FISH-COMMUNITY OBJECTIVES FOR THE ST. LAWRENCE RIVER

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INTRODUCTION

The St. Lawrence River is the only natural outlet for the largest freshwater system in the world, the Great Lakes, and provides a unique and valuable fishery. The long history of human use of the river for subsistence fishing, commercial navigation, hydroelectric generation, industry, residential development, agriculture and recreation has resulted in extensive changes to the river ecosystem. Despite these changes, the river continues to support a diverse and productive warm-water fishery that plays an important role in local economies.

Responsibility for fisheries management in the upper St. Lawrence River (from Lake Ontario to the 45^{th} parallel of latitude) is shared by the Ontario Ministry of Natural Resources (OMNR) for the Province of Ontario and the New York State Department of Environmental Conservation (NYSDEC) for the State of New York.

Fisheries management of shared fish stocks, as defined by the Joint Strategic Plan for Management of Great Lakes Fisheries (Great Lakes Fishery Commission 1997), includes development of fish community objectives by each lake committee. The Lake Ontario Committee (LOC), which includes representatives of NYSDEC and OMNR, completed fish community objectives for Lake Ontario (excluding the St Lawrence River) in 1999. The current document fulfils the commitment of LOC to develop fish community objectives for the upper St. Lawrence River and is the first plan prepared for any of the Great Lakes' connecting channels.

Upper St. Lawrence River FCOs are guided by the same principles outlined in the *Joint Strategic Plan for The Management Of Great Lake Fisheries* (Great Lakes Fishery Commission 1997) and the joint *Lake Ontario Fish Community Objectives* (Stewart et al. 1999). To assist in the development of FCOs, NYSDEC and OMNR carried out public consultation during the summer of 2000. Information regarding the status of the upper St. Lawrence River fisheries reported in this document reflects that presented during public consultation.

This document outlines bi-national fish community objectives for the upper St. Lawrence River and will be used by New York State and Ontario to guide the cooperative management of the fish community and fisheries of the upper St. Lawrence River. These objectives are a starting point for discussion with other agencies, interest groups, and the general public to develop more specific fisheries, habitat, and watershed management plans. In addition, it will contribute to other management planning initiatives such as Remedial Action Plans (RAPs).

GOAL STATEMENT

In the Joint Strategic Plan for the Management of Great Lake Fisheries (Great Lakes Fishery Commission 1997), a common goal statement was developed for all Great Lake fisheries management agencies:

> *To secure fish communities, based on foundations of stable self-sustaining stocks, supplemented by judicious plantings of hatchery reared fish, and provide from these communities an optimum contribution of fish, fishing opportunities and associated benefits to meet needs identified by society for*
>
> - *wholesome food*
> - *recreation*
> - *cultural heritage*
> - *employment income, and*
> - *a healthy human environment.*

GUIDING PRINCIPLES

The following set of principles represents resource management values common to both NYSDEC and OMNR. These principles will form the basis for fisheries management activities in support of fish community objectives for the upper St. Lawrence River.

- The upper St. Lawrence River must be managed as a whole ecosystem because of the complex interrelationships of all species (including humans) and their environment.

- The public has a role to play in ensuring that healthy fish communities and fisheries are passed on to future generations.
- Humans are part of the ecosystem. Their actions can influence certain aspects of the ecosystem , but their ability to directly set its future course is limited. Responsible management, therefore, requires continuous efforts to better understand the structure, function and limits of the ecosystem.
- Stakeholders contribute critical biological, social, economic and cultural information to fisheries management agencies in support of fisheries management decision making; with decision making comes a duty to share accountability and stewardship.
- Managing a fish community requires a long-term perspective that recognizes the shorter-term social, cultural and economic requirements. Human use that is not ecologically sustainable cannot yield sustainable economic benefits.
- Protection and rehabilitation of upper St. Lawrence River fish communities and their habitats are the most fundamental requirements for productive, long-term fisheries.
- The amount of fish that can be produced and harvested from an aquatic ecosystem has ecological limits.
- Managing the upper St. Lawrence River for naturally reproducing (self-sustaining), native species continues to provide the most predictable, sustainable and cost-effective benefits to society. Management actions to increase fish production and expand distribution should emphasize the identification, protection, and rehabilitation of fish spawning and nursery habitat.
- Protecting and rehabilitating native species, including individual genetic stocks, are important actions to support biodiversity.
- Protecting and rehabilitating rare, threatened and endangered species are particularly important actions to support biodiversity.
- Protecting and rehabilitating critical fish habitats, including tributary and nearshore spawning and nursery areas, is required to sustain productive fisheries over the long-term.
- Determining how well the ecosystem is managed depends on the availability of timely scientific information, as provided through broad-based, long-term monitoring programs and research.

DESCRIPTION OF THE UPPER ST. LAWRENCE RIVER

The St. Lawrence River is one of the world's most unique waterways and is the only natural outlet for the largest freshwater system in the world – the Great Lakes. It flows in a northeasterly direction draining Lake Ontario and a watershed of 777,000 km^2 (300,023 $mi.^2$) with an average annual flow at Cornwall (1985-1995) of 7,657 m^3/s (270,369 ft^3/s). The river's waters drop at a rate of about 20 cm/km (1.1 ft/mi.) and travel close to 900 km (559 mi.) from Kingston, Ontario (at Lake Ontario's outlet) to the Gulf of St. Lawrence

The upper St. Lawrence River extends from the outlet of Lake Ontario to the 45^{th} parallel of latitude below the Moses-Saunders Power Dam (MSPD) at Cornwall, Ontario/Massena, New York, and is about 180 km (112 mi.) long (Fig. 1). The remainder of the river flows through the provinces of Ontario and Quebec, Canada with the exception of a small portion in New York below the MSPD.

Lake Ontario supplies nearly all of the water to the upper St. Lawrence River. The amount of water available is dependent on precipitation and evaporation rates in the Great Lakes Basin in conjunction with the amount of water released from Lake Ontario by control structures on the river. The International St. Lawrence River Board of Control, operating under the auspices of the International Joint Commission, determines average weekly flows in the St. Lawrence River to regulate water levels on Lake Ontario and the river.

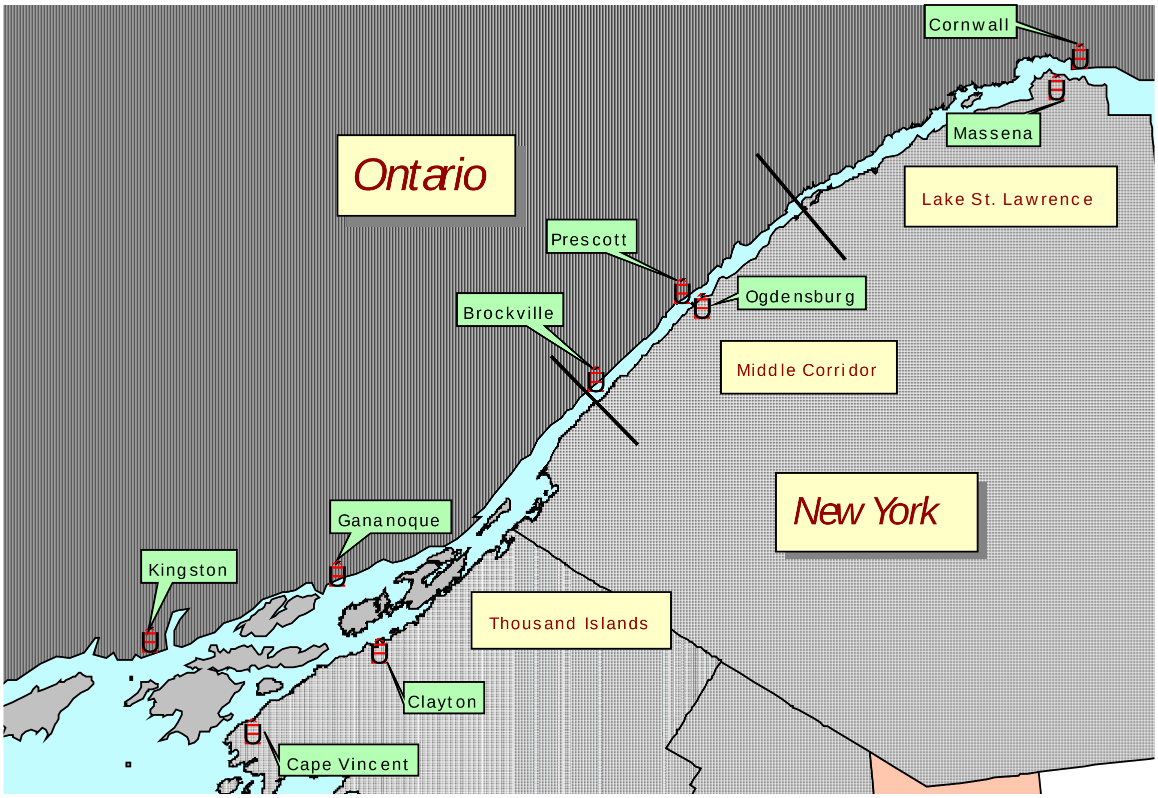

Fig.1.Upper St. Lawrence River.

The Moses-Saunders Power Dam controls water levels to provide optimum hydroelectric power generation and safe navigation of commercial shipping vessels. The control dam at Iroquois, Ontario can be used in an emergency to control the outflow from Lake Ontario, however, it is used primarily to assist in the formation of stable ice cover in winter and prevent water levels from rising too high downstream. The Long Sault Control Dam is largely an emergency control structure capable of discharging the entire flow of the river.

From a socio-economic standpoint the river faces increasing demands for commercial navigation, industrial, residential, agricultural, hydroelectric power, and recreational uses. From an environmental standpoint, the upper St. Lawrence River provides a wide range of habitats that support a diversity of plant and animal life.

The upper St. Lawrence River can be divided into three distinct sections (Fig. 1):

The **Thousand Islands** section lies in the uppermost portion of the international section. This section includes a complex of 1,768 islands, numerous shoals and channels with moderate water currents. Aquatic habitats are most diverse in this section, varying from large shallow bays and wetlands dominated by emergent and submergent vegetation and little to no moving water, to channel areas greater than 60 metres (197 feet) in depth with strong water currents.

The **Middle Corridor** section starts at the Amateur Islands, just upstream from Jones Creek (Ontario) and Crossover Island (New York) and extends downstream to the Iroquois Control Dam. This relatively narrow section (less than 2 km wide) is more riverine in nature having few islands, limited shallow water areas and relatively rapid currents. Water depths through the main channel average 20 to 25 m (65.6 to 82 ft). Prior to construction of the St. Lawrence Seaway and Power Project, this section contained the Galop Rapids, and dropped 4.6 m (15 ft) over the last 24 km (15 miles). The gradient has since been reduced to 0.3 m (1 ft).

