St. Lawrence River Discussion Papers

FISH HABITAT CHANGES - Thousand Islands, Middle Corridor, and Lake St. Lawrence

Issues

Below is a synopsis of habitat issues and proposed management initiatives. More detailed background information is provided in the main-body of the document. ***Please consider whether your support the proposed approaches.***

Water level regulation in the St. Lawrence River has improved navigation, increased hydroelectric power generation, and reduced the incidences of flooding. Unfortunately, the regulation of water reduces the diversity of wetland habitat and this is detrimental to some fish species. Northern pike reproduction, in particular, is reduced.

- ***The Ontario Ministry of Natural Resources and New York State Department of Environmental Conservation plan to encourage the International Joint Commission and St. Lawrence River Control Board to ensure that fish habitat management concerns are considered when revising or setting new water level management objectives.***

Local improvements in pike spawning habitat can be achieved by mechanically cutting into the cattail beds or installing and maintaining dikes to keep areas flooded during the spring. This method can only be applied in specific areas where it is likely to improve habitat, is cost-effective, and does not have a negative impact on property values, boating access, or other uses.

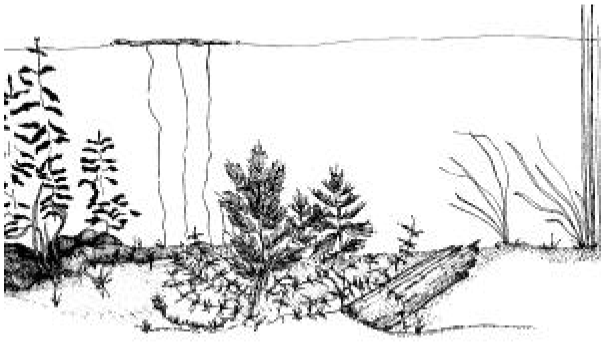
- ***OMNR and NYDEC plan to encourage projects to improve pike habitat and evaluate their effectiveness.***

Water quality has improved to the point where it has met Great Lakes Water Quality Agreeement (GLWQA) for nutrients. The overall effect has produced many benefits beyond fisheries, such as clearer water, more areas for swimming, and reduced blooms of algae. Some fish, like sturgeon may have benefited, but it has likely reduced the capacity of the St Lawrence to support large fish populations. As a result, the St Lawrence River will produce fewer fish than it did historically. This effect may have been accelerated due to the impacts of invading zebra mussel.

- ***OMNR and NYDEC think that a reasonable balance has been established between water quality improvements and fisheries, and plan to continue to encourage the International Joint Commission and St. Lawrence River Control Board to ensure a balance between water quality and fish community interests is maintained.***

Chemical contaminants, both man-made and naturally occurring, are still evident in St. Lawrence River fish. New York State Department of Health and Ontario Ministry of Environment issue annual advisories regarding the consumption of sport fish based on standards set at the federal level for the United States and Canada.

- ***Provincial ministries and federal agencies plan to continue to work together to reduce local nutrient or toxic contaminant inputs in areas where water quality objectives have not been met or where fish consumption health advisories exist.***



RE Grant & Associates, Brockville, Ontario

Background Information

The St. Lawrence River is one of the world's most unique waterways. Its waters drop at a rate of about 20 cm/km (1.1 ft/mi) and travel close to 900 km (559 mi.) from Kingston (at Lake Ontario's outlet) to the Gulf of St. Lawrence. 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 7,657.2 m^3/s (270,410 ft^3/s).

The **international portion** of the St. Lawrence River stretches from Lake Ontario's outlet to the Moses-Saunders Dam at Cornwall and is about 180 km (112 mi.) long. The remainder of the river flows through Canada (Ontario and Quebec) with Ontario's representation being a 7,380 ha (18,236 ac), 49 km (30.4 mi.) section of river below the dam (Lake St. Francis).

The Great Lakes supplies most of water to the St. Lawrence River. The amount of water available is dependent on precipitation and evaporation rates in conjunction with the amount of water released from Lake Ontario by way of control structures on the river. Water levels are controlled by the St Lawrence River Control Board based on directives developed by the International Joint Commission (see box).

