CHAPTER 2 BACKGROUND

2.1 Summary

This chapter presents background information on the climate and physical characteristics of the Lake Ontario basin including lake processes and aquatic communities. It goes on to discuss the demography and economy of the basin. It then describes the history of the Lake Ontario LaMP, including its beginnings under the Lake Ontario Toxics Management Plan (LOTMP). The chapter lists the goals of the LOTMP which were adopted as the goals of the LaMP and records the objectives that were developed to achieve the goals. The LaMP *Structure and Processes* section describes the management structure of the LaMP and goes on to present the scope of activities and the methods the agencies intend to use to address the objectives as described. The Background chapter concludes with an outline of the reporting process that the LaMP has taken on over the past number of years.

2.2 Introduction to Lake Ontario

Lake Ontario is last in the chain of Great Lakes that straddle the Canada/United States border. Its shoreline is bordered by the Province of Ontario on the Canadian side and New York State on the US side (see Figure 2.1). Lake Ontario is the smallest of the Great Lakes, with a surface area of 18,960 km^2 (7,340 square miles), but it has the highest ratio of watershed area to lake surface area. It is relatively deep, with an average depth of 86 meters (283 feet) and a maximum depth of 244 meters (802 feet), second only to Lake Superior. Approximately 80 per cent of the water flowing into Lake Ontario comes from Lake Erie through the Niagara River (USEPA et al., 1987). The remaining flow comes from Lake Ontario basin tributaries (14 per cent) and precipitation (7 per cent). About 93 per cent of the water in Lake Ontario flows out to the St. Lawrence River; the remaining 7 per cent leaves through evaporation. Since Lake Ontario is the downstream Great Lake, it is impacted by human activities occurring throughout the Lake Superior, Michigan, Huron, and Erie basins.

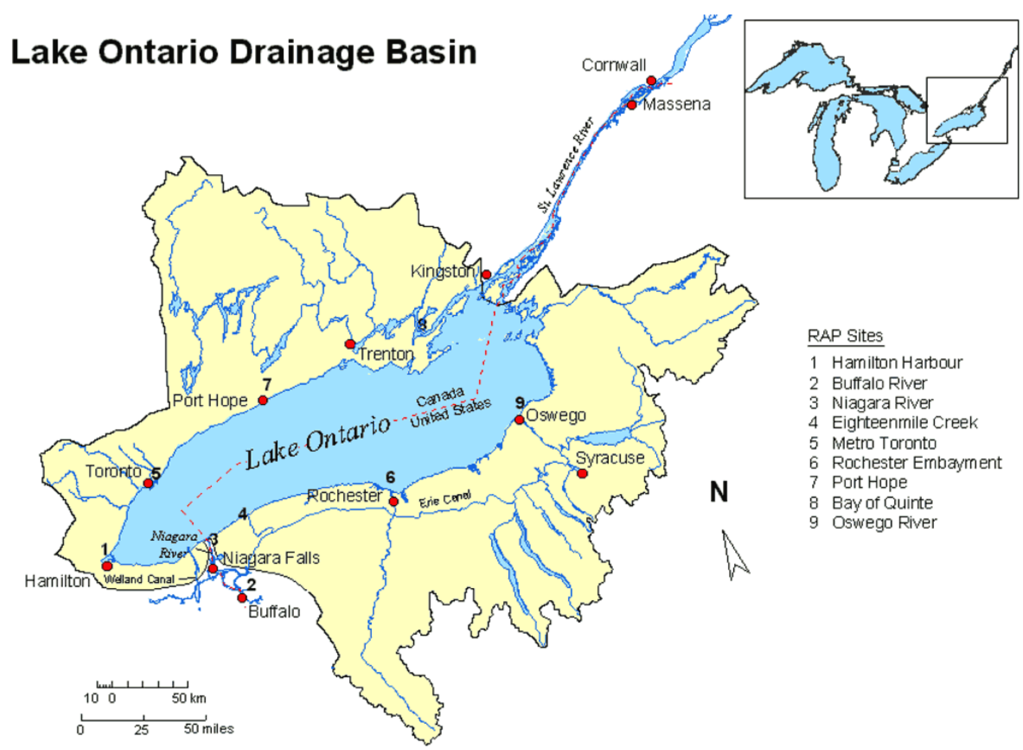

Figure 2.1 Lake Ontario Drainage Basin

2.2.1 Climate

The climate of the entire Great Lakes basin is characterized as humid and temperate (USEPA et al., 1987). The position and size of each lake, together with the effects of outside air masses, further influence climate. Each lake acts as a heat sink, absorbing heat when the air is warm and releasing it when the air is cold. This results in more moderate temperatures at nearshore areas than other locations at the same latitude. The influence of external air masses varies seasonally. In the summer, the Lake Ontario basin is influenced mainly by warm humid air from the Gulf of Mexico, whereas in winter the weather is influenced more by Arctic and Pacific air masses.