Below the Iroquois Control Dam, the river widens at the upper end of **Lake St. Lawrence**. Lake St. Lawrence is a 49 km (30 mile) long reservoir created by the construction of the Moses-Saunders Power Dam. Unlike the Thousand Islands and Middle Corridor sections, water level fluctuations up to 2.0 m (6.6 ft) can occur at any time of the year and significantly influence the availability or suitability of nearshore spawning and nursery habitats. Average water depth is approximately 8 m (26.2 ft) with a maximum depth of 30 m (98.4 ft).   Lake St. Lawrence has relatively strong water currents and contains a number of islands and shoals, the character and extent of which were dramatically altered by flooding and dredging for the St. Lawrence Seaway and Power Project. Prior to Seaway construction this section was characterized as narrow and fast flowing, particularly in the Long Sault Rapids section, with many large islands. Impoundment reduced the gradient in this portion of the river, from Iroquois to Cornwall, from approximately 19.8 m (65 feet) to 0.91 m (3 feet).

PHYSICAL ALTERATIONS AND CHANGES TO FISH HABITATS

The St. Lawrence River is fed by water from the upper or epilimnion layer of Lake Ontario and does not thermally stratify to a great extent. This results in summer water temperatures too warm to support cold water fishes such as trout and salmon. Cold water fishes can and do migrate into the St. Lawrence River during late fall and winter when water temperatures decline.

Habitat requirements for the warmwater fish community of the St. Lawrence River can vary from species to species and also within the life cycle of a particular species. Most fish species in the St. Lawrence River require wetlands and vegetated nearshore habitats to complete their life cycle, including spawning and nursery periods. In addition, many species rely on forage fish that are produced in these habitats. These habitats are generally very productive and contain a diversity of submergent, emergent, and floating aquatic vegetation that provide shelter, food and protection from predators. Other species require rocky substrates in fast-moving water, such as lake sturgeon and redhorse suckers. Dramatic alterations to the St. Lawrence River's habitats have occurred since early settlement of this area. It is difficult to assess the significance of habitat changes on the fish community because of a lack of pre-and post-impoundment biological data. Changes in water levels and flows resulting from the construction and operation of the Moses-Saunders Power Dam are implicated in the impairment of critical fish habitats throughout the international portion of the St. Lawrence River. Planning efforts to improve fish habitat and manage fisheries must consider the current altered, controlled state of the river.

Significant physical alterations to the St. Lawrence River began as early as 1783 when 2.7 m (9 ft) deep canals were constructed between Lake Ontario and Montreal for the purpose of navigation. By 1875, these canals were dredged to accept vessels with a 4.3 m (14 ft) draft. Maintenance dredging occurred throughout the first half of the 20^{th} century.

Construction of the St. Lawrence Seaway and Power Project began in 1954 and was completed in 1962. Construction of the Moses-Saunders Power Dam at Cornwall/Massena, a double-lock system, Long Sault Control Dam, and the Iroquois Control Dam and lock were completed by 1959. Dredging of the channel from Cornwall to a point west of Brockville was completed between 1961 and 1962. Channel depths now provide for an 8.2 m (27 ft) draft. In addition to physical changes resulting from the St. Lawrence Seaway and Power Project, the Seaway has likely increased exotic species introductions. Over one-third of the 140 exotic organisms established in the Great Lakes/St. Lawrence River Basin since the early 1800's have been introduced since the opening of the Seaway (Great Lakes Commission 1996, *see also Exotic Species Introductions*).

The physical effects of impounding the St. Lawrence River were most obvious in Lake St. Lawrence, where flooding raised water levels as much as 24.7 m (81 feet) resulting in a 200 to 300 percent increase in the river's surface area. The flooding of Lake St. Lawrence also eliminated the Long Sault Rapids, which likely served as a spawning area for white water spawners such as the walleye, lake sturgeon, and numerous species belonging to the sucker family. In addition, wetlands associated with tributaries that served as fish spawning and nursery sites were also flooded. While there was nearly a 20% increase in nearshore aquatic habitat in Lake St. Lawrence, frequent and large daily and seasonal water level fluctuations make this nearshore area unstable and unsuited for fish, particularly during their early life stages. Aquatic plants are very sparse and during drawdown periods these areas turn into mudflats.

While flooding resulting from impoundment was not as dramatic in the Middle Corridor, extensive dredging and dredge spoil disposal dramatically altered its character. Channelization and flooding in the Red Mills, NY/Cardinal, Ontario area destroyed the Galop Rapids. A complex of eleven islands in this area was excavated/dredged, and interconnected with dredge spoils resulting in the creation of one island.

The natural “sill” at Johnstown, Ontario that regulated Lake Ontario’s outflow was removed, transferring control of water levels to the Moses-Saunders Power Dam. These activities provided navigational access but slowed the water current speed to less than 0.68 m/s (2.2 ft/sec).

The construction of the St. Lawrence Seaway and Power Project had relatively minimal physical impact on the Thousand Islands region. While blasting and dredging activities were necessary to accommodate commercial navigation, there was no significant change in water elevation as a result of the impoundment downstream. The current seasonal regulation of water levels, however, likely affects fish habitats (*see Factors Affecting Fish Abundance).*

Incremental losses of habitat continue to occur throughout the St. Lawrence River, particularly in the Thousand Islands. Vegetated shoreline areas that are utilized as fish spawning and nursery habitat are often considered undesirable to the waterfront owner. These areas are subject to alterations including dock and boathouse construction, dredging, filling, and “hardening” of shorelines with rip rap and concrete.

HISTORICAL FISH COMMUNITY

The St. Lawrence River has supported and continues to support a very diverse fish community dominated by self-sustaining, warm and cool water species. Historic and more recent surveys have documented 85 species inhabiting this section of the river (Appendix A). Quantitative estimates of historical fish abundance are not available, however, Greeley and Greene (1931) reported the following species as providing important fisheries: smallmouth bass, northern pike, walleye, muskellunge, yellow perch, pumpkinseed sunfish, rock bass, lake sturgeon (commercial) and American eel (commercial).

The species list has changed little since the 1930s and the number of fish species that are sensitive to or intolerant of pollution (such as mooneye, pugnose shiner, greater redhorse and stonecat) has not decreased with time (Carlson and LaPan 1997). The following is a list of some of the most notable changes:

- Channel darter, blacknose dace and sauger have not been caught in the river since 1931 or earlier, however, channel darter and blacknose dace have been observed in nearby waters (Carlson and LaPan 1997).
- Several species (including lake sturgeon, mooneye, and cutlips minnow) were reported to have been common in the early 1900’s but are now considered rare (Carlson and LaPan 1997).
- Channel Catfish were rare in the early 1900’s and are now considered common (Eckert and Hanlon 1977).
- Historically, Atlantic salmon are thought to have ascended the St. Lawrence River from the Atlantic Ocean (Parsons 1973). In their 1930 survey, Greeley and Greene (1931) listed the species as “extinct in the region”. In recent years, Atlantic salmon stocked in Lake Ontario have been collected in St. Lawrence River tributary mouths.
- Ten species have been introduced to the upper St. Lawrence, most prominent of which are common carp, rainbow smelt and white perch (Carlson and LaPan 1997, Appendix A). Some introductions have been accidental, such as white perch and rudd, while several cold-water fish species such as chinook salmon, coho salmon, rainbow trout and brown trout were intentionally stocked into Lake Ontario and strayed into the river.

CURRENT FISH COMMUNITY

The current fish community in the upper St. Lawrence River is largely unchanged to that prior to the 1930s as described by Greeley and Greene (1931). Carlson and LaPan (1997) provide a list of species observed in the upper St. Lawrence in recent years (see Appendix A). Major sport fish species for the upper St.

Lawrence River remain smallmouth bass, northern pike, yellow perch, walleye, muskellunge, and brown bullhead. Yellow perch, sunfish and brown bullhead support an important commercial fishery in Ontario waters.

Movements of fish to and from tributary rivers and eastern Lake Ontario undoubtedly influence the fish community of the upper St. Lawrence River. Cold-water fish (including chinook salmon, lake trout, and rainbow trout) often move from eastern Lake Ontario into the upper St. Lawrence and its' tributaries when water temperatures permit. Fish tagging studies (Eckert and Hanlon 1977) suggest that warm water fish move extensively throughout the upper river. The Moses-Saunders Power Dam restricts fish movements upstream, however, a variety of fish species pass downstream through the power dam's turbines and survive. Qualitative assessment suggests that overall the impact of turbine entrainment on major sport and commercial species is relatively insignificant (Normandeau Associates Inc. and Alden Research Laboratory, Inc. 1999). The extent to which fish move through Eisenhower and Snell Locks is unknown.

Gillnet surveys conducted by NYSDEC and OMNR provide indices of abundance for a number of fish species in the upper St. Lawrence River. Gillnet catches of fish in the Thousand Islands area have been approximately 2.5 times higher relative to those in the Lake St. Lawrence and Middle Corridor areas (Fig. 2). These differences may reflect deviations in netting efficiency in the different areas; however, it is likely that fish abundance is in fact higher in the Thousand Islands area due to greater primary productivity and abundance of productive habitats. Gillnet catches of all species declined during the mid-1990s, which is likely a reflection of declining nutrients and productivity of the river during this time period (see *Factors Affecting Fish Abundance*).