Factors Influencing the Supply and Quantity of Water in the Great Lakes-St. Lawrence River System

Natural Factors

- ⇨ earlier than normal spring runoffs in recent years
- ⇨ lower than normal levels of precipitation
- ⇨ increased evaporation rates due to increased spring and summer temperatures (global warming)

Human Factors

- ⇨ direct industrial and domestic use of water from the system
- ⇨ water regulation for hydroelectric power generation
- ⇨ water regulation to support commercial shipping/navigational interests

International Joint Commission (IJC) Approved Management Plan 1958-D

- a six-member group representative for shore property owners, fish and wildlife, navigational and hydropower interests
- responsible for making decisions related to boundary and transboundary waters shared by United States and Canada
- **emergency provision**

  provides for relief to shoreline owners both up and downstream at times when water supply is higher than normal

  provides relief to navigation and power interests when water supply is lower than normal

St. Lawrence River Control Board (SLRCB)

- a ten-member group made up of representatives of Corps of Engineers, Transport Canada, Environment Canada and five other state, provincial and local agencies
- the operating board in the regulation of Lake Ontario outflows
- ensures compliance with the provisions of the Orders of the **IJC**

The Moses-Saunders Dam controls water levels to provide optimum hydroelectric power generation and safe navigational passage of commercial shipping vessels. The dam at Iroquois can be used in an emergency to control the outflow from Lake Ontario. 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 Dam acts as a spillway and is an emergency control dam capable of controlling the entire flow of the river.

From a socio-economic standpoint the river supports an ever-growing industrial, residential, agricultural, recreational, hydroelectric power and transportation demand. As an aquatic environment the St. Lawrence River provides a range of habitats that support a diversity of plant and animal life.

Physical Description - International Portion

The international portion of river can be divided into three distinct sections.

The **Thousand Islands** section lies in the most upstream portion of the international section. This section is a complex series 1768 islands, numerous shoals and channels with moderate water currents. Aquatic habitats are diverse, varying from large shallow bays dominated by emergent vegetation and slow moving water, to channel areas deeper than 60 metres (197 feet) with strong currents.

The **Middle Corridor** section starts at the Amateur Islands, just upstream from Jones Creek (Ontario) and Crossover Island (New York) and extends to the Iroquois dam. This section is more reflective of a river channel that gets no wider than 2 km. It has few islands, limited shallow water areas and several areas of fast current. Water flow in this section was once rapid, dropping 4.6 m (15 ft) over the last 24 km (15 miles). The Iroquois dam has since reduced this drop to 0.3 m (1 ft). Water depths through the main channel average 20 to 25 m (65.6 to 82 ft).

The river widens downstream of the Iroquois Dam forming Lake **St. Lawrence**. It is a 6,150 ha (15,196 ac), 52 km (32 mile) long impoundment reservoir created by the construction of the Moses Saunders Power Dam. Unlike the Thousand Islands and Middle Corridor sections, water drawdowns of 2.0 m (6.6 ft) can occur at any time of the year and influence the availability or suitability of nearshore spawning and nursery habitats significantly. Average depth is about 8 m (26.2 ft) with a maximum depth of 30 m (98.4 ft). Lake St. Lawrence has a strong water flow and contains a variety islands and shoals, many created by flooding during the construction of the St. Lawrence Seaway and Hydroelectric Project.

Changes to Fish Habitat

Dredging and impoundment of water associated with the Seaway and Hydroelectric project greatly changed the character of the river and associated habitats. Prior to the construction of the Seaway, most of the river looked very much like the area of the Thousand Islands. The middle and lower sections down to Cornwall had numerous islands and shoals. The lower portion of the international section of the river also had many rapids. These changes have greatly altered fish habitat and changed the fish community. It is difficult to assess the significance of habitat changes on the fish community because of a lack of pre- and post-impoundment information. Efforts to improve fish habitat and manage fisheries have to consider the current altered and controlled state of the river.

Physical Alterations

Stable nearshore habitats, where fish spawn and where young fish spend most of the first year of their lives growing, are essential for warm-water fish communities like those in the St. Lawrence River. These areas are highly vegetated, productive water-covered areas that provide shelter, food and protection from predators. Dramatic alterations to the St. Lawrence River's nearshore habitats have occurred since early settlement of this area.