2.2.2 Physical Characteristics and Lake Processes

There are two major sedimentary basins within Lake Ontario: 1) the Kingston Basin, which is a shallow basin located northeast of Duck-Galloo Island; and 2) a deeper main basin that covers the rest of the lake (see Figure 2.2). Within the main basin there are three deep sub-basins: the Rochester, Mississauga, and Niagara Basins. These basins are bordered by a shallow inshore zone that extends along the perimeter of the main basin.

Lake Ontario has a seasonally dependent pattern of both horizontal and vertical thermal stratification. In the spring, nearshore water warms more quickly than the deep offshore waters. The density of water varies with temperature, resulting in little mixing between these waters. The lake becomes stratified horizontally between the nearshore and the offshore zones (except in the Kingston Basin which is shallow throughout). This thermal stratification lasts until around the middle of June when offshore waters warm and mixing occurs between offshore and nearshore waters. For the rest of the summer, there is vertical stratification between the warm surface waters (epilimnion) and cool deeper waters (hypolimnion). The depth of the thermocline varies between sub-basins. Summer water temperatures are generally warmer in the southeast end of the lake and cooler in the northwest end. Mixing of the waters in the epilimnion and the hypolimnion begins during September, when the surface waters have cooled, and continues until isothermal conditions occur. During the winter months, inshore areas freeze (including Kingston Basin) but deep waters remain open.

The prevailing west-southwest winds combined with the eastward flow of water from the Niagara River are the most important influences on lake circulation resulting in a counter-clockwise motion (Sly, 1991). Circulation of water generally occurs along the eastern shore and within sub-basins of the main lake. There is very little net flow along the north inshore zone. Lake Ontario's resultant circulation consists of a dominant counter clockwise gyre in the main basin of the lake that connects or causes a smaller clockwise gyre in the northwest portion of the lake (Schertzer, 2003).

Circulation patterns, sedimentation rates, and thermal stratification influence the effects of human activities on the lake. Although water retention time in the lake is estimated to be about seven years, based on inflow and outflow rates it may take much longer for substances such as toxic chemicals to leave the lake (Sly, 1991). Contaminants may bind to sediments on the lake floor, be covered over, and remain indefinitely. Alternatively, contaminants may be resuspended to the water column or ingested by benthic organisms and be introduced to the food chain. In the summer when the lake is stratified, only water from the epilimnion flows out into the St. Lawrence River, but during the winter months when the water is thoroughly mixed, water from the deeper parts of the lake reaches the St. Lawrence.

The trophic status of the lake has been influenced by human activities. Prior to European settlement, Lake Ontario was oligotrophic. In the 1960s and 1970s, excess nutrients in the form of phosphorus (from household detergents, for example) caused excess algal growth. The trophic status of the main basin changed from oligotrophic to mesotrophic, and many nearshore areas became eutrophic. Phosphorus controls were implemented in the 1970s and have been successful in reducing the amount of nutrients entering the lake. Phosphorus levels, which were over 20 µg/L in the 1970s, have dropped to less than 10 µg/L since 1986 (Neilson et al., 1994) indicating that the lake is returning to its original oligotrophic condition.

