Bendig

Special Projects

Walleye Synthesis:
Participants: Jim Bowlby
Alastair Mathers
Sandra Orsattii
Mike Rawson

Research Programs

Seasonal fish community dynamics of eastern Lake Ontario
Project Leader: Dr. John Casselman

Lake trout rehabilitation studies
Project Leader: Dr. John Casselman

Comparison of monofilament and multifilament gillnets
Project Leader: Dr. John Casselman

Lake whitefish stock discrimination studies
Project Leader: Dr. John Casselman

Development of a calcified structure age and growth data extraction software (CSAGES)
Project Leader: Dr. John Casselman

Factors affecting year-class strength and abundance of Northern Pike, *Esox lucius*, in the Bay of Quinte and Eastern Lake Ontario, 1971-1992.
Project Leader: Dr. John Casselman

American eel growth and year-class chronologies
Project Leader: Dr. John Casselman

Modelling predator-prey interactions among Lake Ontario offshore pelagic fish species
Project Leader: Dr. Michael Jones

Evaluating constraints to the restoration of Atlantic salmon populations in Lake Ontario
Project Leader: Dr. Michael Jones

Development and testing of reliable methods for the determination of stream salmonid biomass and abundance
Project Leader: Dr. Michael Jones

Investigations of life history variations in naturalized steelhead populations in the Great Lakes
Project Leader: Dr. Michael Jones

Development of models relating stream habitat and watershed characteristics to production of stream salmonids
Project Leader: Dr. Michael Jones

APPENDIX A2. Staff of the Lake Ontario Management Unit, staff of the Aquatic Ecosystems Research Section and graduate students and associates located at Glenora in 1994.

Management and Compliance Staff at Napanee

Phil Smith, Lake Manager
Ron Harvey, Compliance Supervisor
Joanne Kerr, Secretary
Rick Todd, Conservation Officer
Mike MacDonald, Conservation Officer
Bruce Chenier, Conservation Officer
Sandra Orsatti, Management Biologist
Alastair Mathers, Management and Planning Biologist
Andy Smith, Biologist
Leslie Cope, RAP Program

Other Compliance Staff

Brad Labadie, Conservation Officer, Maple
Ken Forster, Conservation Officer, Cambridge

Assessment Staff at Glenora

Tom Stewart, Assessment Supervisor
Ted Schaner, Assessment Biologist
Jim Bowlby, Assessment Biologist
Jim Hoyle, Assessment Biologist

Assessment and Operations Staff at Maple

Paul Savoie, Assessment Biologist
Mike Rawson, Assessment Biologist
Sandra Malcic, Assessment Biologist
Rob Dalziel, Special Projects Technician

Assessment and Operations Staff at Brockville (St. Lawrence River Fisheries Unit)

Anne Bendig, Assessment Biologist
Sean Bond, Technician

Operations Staff at Glenora

David Jeffrey, Operations Supervisor
Linda Blake, Administrative Clerk
Carol Ward, Secretary/Administrative Support/Library
Ken Scott, Computer Systems and Database Manager
Kelly Sarley, Data Processing Technician
Wayne Miller, Senior Technician-Base Operations
Dawn Walsh, Senior Technician-Field Operations
Chuck Wood, Senior Technician-Marine Service
Jeff Church, Age & Growth Interpretation Technician
Dale Dewey, Resource Technician
Steve Lawrence, Resource Technician
Tim Shannon, Resource Technician
Steve Welham, Technician
Terry Cronin, Technician
Randy Gurnsey, Technician
Ambrose McCambridge, Technician
Tom Lawrence, Technician
Elaine Lockwood, Technician
Shane Lockwood, Technician
Lisa McWilliam, Technician
Sean Corrigan, Technician
Laura Fietz, Technician
Alan McIntosh, Boat Captain
Vaughan Jamieson, Technician, Commercial Fish, Fish Culture

