LAKE ONTARIO

LAKEWIDE MANAGEMENT PLAN

STATUS

APRIL 22, 2004

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CHAPTER 1 STATE OF LAKE ONTARIO

1.1 Summary

The State of the Lake chapter is intended to provide up-to-date information on the conditions present in Lake Ontario. It is to be a synopsis of information found throughout the rest of the report, enabling the reader to get a snapshot of the current situation without going through the entire report. As this LaMP 2004 Report is the first edition, not all chapters have been updated from the baseline data which has been assembled using previously published documents. It is therefore premature to prepare a State of the Lake chapter at this time. This chapter will be available in the LaMP 2006 Report.

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 the last of 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 U.S. 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 percent 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%) and precipitation (7%). About 93 percent of the water in Lake Ontario flows out to the St. Lawrence River; the remaining 7 percent 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.

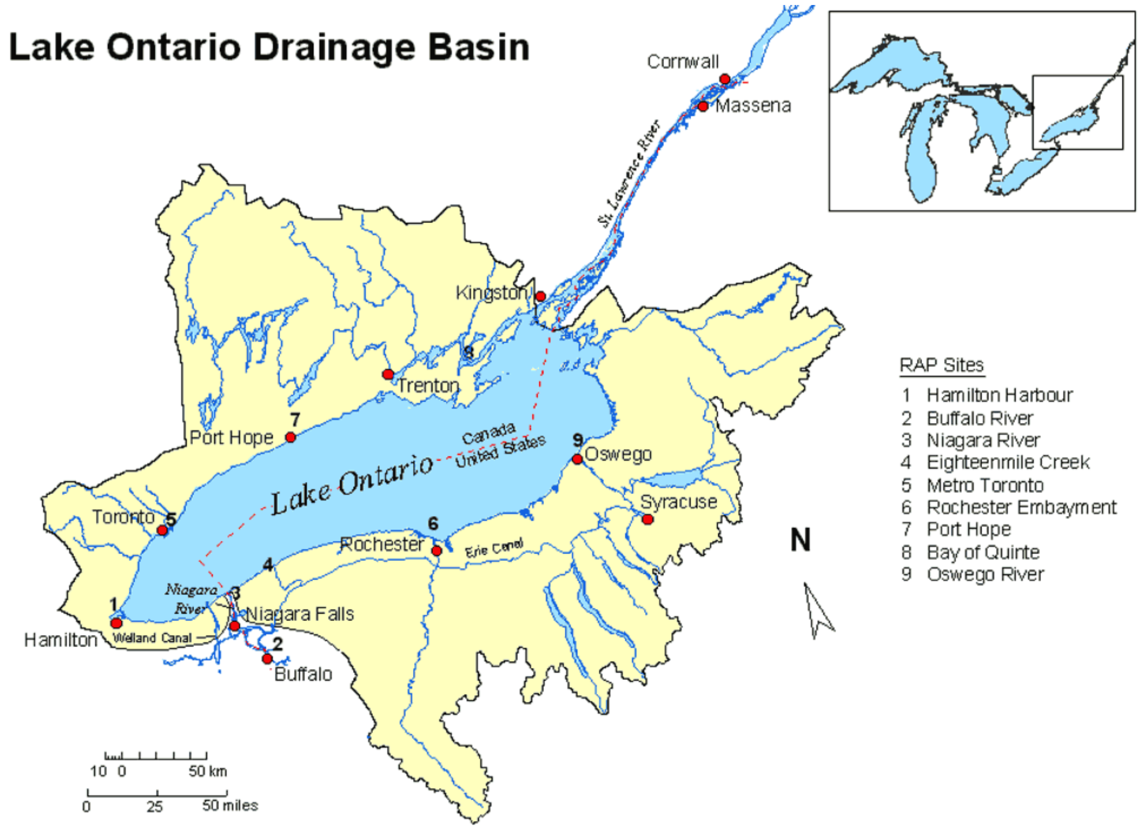

Figure 2.1 Lake Ontario Drainage Basin

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-northwest 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, 1990). 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.