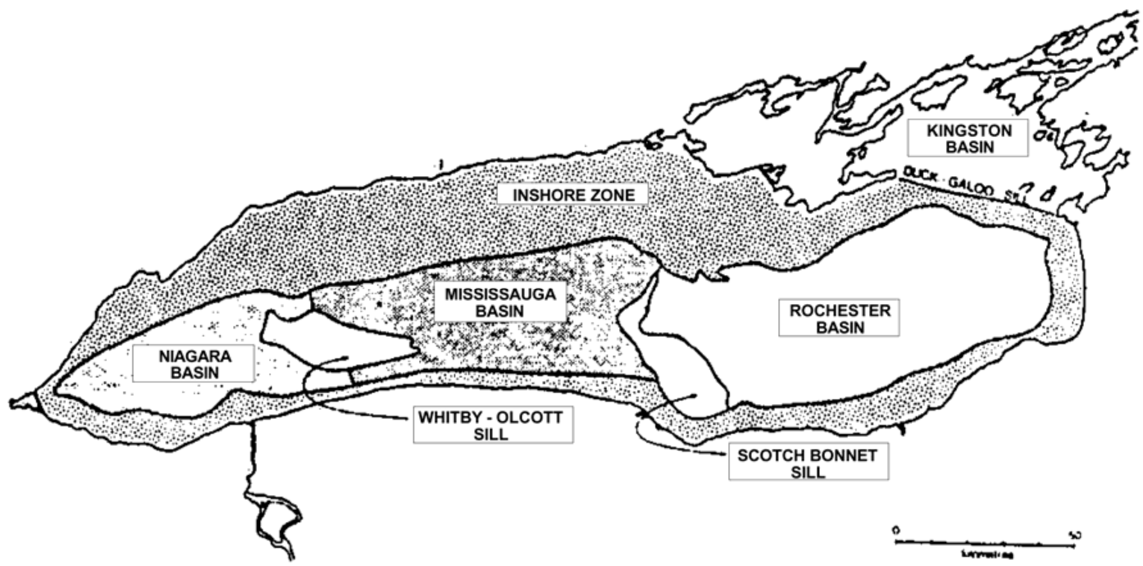

Figure 2.2 Sedimentation Basins in Lake Ontario (Thomas, 1983)

2.2.3 Aquatic Communities

The aquatic communities of Lake Ontario are dynamic and under continuous stress from environmental drivers and human activity. Anthropogenic stress increased rapidly following the colonization of Ontario by non-aboriginal peoples and subsequent industrialization (Christie, 1972, 1973; Smith, 1972). In the last 200 years the biodiversity of the lake changed from one dominated by native cold and warm water species to one with many non-native species and fewer native species. This rate of change increased with time. The introduction of non-native species is not the only driver causing change because climate, habitat modification, and direct exploitation are other factors to consider. A major anthropogenic driver of ecosystem change was eutrophication followed by oligotrophication as a result of the implementation of phosphorus control under the Great Lakes Water Quality Agreement (GLQWA 1972). The following is a brief history of how the aquatic community became what it is today.

As was discussed in the previous section, Lake Ontario's offshore main and Kingston basins were oligotrophic prior to the early 1900s (Ryder, 1972). The near shore, places like the Bay of Quinte, Frenchman's Bay, and Chaumont Bay were more likely mesotrophic. One can directly relate the oligo (meaning few) and meso (meaning moderate) prefix to the biodiversity in the lake too. Towards the end of the 19th century, Lake Ontario had a different and arguably less complex offshore food web than it does now (Christie, 1973; Mills et al, 2004). Invertebrate biodiversity offshore was composed only of native species including a variety of mollusks such as freshwater clam and fingernail clam (*Sphaerium* spp.) as well as several snail species (Mills et al, 2004). Amphipods like *Diporeia hoyi* and crustaceans like *Mysis relicta* were the most abundant invertebrates in the offshore. Fish species included Atlantic salmon (*Salmo salar*) as the top pelagic predator, a host of cisco (*Coregonus* spp.) species throughout the offshore water column and lake trout (*Salvelinus namaycush*), burbot (*Lota lota*) and sculpins (deepwater, *Myoxocephalus thompsoni* and slimy, *Cottus cognatus*) at the bottom of the lake (Christie, 1973).

Atlantic salmon were extirpated by the late 1800s, lake trout and blue pickerel (*Stizostedion vitreum glaucum*) were extirpated by the 1960s, deep water sculpin and all ciscoes except one shallow water form of lake herring found in eastern Lake Ontario were also virtually, if not completely, extirpated from Lake Ontario. In the first half of the 20th century, alewife (*Alosa pseudoharengus*), rainbow smelt (*Osmerus mordax*) and white perch (*Morones americana*) were introduced or invaded Lake Ontario. Due to the extirpation of native species, and eutrophication of the nearshore, these three species increased in numbers dramatically. The cumulative effects of these non-native species, severe habitat degradation, and continued exploitation were permanent changes to the near and offshore food webs.

The restoration of native species to provide fishing opportunities began very early in Lake Ontario with attempts to culture and stock Atlantic salmon but these failed for a variety of reasons. The lack of offshore predators allowed alewife to become very abundant during the mid-1900s and huge die offs were causing a real pollution concern along Lake Ontario's shoreline. During this build up of alewife, rainbow smelt, became very abundant as well. During the late 1960s and early 1970s, lake trout became a focus for restoration on Lake Ontario but any restoration efforts were hampered because of both increased mortality of their young of the year and competition for food between young lake trout and alewife and smelt (Jones et al., 1995; Mills et al. 2004). Both smelt and alewife needed to be reduced before any restoration effort would work. As a result, both New York and Ontario explored a wide variety of species and strains of non-native salmonids as potential alewife control options.