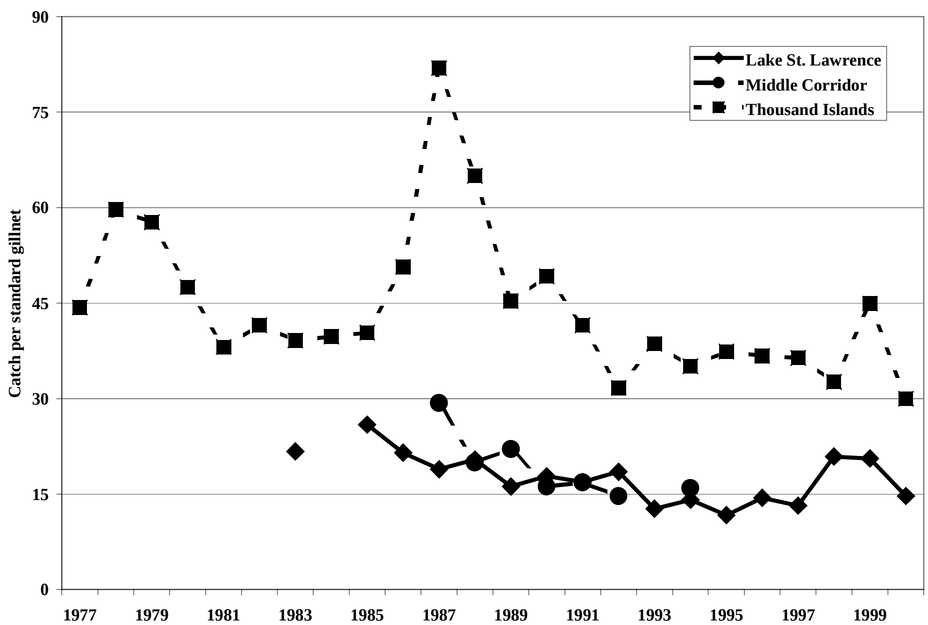

Fig. 2. Catch of fish of all species in gillnets set in New York waters of the upper St. Lawrence River.

Smallmouth Bass

In Lake St. Lawrence, smallmouth bass abundance decreased between 1983 and 1997, but has increased since. Smallmouth bass abundance has declined since 1989 in the Thousand Islands (Fig. 3). Potential causes for declines in smallmouth bass abundance include poor recruitment resulting from low summer water temperatures during the early 1990's, over-harvest by anglers, predation by cormorants, and disruption of spawning by pre-season bass anglers.

Northern Pike

Abundance of northern pike has declined in the Thousand Islands throughout the 1990s (Fig. 4). In Lake St. Lawrence, northern pike abundance is typically much lower than in the Thousand Islands. Water level regulation and its impact on spawning and nursery habitats is implicated in the poor recruitment of northern pike observed in recent years (see O*ther Factors Influencing Fish).*

Walleye

Walleye abundance in the upper St. Lawrence River, particularly between Ogdensburg and Massena, NY, declined following the construction of the St. Lawrence Seaway and Power Project (Patch and Busch 1983). Construction resulted in the removal or significant alteration of underwater shoals, particularly in the Lake St. Lawrence area, which provided spawning habitat for many fish including walleye (see *Physical Alterations and Changes to Fish Habitats*). Walleye abundance in Lake St. Lawrence has shown a dramatic increase since 1983 (Fig. 5). Walleye spawning bed rehabilitation at Hoople Creek (Ontario), stocking of St. Lawrence River walleye (New York) and improvements in water quality may be contributing to the increased abundance of walleye in Lake St. Lawrence. While walleye abundance in Eastern Lake Ontario rebounded in the late 1980s and early 1990s, only modest increases in walleye abundance were observed in Thousand Islands assessment programs (Fig. 5).

Yellow Perch

Yellow perch remain the most abundant fish caught in index-netting programs in both the Thousand Islands and Lake St. Lawrence (Fig. 6). Following a dramatic decline in abundance in the late 1970s and early 1980s, yellow perch abundance in the Thousand Islands stabilized, and in recent years has shown modest increases. Yellow perch abundance in Lake St. Lawrence has declined in recent years.

Pumpkinseed and Brown bullhead

Pumpkinseed and brown bullhead are the second and third most important fish species to the Thousand Islands - Middle Corridor commercial fishery. In the Thousand Islands, pumpkinseed populations appear to have followed a similar trend to that of smallmouth bass, peaking in 1989 and gradually declining since that time (Fig. 7). In Lake St. Lawrence, pumpkinseeds have been uncommon throughout the history of the survey. Brown bullhead catches in the upper St. Lawrence have fluctuated considerably between years, with recent catches below and above the long-term average in the Thousand Islands and Lake St. Lawrence, respectively (Fig. 8).

Muskellunge

The *Strategic Plan for Management of the Muskellunge Population and Sportfishery of the St. Lawrence River* 1990-2000 (LaPan and Penny 1991) provides a summary of biological data, as well as guidance for the management of this species. Based on all available information, muskellunge stocks declined from the 1950s to the 1980s, but have recovered during recent years in the Thousand Islands area. Catches in Lake St. Lawrence remain low, likely due to limited spawning and nursery habitats. Increased minimum size limits and the growing popularity of catch and release fishing likely contributed to the increase in the Thousand Islands muskellunge population.

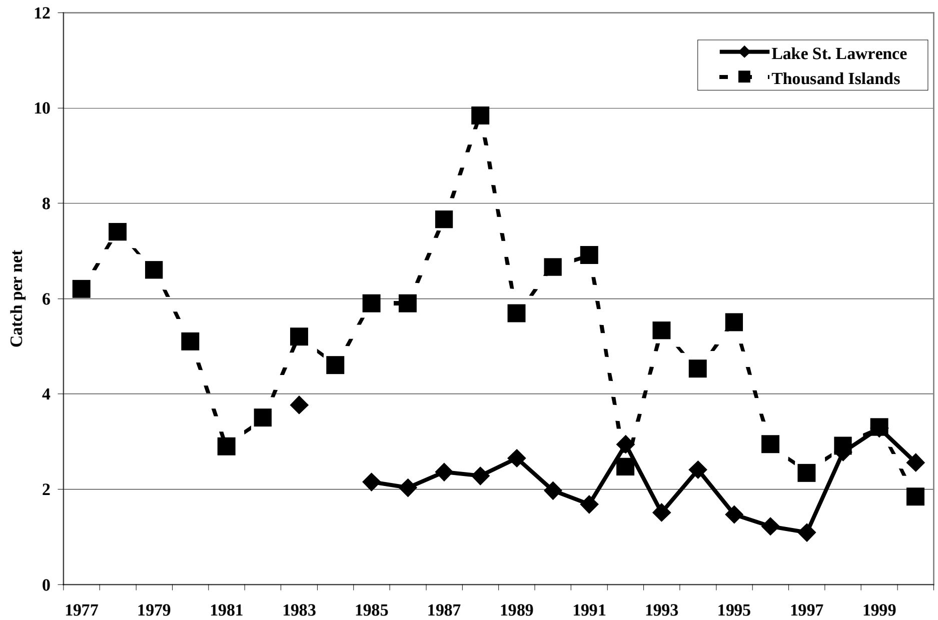

Fig. 3. Smallmouth bass catch in standard gillnets set in New York waters of the Thousand Islands and Lake St. Lawrence, 1977 to 1999.

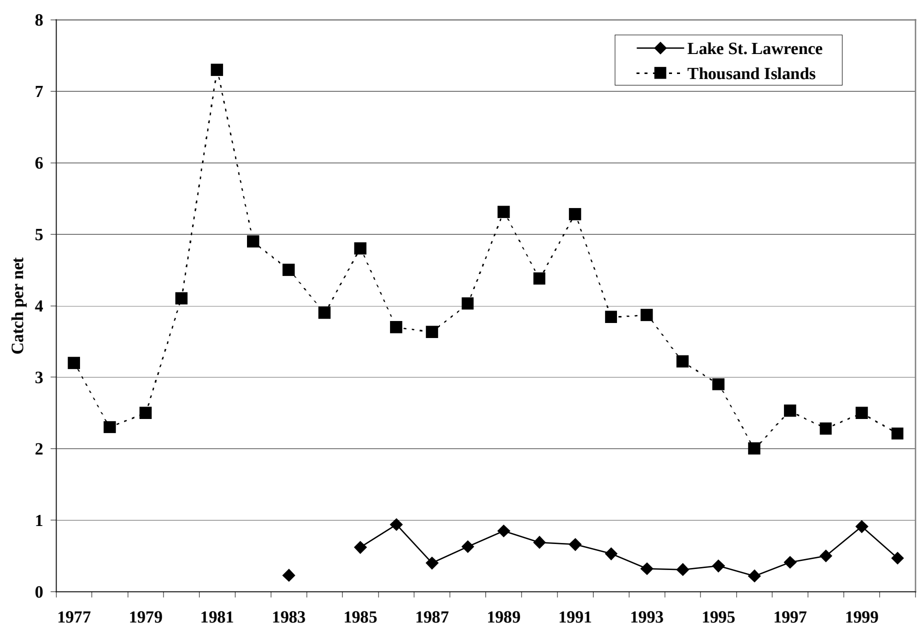

Fig. 4. Northern pike catch in standard gillnets set in New York waters of the Thousand Islands and Lake St. Lawrence, 1977 to 1999.

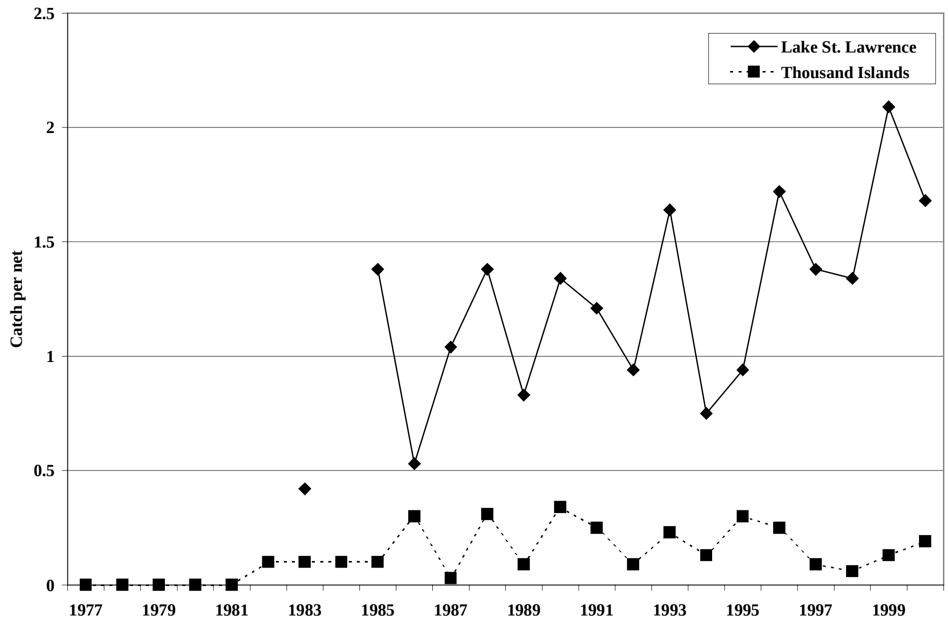

Fig. 5. Walleye catch in standard gillnets set in New York waters of the Thousand Islands and Lake St. Lawrence, 1977 to 1999.