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. MacKay (1989) suggests that, for some persistent toxics, the lake will actually cleanse itself more quickly than reported by Sly.

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 algae 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 ug/L in the 1970s have dropped to less than 10 ug/L since 1986 (Neilson et al., 1994) indicating that the lake is returning to its original oligotrophic condition.

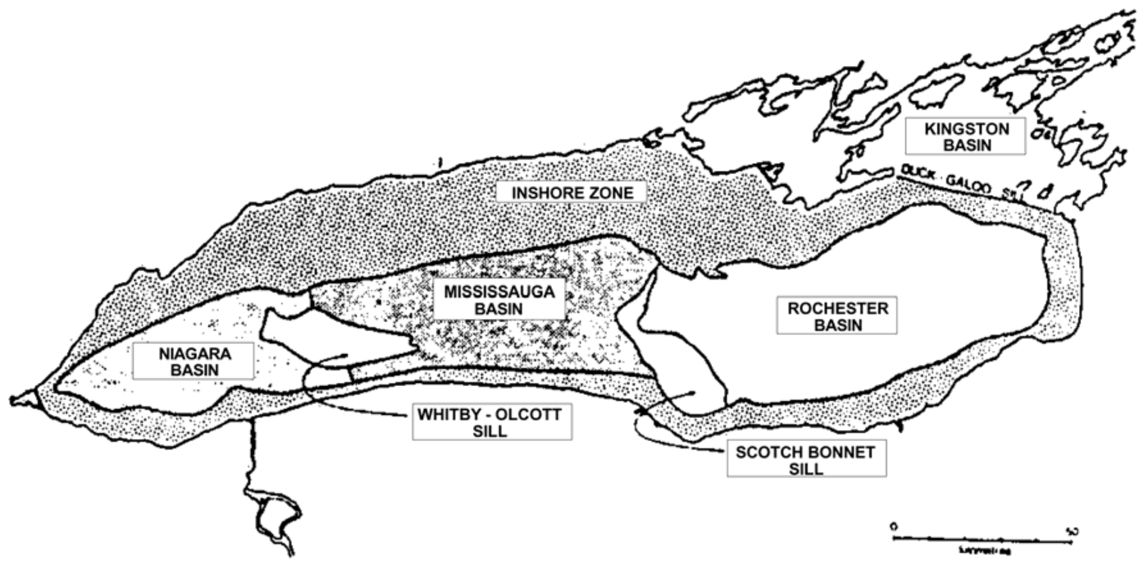

Figure 2.2 Sedimentation Basins in Lake Ontario (Thomas, 1983*)*

2.2.3 Aquatic Communities

The aquatic communities of Lake Ontario are indicative of the trophic status of the lake. Benthic communities in the Kingston and main basins were once dominated by the aquatic crustacean, *Diporeia* sp., a species characteristic of oligotrophic conditions, that is now virtually extirpated from the Kingston basin and at depths less than 80m in the main basins. Benthic communities are now dominated by two exotic species from the Caspian Sea region, zebra and quagga mussels (*Dreissena polymorpha and D. bugensis*). In some near shore areas oligochaete worms dominate this community, 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, a form of freshwater shrimp, is a very important part of the pelagic food web, however, the status of this invertebrate is now uncertain. The exotic cladoceran, *Cercopagis pengoi* (the fish hook water flea), has become a persistent and important component of the summer zooplankton community.

The fish communities of Lake Ontario have changed significantly since the 1700s when Europeans first settled along the shores of Lake Ontario. These changes have resulted primarily from human activities including destruction of habitat, overharvesting, the introduction of exotic species, and increased nutrients. Historically, as an oligotrophic lake, Lake Ontario's top predators were lake trout, Atlantic salmon, and burbot. The main forage species were lake herring, and deepwater ciscoes and sculpins. As early as the 1830s, concerns existed about the decline in Atlantic salmon populations, and this species had disappeared by the late 1800s. Lake trout and burbot populations were almost eliminated in the 1940s. By the 1950s, natural populations of lake trout and deepwater sculpin no longer existed in Lake Ontario. Another top predator inhabiting both the near and offshore, the blue pickerel, also became extinct at this time.