Research Staff at Glenora

Dr. John Casselman, Senior Research Scientist
David Brown, Research Project Biologist
Lucian Marcogliese, Research Graduate Student
Dr. Michael Jones, Research Scientist (Salmonid Unit)
Les Stanfield, Research Project Biologist (Salmonid Unit)
Mike Stoneman, Research Technician (Salmonid Unit)
Christine VanderDussen, Research Graduate Student (Salmonid Unit)
Janice Clarkson, Research Graduate Student (Salnonid Unit)

Fisheries Policy Branch Staff at Glenora

Cheryl Lewis, Warmwater Community Ecologist

APPENDIX B

Salmon, trout and walleye stocked in the Province of Ontario Waters of Lake Ontario in 1994.

Waterbody Name	Site Name	Month Stocked	Year Class	Hatchery/Source	Strain/Egg Source	Age Months	Weight (g)	Marks	Number Stocked
ATLANTIC SALMON - FRY									
Wilmot Creek	Orono Cr Taunton Rd	04	1994	Ringwood/Normandale	Anadromous/LeHave, NS	04	0.9	None	7,950
Wilmot Creek	Conc 4	04	1994	Ringwood/Normandale	Anadromous/LeHave, NS	04	0.9	None	9,360
WILMOT CREEK TOTAL									17,310
ATLANTIC SALMON - YEARLINGS									
Credit River	Black Cr Georgetown	03	1993	Ringwood	Anadromous/LeHave, NS	14	33.0	RV	4,902
Credit River	Black Cr Stewartown	03	1993	Ringwood	Anadromous/LeHave, NS	14	29.9	RV	4,973
Credit River	Inglewood	03	1993	Ringwood	Anadromous/LeHave, NS	14	29.9	RV	4,978
Credit River	Silver Cr (E Branch)	03	1993	Ringwood	Anadromous/LeHave, NS	14	31.7	RV	4,871
Credit River	Silver creek (27th Side Rd)	03	1993	Ringwood	Anadromous/LeHave, NS	14	29.2	RV	4,876
CREDIT RIVER TOTAL									24,600
Wilmot Creek	Conc 5	03	1993	Ringwood	Anadromous/LeHave, NS	14	32.2	RV	9,956
Wilmot Creek	Conc 3	03	1993	Ringwood	Anadromous/LeHave, NS	14	32.0	RV	14,946
WILMOT CREEK TOTAL									24,902
TOTAL ATLANTIC SALMON FRY									17,310
TOTAL ATLANTIC SALMON YEARLINGS									49,502
TOTAL ATLANTIC SALMON									66,812

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Waterbody Name	Site Name	Month Stocked	Year Spawned	Hatchery/ Source	Strain/Egg Source	Age Months	Mean Wt. (g)	Marks	Number Stocked
BROWN TROUT - FALL FINGERLINGS									
Humber River	Boyd Field	11	1994	Normandale	Ganaraska/Normandale	10	18.0	RV	7,500
Lake Ontario	Bluffers Park	10	1994	Harwood	Ganaraska/Normandale	11	18.8	Ad	48,508
BROWN TROUT - YEARLINGS									
Duffins Creek	Rotary Park Ramp	03	1993	White Lake	Ganaraska/Normandale	15	31.5	RV	10,019
Etobicoke Creek	Marie Curtis Park	03	1993	Ringwood	Ganaraska/Normandale	16	41.6	RV	15,658
Lake Ontario	Ashbridges Bay Ramp	03	1993	Normandale	Ganaraska/Normandale	14	57.0	AdRV	15,472
Lake Ontario	Bluffer's Park	03	1993	Ringwood	Ganaraska/Normandale	16	38.9	RV	15,630
Lake Ontario	Burlington Canal	04	1993	Ringwood	Ganaraska/Normandale	15	54.2	RV	15,477
Lake Ontario	Collins Bay Wharf	04	1993	White Lake	Ganaraska/Normandale	16	35.0	RV	16,442
Lake Ontario	Fifty Point CA	04	1993	Normandale	Ganaraska/Normandale	15	58.2	RV	15,478
Lake Ontario	Jordan Harbour	04	1993	Normandale	Ganaraska/Normandale	15	56.5	RV	30,955
Lake Ontario	Millhaven Wharf	04	1993	White Lake	Ganaraska/Normandale	16	34.3	RV	13,897
Lake Ontario	Port Dalhousie East	04	1993	Normandale	Ganaraska/Normandale	15	58.8	RV	14,883
Mimico Creek	Humber Bay Park West	03	1993	Ringwood	Ganaraska/Normandale	16	43.1	RV	15,577
TOTAL BROWN TROUT FALL FINGERLINGS									**56,008**
TOTAL BROWN TROUT YEARLINGS									**179,488**
TOTAL BROWN TROUT									**235,496**