In conjunction with stocking of non-native species came the implementation of the very effective sea lamprey (*Petromyzon marinus*) control program. This predator of many cold water fish species has a preference for lake trout and induced heavy mortality on them. In the late 1950s, both Canada and the United States of America signed the Convention of Great Lakes Fisheries and the Great Lakes Fishery Commission was established (Stewart et al, 1999). Lake Ontario's sea lamprey population was significantly reduced in size during the early 1980s. Shortly thereafter, the stocked non-native and native salmonids really started to show increases in the number of fish surviving to adults.

As was described earlier in this status report, the Great Lakes Water Quality agreement (1972) resulted in significant reductions in phosphorus loadings in all of the Great Lakes. There were rapid and substantial impacts in the Lake Ontario near and off shore ecosystem as the lake became more oligotrophic (Mills et al, 2004). For example, many native species of fish that used the near shore for spawning and early life had been negatively impacted by the eutrophication occurring there. Shortly after phosphorus abatement was instituted, many of these species, particularly walleye (*Zander vitreus*) and lake whitefish (*Coregonus clupeaformis*) rebounded.

Meanwhile in the offshore, almost all stocked salmonids showed substantial increases in survival and also increases in wild reproduction were observed particularly for rainbow trout (*Onchorhynchus mykiss*), Coho salmon (*Onchorhynchus kisutch*)and lake trout. A premier sport fishery developed and is now a primary driver for continuing stocking of non-native species of salmon and trout. During this period contaminant levels in fish tissue declined (reference). By the late 1980s, Lake Ontario was showing signs of improvement not only of native species but also of ecosystem function even though the food webs had become, inarguably, much more complex with respect to the variety of top predators and other non-native species (see Chapter 4).

Unfortunately, these improvements were short lived. In the early 1990s, a Ponto-Caspian species called the zebra mussel (*Dreissena polymorpha*) was introduced into Lake Ontario probably from both natural flow of water and also from inter-lake shipping having first been introduced to Detroit River/Lake St. Clair. This benthic organism had immediate impacts on benthic habitat and physical qualities of water. As well, it was predicted that this mussel would create severe changes in biodiversity and it did. Many native mollusks and the amphipod, *Diporeia hoyi* showed significant declines since 1972 (Lozano and Nalepa, 2004). *Diporeia* was extirpated from areas less than 100 m deep by 1997 (Lozano et al, 2001; Mills et al., 2004). While zebra mussels were colonizing the lakes near shore, quagga mussels (*D. bugensis*) were also introduced and began out-competing zebra mussels and colonizing far into the offshore causing further benthic habitat change and perhaps, further shrinking of the distribution of *Diporeia hoyi*.

The loss of Diporeia hoyi from a large area of the offshore meant a loss of a critical component of the offshore food web. This amphipod is rich in fat and was the primary component of the diet of lake whitefish and probably lake herring (*Coregonus artedii*), and an important component of the diet of young lake trout, slimy sculpin, deep water sculpin, alewife and smelt. Concurrent with the rapid decline of this amphipod came the precipitous decline in lake whitefish reproductive success (6 out of the last 7 years), poor wild reproduction among lake trout and a decline in both alewife and rainbow smelt. The alewife was also subject to heavy predation because it is an important diet component of all salmonids and walleye as well as double crested cormorants (*Phalacrocorax auritus*). The double crested cormorant benefited greatly from the reductions in contaminants and later improvements in water clarity and is now an important fish predator in much of the near shore of Lake Ontario (Johnson, 2002).

Today, *Diporeia hoyi* is found only at the deepest survey sites in Lake Ontario main basin (Dermott 2001). Many benthic communities are now dominated by zebra and quagga mussels (reference see Project Quinte). In some nearshore areas, particularly those near urban development, oligochaete worms dominate, reflecting the eutrophic status of these areas. Zooplankton communities are dominated by cladocerans (water fleas) and cyclopoid copepods. Diatoms and green algae are the most common types of phytoplankton. *Mysis relicta*, the opossum shrimp, is a very important part of the pelagic offshore food web. The exotic cladoceran, *Cercopagis pengoi* (the fish hook water flea), has become a persistent and important component of the summer zooplankton community. *Bythotrephes longiminus*, (spiny water flea) was introduced into Lake Ontario several years ago (Johannsson, 2003) and is showing a resurgence of late.