In addition to severe declines in a number of fish populations, other fish community changes have occurred, resulting from the introduction (both accidental and intentional) of exotic species. Over the past 100 years, exotic forage fish such as alewives, rainbow smelt, and white perch became established, filling niches of extirpated, native species. In response, government stocking programs focused on controlling these exotic fish species in the lake and providing viable sport fisheries.

Stocking of lake trout began as early as the 1890s, but it was not until the 1970s that effective sea lamprey control and improvements in water quality that this program provided significant numbers of adult fish. Since the 1960s, agencies around the lake expanded stocking programs for several salmonid species including Atlantic, chinook, coho, and sockeye salmon and also brown and rainbow trout. The chinook and rainbow trout are the keystone species in the stocking programs. The introduction of Pacific salmon was meant as a control of the exotic alewife and subsequently resulted in the development of a significant sport fishery for salmon and trout in Lake Ontario and many of its tributaries.

Presently, chinook and coho salmon, rainbow and brown trout populations are maintained primarily through stocking programs; natural reproduction of these species has been documented in a number of tributary systems. Stocking programs for lake trout are directed at rehabilitation for this native species. Very low levels of natural reproduction by lake trout have been observed in recent years; however, there are still serious problems associated with thiaminase deficiency and predation of fry by exotic species. Adult abundance has declined in recent years, however, and this species would not persist without stocking. An Atlantic salmon restoration program remains in a research mode. Rainbow trout have been very successful in establishing wild populations in a number of tributaries, particularly on the north shore.

In the early 1990s, concerns were raised about the long-term stability and sustainability of the open water fish community. Populations of alewife and smelt had declined due to the lower productivity of the lake and the increased stocking of trout and salmon that feed on these species. The New York State Department of Environmental Conservation (NYSDEC) and the Ontario Ministry of Natural Resources (OMNR) reduced stocking rates in 1994 in recognition of these changing predator-prey relationships in the lake, and subsequently made moderate increases in stocking rates in 1997. Most recently, abundance of rainbow smelt have declined to record-low levels. Trout and salmon stocking rates have remained stable since 1997.

Alewife declines in the 1990's are believed to have been an important factor in the resurgence of native species. Predation and competition by alewife on the juvenile life stages of native species had formerly suppressed their recovery. Alewife numbers have remained low but relatively stable; however, there have been recent signs of poorer condition in the population. Alewife are an important diet item for salmonids and walleye in Lake Ontario.

Over the past two decades, there were dramatic improvements in the status of formerly depleted stocks of two native species. Beginning in the late 1970s, walleye and lake whitefish populations began to recover in eastern Lake Ontario; populations of these species reached historically high levels in the eastern end of the lake during the late 1980s and early 1990s. The rapid changes in the ecosystem occurring concurrently with the colonization of the lake by zebra mussels appear to have driven the lake whitefish to a low population size with virtually no fish less than age 7. In recent years, walleye abundance declined dramatically and is now relatively stable but at much lower levels than in the late 80s early 90s.

The walleye, channel catfish and common carp all have persistent contamination problems as indicated in fish consumption guides and restrictions on the commercial sale of fish. 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. How these contaminants affect the fitness of these species is uncertain.

The American eel was once a common species in the Kingston basin. This near shore piscivore supported a large commercial fishery and was an important component of the food web. Since the early 90s, 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.

As a consequence of zebra and quagga mussel invasion, benthic pathways will become more important in the aquatic food web, favoring benthic and deepwater fish species such as lake trout, burbot, lake sturgeon, and sculpin. The near shore fish communities responded to the invasion of *Dreissena* mussels and the resulting dramatic habitat changes in a variety of ways. For example, sunfishes and largemouth bass have shown dramatic increases in abundance. Some species such as smallmouth bass and rock bass did not show such favorable responses to the change. The increases in water clarity have significantly reduced the amount of habitat for species preferring turbid water such as walleye.