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 deepened to accept vessels with a 4.3 m (14 ft) draft. Maintenance dredging occurred throughout the first half of the 20th century. Channel depths now provide for an 8.2 m (27 ft) draft.

Construction of the Seaway began in 1954 and was completed in 1962. The Moses-Saunders Dam at Cornwall-Massena, a double-lock system, Long Sault Control Dam, Iroquois Control Dam and associated locks all were completed by 1959. Dredging of the channel between Cornwall and west of Brockville was completed between 1961 and 1962.

Underwater structures that created diversity in flow and spawning habitat for fish like walleye were either removed or significantly altered. The Seaway resulted in the flooding of three major rapids in the Lake St. Lawrence section. Extensive dredging

activities occurred in the stretch below Iroquois and in the lower part of the Middle Corridor. All these activities provided navigational access but slowed the water current speed to less than 0.68 m/s (2.2 ft/sec).

After impoundment there was nearly a 20% increase in nearshore aquatic habitat of Lake St. Lawrence. However, 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.

Incremental losses of 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 replaced with concrete or rock retaining walls or rip rap. Dock structures may occupy the riverbed and aquatic vegetation often is removed.

Water levels and consequently fish habitat were altered significantly after construction of the Hydropower and Seaway projects. While no real change is experienced at the Lake Ontario outlet, water levels at Iroquois are now 3.7 m (12 ft) higher than before construction. Post-construction water levels at Cornwall show the greatest change, being anywhere from 21.6 m (70.9 ft) to 24.7 m (81.0 ft) higher than before the Moses-Saunders Power Dam was constructed.

Prior to the Seaway, annual water level fluctuations were about 2 m (6 ft). Since Seaway construction, fluctuations have been reduced to 1.2 m (4 ft).

Impacts of habitat change on fish

Northern Pike

In Lake St. Lawrence, initially northern pike abundance showed a major response to development of the Seaway. The early 1960s showed a substantial increase in the population because the flooding of land created new spawning and nursery areas. As the drawdown effect became more obvious, this new habitat quickly changed to mudflats. By the late 1960s and into the 1970s, loss of nearshore vegetation and tributary spawning areas resulted in a decline in pike abundance. Over the years, new weed beds have become established below the drawdown zone and northern pike populations in Lake St. Lawrence have stabilized and increased slightly.

Projects to create or enhance spawning habitat for a variety of fish species have been done in the last decade. Channels mechanically cut into large cattail beds and nearshore flooding projects to create suitable spawning areas for northern pike in the spring are just two such project types. Cost-benefits and success of these types of projects is not yet known due to a lack of long-term assessments.

Walleye

Walleye have taken close to 30 years to begin to recover from the effects of Seaway construction. Major spawning areas were eliminated when rapids in Lake St. Lawrence were flooded. It was not until a spawning run was established in Hoople Creek (Ontario) that walleye began to show a recovery. Improvements in water quality, habitat rehabilitative efforts (Ontario) and walleye culture and stocking programs (New York) may be contributing to this trend.

Muskellunge

Overfishing may have been the cause for the initial decline of muskellunge in the middle 1950s. However, their numbers have remained low since that time and loss of spawning and nursery habitats may be a contributing factor.

Lake Sturgeon

Water quality degradation, losses of spawning habitat and overfishing are contributing factors to Lake Sturgeon decline throughout the river. Older dams that blocked passage to spawning areas on major tributaries of the river may have contributed to the early decline of sturgeon. Spawning habitat enhancement efforts in the Grasse River (New York)

appear to be beneficial. Successful sturgeon spawning has been recently documented.

American eels

American eel numbers have shown a dramatic decline in recent years. The cause for this decline is still very much unknown, although blockage of migratory routes by dams, chemical contamination, changes in global conditions and habitat loss all may be contributing factors.

Water Quality and Nutrients

The *Great Lakes Water Quality Agreement* adopted five general objectives to ensure the waters of the Great Lakes system are: 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 colour, odour 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; and, 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, nitrogen) are introduced into the system. 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 available oxygen for other aquatic life. Water clarity is also reduced. Conditions that promote algae growth can also stimulate growths of submergent and emergent plants.