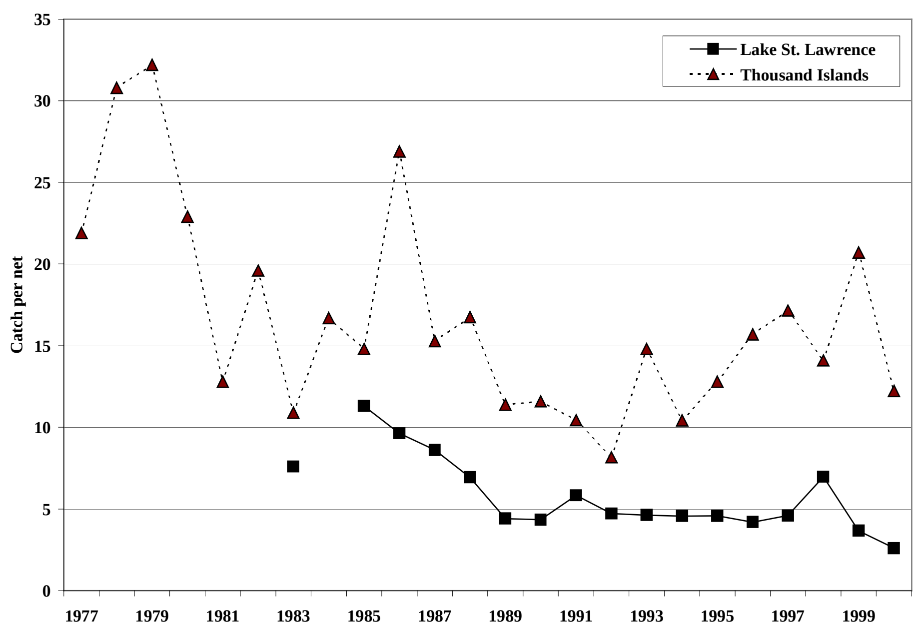

Fig. 6. Yellow perch catch in standard gillnets set in New York waters of the Thousand Islands and Lake St. Lawrence, 1977 to 1999.

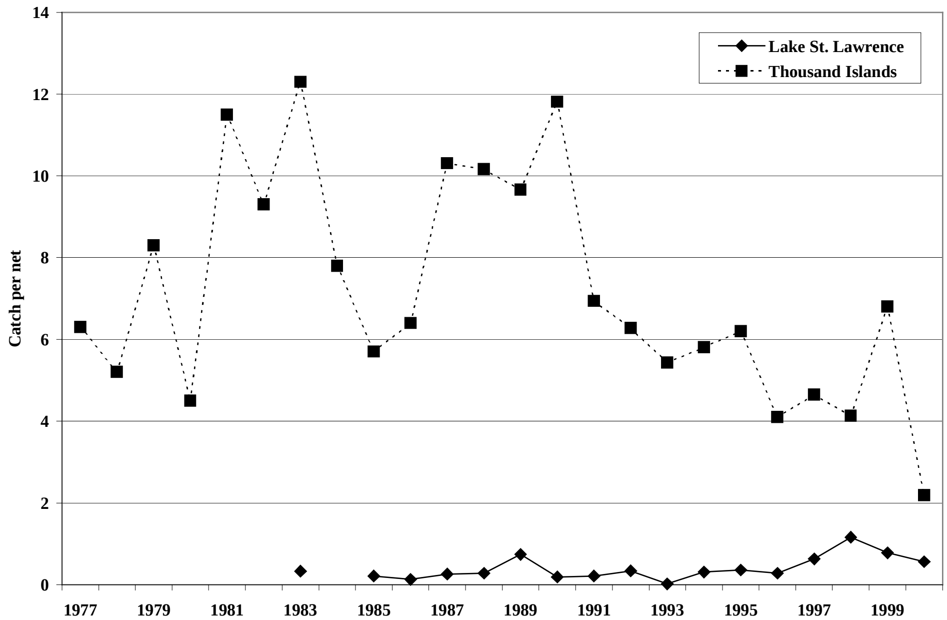

Fig. 7. Pumpkinseed catch in standard gillnets set in New York waters of the Thousand Islands and Lake St. Lawrence, 1977 to 1999.

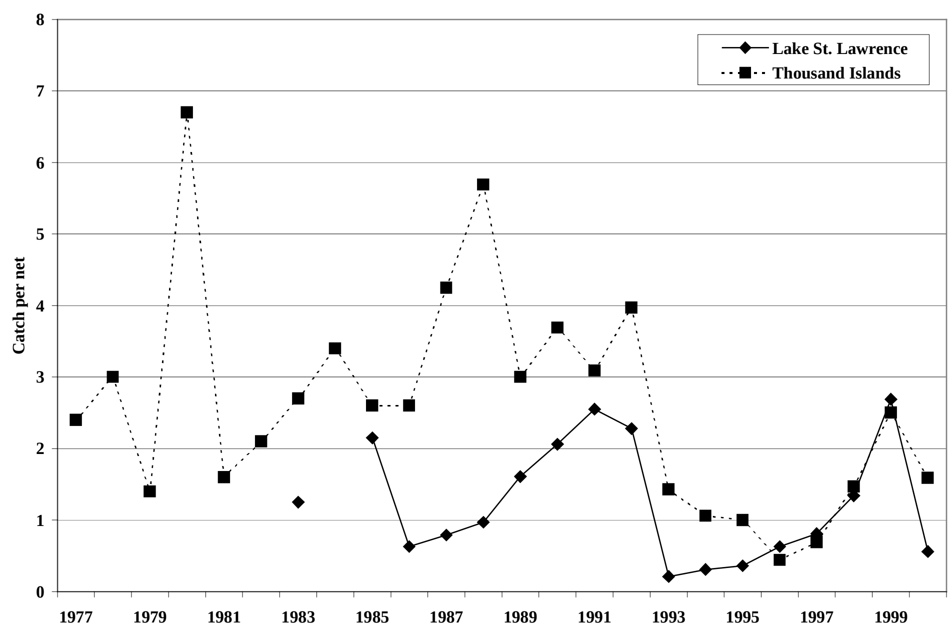

Fig. 8. Bullhead bass catch in standard gillnets set in New York waters of the Thousand Islands and Lake St. Lawrence, 1977 to 1999.

Factors affecting fish abundance

A variety of factors are known to influence fish abundance. This section provides information on the major factors that have been identified including the commercial fishery, recreational fishery, alterations to water levels and fish habitat, water quality and nutrients, weather and climate change, exotic species introductions, and double-crested cormorants.

Commercial Fishery

While no licenced commercial fishery exists in New York waters of the St. Lawrence River, individuals are allowed to sell hook-and-line-caught fish species that are not protected by minimum length and/or closed season restrictions (this excludes all game-fish species). The magnitude of this fishery is unknown, however, yellow perch is thought to be the primary target species.

A licensed commercial fishery exists in Ontario waters in the Thousand Islands and Middle Corridor areas of the upper St. Lawrence River. In 2000, 19 fishers held 30 fishing licences for the international portion of the St. Lawrence River (above Cornwall). Fish are caught in hoopnets, seines, set lines, and large mesh gillnets (set for carp only). Harvest levels are regulated by quota and season restrictions. Thirteen species of fish were harvested, with the bulk of the harvest comprised of American eel, sunfishes, brown bullhead, and yellow perch. From 1996-2000, total annual harvest ranged from 98-153 metric tons with indications of a declining trend. In 2000, the 'landed-value' of all fish caught during this time period was $312 thousand (CAN) (Hoyle et al. 2001), while the total sales impact of the fishery is estimated to be over $800 thousand (using a conversion factor from Legg 1996).

Commercial licenses restrict fishing to specific areas, seasons and specific fishing gears are used to reduce incidental catches of non-target species and minimize conflicts with other resource users. Fishers may use hoopnets and trapnets for most fish species, and may use large-mesh gillnet for carp. Commercial fisheries for black crappie, yellow perch, and American eel are managed using quotas in order to meet current fisheries management objectives and protect fish stocks.

Recreational Fishery

Recreational fishing on the upper St. Lawrence River is a very important component of local economies in both New York State and Ontario. Estimates of angler expenditures in New York and Ontario can't be directly compared due to differences in methodologies, however, the following information provides some idea of the overall value of the St. Lawrence River recreational fishery. Anglers fishing New York waters spent an estimated $30.7 million (US) locally in 1996 (Connelly et al. 1997). Angler expenditures for the Ontario waters of the St. Lawrence River from Gananoque to the Quebec border were estimated at $11.6 million (CAN) for the 1995-angling season (Brickley and Legg 1998).

For both New York and Ontario waters, angling effort in the Thousand Islands area is far greater than that of the Middle Corridor or Lake St. Lawrence areas (McCullough 1987, Hendrick et al. 1991). During 1988, angling effort on the Ontario waters of the St. Lawrence River was estimated at 14.1 angler hours per hectare for the open water season and 1.8 angler hours per hectare for the ice fishery (Hendrick et al. 1991). McCullough (1987) reported estimates of 19.0 and 10.6 angler hours per hectare for the New York waters of the Thousand Islands and Middle Corridor/Lake St. Lawrence sections, respectively. Surveys suggest that angling effort in the river during the mid-1990s has increased relative to the previous two decades (Connelly et al. 1997). In comparison, angling effort throughout the entire Great Lakes system has generally declined over the past 10 years.

Yellow perch, smallmouth bass, and northern pike dominate angler's catch in all areas of the upper St. Lawrence River, with the exception of Lake St. Lawrence, where walleye are also commonly caught. Anglers in New York preferred fishing for smallmouth bass (34.1%), followed by northern pike (18.2%), walleye (17%), and yellow perch (12.5%). In contrast, Ontario anglers most preferred northern pike (22%), followed by smallmouth bass (14%), yellow perch and walleye (both 12%). Muskellunge and largemouth bass are sought after by relatively small but dedicated groups of anglers (Brown et al. 2000).

A comparison of the New York and Ontario sport fishing regulations reveals differences in open seasons for northern pike and bass on the St. Lawrence River (Table 1). While New York State applies minimum size restrictions to most game fish (smallmouth and largemouth bass, northern pike, walleye, muskellunge, and black crappie), Ontario applies a minimum size restriction to only muskellunge. In Ontario, a holder of a resident conservation fishing licence is subject to lower catch and possession limits than a regular, resident fishing licence holder. A similar licensing structure does not exist in New York State.

Table 1. Summary of 2001 fishing regulations in the upper St. Lawrence River in Ontario (Division 11) and New York (St. Lawrence, Lake Ontario and lower Niagara River). This summary was prepared for comparative purposes only, please consult the appropriate agency for the current regulations.