During the invasion of Lake Ontario by *Dreissena* sp., cormorants became well established. 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.

More recently, the goby, an exotic benthic fish also from the Caspian Sea watershed, has become established in many near shore areas of Lake Ontario. This fish will undoubtedly become an important diet item of many fish species. Its range extends to the offshore in association with quagga mussels. Unfortunately, it is a very territorial fish and will displace native benthic fishes. Larger gobies feed primarily on *Dreissena* spp. but they are voracious egg and larval fish eaters, too. The re-direction of energy and contaminants from the benthos through the food chain will be of particular interest in the future.

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 water shed 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 5 years. This review involves fisheries professionals and stakeholders. The results of the review are Fish Community Goals and Objectives (FCO s) for Lake Ontario, which should be available for review in early 2005.

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 Falls.

Commercial fishing yields in Lake Ontario were never as high as more productive lakes such as Lake Erie. Ontario does however support a Canadian commercial fishery for lake whitefish, American eel, yellow perch, and bullheads that was worth $1.5 million (CDN) in 1996 (Hoyles and Harvey, 1997). The U.S. commercial fishery for Lake Ontario was valued at $68,000 (US) in 1995 (Cluett, 1995). 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 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 Coburg in the east, around the western end of Lake Ontario to Niagara Falls. The U.S. 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, Oswego, and Watertown, 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, U.S. 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 U.S. 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.

This LaMP for Lake Ontario has been developed by Region II of the U.S. Environmental Protection Agency (USEPA), Environment Canada (EC), the New York State Department of Environmental Conservation (NYSDEC), and the Ontario Ministry of the Environment (MOE) (the Four Parties) in consultation with the public. It identifies the progress seen to date in the lake as a result of actions already implemented and proposes future actions that the Four Parties can take, individually or jointly, to address identified problems.

One of the challenges of the LaMP is to understand the state of Lake Ontario 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.

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

The Four Parties 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 U.S. 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 U.S. 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.

2.5 Actions and Progress

This LaMP 2004 report is 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 this binder, a Highlights brochure is to be produced, which will inform the public of the progress of the LaMP, as described in the binder.

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CHAPTER 3 ECOSYSTEM GOALS, OBJECTIVES AND INDICATORS

3.1 Summary

This chapter summarizes information from earlier reports on Lake Ontario LaMP ecosystem objectives and indicators describing how these indicators are to be used. Future LaMP reports will provide an assessment of each indicator. Information is also provided on other measures of the status of Lake Ontario's ecosystem collected by a variety of monitoring programs.

3.2 Development of Lake Ontario Ecosystem Goals and Objectives

After several years of work, the LaMP has adopted ecosystem goals, objectives and indicators that will be used to measure progress in restoring and maintaining the health of the Lake Ontario ecosystem. The selected ecosystem indicators reflect lakewide conditions and are sensitive to a number of stressors. For example, healthy populations of bald eagles and lake trout, both top-level native predators, indicate the presence of suitable habitat, healthy populations of prey organisms, and low levels of environmental contaminants. Healthy populations of eagles and trout also reflect our society's commitment to responsible stewardship in protecting habitat, limiting harvests and reducing levels of contaminants in the environment.

3.2.1 Ecosystem Goals for Lake Ontario

Work first began on Lake Ontario ecosystem goals, objectives and indicators as part of the Lake Ontario Toxics Management Plan (LOTMP) in the late 1980s. U.S. and Canadian monitoring experts brought together by LOTMP developed ecosystem goals and objectives for the lake. The LaMP has adopted these goals, which provide a vision for the future of Lake Ontario and the role human society should play:

- The Lake Ontario ecosystem should be maintained and, as necessary, restored or enhanced to support self-reproducing and diverse biological communities.
- The presence of contaminants shall not limit uses of fish, wildlife and waters of the Lake Ontario basin by humans, and shall not cause adverse health effects in plants and animals.
- We, as a society, shall recognize our capacity to cause great changes in the ecosystem and we shall conduct our activities with responsible stewardship for the Lake Ontario basin.