Excessive amounts of aquatic plants and algae were evident in the St. Lawrence River during the 1970s. Underwater plants broken off by propellers of recreational and commercial vessels washed up onto shores or floated on the surface. The natural decaying process of these plants perpetuated the nutrient loading problem.

Better sewage 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 show a decrease in phosphorus concentrations over the past 20 years (Figure 1).

Reductions in nutrients not only reduce the incidence of blooms of nuisance algae but it also results in the reduction in beneficial microscopic plants and animals, called phytoplankton and zooplankton. The young of many fish species rely on phytoplankton and zooplankton to survive and grow. Large fish, in-turn, rely on small fish for their growth and survival. Declines in nutrients, reduces results in a reduction in the quantity of fish the river can produce and sustain.

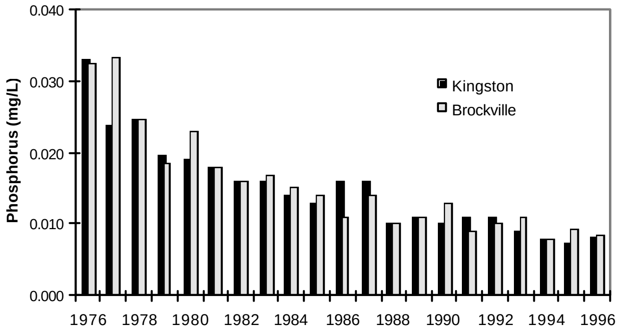


Figure 1. 1976- 1996 concentrations of phosphorus from monitoring stations located at Kingston and Brockville, Ontario. (Data provided by Ontario Ministry of Environment and Energy)

Zebra mussel have also changed conditions in river and impacted the fish community. Water clarity began increasing due to mussel invasion in the upstream waters of Lake Erie and Lake Ontario in the 1990s. Colonization of the river directly by mussels from 1992-1994 was associated with very noticeable increases in water clarity

Water clarity improves light penetration, permitting vegetative growth in deeper waters. However, lower nutrient levels in the water limit overall vegetative growth. Invertebrate production, an important food source to young and some adult fish species, is highly dependent on abundance of vegetative growth. Most fish species have a strong association with aquatic plants at some time in their life.

Abundance of young-of-the-year fish is often higher in vegetated than in non-vegetated habitats.

Zebra mussels feed on phytoplankton and zooplankton, an important food source for young fish, and this may further reduce the production of fish in the river.

Reductions in nutrients, the invasion of zebra mussels and reduced aquatic vegetative growth could effectively reduce fish numbers, growth rates and cause major shifts in fish and aquatic invertebrate community structure.

The table on the following pages summarizes some of the major disturbances that have occurred or continue to occur in the St. Lawrence River, the potential effects they may have on fish and what efforts have been made to help minimize these effects.

Public inquiries should be directed to the following offices:
NYSDEC (315) 785-2262
OMNR (613) 476-3255

Fisheries assessment information presented in this paper was provided by the Lake Ontario Fisheries Management Unit, Ontario Ministry of Natural Resources, R. R. 4 Picton, Ontario K0K 2T0 and Region 6 Fisheries Unit, New York State Department of Environmental Conservation, 317 Washington Street, Watertown, New York 13601. Additional information was obtained by a review of scientific literature and reports from other sources.

This discussion paper was based on an original paper written and designed by ***RE Grant & Associates*** • 1525 Lyn Road • RR 3 Brockville, Ontario • K6V 5T3 • Phone: (613) 342-5917 • Fax: (613) 342-8928 • Email: rgrant@recorder.ca