The prey fishes are dominated by non-native species particularly alewife which is the central vertebrate prey item in the offshore food web of all of Lake Ontario (Mills et al, 2004; OMNR, 2005) . Alewife status is difficult to assess as the older alewife in the lake are in very good body condition (they are fat for their length) but there are virtually no younger alewife being captured. Smelt and slimy sculpin are doing poorly. The offshore has some surprising peculiarities being observed as threespine stickleback (*Gasterosteus aculeatus*), a nearshore spawning fish and usually lifelong inhabitant is being found throughout the offshore. In 2005, several deep water sculpin were found.

If one considers the recreational fishery catch on Lake Ontario to be an index of relative abundance, then its most abundant top predators, in descending order are Chinook salmon (*Oncorhynchus tshawytscha*), brown (*Salmo trutta*) and rainbow trout, lake trout, Coho salmon, and Atlantic salmon with Chinook representing about 65 per cent of the catch or about five times more fish than either brown or rainbow trout (NYSDEC, 2005; OMNR 2005). One benthic top predator that is not well assessed is the burbot, a native species; its status is uncertain. All of the salmonids are maintained primarily through stocking programs (Crawford, 2001; Mills et al, 2004). However, natural reproduction of these species has been documented in a number of tributary systems and is the focus of some intense research (see Chapter 4, Degradation of Fish Populations BUI).

In the nearshore areas of Lake Ontario, the food web has undergone a shift too. The nearshore was first colonized by zebra mussels and then replaced by quagga mussels. The amphipod *Gammarus fasciatus* became more abundant as a result but the non-native amphipod *Echinogammarus ischnus* creates some uncertainty (Mills et al. 2004). Non-native fish species like white perch, alewife and smelt are less abundant in the nearshore allowing for better survival of some native species (Mills et al, 2004). But, the reduction of abundance of alewife and smelt further supports the offshore observations of reduced production of alewife and rainbow smelt. The increase in abundance of cormorants has further increased demands on the prey base (Mills et al, 2004).

Fishes like the largemouth bass (*Micropterus salmoides*), sunfishes (*Lepomis* sp.), yellow perch (*Perca flavescens*), common carp (*Cyprinus carpio*), catfishes (*Ameiuruss* spp.) and the newest non-native species the round goby (*Neogobius melanostomus*) have shown marked increases in abundance, particularly since the establishment of Dreissenid mussels. But some native species like walleye, smallmouth bass and rock bass have not adapted well to the rapid changes in the nearshore. Walleye abundance has declined dramatically but the population remains stable at about half the size it was in the late 80s and early 90s (OMNR, 2005).

The round goby (*Neogobius melanostomus*) is clearly becoming an important diet item of many fish species (Lake Ontario Management Unit, OMNR, RR#4 Picton, ON, unpublished data). Its range extends to the offshore in association with quagga mussels. It is a very territorial fish that is displacing native benthic fishes. Larger gobies feed primarily on *Dreissena* spp. but they are suspected to be voracious egg and larval fish predators, too. The re-direction of energy and contaminants from the benthos by the addition of round goby in the food chain will be of particular interest in the future.

During the 1990s invasion of Lake Ontario by *Dreissena* spp., double crested cormorants showed exponential increases in abundance. Their success was in large part due to the reduction of persistent bioaccumulative chemicals in the lake. Their impact on fish communities is currently being investigated but this top predator has the potential to consume a large biomass of both forage and sport fish. Their negative impacts on other colonial water birds and coastal/riparian habitat are well documented.

Although the nearshore is dynamic and has undergone some rapid perturbations, it still supports many healthy populations of native species. But there are some disturbing trends. The worst would be the trends observed for the American eel (*Anguilla rostrata*). It was once a common species throughout the lake, especially in the Kingston basin and all of the St. Lawrence River where it supported a large commercial fishery. This near shore piscivore was an important component of the food web. Since the early 1990s, this species has shown a rapid and catastrophic decline in abundance in Lake Ontario. There are many factors affecting the survival of eels during their migration into Lake Ontario to live and grow, and then back to the Atlantic Ocean to spawn. The future of the American eel in Lake Ontario is grave. (see also Chapter 10)

Another factor affecting many fish species is contaminants. Many of the contaminants found in the fishes of Lake Ontario bioaccumulate reaching restrictive concentrations in larger older fish and at higher trophic levels. Walleye, channel catfish and common carp all have elevated levels of persistent toxic substances as indicated in fish consumption guides in both New York and Ontario. In Ontario, some restrictions on the commercial sale of fish are in place due to contaminants. While long-term trends in the reduction of persistent contaminants in lake trout are promising, the recent, dramatic increase in polybrominated diphenyl ethers (PBDE's) in lake trout is of concern. See also 2004 SOLEC Indicators report: Indicator #121 - Contaminants in Whole Fish.