3.2.2 Ecosystem Objectives for Lake Ontario

The LaMP also adopted the LOTMP's five ecosystem objectives that describe the conditions necessary to achieve LaMP ecosystem goals:

- Aquatic Communities: The waters of Lake Ontario shall support diverse and healthy reproducing and self-sustaining communities in dynamic equilibrium, with an emphasis on native species.
- Wildlife: The perpetuation of a healthy, diverse and self-sustaining wildlife community that utilizes the lake habitat and/or food shall be ensured by attaining and sustaining the waters,

coastal wetlands, and upland habitats of the Lake Ontario basin in sufficient quantity and quality.

- Human Health: The waters, plants and animals of Lake Ontario shall be free from contaminants and organisms resulting from human activities at levels that affect human health or aesthetic factors, such as tainting, odour and turbidity.
- Habitat: Lake Ontario offshore and nearshore zones surrounding tributary, wetland and upland habitats shall be of sufficient quality and quantity to support ecosystem objectives for the health, productivity and distribution of plants and animals in and adjacent to Lake Ontario.
- Stewardship: Human activities and decisions shall embrace environmental ethics and a commitment to responsible stewardship.

3.3 Ecosystem Indicators

Annex 11 of the Great Lakes Water Quality Agreement (GLWQA) describes the surveillance and monitoring activities that the parties will carry out in order to assist in evaluating the attainment of specific water quality objectives listed in Annex 1 of the GLWQA. These activities include the development of ecosystem health indicators for each of the Great Lakes.

Indicators proposed by the LOTMP and the State of the Lakes Ecosystem Conferences (SOLEC) served as a starting point for the LaMP's selection process. SOLEC has provided a forum for Great Lakes monitoring and ecosystem indicator issues. Data collected and reported by U.S. and Canadian monitoring programs were reviewed to identify what types of information, collected on a regular basis, could be used to measure long-term trends. The LaMP used six criteria to select appropriate ecosystem indicators that are:

- well-recognized by monitoring experts;
- supported by historical data available for comparison purposes;
- consistent with SOLEC and LOTMP indicator recommendations;
- easily understood by the general public;
- supported by data available from existing monitoring programs; and
- reflective of general "ecosystem health" on a lakewide scale.

The eleven indicators selected provide a good characterization of ecosystem health across the foodweb. The selected indicators can be divided into three groups:

(1) Critical Pollutant Indicators: which measure concentrations of critical pollutants in water, young of the year fish, herring gull eggs and lake trout, and compare this information against existing guidelines;

(2) Lower Foodweb Indicators: which track the status of nutrients, zooplankton and prey fish (such as alewife and smelt). These indicators reflect the ability of the ecosystem to support higher level organisms (such as lake trout and waterbirds); and

(3) Upper Foodweb Indicators: which monitor the health of herring gull, lake trout, bald eagle, mink and otter populations. These top level predators are dependent on quality habitat and sufficient prey populations, free of problematic contaminant levels.

The indicators were presented at SOLEC, RAP meetings, the Finger Lakes-Lake Ontario Watershed Protection Alliance Conference and in the LaMP 2001 Update Report. In general, the indicators have been well received by the public. The LaMP adopted the indicators in 2001.

The process of fine tuning and reporting on these indicators will foster closer working relationships between U.S. and Canadian monitoring programs and will promote better binational coordination. Additional indicators will be considered, as necessary, to help guide LaMP restoration activities. A brief overview of each of the selected indicators is provided below.

3.3.1 Critical Pollutant Indicators

Critical pollutant indicators measure concentrations of critical pollutants in water, young of the year (YoY) fish, herring gull eggs and lake trout, and compare this information against existing guidelines.