APPENDIX B
Salmon, trout and walleye stocked in the Province of Ontario Waters of Lake Ontario in 1993.

Waterbody Name	Site Name	Month Stocked	Year Spawned	Hatchery/ Source	Strain/Egg Source	Age Months	Mean Wt. (g)	Marks	Number Stocked
CHINOOK SALMON - SPRING FINGERLINGS									
Bronte Creek	2nd Side Rd Bridge	05	1994	Ringwood	Lake Ontario	06	4.3	None	34,854
Cobourg Creek	South Of King St	04	1994	Ringwood	Lake Ontario	05	8.4	NoneC	4,865
Cobourg Creek	South Of King St	04	1994	S.Sandford Fleming	Lake Ontario	06	4.9	None	34,573
COBOURG CREEK TOTAL									39,438
Credit River	Eldorado Park	05	1994	Ringwood	Lake Ontario	06	4.5	None	34,726
Credit River	Huttonville	05	1994	Ringwood	Lake Ontario	06	3.9	None	34,428
Credit River	Norval	05	1994	Ringwood	Lake Ontario	06	4.4	None	34,357
CREDIT RIVER TOTAL									103,511
Lake Ontario	Bluffer's Park	05	1994	Ringwood	Lake Ontario	06	4.4	None	49,712
Lake Ontario	Burlington Canal	05	1994	Ringwood	Lake Ontario	06	4.5	None	49,624
Lake Ontario	Oshawa	05	1994	Ringwood	Lake Ontario	06	4.2	None	24,824
Lake Ontario	Port Dalhousie East	05	1994	Ringwood	Lake Ontario	06	4.7	None	98,887
Lake Ontario	Presqu'ile Park	05	1994	Ringwood	Lake Ontario	06	4.7	None	24,654
Lake Ontario	Wellington Channel	05	1994	Ringwood	Lake Ontario	06	4.7	None	24,654
Lake Ontario	Whitby Harbour	05	1994	Ringwood	Lake Ontario	05	4.2	None	24,823
TOTAL CHINOOK SALMON									474,981

APPENDIX B

Salmon, trout and walleye stocked in the Province of Ontario Waters of Lake Ontario in 1993.