	Open Season		***Size Limit***		***Catch Limit***	
Species	*New York*	*Ontario*	*New York*	*Ontario*	*New York*	*Ontario*
Bass	3rd Saturday in June to November 30	Last Saturday in June to November 30	12" minimum size	None	5	6
Northern Pike	1st Saturday in May to March 15	1st Saturday in May to March 31	22" minimum size	None	5	6
Muskie	3rd Saturday in June to November 30	3rd Saturday in June to November 30	44" minimum size	121.9cm (48 in) minimum size	1	1
Walleye	1st Saturday in May to March 15	1st Saturday in May to March 15	18" minimum size	None	3	6
Sturgeon	Closed	Closed	NA	NA	NA	NA
Lake Trout	Jan 1 to Sept 30	Dec 1 to Sept 31	25" to 30" protected slot	None	3	3
Brown Trout	All Year	All Year	9" minimum size	None	3 in combination	5
Rainbow Trout	All Year	All Year	9" minimum size	None	3 in combination	5
Pacific Salmon	All Year	All Year	9" minimum size	None	3 in combination	5
Atlantic Salmon	All Year	Jan 1 to Sept 30	25" minimum size	None	1	1
Crappie	NA	NA	9" minimum size	None	25	30

Alterations to Water Levels and Fish Habitat

Since 1963, the International Joint Commission has approved the use of Plan 1958-D to regulate Lake Ontario/St. Lawrence River water levels at the Moses-Saunders Power Dam. Criteria included in the plan were designed to facilitate commercial navigation and hydropower generation on the St. Lawrence River, and provide protection for shore property owners (Yee et al. 1990). Environmental concerns are not included in the Lake Ontario/St. Lawrence River water level regulating scheme. Since 1966, Plan 1958-D has been used to maintain Lake Ontario water levels between 74.0 and 75.2 m (242.8 and 246.8 ft) above sea level, an annual fluctuation of 1.2 m (4 ft). Prior to the implementation of Plan 1958-D, annual water level fluctuations were about 2 m (6 ft).

Changes in water levels and flows resulting from the construction and operation of the Moses-Saunders Power Dam and implementation of Plan 1958-D are implicated in impairment of critical fish habitats throughout the international portion of the St. Lawrence River. Flooding of the area immediately upstream of the power dam, creating Lake St. Lawrence, destroyed areas of rapids, impairing spawning habitat for white-water spawning fish including walleye and lake sturgeon (Patch and Busch 1984). Extensive dredging occurred in the stretch below Iroquois and in the lower part of the Middle Corridor, removing additional shoal areas which were critical fish habitats. Wetlands and tributary mouths were flooded, impairing critical spawning and nursery habitats for a variety of warmwater fish species, including muskellunge, northern pike, and smallmouth bass. In addition, maintenance of desired Lake Ontario water levels results in frequent and relatively large water level fluctuations in Lake St. Lawrence, discouraging establishment of wetlands and submergent aquatic vegetation in the nearshore zone. Aquatic plants are very sparse and during drawdown periods these areas turn into mudflats. Efforts to improve fish habitat and manage fisheries must consider the current altered and controlled state of the river.

In the Thousand Islands section, an area particularly rich in wetland habitats, compression of natural water level fluctuations and alteration of the seasonal water level cycle imposed by Plan 1958D may be negatively affecting spawning and nursery habitats for warmwater fish species, such as northern pike, that rely on wetlands. An International Joint Commission report (Levels Reference Study Board 1993) concluded that water level fluctuations are important in maintaining the extent of coastal marshes on the Great Lakes and St. Lawrence River. In addition, the study found that a reduction in Lake Ontario water level fluctuations has had a significantly adverse effect on the extent, diversity, and integrity of its wetlands.

Incremental losses of fish habitat continue to occur throughout the St. Lawrence River. Highly vegetated areas, that are productive for fish, are often considered undesirable to the waterfront owner. These vegetated areas are subject to dredging, filling and shoreline changes. Soft vegetated shorelines are often replaced with concrete or rock retaining walls or rip rap. Dock structures may occupy the riverbed and aquatic vegetation is often removed.

Water Quality and Nutrients

In the 1960s growing pubic concern about deteriorating water quality in the Great Lakes and the St. Lawrence River stimulated new investment in pollution research, especially the problems of eutrophication (excessive nutrients) and DDT. Governments responded to the concern by controlling and regulating pollutant discharges and assisting in the funding for construction of municipal sewage treatment works. This concern was formalized in the first *Great Lakes Water Quality Agreement* between Canada and the U.S. in 1972.

The *Great Lakes Water Quality Agreement* provided five general management objectives to ensure that water will be:

1) free from substances that will adversely affect aquatic life or waterfowl;
2) free from floating materials that are unsightly or deleterious;
3) free from materials and heat that will produce color, odor or taste that will interfere with beneficial uses;
4) free from materials and heat that will produce conditions that are toxic or harmful to human, animal and aquatic life;
5) free from nutrients that create growths of aquatic life that interfere with beneficial uses. These objectives are met by controlling human activities.

Water quality degradation begins when excessive amounts of nutrients (e.g. phosphorus or nitrogen) are introduced into the system. Out-dated or poorly operated sewage treatment plants, sewer overflows, use and improper disposal of phosphate-based detergents and poor agricultural practices all contribute to poor water quality. Excessive nutrient loading increases algal blooms and eventually decreases the amount of oxygen available for other aquatic life. Water clarity is also reduced. Conditions that promote algae growth can also stimulate growth of submergent and emergent plants. Excessive growth of aquatic plants and algae were evident in the St. Lawrence River during the 1970s. Submerged plants severed by propellers of recreational and commercial vessels washed onshore or floated on the surface. The biological decay of these plants re-circulated nutrients back into the system.

Improved sewage treatment and agricultural management practices have helped improve St. Lawrence River water quality to the point that it now meets 1988 *Great Lakes Water Quality Agreement* objectives for Lake Ontario (0.010 ppm phosphorus). Monitoring results at Kingston and Brockville, Ontario illustrate a decrease in phosphorus concentrations over the past 20 years (Fig. 9). Water quality in the upper St. Lawrence River would now be classified as oligotrophic.

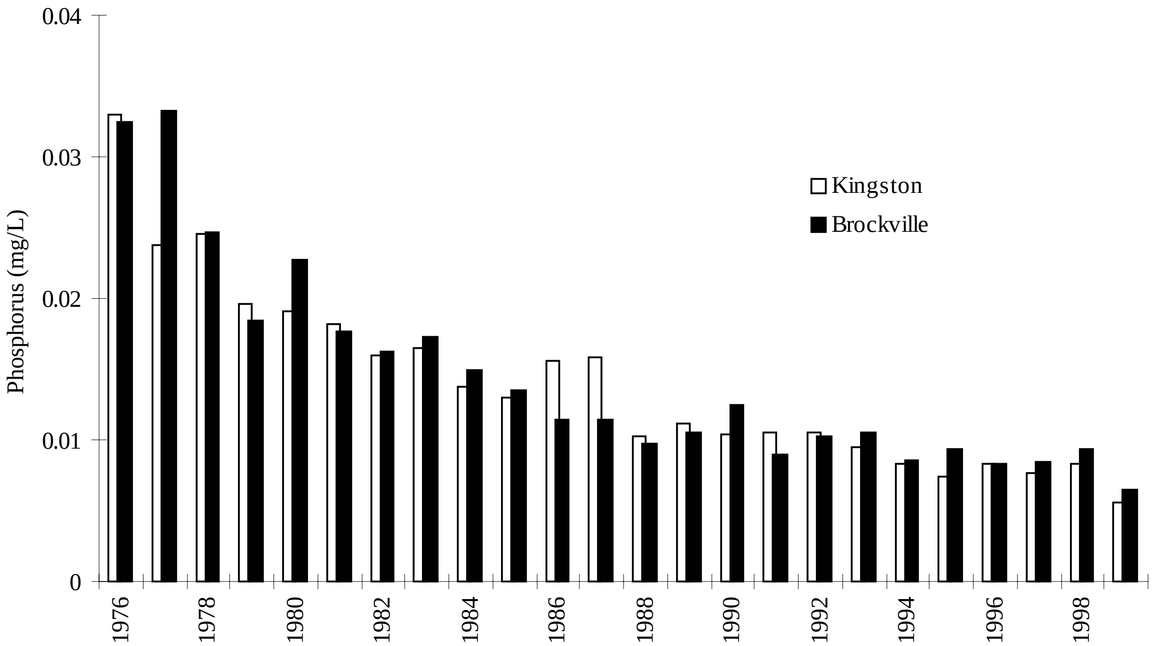

Fig. 9. Phosphorus levels in upper St. Lawrence River as indicated by seasonal means of measurements taken at the Kingston and Brockville water intake plants (data from Nicholls et al. 2001).

The decline in nutrients in the St. Lawrence River (Fig. 9), in concert with the invasion of zebra mussels, are likely contributing to an overall reduction in primary production which can reduce fisheries yields (Oglesby 1977; Leach et al. 1987). Declines in nutrients reduce the incidence of nuisance algal blooms, but also result in reduced production of beneficial microscopic plants and animals, called phytoplankton and zooplankton, respectively. The young of many fish species rely on phytoplankton and zooplankton for growth and survival. Large fish, in-turn, rely on small fish for their growth and survival. While fish production is, in general, linked to nutrient levels, it is important to note that increasing nutrient levels may not result in increased fish production.

Zebra and quagga mussels, accidentally introduced into the Great Lakes via ballast water discharged from ocean-going vessels, have disrupted the flow of nutrients and energy through the aquatic food web, resulting in shifts in the structure of the fish community. The mussels filter-feed on phytoplankton and zooplankton, competing with fish for these important food sources and dramatically increase water clarity. Mussels colonized the river during the early 1990's, and noticeable increases in water clarity were observed shortly thereafter.

Increased in water clarity improved light penetration in the St. Lawrence River, permitting vegetative growth in deeper waters. Lower nutrient levels, however, limit overall vegetative growth. Production of invertebrates, an important food source for young fish and a number adult fish species, is highly dependent upon abundance of aquatic vegetation. In addition, most warmwater fish species have a strong association with aquatic plants at some point in their life cycle, particularly during vulnerable juvenile stages.

Weather and Climate Change

On an annual basis, weather conditions can have profound effects on fish reproductive success and the growth and survival of juvenile stages. Prolonged cold or abrupt changes in water temperatures can delay or greatly reduce spawning activity in a given year. Delayed spawning can also result in poor size and condition of juvenile fish, impairing survival through their first winter.