Critical Pollutants in Offshore Waters

Objective: critical pollutants in open waters should not pose a threat to human, animal and aquatic life ***Measure:*** concentration of critical pollutants in offshore waters
Purpose: to measure priority toxic chemicals in offshore waters and to assess the potential impacts of toxic chemicals on human health and the aquatic ecosystem and the progress of contaminant reduction efforts
Target: concentrations of critical pollutants in offshore waters are below standards and criteria designed to protect the health of human, animal and aquatic life

Critical pollutant levels in Lake Ontario have generally declined over the last 20 to 25 years. Nevertheless, critical pollutants are still detected at extremely low concentrations in open waters at levels that exceed the most stringent surface water criteria designed to protect wildlife and humans who consume fish (Table 3.1).

With proper treatment, regular monitoring of Lake Ontario water supplies shows that water quality meets public health standards for drinking water supplies.

The most recent data available (collected by NYSDEC in 1997) suggest that DDE levels are now slightly above the open water standard, while PCB and dieldrin levels are approximately 100 times higher than their respective standards. Water sampling results from the Niagara River and the St. Lawrence River suggest that mirex and mercury levels also exceed standards in open waters (although information on mirex and mercury was not collected in the 1997 study).

Canadian and U.S. monitoring programs are continually improving sampling and analytical methods with the goal of achieving lower detection limits. The results of U.S. open lake water critical pollutant sampling conducted in 1999 are now being finalized and will be summarized in future LaMP reports. Environment Canada measured open lake water critical pollutant concentrations in 2003. The LaMP will continue to monitor critical pollutant levels and trends in open waters and report on the results.

Table 3.1 Critical Pollutant Concentrations in Lake Ontario Open Waters, 1997

	NYS WQS	Measured	
Critical Pollutant	*Standard (pg/L)*	*Concentration(pg/L)*	*Exceeds WQS*
PCBs	1	110	Yes
Dioxins + Furans	0.0006	0.0046	Yes
p,p' - DDE	7	10	Yes
p,p' - DDD	80	13	No
p,p' - DDT	10	2.6	No
Dieldrin	0.6	51	Yes
Mirex	1	R	NA
Dissolved Mercury	700	NS	NA

pg/L = parts per quadrillion
R - Data rejected due to lab problems
NS - Not sampled
NA - Data not available for this time period
NYS WQS - New York State Water Quality Standard for pollutants in open water

Source: Litten & Donlon 1998.

Critical Pollutants in Young-of-the-Year (YoY) Fish

Objective: critical pollutants should not pose a risk to fish-eating wildlife
Measure: concentration of critical pollutants in YoY fish
Purpose: to measure persistent toxic chemicals in YoY fish and to evaluate and measure potential harm to fish-eating wildlife
Target: concentrations of critical pollutants in YoY fish are below standards and criteria designed to protect fish-eating wildlife