Waterbody Name	Site Name	Month Stocked	Year Spawned	Hatchery/ Source	Strain/Egg Source	Age Months	Mean Wt. (g)	Marks	Number Stocked
LAKE TROUT - YEARLINGS									
Lake Ontario	Cobourg Harbour Pier	03	1993	Harwood	Slate Island/Dorion	16	33.3	AdCWT	42,284
Lake Ontario	Cobourg Harbour Pier	04	1993	Harwood	Slate Island/Dorion	17	38.8	AdCWT	41,918
COBOURG HARBOUR TOTAL									84,202
Lake Ontario	Fifty Point CA	03	1993	Harwood	Slate Island/Dorion	16	33.6	AdCWT	41,295
Lake Ontario	Fifty Point CA	04	1993	Harwood	Slate Island/Dorion	17	42.5	AdCWT	21,195
Lake Ontario	Fifty Point CA	05	1993	Harwood	Slate Island/Dorion	18	43.5	AdCWT	18,323
FIFTY POINT CA TOTAL									80,813
Lake Ontario	Scotch Bonnet Shoal	05	1993	Harwood	Slate Island/Dorion	18	40.6	AdCWT	84,025
Lake Ontario	Scotch Bonnet Shoal	05	1993	Harwood	Seneca Lake/Normandale	17	52.9	AdCWT	20,921
SCOTCH BONNET SHOAL TOTAL									104,946
Lake Ontario	N Of Main Duck Sill	04	1993	Harwood	Slate Island/Dorion	17	38.7	AdCWT	52,084
Lake Ontario	N Of Main Duck Sill	05	1993	Harwood	Slate Island/Dorion	18	42.3	AdCWT	67,443
Lake Ontario	N Of Main Duck Sill	05	1993	Harwood	Seneca Lake/Normandale	17	52.0	AdCWT	20,181
NORTH OF MAIN DUCK SILL TOTAL									139,708
Lake Ontario	S Of Long Point	04	1993	White Lake	Slate Island/Dorion	17	21.6	AdCWT	123,462
LAKE TROUT - ADULTS									
Lake Ontario	Collins Bay	05		Harwood	Seneca Lake/Normandale	28	279.0	AdCWT	1,003
Lake Ontario	Collins Bay	05		Harwood	Seneca Lake/Normandale	40	613.6	AdCWT	813
TOTAL LAKE TROUT YEARLINGS									**533,131**
TOTAL LAKETROUT ADULT									**1,816**
TOTAL LAKE TROUT									**534,947**

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Salmon, trout and walleye stocked in the Province of Ontario Waters of Lake Ontario in 1993.

Waterbody Name	Site Name	Month Stocked	Year Spawned	Hatchery/ Source	Strain/Egg Source	Age Months	Mean Wt. (g)	Marks	Number Stocked
RAINBOW TROUT - FALL FINGERLINGS									
Bronte Creek	5th Side Rd Bridge	12	1994	Normandale	Ganaraska/Normandale	07	8.7	Ad	30,000
Bronte Creek	Lowville Park	12	1994	Normandale	Ganaraska/Normandale	07	7.5	Ad	30,000
BRONTE CREEK TOTAL									60,000
Credit River	Huttonville	10	1994	Normandale	Ganaraska/Normandale	06	4.5	Ad	30,975
Credit River	Norval	12	1994	Normandale	Ganaraska/Normandale	06	7.5	Ad	30,000
CREDIT RIVER TOTAL									60,975
Humber River	East Branch	11	1994	Normandale	Ganaraska/Normandale	06	2.5	Ad	10,000
Humber River	King Vaughn	11	1994	Normandale	Ganaraska/Normandale	06	2.5	Ad	50,000
HUMBER RIVER TOTAL									60,000
Lake Ontario	Port Dalhousie East	11	1994	Normandale	Ganaraska/Normandale	06	7.3	Ad	60,000
Rouge River	Berczy Creek	11	1994	Normandale	Ganaraska/Normandale	06	3.1	Ad	10,000
Rouge River	Silver Spring	11	1994	Normandale	Ganaraska/Normandale	06	3.1	Ad	20,000
Rouge River	Bruce Creek	12	1994	Normandale	Ganaraska/Normandale	07	8.7	Ad	15,000
Rouge River	Robinson Rd	12	1994	Normandale	Ganaraska/Normandale	07	8.7	Ad	15,000
ROUGE RIVER TOTAL									60,000
RAINBOW TROUT - YEARLINGS									
Bronte Creek	Lowville Park	04	1993	Normandale	Ganaraska/Normandale	11	25.0	RV	5,000
Bronte Creek	5th Side Rd Bridge	04	1993	Normandale	Ganaraska/Normandale	11	25.0	RV	5,000
BRONTE CREEK TOTAL									10,000
Credit River	Glen Williams	04	1993	Normandale	Ganaraska/Normandale	11	25.0	RV	5,000
Credit River	Main Credit	04	1993	Normandale	Ganaraska/Normandale	11	25.0	RV	5,000
CREDIT RIVER TOTAL									10,000
Rouge River	Glen Rouge Pk	04	1993	Normandale	Ganaraska/Normandale	11	25.0	RV	8,000
TOTAL RAINBOW TROUT FALL FINGERLINGS									**300,975**
TOTAL RAINBOW TROUT YEARLINGS									**28,000**
TOTAL RAINBOW TROUT									**328,975**