Not all chemical compounds causing health problems for fish are man-made. An enzyme called thiaminase is also present in many prey fish such as alewife, rainbow smelt and gizzard shad. It is also found in some invertebrates like *Diporeia hoyi*. Chinook and Coho salmon as well as lake trout and Atlantic salmon eat these prey fishes. For the latter two species this enzyme causes increased mortality of their young soon after hatching, hence the disease is named early mortality syndrome. Recent research has shown this enzyme to cause secondary non-lethal effects including lethargy in salmonids, making young salmonids more vulnerable to predators, and giving them a lack of migratory ability, and reduced growth (Honeyfield et al, 2005; Ketola et al. 2005). Thiaminase induced mortality and secondary effects are a high priority for the Lake Ontario Technical Committee of the Great Lakes Fishery Commission because both are major impedances to the restoration of Atlantic salmon and lake trout.

Lake Ontario has been the recipient of many exotic species and has been subject to several recent and rapid ecological changes due to the invaders. Our awareness of future invaders is heightened and as such it is important to note that a variety of species of Asian carp are set to invade Lake Ontario. Grass carp have been reported in the watershed and bighead carp have been captured in Lake Erie. The impact of these and other large omnivorous fish is uncertain but they have the reproductive capacity to become well established quickly.

As part of their shared responsibility to the Great Lakes Fishery Commission, the NYSDEC and the OMNR review fisheries management direction for the lake every five years. This review involves fisheries professionals and stakeholders. The results of the review are Fish Community Goals and Objectives (FCOs) for Lake Ontario, which should be available for review in early 2007.

2.2.4 Demographics and Economy of the Basin

The present day demographics of Lake Ontario are a result of the historical patterns of settlement which were closely tied to the physical and environmental features of the basin. Native people have lived along the shores of the Great Lakes for over 10,000 years. They fished the waters, grew crops on the land, and used the rivers for transportation. Europeans first settled along the shores of Lake Ontario in the 1700s. Cities and towns sprung up near tributaries because of the abundant water supply and transportation opportunities. The mixed hardwood forests provided a rich resource. Logging became a major activity, both for the valuable timber and to clear the land for agriculture. The Lake Ontario basin has an ideal climate and soil types for agriculture. Some areas, such as the Niagara region, are highly specialized in the growing of fruit and vegetable crops.

Shipping is a major activity on the lake and has led to the growth of manufacturing and population increases in port communities. Major steel mills that rely on shipping were established at Hamilton. In the 1900s, the chemical industry was established near Niagara Falls due to the abundant supply of hydroelectric power generated by the Niagara Falls.

Commercial fishing yields in Lake Ontario were never as high as more productive lakes such as Lake Erie. In the Canadian waters of Lake Ontario the commercial fishery had been worth about $1.5 million (CDN) during the late 1980s. Since then, the fishery has dwindled down to about $250,000 (CDN) as a result of reduced abundance and value of lake whitefish, the removal of American eel from the commercial fishery in 2004 and lower harvests of all other species (OMNR, 2005). The American eel was removed from the commercial fishery in 2004 as part of the Ontario government’s effort to maintain this species in Lake Ontario and ensure its survival worldwide (OMNR, 2005). The US commercial fishery for Lake Ontario was valued at $68,000 (US) in 1995 and in 2004 was about $46,000 (US) (Cluett, 1995; NYSDEC, 2005). The recreational fishery is based primarily on salmon and trout species in the open lake and tributaries, walleye in the eastern lake, and smaller numbers of perch, smallmouth and largemouth bass, and panfish species in embayments. The economic value of recreational fishing to local communities is estimated to range from $100 million to over $200 million per year (USEPA et al., 1987; Kerr and LeTendre, 1991).

The Lake Ontario basin, its major sub-basins, and communities are shown in Figure 2.1. At the present time, over 5.4 million people live on the Canadian side of the basin (Statistics Canada, 1994). The northwestern part of the shoreline is a highly urbanized and industrialized area referred to as the “Golden

Horseshoe." This area extends from Cobourg in the east, around the western end of Lake Ontario to Niagara Falls. The US side of the lake is not as heavily populated, with approximately 2.2 million residents (NYSDED, 1991). There are, however, concentrated areas of urbanization at Rochester, Syracuse, and Oswego, New York.