Smith (2000) investigated year class formation of northern pike in the St. Lawrence River. He found that strong northern pike year classes were associated with early springs, high spring water levels, high summer water temperatures, and low fall water levels. Hoyle et al. (1999) and Casselman et al. (2001) studied year class strength of smallmouth bass in Eastern Lake Ontario, and found a strong correlation between large year classes of smallmouth bass and relatively warm water temperatures in July and August.

Long-term changes in climate may also impact the St. Lawrence River fish community. Increased emissions of "greenhouse" gases into earth's atmosphere result in global warming, which could result in major changes to Great Lakes hydrology. Modeling scenarios project that global warming could result in a lowering of lake level regimes by up to a meter or more by the middle of the 21st century, a development that would cause severe economic, environmental, and social impacts throughout the Great Lakes region. However, given the large discrepancies in some results of the models, there continues to be a high degree of uncertainty associated with the magnitude of potential changes (International Joint Commission 2000). Decreased water levels in the upper St. Lawrence River would likely result in serious impacts to critical fish habitats (particularly wetlands) and fish access to these habitats.

Exotic Species Introductions

More than 160 non-indigenous aquatic species have become established since the early 1800s, particularly since the expansion of the St. Lawrence Seaway in 1959 (International Joint Commission 2001). The majority of these introductions have been related to the shipping industry, but have also resulted from canal construction, accidental and intentional releases from aquaculture, the fishing bait trade, the aquarium trade and horticultural activities.

The ecological impacts of exotic species introductions on Great Lakes/St. Lawrence River fisheries range from dramatic to negligible or unknown. The establishment of sea lamprey in the Great Lakes system contributed to declines of large, native fish species including lake trout, Atlantic salmon, burbot, and whitefish. In the relative absence of a large predator base, exotic alewife populations grew unchecked, often resulting in massive die-offs that littered the shoreline with alewife carcasses. While alewife provide energy-rich forage for predators such as northern pike and smallmouth bass in the Thousand Islands area, large populations of alewife can suppress yellow perch populations through predation on their young.

Sea lampreys have been observed in the upper St. Lawrence River, and its tributaries could provide habitat for their reproduction. Sea lampreys are known to prey on several of the fish species that inhabit the upper St. Lawrence River, including yellow perch, walleye and catfish. In addition, sea lamprey produced in St. Lawrence River tributaries could have a negative impact on the fish community in Lake Ontario. Maintaining sea lamprey surveillance programs in tributaries to the upper St. Lawrence River will minimize the risk of negative impacts to fish communities in both the River and in Lake Ontario.

The establishment of filter-feeding zebra and quagga mussels in the upper St. Lawrence River has contributed to increases in water clarity and a potential reduction in the availability of zooplankton (small invertebrates). Zooplankton is utilized by the young of many fish species, as well as some adult fish (*also see Water Quality and Nutrients*). Reductions in nutrients, phytoplankton and zooplankton can result in reduced growth and survival of juvenile fish, ultimately leading to reductions in overall fish abundance.

Round gobies have become established in Lake Ontario, and will likely proliferate in the upper St. Lawrence River in the near future. As with any exotic species introduction, the future ecological impacts of round goby on the St. Lawrence River fish community are largely unknown. Kuhns and Berg (1999) concluded that the invasion of round gobies and zebra mussels into Lake Michigan has the potential to change food web dynamics of benthic communities in nearshore rocky areas.

Until technological advances eliminate the potential for transfer of living organisms from ocean-going vessels to Great Lakes waters, the fish community of the upper St. Lawrence River will face continued challenges by exotic organisms.

Double-crested Cormorants

Nesting of double-crested cormorants (DCC) was first noted on Lake Ontario in 1938 (Baille 1947), and by the early 1950's DCC were so common that the Province of Ontario authorized localized control measures to reduce suspected competition with recreational interests (Gross 1950). Throughout the 1960s and 70s, DCC populations, as well as other fish eating birds, declined dramatically across the Great Lakes due to reproductive failure resulting from toxic contamination (primarily DDE and PCB's). Following successful government efforts to reduce the release of toxic chemicals into Great Lakes waters, DCC populations began to rebound rapidly.

In the upper St. Lawrence River, DCC nesting was first documented in Lake St. Lawrence on Strachan Island in 1992 (38 nests). Since that time, DCC nesting activity has spread to two additional islands (McNare Island in the Middle Corridor and Griswold Island in the Thousand Islands) supporting a collective total for the three colonies of over 900 nests in 2000.

At DCC nesting and roosting sites, accumulations of ammonia-rich droppings are capable of destroying ground vegetation, shrubs and trees. DCC can successfully displace other nesting bird species including great blue herons, black-crowned night herons, terns and egrets. DCC's have also been implicated as a potential cause of increased mortality rates of young smallmouth bass in the New York waters of Eastern Lake Ontario (Lantry et. al 1999).

The impacts of DCC predation on the fish community of the upper St. Lawrence River are not known. Diet studies conducted on the three DCC colonies in the Upper St. Lawrence River in 2000 indicated that DCC's fed primarily on yellow perch, followed by rock bass and minnows (Johnson et al. 2001).

STAKEHOLDER CONSULTATION PROCESS

Fish community objectives need to balance several factors including the diverse interests of user groups, the natural limitations of the ecosystem and the mandates of the fisheries management agencies. To solicit and characterize public opinion, NYSDEC and OMNR held a series of six public meetings, three each in New York and Ontario during July and August 2000. A combined total of 174 individuals attended the meetings.

Prior to the public meetings, a series of discussion papers were developed to summarize current information on the status of the St. Lawrence River fish community, fisheries, and factors influencing the fish community. Funding for the development of the discussion papers was provided by the GLFC. The discussion papers were disseminated to the public via mail, posting on the GLFC Internet web site, and in oral presentations at the public meetings. Meeting participants and other interested individuals were asked to fill out a survey questionnaire that was developed and analyzed by Cornell University's Human Dimensions Research Unit (HDRU). Survey questions included anglers' preferences and concerns, as well as hypothetical management scenarios designed to measure respondents' receptiveness to more restrictive angling regulations. One exception to the aforementioned was a survey question regarding an actual proposal in increase the minimum size limit of muskellunge in the Ontario waters of the St. Lawrence River. If other regulation changes are proposed as a result of the FCO process, OMNR and NYSDEC will conduct further public consultation on specific proposals.

A total of 162 survey questionnaires were completed; 138 at public meetings and 24 submitted by mail. Brown et al. (2000) provides a detailed summary of survey responses. Briefly, the survey results suggest the following:

- A variety of user groups participated in the survey, including anglers, boaters, property owners, fishing guides, and local business owners.
- Smallmouth bass, northern pike, walleye and yellow perch were the top four fish species preferred by anglers.

- The vast majority of respondents were willing to consider more restrictive minimum length and creel limit regulations for smallmouth bass and northern pike, provided the regulations were likely to improve the sport fishery in the future.
- The majority of participants indicated moderate or strong support for agency programs that focus on uncommon species such as pugnose shiner, mooneye, sand darter, lake sturgeon and American eel.

In addition to the comments and concerns received from the public at meetings and through the survey questionnaire, public comments were also solicited via newspaper articles, television, radio, and the Internet. Generally respondents were concerned about the declining quality of St. Lawrence River sport fisheries. The following provides a brief summary of public comments received:

- The majority of the comments received centered on the negative impact of cormorants on recreational fisheries, nesting/roosting habitats of other birds, the commercial fishing industry and the bait fish industry.
- Considerable concern was expressed regarding the impact of pre-season fishing on bass and the mortality of bass released by anglers.
- Interest was expressed for fish stocking programs, including bass, pike, walleye, muskellunge, and salmonids.
- Participants were interested in seeing an increased presence of environmental law enforcement officers on the River, as well as higher fines for violations of angling regulations and habitat protection laws.
- General support was expressed for common angling regulations in the New York and Ontario waters of the River.
- The negative impact of Lake St. Lawrence water level regulation on the fishery and boating was addressed.
- The public felt that those agencies responsible for the Moses-Saunders Power Dam and the St. Lawrence Seaway should be responsible for restoration of impaired habitats and fisheries.
- Zebra mussels, increased water clarity and algae growth is hurting fisheries.
- Not enough is known on regarding the impacts of toxins on fish populations and humans
- Governments should enact more stringent regulations to prevent releases of toxins.

NYSDEC and OMNR submitted a draft St. Lawrence River Fish Community Objectives document to the Lake Ontario Committee of the Great Lakes Fishery Commission (LOC/GLFC) in August 2001. Following approval by the LOC/GLFC, the draft document was released for public comment. As part of the public comment process, meeting participants and relevant stakeholder organizations were sent a copy of the draft document for comment. To encourage additional comment, the draft document was placed on Ontario's Environmental Bill of Rights Registry and on the websites of the NYSDEC and the GLFC.

FISH-COMMUNITY OBJECTIVES

A general goal for management of the fisheries of the Upper St. Lawrence River is the maintenance of native, self-sustaining fish stocks. Management actions to increase fishing quality, fish abundance, and fish distribution should focus on sound management regulations, and the identification, protection, and rehabilitation of critical fish spawning and nursery habitats.

In establishing fish community objectives for the upper St. Lawrence River, it must be recognized that:

1) The number of fish species and their abundance are strongly influenced by habitat features, including water levels, nutrient levels, and climate (temperature), that are beyond the control of fish managers. Nutrient levels in the upper St. Lawrence River have declined into the "oligotrophic" range, and the River may not be capable of supporting levels of fish production comparable to that when nutrient levels were higher. The following objectives are based on the underlying assumption that primary productivity in the Upper St. Lawrence River will not decline further. Should this assumption prove to be incorrect, these objectives may be unrealistic.
2) Double-crested cormorants in the upper St. Lawrence will very likely persist in the future. While it is still unclear whether cormorant predation results in significant impacts on upper St. Lawrence River fish populations, the current level of predation could be limiting fish abundance. The efficacy of

controlling Double-Crested Cormorant populations as a means of maintaining/restoring fish abundance is currently being investigated. Fisheries and wildlife managers in New York and Ontario will collaborate to insure that DCC numbers are compatible with recreational/commercial fisheries.