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Salmon, trout and walleye stocked in the Province of Ontario Waters of Lake Ontario in 1993.

Waterbody Name	Site Name	Month Stocked	Year Spawned	Hatchery/ Source	Strain/Egg Source	Age Months	Mean Wt. (g)	Marks	Number Stocked
WALLEYE - ADULTS									
Lake Ontario	Hamilton Harbour	10		Bay of Quinte	Lake Ontario		1500.0	None	129
WALLEYE - FRY									
Lake Ontario	Leslie Spit	08	1994	Private	Lake Ontario	03	11.0	None	9,400
TOTAL WALLEYE									**9,529**

Species-specific catch-per-standard gillnet lift, northeastern Lake Ontario, 1994.

	Brighton					Main Duck Sill					Middle Ground	Rocky Point					Wellington				
Site Depth (m)	8	13	18	23	28	8	13	18	23	28	5	8	13	18	23	28	8	13	18	23	28
Alewife	415	356	447	211	155	791	49	263	0	11	76	890	438	186	442	214	87	319	412	11	22
Gizzard shad	10	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chinook salmon	0	0	71	36	20	0	0	0	0	0	0	0	0	10	10	0	0	0	0	0	0
Atlantic salmon	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Brown trout	0	0	13	3	3	5	2	0	0	0	0	0	5	8	2	0	0	0	3	3	3
Lake trout	0	0	0	16	244	21	59	58	124	169	0	23	85	75	90	116	0	20	53	92	185
Lake whitefish	0	0	0	0	7	105	28	5	18	24	0	0	0	0	10	18	0	0	0	0	33
Lake herring	0	3	3	0	0	5	2	0	0	3	0	0	2	2	0	0	0	0	0	3	7
Round whitefish	0	0	10	24	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainbow smelt	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Northern pike	14	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
White sucker	49	23	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carp	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Channel catfish	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burbot	0	0	0	0	0	0	5	3	0	0	0	0	0	0	5	5	0	0	0	3	3
White perch	7	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Rock bass	30	0	0	0	0	2	0	0	0	0	3	8	2	0	0	0	0	0	0	0	0
Smallmouth bass	0	0	0	0	0	61	3	0	0	0	0	27	17	0	0	0	0	0	0	0	0
Yellow perch	212	289	11	0	0	0	0	0	0	0	455	0	5	0	5	0	720	303	160	235	0
Walleye	33	7	0	0	0	122	2	0	0	0	26	28	7	0	0	0	3	0	0	0	0
Freshwater drum	13	0	0	0	0	3	0	0	0	0	0	21	2	0	0	0	0	0	0	0	0

Species-specific catch-per-standard gillnet lift, outlet basin, Lake Ontario 1994.