Original artwork provided by Ruth Grant

St. Lawrence River alterations and how they affect fish habitat and fish

Alteration	Location	Subsequent Changes	Potential Fish Affected	Existing and Potential Restorative Efforts
Dam Construction - three major dams - numerous tributary dams	• traditionally on river sections with significant elevation drops • usually sites with groundwater upwellings	• destruction of spawning and forage habitats • alters water temperature regime from cold water to cool to warm water • leads to changes in fish community structure (upstream tends to favour warm water species) • blocks traditional fish passage, migration routes • changes in water levels and velocities	• all species, but primarily walleye, lake sturgeon, American eel	• an eel ladder designed to pass American eels is constructed at Moses-Saunders Dam
Dredging and Filling	• throughout • both nearshore (ongoing) and deep water (during Seaway construction) • present day loss primarily due to residential, recreational, commercial and industrial activities	• loss of wetland and nearshore water habitats (potential spawning, nursery and feeding habitats) • potential for reintroduxction of contaminants and toxins in water column • loss or alteration of invertebrates that provide food for fish	all species of all life stages	• existing fish habitat protection laws in Ontario (Canada Fisheries Act) and in New York (New York State Department of State's Significant Coastal Fish and Wildlife Habitat designation; NYSDEC wetland protection legislation) • existing State and Provincial shoreland and in-water work permit application reviews take fish habitat into account • improved mitigation and remedial methods to minimize effects
Shoreline Modifications	• throughout • historical and present day losses due to land development, deforestation, agricultural, residential and industrial shoreline encroachments • present day losses due to erosion, aggressive shoreline protection measures/stabilization	• erosion and subsequent suspended materials increase turbidity of nearshore areas • replacement of soft, vegetated shorelines by hard materials (rock) • hard shorelines limit landward migration of wetlands and plant diversity	• suspended materials particularly harmful to eggs, fry, young-of- the-year and juvenile fish	• potential to retain existing shore to water interfaces • existing shoreland protection laws
Water Regulation - fluctuating water levels and velocities - water extraction for industrial and residential use	• entire river system with greatest effects directly upstream and downstream of dam structures • includes all three sections of the river	• overall increase in mean water levels and limited annual water level fluctuations • creates unstable and unproductive habitats • reduction in productive wetland area	• northern pike, yellow perch, muskellunge, smallmouth bass, forage and panfish species • particularly egg, fry, young-of-the-year and juvenile fish; can also affect adult feeding	• return annual water level fluctuations to a more natural state • enhance or recreate spawning and nursery habitats for affected fish species

Alteration	Location	Subsequent Changes	Potential Fish Affected	Existing and Potential Restorative Efforts
Passage of Large Vessels	• throughout • particularly in Thousand Islands and Middle Corridor sections • particularly damaging during periods of solid ice cover	• sudden disruption of normal water level and flow conditions (drawdown and potential dewatering of shoreline habitats) • fragmentation of underwater plants • erosion of sand, clay and silt materials causing uprooting of underwater and above water plants • shoreline erosion	• most fish species; all life stages due to loss or destruction of weed beds and associated invertebrates used by fish for food	• present restriction of winter shipping • reduced speed limits in selected areas with high shoreline erosion potential
Pollution - discharges and spills - stormwater drainage - sewage treatment or industrial plants - agricultural runoff	throughout	• decrease water clarity in localized areas (eg. tributary mouths) • limit growth of aquatic plants • aids in heavy metal and chemical transport	• all fish species and life stages • long-term suspended materials can affect efficiency of sight-feeding species such as northern pike, muskellunge, smallmouth and largemouth bass • can also be damaging to eggs, fry young-of-the-year and juvenile fish • potential for increased contaminants in fish	• *Water Quality Agreement* objectives to reduce amount of incoming pollutants and restore affected areas • banning or restricting use of man-made chemicals (PCBs, mirex, DDT, toxophene, chlordane) and naturally occurring chemicals (mercury, cadmium) continues to show positive results in the fish consumption health advisories issued by New York State Department of Health and Ontario Ministry of Environment
Species Introductions (Exotics) - intentional - unintentional	• throughout the Great Lakes - St. Lawrence River region	• may lead to loss of species diversity • alteration of native fish community structure and composition • unsuitable environmental or habitat changes • includes plants (e.g. Eurasian milfoil); fish (e.g. round goby); molluscs (e.g. zebra mussels)	• potential to affect fish of all life stages e.g. • Eurasian milfoil - develops massive beds; decreases plant diversity; reduces fish and invertebrate populations • round goby - can displace, native fish, eat the eggs and young and take over optimal fish habitat • zebra mussels - increase water clarity which may affect fish behaviour; out-competes larval fish and young-of-the-year for food; increases food supply for bottom- feeding fish	• eliminate ballast water exchange • improved communications and education about the consequences of non-native species introductions and how they can be prevented • enforceable guidelines to prevent new introductions