3) Habitat manipulation, regulation of fisheries, and fish stocking are the only management options available for altering fish abundance, and the results of these actions are often not precise. It must be recognized that fish stocking, if undertaken, will be for the purpose of spawning stock rehabilitation and expansion into new habitats. Fish will not be stocked to supplement abundance of wild fish.
4) Fisheries managers typically measure the relative "health" of fish populations through netting surveys and/or gauging fishing success/angler satisfaction with angler surveys. NYSDEC and OMNR conduct gill net assessment programs on the upper St. Lawrence River annually, however, angler surveys are conducted infrequently. Where possible, we propose to use species-specific catch per unit of effort (CPUE) from index gill netting programs as an indicator of fish abundance. While the precision of gill net CPUE can be variable, it is very useful in detecting long-term trends in fish populations. Exploring options for improving our knowledge and management of upper St. Lawrence River fisheries is a critical aspect of this document.
5) The following objectives and indicators are based on public input indicating general dissatisfaction with the quality of upper St. Lawrence River sportfisheries in recent years. The benchmark selected for future comparisons will be the average index gillnet CPUE for the period 1995 to 1999 from NYSDEC's Thousand Islands and Lake St. Lawrence assessment programs (conducted annually) and OMNR's Thousand Islands netting surveys (conducted biannually). While the improvements to Upper St. Lawrence River sportfisheries proposed in this document may appear conservative, it is important to note that fishing regulation changes, habitat manipulations, etc. will take time to implement, and responses of fish populations to these management actions will be impossible to detect for at least several years.

***** Average catch per unit effort (CPUE) refers to a five-year, rolling average of the number of fish per net night in index gill netting surveys conducted by NYSDEC and OMNR. For smallmouth bass and northern pike, these CPUE's represent a 10% improvement over 1995-1999 values.

Species or Group	**Objectives**	**Indicators**
Smallmouth Bass	**Increase abundance of self-sustaining smallmouth bass and the proportion of larger bass.**	Thousand Islands/Middle Corridor Average* catch per unit effort (CPUE) > 2.5 fish/net/night. In addition, maintain a CPUE of 1.4 fish/net/night for bass 30.5 cm (12 in) and longer. Lake St. Lawrence Average* catch per unit effort (CPUE) > 2.0 fish/net/night. In addition, maintain a CPUE of 1.6 fish/net/night for bass 30.5 cm (12 in) and longer.
Largemouth Bass	**Increase abundance of self-sustaining largemouth bass and the proportion of larger bass.**	We recognize the importance of largemouth bass and note that current fisheries assessment programs do not adequately index the status of largemouth bass. It is our intent to develop a largemouth assessment program by 2006.

<table>
<tr><th>Species or Group</th><th>Objectives</th><th>Indicators</th></tr>
<tr><td>Muskellunge</td><td>The management goals for the upper St. Lawrence River muskellunge population are:
1) maintain/increase the abundance of wild muskellunge in the St. Lawrence River, and
2) to provide a high quality, trophy fishery.</td><td>Specific management strategies, objectives, and tactics for this population are being developed in an update of LaPan and Penney (1991).</td></tr>
<tr><td>Northern Pike</td><td>1) Increase abundance of larger, self-sustaining northern pike
2) Increase northern pike recruitment in association with habitat enhancement projects</td><td><u>Thousand Islands/Middle Corridor</u>
Average* catch per unit effort (CPUE) > 2.2 fish/net/night. In addition, maintain a CPUEs of 1.3 fish/net/night for northern pike 56 cm (22 in) and longer.

<u>Lake St. Lawrence</u>
Average* catch per unit effort (CPUE) > 0.5 fish/net/night. In addition, maintain a CPUE of 0.3 fish/net/night for northern pike 56 cm (22 in) and longer.</td></tr>
<tr><td>Walleye</td><td>1) Maintenance of existing, self-sustaining walleye populations and expansion of walleye populations into favorable habitats.
2) Where biologically and logistically feasible, enhance walleye spawning habitat.</td><td><u>Thousand Islands/Middle Corridor</u>
Average* catch per unit effort (CPUE) > 0.2 fish/net/night.

<u>Lake St. Lawrence</u>
Average* catch per unit effort (CPUE) > 1.5 fish/net/night. In addition, maintain a CPUE of 0.4 fish/net/night for walleye 46 cm (18 in) and longer.</td></tr>
<tr><td>Panfish</td><td>Maintain abundance of self-sustaining panfish populations</td><td>Yellow perch
<u>Thousand Islands/Middle Corridor</u>
Average* catch per unit effort (CPUE) > 15.1 fish/net/night.
<u>Lake St. Lawrence</u> Average* catch per unit effort (CPUE) > 4.8 fish/net/night.

Pumpkinseed
<u>Thousand Islands/Middle Corridor</u>
Average* catch per unit effort (CPUE) > 3.4 fish/net/night.
<u>Lake St. Lawrence</u> Average* catch per unit effort (CPUE) > 0.6 fish/net/night.

Rock Bass
<u>Thousand Islands/Middle Corridor</u>
Average* catch per unit effort (CPUE) > 5.0 fish/net/night.
<u>Lake St. Lawrence</u> Average* catch per unit effort (CPUE) > 2.6 fish/net/night.</td></tr>
</table>

Species or Group	Objectives	Indicators
		Brown Bullhead Thousand Islands/Middle Corridor Average* catch per unit effort (CPUE) > 1.4 fish/net/night. Lake St. Lawrence Average* catch per unit effort (CPUE) > 1.2 fish/net/night.
Lake Sturgeon	**1) Rehabilitation of lake sturgeon populations including expansion of sturgeon populations into favorable habitats.** **2) Where biologically and logistically feasible, enhance lake sturgeon spawning habitat.**	Average* CPUE for sturgeon of all ages in index gill netting programs of 0.1 sturgeon/net/night (aggregate average of all three assessment netting programs).
American Eel	**Maintenance of American eel as a self-sustaining component of the St. Lawrence River fish community through reducing all sources of mortality at the yellow and silver life stages, and facilitate upstream passage at the St. Lawrence Power Project.**	Continued presence of American eel transiting the eel ladder at the St. Lawrence Power Project and in index trawl and electrofishing surveys.
General	**1) Maintain a commercial fishery comprised of a diversity of species and adjust individual species harvests in conjunction with changes in fish species abundance as required (Ontario only).** **2) When possible, support programs to rehabilitate rare, threatened and endangered fish species.**	1) No indicator 2) Increased sightings and catches of rare fish.

MANAGEMENT ACTIONS TO SUPPORT HEALTHY FISH COMMUNITIES

Actions

While the preceding section was limited to species-specific fish community objectives, the following also includes strategies relevant and important to the overall health of the upper St. Lawrence River fish community.

Management actions that support healthy fish communities will include:

Investigation and implementation of improved fishery assessment/surveillance

- Develop/implement periodic recreational angling survey(s)
- Further develop/implement fish community surveillance programs (largemouth bass, walleye, etc.)

Regulation of fish harvest

- Evaluate existing recreational fishing regulations (seasons, size limits, and creel limits), and, if deemed necessary, propose revisions. Proposed regulation changes will be subject to a public comment period prior to approval.
- When appropriate, assign high priority to harmonization of fishing regulations
- Manage commercial fisheries consistent with fish community objectives

Protecting species biodiversity

- Protecting the genetic diversity of native fishes
- Protecting and rehabilitating native fishes
- Protecting and enhancing populations of rare and endangered fishes
- Controlling new introductions of exotic fish and other aquatic species

Maintaining or improving ecosystem function

- Within the guidelines set by the Great Lakes Water Quality Agreement (GLWQA) work with the International Joint Commission to ensure that phosphorus levels do not continue to decline.
- Maintaining surveillance programs for sea lamprey in tributaries to the St. Lawrence River
- Protecting and rehabilitating critical fish habitat, including tributaries and nearshore spawning and nursery areas
  - Create wetland areas to replace lost spawning and nursery habitats for fish including northern pike
  - Create and rehabilitate walleye and sturgeon spawning areas
  - Work with St. Lawrence River Board of Control to develop water level management practices which will promote maintenance and recovery of habitat diversity and successful reproduction of northern pike and other fish and wildlife species

Reducing contaminant levels

- Reduce contaminant concentrations in fish to levels that will result in no sportfish consumption advisories, and that cause no impairment of fish and wildlife reproduction

CONCLUSION

The upper St. Lawrence River has undergone significant physical alterations, and many fish habitats remain impaired due to the controlled nature of the river. Declines in nutrient levels and introductions of exotic fishes and other aquatic organisms will continue to affect the overall health and productivity of the St. Lawrence River fish community. In spite of these impairments, the upper St. Lawrence River continues to support a diverse and productive, self-sustaining, native fish community that provides great economic benefits. In the face of repeated challenges to the integrity of the St. Lawrence River fish community, sound fisheries management requires focusing on habitat protection and enhancement, harvest controls, and fisheries monitoring programs for evaluating change and the efficacy of management policies.

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REFERENCES

Baille, J.L. 1947. The double-crested cormorant in Ontario. Can. Field Nat. 61(4):119-126.

Brickley, K and D. Legg. 1998. 1995 Survey of recreational fishing in Canada. Selected results for the Great Lakes Fishery. Economic and Commercial Analysis Report No. 155. Economic and Policy Analysis Directorate, Department of Fisheries and Oceans, Ottawa, Ontario, K1A 0E6. 76 pages.

Brown, T.L., S.R. LaPan and A. Mathers. 2000. Public input to St. Lawrence River Fish Community Objectives. HRDU Series No. 00-13. Human Resources Dimensions Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY, 14853

Carlson, D.M. and S.R. LaPan. 1997. Fish species inhabiting the international portion of the St. Lawrence River. Fact Sheet. New York State Department of Environmental Conservation. Division of Fish Wildlife and Marine Resources. 317 Washington St., Watertown, New York 13601. 11 pages.

Casselman, J.M. D. Brown, J. A., Hoyle and T.H Eckert. 2001. Effects of climate and global warming on year-class production of smallmouth bass in eastern Lake Ontario. Paper presented to the Bass Symposium 2000. [checking this with John C]

Connelly, N.A., T.L. Brown, and B.A. Knuth. 1997. New York Statewide Angler Survey. Report 1: Angler effort and expenditures. New York State Department of Environmental Conservation. Division of Fish and Wildlife. 50 Wolf Rd., Albany, New York 12233-4753. 107 pages.

Eckert, T.H. and J.R. Hanlon 1977. Fisheries studies along the St. Lawrence River. In J.W. Geis (ed), Preliminary report: biological characteristics of the St. Lawrence River. SUNY College of Environmental Science and Forestry. Syracuse, NY.