	Outlet Basin		Flatt Point					Grape Island					Melville Shoal				
Site Depth (m)	30 (02)	30 (06)	8	13	18	23	28	8	13	18	23	28	8	13	18	23	28
Alewife	66	35	249	55	61	223	283	602	471	235	43	217	83	112	177	22	13
Chinook salmon	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake trout	196	219	147	81	90	207	215	0	23	43	115	141	0	3	3	39	99
Lake whitefish	18	39	0	0	36	84	49	0	0	39	142	122	0	0	0	16	33
Lake herring	4	1	0	0	0	36	33	0	0	0	0	3	0	0	0	0	0
Rainbow smelt	4	7	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0
Northern pike	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
White sucker	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burbot	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
White perch	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0
Rock bass	0	0	0	0	0	0	0	31	0	11	0	0	63	3	0	0	0
Smallmouth bass	0	0	0	0	0	0	0	13	0	0	0	0	10	3	0	0	0
Yellow perch	0	0	219	204	33	19	0	71	158	22	11	0	114	435	138	25	0
Walleye	1	0	0	0	0	0	0	89	10	3	0	0	201	56	3	3	0
Freshwater drum	0	0	0	0	0	0	0	16	3	0	0	0	3	0	0	0	0

Species-specific catch-per-standard gillnet lift, Bay of Quinte, 1994.

	Big Bay		Conway		Hay Bay	
Site Depth (m)	5	8	13	20	8	13
Longnose gar	1	0	0	0	0	0
Alewife	0	490	1240	249	29	76
Gizzard shad	31	0	0	0	1	0
Atlantic salmon	0	0	1	0	0	0
Brown trout	0	0	3	4	0	0
Lake trout	0	0	3	38	0	1
Lake whitefish	0	0	0	15	0	0
Lake herring	0	0	0	2	0	7
Rainbow smelt	0	0	0	0	2	8
Northern pike	8	0	1	0	21	11
White sucker	55	22	15	12	37	44
Carp	7	1	0	0	0	0
Brown bullhead	57	1	1	0	10	0
Channel catfish	5	0	1	0	0	0
White perch	1537	15	5	0	86	12
Rock bass	0	22	4	0	1	0
Smallmouth bass	0	3	0	0	0	0
Yellow perch	63	683	474	241	844	773
Walleye	123	124	53	12	14	1
Freshwater drum	86	9	0	0	1	0

Species-specific catch-per-trawl, Bay of Quinte and Outlet Basin Lake Ontario, 1994

	Bay of Quinte						Outlet		
Site Location	Trenton	Belleville	Big Bay	Deseronto	Hay Bay	Conway	EB02	EB03	EB06
Alewife	12	2	2	128	199	35	289	925	42
Gizzard shad	692	31	12	94	3	0	0	0	0
Lake trout	0	0	0	0	0	0	0	5	1
Lake whitefish	0	0	0	0	0	41	3	89	3
Lake herring	0	0	0	0	0	15	2	2	0
Rainbow smelt	0	0	0	0	0	11	397	928	383
White sucker	2	11	7	1	2	1	0	0	0
Carp	0	1	1	1	1	0	0	0	0
Spottail shiner	207	115	38	38	8	0	0	4	0
Brown bullhead	20	36	64	41	14	0	0	0	0
Channel catfish	0	0	1	1	0	0	0	0	0
American eel	1	1	1	3	6	0	0	0	0
Threespine stickleback	0	0	0	0	0	0	0	1	0
Trout-perch	79	302	72	90	83	395	5	2073	2
White perch	602	122	178	141	35	0	0	0	0
White bass	1	0	1	2	1	0	0	0	0
Sunfish sp.	1	0	0	0	0	0	0	0	0
Rock bass	1	0	0	0	0	0	0	0	0
Pumpkinseed	16	2	1	1	2	0	0	0	0
Black crappie	9	0	0	0	0	0	0	0	0
Lepomis sp.	7	0	0	0	0	0	0	0	0
Yellow perch	527	51	10	102	29	7	0	0	0
Walleye	24	33	19	40	15	14	0	0	0
Johnny darter	1	0	0	0	0	0	1	2	0
Logperch	0	0	0	0	0	0	0	0	0
Freshwater drum	12	36	20	24	0	0	0	0	0
Slimy sculpin	0	0	0	0	0	0	4	1	0