Land use in the basin and along the shoreline is presented in Tables 2.1 and 2.2, respectively. Forested areas are mainly in the northernmost and southernmost areas of the watershed. Nearer to the lake, forest habitat is highly fragmented.

Table 2.1 Basin Land Use (expressed as percentages of Canadian basin, US basin, and total basin)

	Agriculture	*Residential*	*Forest*	*Other*
Canada	49	6	42	3
U.S.	33	8	53	6
Total	39	7	49	5

Table 2.2 Shoreline Land Use (expressed as percentages of Canadian and US basins)

	Residential	*Recreational*	*Agricultural*	*Commercial*	*Other*
Canada	25	15	30	18	12
U.S.	40	12	33	8	7

Rural and urban land use activities in the watershed influence the environmental health of Lake Ontario. Herbicides, pesticides, and excess nutrients from agricultural runoff are types of non-point source contaminants. Sources of pollution from urban areas include stormwater runoff from paved streets, effluent from sewage treatment plants, and combined sewer overflows (CSOs).

2.3 LaMP Background

In 1987, the governments of Canada and the United States made a commitment, as part of the Great Lakes Water Quality Agreement (GLWQA), to develop a Lakewide Management Plan for each of the five Great Lakes. The purpose of a Lakewide Management Plan (LaMP) is to identify the actions necessary to restore and protect the lake. There are a number of important principles that guide the development of LaMPs. According to the 1987 Agreement, "LaMPs shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in ... open lake waters," including consultation with the public. LaMPs will also provide an important step towards the virtual elimination of persistent toxic substances and the restoration of "physical, chemical, and biological integrity" (IJC, 1987) of the lakes. Through a LaMP, efforts are to be coordinated among governmental agencies to reduce amounts of contaminants entering the lake and address causes of lakewide environmental problems. LaMPs also identify the progress seen to date in the lake as a result of actions already implemented and propose future actions that the agencies can take, individually or jointly, to address identified problems.

For Lake Ontario, one of the challenges of the LaMP is to understand the state of the lake as it exists today and how it may change in the near future and over the long term. Concentrations of toxic substances in water, sediment, fish, and wildlife respond at different rates to changes in loadings and changes in biological or physical conditions. Programs in place today which have already reduced critical pollutant loadings may not have an impact on environmental levels for decades, particularly in fish and wildlife. This time lag must be considered when evaluating data which were often collected several years before being reported on and which reflect loadings which occurred many more years before data collection. Organisms accumulate chemicals or metals that have been in the ecosystem for long periods of time, either in sediment or in organisms which are lower on the food chain. Estimating if current programs will eventually resolve some of these ecosystem issues and over what time frame is an important step in understanding what additional measures are necessary to accelerate the cleanup of Lake Ontario.

The LaMP for Lake Ontario was originally developed by Region 2 of the US Environmental Protection Agency (USEPA), Environment Canada (EC), the New York State Department of Environmental Conservation (NYSDEC), and the Ontario Ministry of the Environment (OMOE) (the Four Parties) in consultation with the public.

In response to an identified toxics problem in the Niagara River and Lake Ontario, a Niagara River Declaration of Intent was signed on February 4, 1987, by the Four Parties. This document included a commitment to develop a Lake Ontario Toxics Management Plan (LOTMP). The main purpose of the LOTMP was to define the toxics problem in Lake Ontario and to develop and implement a plan to eliminate the problem through both individual agency and joint agency actions. The Four Parties developed a draft Toxics Management Plan which was presented for public review in 1988. The completed LOTMP was published in 1989 (LOTMP, 1989). Updates of the LOTMP were completed in 1991 (LOTMP, 1991) and in 1993 (LOTMP, 1993).