Great Lakes Fishery Commission. 1997. A Joint Strategic Plan for Management of Great Lakes Fisheries. Ann Arbor, MI. (Supersedes 1994 version).

Great Lakes Panel on Aquatic Nuisance Species. 1996. Biological Invasions. Great Lakes Commission, Ann Arbor, Michigan.

Greeley, J.R. and C.W. Greene. 1931. Fishes of the area with annotated list. Pp 44-94. In A biological survey of the St. Lawrence watershed. Supplement to 20th Annual Report 1930. New York Conservation Department, Albany.

Gross, A.G. 1950. The herring gull-cormorant control project. P{roc. 15th Internatl. Ornithl. Congress. Pp. 532-536.

Hendrick, A., R. Cholmondeley, and P.D. MacMahon. 1991. Open water and winter creel surveys on the St. Lawrence River, 1988-89. St. Lawrence River Fisheries Management Unit Report 1991-02. Ontario Ministry of Natural Resources. Cornwall District. P.O. Box 1749, Cornwall, Ontario. K6H 5V7

Hoyle J. A., J. M. Casselman, and T. Schaner. 1999. Smallmouth bass (*Micropterus dolomieui*) population status in eastern Lake Ontario. 6 p. Part III. Additional Topics. *In* Lake Ontario Fish Communities and Fisheries: 1998 Annual Report of the Lake Ontario Management Unit. Ontario Ministry of Natural Resources, Picton, Ontario.

Hoyle J. A., R. Harvey and A. Mathers 2001. St. Lawrence River Commercial Fisheries. 3 p. Part II. Fisheries. *In* Lake Ontario Fish Communities and Fisheries: 2000 Annual Report Lake Ontario Management Unit. Ontario Ministry of Natural Resources, Picton, Ontario.

International Joint Commission 2000. Protection of the waters of the Great Lakes. Final Report to the Governments of Canada and the United States, March 2000

International Joint Commission 2001. Alien Invasive Species and Biological Pollution of the Great Lakes Basin Ecosystem. Report of the Great Lakes Water Quality Board to the International Joint Commission, May 2001.

Johnson, J.H., S. R. LaPan, B. Edmonds, and A. Bendig. 2001. Diet composition and fish consumption of double-crested cormorants from three St. Lawrence River colonies in 2000. *In* 2000 NYSDEC Annual report Lake Ontario Unit and St. Lawrence River Unit to the Lake Ontario Committee, Great Lakes Fishery Commission. March 2001.

Kuhns, L.A. and M.B. Berg. 1999. Benthic invertebrate community responses to round goby (Neobobius melanostomus) and zebra mussel (Dreissena polymorpha)invasion in southern Lake Michigan. J. Great Lakes Res. 25(4): 910-917.

Lantry, B.F., T.H. Eckert, and C.P. Schneider. 1991. The relationship between the abundance of smallmouth bass and double-crested cormorants in the Eastern Basin of Lake Ontario. *In* NYSDEC Final report: to assess the impact of double-crested cormorant predation on the smallmouth bass and other fishes of the Eastern Basin of Lake Ontario. N.Y.S. Dept. of Environmental Conservation Special Report, February 1999.

LaPan, S.R. and L. Penny. 1991. Strategic Plan for Management of the Muskellunge Population and Sportfishery of the St. Lawrence River 1990-2000. Phase II: 1991-2000. New York State Department of Environmental Conservation. Division of Fish Wildlife and Marine Resources. 317 Washington St., Watertown, New York 13601. 51 pages.

Leach, J. H.,, L.M. Dickie, b. J. Shuter,U. Borgamn, J, Hyman, and W. Lysack. 1987. A review of methods for prediction of potential fish production with application the the Great Lakes and Lake Winnipeg. Can J. Fish. Aqua. Sci. 44(Suppl. 2): 471-485

Legg, D. 1996. The economic impact of commercial fishing in Ontario, 1994. Fact Sheet. Ontario Ministry of Natural Resources, Resource Stewardship and Development Branch, Toronto, Ontario.

Levels Reference Study Board. 1993. Levels reference study: Great Lakes-St. Lawrence River basin. Submitted to the International Joint Commission, March 1993.

McCullough, R.D.. 1987. The summer sport fishery of the St. Lawrence River, Thousand Islands: 1983-1984. NYSDEC 1987 Annual report, St. Lawrence River sub-committee to the Lake Ontario Committee and the Great Lakes Fishery Commission. March 1987.

Nicholls, K.H., Hopkins, G.J., Standke, S.J. and Nakamoto, L. 2001. Trends in total phosphorus in Canadian near-shore waters of the Laurentian Great Lakes: 1976-1999. J. Great Lakes Res. 27(4): 402-422.

Normandeau Associates, Inc. and Alden Research Laboratory, Inc, 1999. Qualitative analysis of entrainment and survival of fish species at the St. Lawrence-FDR power project, New York. Report prepared by Normandeau Associates Inc. and Alden Research Laboratory, Inc. for the New York Power Authority, 1633 Broadway, New York, NY, U.S.A. 10019

Oglesby, R.T. 1977. Relationships of fish yield to lake phytoplankton standing crop, production, and morphoedaphic factors. J. Fish Res Board Can. 34: 2271-2279

Ohio Environmental Protection Agency. 1987. Biological criteria for the protection of aquatic life: volume II. Users manual for biological field assessments of Ohio surface waters. Division of water quality monitoring and assessment, surface water section, Columbus, Ohio.

Parsons, J.W. 1973. History of salmon in the Great Lakes, 1850-1970. Technical Report 68. Bureau of Sport Fisheries and Wildlife. 80 pp.

Patch S.P. and W.D. Busch. 1984. Fisheries in The St. Lawrence River – past and present: a review of historical natural resources information and habitat changes in the International section of the St. Lawrence River. U.S. Fish and Wildlife Service, Cortland NY.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fishes. US Environmental Protection Agency, EPA/444/489-001.

Smith, C.L. 1985. Freshwater fishes of New York State. New York State Department of Environmental Conservation, Albany, NY.

Smith, B. 2000. Year-class formation of St. Lawrence River northern pike. Master's thesis. SUNY College of Environmental Science and Forestry, Syracuse, N.Y.. 95 p.

Stewart, T.J., R.E. Lange, S.D. Orsatti, C.P. Schneider, A. Mathers, M.E. Daniels. 1999. Fish-community objectives for Lake Ontario. Great Lakes Fish. Comm. Spec. Pub. 99-1. 56 p.

Yee, P., R. Edgett and A. Eberhardt. 1990. Great Lakes-St. Lawrence River regulation; what it means and how it works. Joint publication of Environment Canada, Ontario Region, and the U.S. Army Corps of Engineers. May 1990.

APPENDIX 1.

Fish species of the upper St. Lawrence River from field studies through 1996 (from Carlson and LaPan 1997). Species present during a time period are identified with '+' and species identified with '-' were not present. The Comment column identifies species which were 'introduced' (according to Smith 1985 and Eckert and Hanlon 1977) also species sensitive or intolerant to pollution (according to Plafkin et al. 1989 and Ohio EPA 1987) are labeled 'sensitive'. References used in development of this list are included in Carlson and LaPan (1997).

Species	1931 or earlier	1976 to 1978	1982 to 1996	Comment
Silver lamprey	+	+	-	
Sea lamprey	+	+	+	
Lake sturgeon	+	+	+	
Longnose gar	+	+	+	
Bowfin	+	+	+	
Mooneye	+	+	+	sensitive
American eel	+	+	+	
Alewife	+	+	+	
Gizzard shad	-	+	+	
Goldfish	-	+	-	introduced
Lake chub	+	-	+	
Spotfin shiner	+	+	+	
Common carp	+	+	+	introduced
Cutlips minnow	+	+	+	
Brassy minnow	-	+	-	
Eastern silvery minnow	-	+	+	
Common shiner	+	+	+	
Golden shiner	+	+	+	
Pugnose shiner	+	+	+	sensitive
Emerald shiner	+	+	+	
Bridle shiner	+	+	+	
Blackchin shiner	+	+	+	sensitive
Blacknose shiner	+	+	+	sensitive
Spottail shiner	+	+	+	
Rosyface shiner	-	+	+	sensitive
Sand shiner	+	+	+	sensitive
Mimic shiner	+	+	+	sensitive
Bluntnose minnow	+	+	+	
Fathead minnow	+	+	+	
Blacknose dace	+	-	-	
Longnose dace	+	+	-	sensitive
Rudd	-	-	+	introduced
Creek chub	+	+	+	
Fallfish	+	+	+	
Quillback	-	+	+	
Longnose sucker	-	-	+	
White sucker	+	+	+	
Silver redhorse	+	+	+	sensitive
Shorthead redhorse	+	+	+	sensitive
Greater redhorse	+	+	+	sensitive

Species	1931 or earlier	1976 to 1978	1982 to 1996	Comment
Yellow bullhead	-	+	+	
Brown bullhead	+	+	+	
Channel catfish	+	+	+	
Stonecat	+	+	+	sensitive
Tadpole madtom	+	+	+	
Grass pickerel	+	+	+	
Northern pike	+	+	+	
Muskellunge	+	+	+	
Chain pickerel	-	-	+	introduced
Central mudminnow	+	+	+	
Rainbow smelt	-	+	+	introduced
Coho salmon	-	-	+	introduced
Chinook salmon	-	-	+	introduced
Rainbow trout	-	+	+	introduced
Atlantic salmon	+	-	+	
Brown trout	-	+	+	introduced
Lake trout	-	-	+	
Cisco	+	-	+	
Lake whitefish	-	-	+	
Trout-perch	+	+	+	
Burbot	+	+	+	
Banded killifish	+	+	+	
Brook silverside	+	+	+	sensitive
Brook stickleback	+	+	+	
Threespine stickleback	+	+	-	
Mottled sculpin	+	+	+	
Slimy sculpin	-	+	-	
White perch	-	+	+	introduced
White bass	-	+	+	
Rock bass	+	+	+	
Pumpkinseed	+	+	+	
Bluegill	-	+	+	
Smallmouth bass	+	+	+	
Largemouth bass	+	+	+	
Black crappie	+	+	+	
Iowa darter	+	+	+	
Fantail darter	+	-	+	
Johnny darter	-	+	+	
Tessellated darter	+	+	+	
Yellow perch	+	+	+	
Logperch	+	+	+	sensitive
Channel darter	+	-	-	sensitive
Sauger	+	-	-	
Walleye	+	+	+	
Freshwater drum	-	+	+	
Species present	62	71	76	
Sensitive species present	15	14	16	
Introduced species present	1	6	9	