Goals of the Lake Ontario Toxics Management Plan:

- Drinking water and fish that are safe for unlimited human consumption
- Natural reproduction, within the ecosystem, of the most sensitive native species, such as bald eagle, osprey, mink, and river otter

To achieve the goals, four objectives were developed:

- Reductions in Toxic Inputs Driven by Existing and Developing Programs
- Further Reductions in Toxic Inputs Driven by Special Efforts in Geographic Areas of Concern
- Further Reductions in Toxic Inputs Driven by Lakewide Analyses of Pollutant Fate
- Zero Discharge

The LOTMP identified 11 priority toxic chemicals in the lake and provided information regarding ongoing load reduction efforts. This program has been the primary binational toxic substances reduction planning effort for Lake Ontario. As such, it serves as a foundation for the development of the Lake Ontario LaMP, which incorporates an ecosystem approach through the assessment of beneficial uses. In May of 1996, the Four Parties signed a Letter of Intent (see Appendix B) agreeing that the LaMP should provide the binational framework for environmental protection efforts in Lake Ontario. The Four Parties have reviewed and incorporated all relevant LOTMP commitments into this plan.

2.4 LaMP Structure and Processes

In 2004 the membership of the LaMP expanded to include Fisheries and Oceans Canada, the United States Fish and Wildlife Service and the Ontario Ministry of Natural Resources. The participation of these agencies will allow better integration of fish and wildlife objectives and indicators into the LaMP.

The agencies have the responsibility for developing the Lake Ontario LaMP and have approved a LaMP management structure that consists of a Coordination Committee, a Management Committee, and a Lake Ontario Workgroup.

The Lake Ontario LaMP focuses on resolving:

- Lakewide beneficial use impairments as defined in the Great Lakes Water Quality Agreement (Annex 2) and described in Chapter 4 of this report;
- Critical pollutants contributing to, or likely to contribute to, these impairments despite past application of regulatory controls, due to their toxicity, persistence in the environment, and/or their ability to accumulate in organisms; and
- Physical and biological problems caused by human activities.

The LaMP addresses sources of lakewide critical pollutants, which are those substances responsible, either singly or in synergistic or additive combination, for beneficial use impairments in the open lake waters of both countries, as well as those substances that exceed criteria and are therefore likely to impair such uses, which require binational actions for resolution. This plan is to be coordinated with Remedial Action Plans within the Lake Ontario drainage basin and other localized efforts which are best suited to address issues of local concern. In addition, this Plan is to utilize linkages to other natural resource management activities, such as the development of Lake Ontario fish community objectives by the Great Lakes Fishery Commission and the Lake Ontario Committee of fisheries managers. The LaMP addresses impairments found in open waters of the lake and nearshore areas, without duplicating the efforts of localized remedial action plans. Tributaries, including the Niagara River, are treated as inputs to the lake. The St. Lawrence River is treated as an output from the lake.

The LaMP will provide an assessment of the physical and biological problems after these objectives and indicators have been completed. Recognizing that the development of ecosystem objectives may require a considerable amount of time, the LaMP has been moving forward with the development of a critical pollutants reduction strategy rather than waiting until all physical and biological problems have been defined.

In addition to the Lake Ontario LaMP, there are a number of other environmental planning efforts upstream and downstream of the Lake Ontario basin. Plans are being implemented for the Niagara River, including Remedial Action Plans in both Canada and the US and a binational Toxics Management Plan. The major sources of pollutants within the downstream St. Lawrence River are being addressed through three ongoing planning efforts: Canadian and US Remedial Action Plans for the St. Lawrence River at Cornwall and Massena, respectively, and a St. Lawrence River Action Plan for the section of the river located in the Province of Quebec.

The LaMP Stage 1 Report, released in 1998, identified the problems existing lakewide in Lake Ontario, and the chemical, physical, and biological causes of these impairments. It also included information on progress made to date, monitoring results, and a three-year binational work plan that identified the activities the LaMP partners would undertake to restore beneficial uses of the Lake. The work plan identified activities to further reduce inputs of critical pollutants to Lake Ontario, reassess beneficial use impairments in open lake waters, manage biological and habitat issues, and develop ecosystem objectives and indicators. The binational work plan has since been revised and updated.

In July 1999, the Great Lakes Binational Executive Committee (BEC), which is the group of senior government representatives to the Great Lakes Water Quality Agreement, adopted a resolution that called for the reporting on all elements of LaMPs every two years. In 2002, the Lake Ontario LaMP presented its first biennial LaMP report. The 2002 LaMP Report provided a summary of actions taken and progress made by the LaMP since the LaMP Stage 1 Report.

The LaMP 2004 report was the first report in binder layout for the Lake Ontario LaMP and it represents the format that will be utilized over the coming years. Every two years the binder will be reviewed and, where appropriate, chapters will be replaced with updated versions. Where there is no new information, the chapter will remain unchanged.

In addition to the binder, a brochure titled *Update* is to be produced, which will inform the public of the progress of the LaMP, as described in the binder.

2.5 References

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