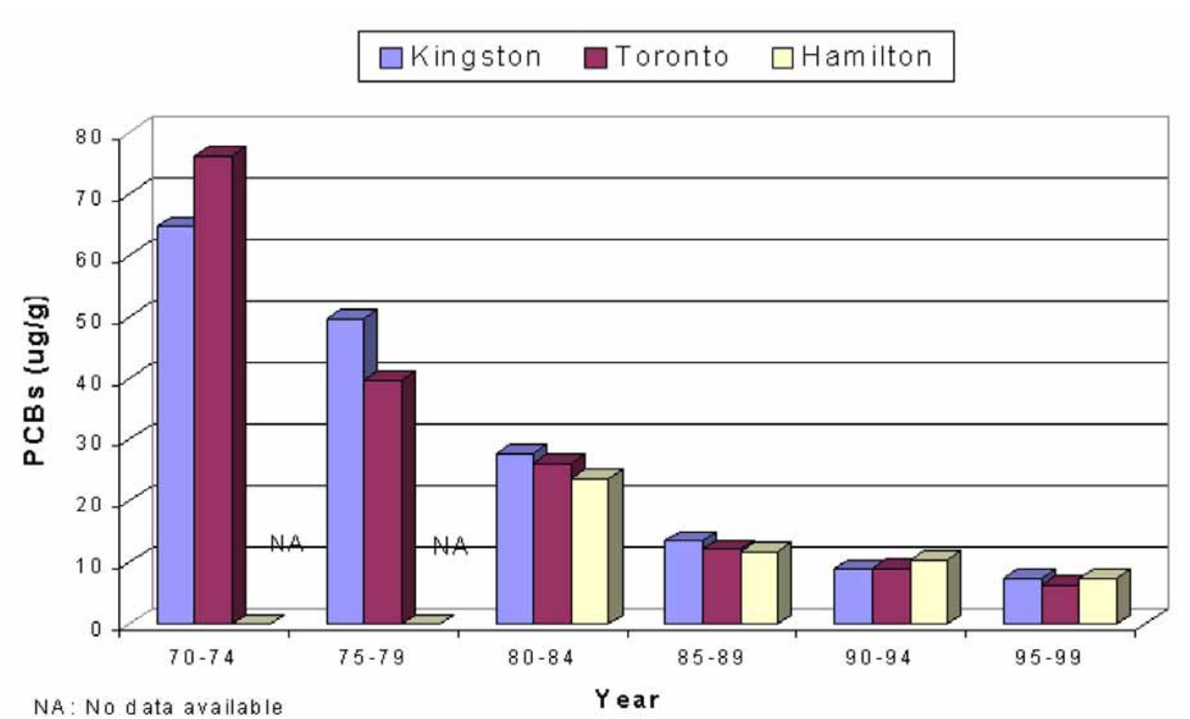
Critical Pollutants in Herring Gull Eggs

Objective: the health and reproductive success of waterbirds should not be impaired by contaminants present in the aquatic foodweb
Measure: annual concentrations of persistent toxic chemicals in herring gull eggs from colonies
Purpose: to measure critical pollutants in herring gull eggs from colonies that reflect general lakewide conditions and to compare contaminant concentrations to criteria designed to protect waterbirds
Target: contaminant levels in colonial nesting waterbird eggs are similar to those of unaffected reference sites or are below existing standards or criteria designed to protect colonial waterbirds

Fish-eating birds, such as gulls, terns, cormorants and night herons, have been used as bio-indicators of contamination on Lake Ontario and throughout the Great Lakes for more than 30 years. In the 1970s, fish-eating birds in the Great Lakes, including Lake Ontario, were found to have very high levels of contaminants such as PCBs, DDE and mirex in their eggs. At that time some species of colonial waterbirds exhibited much thinner eggshells than normal, elevated rates of embryonic mortality and deformities, total reproductive failure, and declining population levels. Eggshell thickness has returned to normal or, at least, is not a problem for any of the species. Today Lake Ontario colonial waterbirds are reproducing normally due in part to controls and bans placed on persistent toxic chemicals such as DDT more than two decades ago.

The herring gull is the most widespread colonial waterbird nesting on the Great Lakes. As a native, non-migratory species that relies heavily on aquatic prey organisms the herring gull provides an excellent indicator species. The Canadian Wildlife Service's herring gull egg contaminant monitoring program has provided an excellent way to track environmental trends in persistent toxic chemicals. PCBs and DDE levels have declined dramatically in eggs of herring gulls (Figures 3.1 and 3.2) although other contaminants such as dioxin appear to be declining more slowly (Figure 3.3). Although many of the obvious signs of toxic contamination are no longer apparent, the Canadian Wildlife Service is continuing its research to better understand the potential for more subtle effects of environmental contaminants on fish-eating birds and other wildlife on Lake Ontario. The direct correlation of load reduction activities and ecosystem improvements is further illustrated in the reduced levels of contaminants in herring gull eggs.

Figure 3.1 PCB Concentrations in Herring Gull Eggs from Lake Ontario Colonies, 1970 - 1999



Sources: Bishop et *al*. (1992), Pettit et *al*. (1994), Pekarik et *al*. (1998) and D.V. Weseloh (Unpublished).

Figure 3.2 DDE Levels in Herring Gull Eggs from Kingston Harbour, 1974-2001

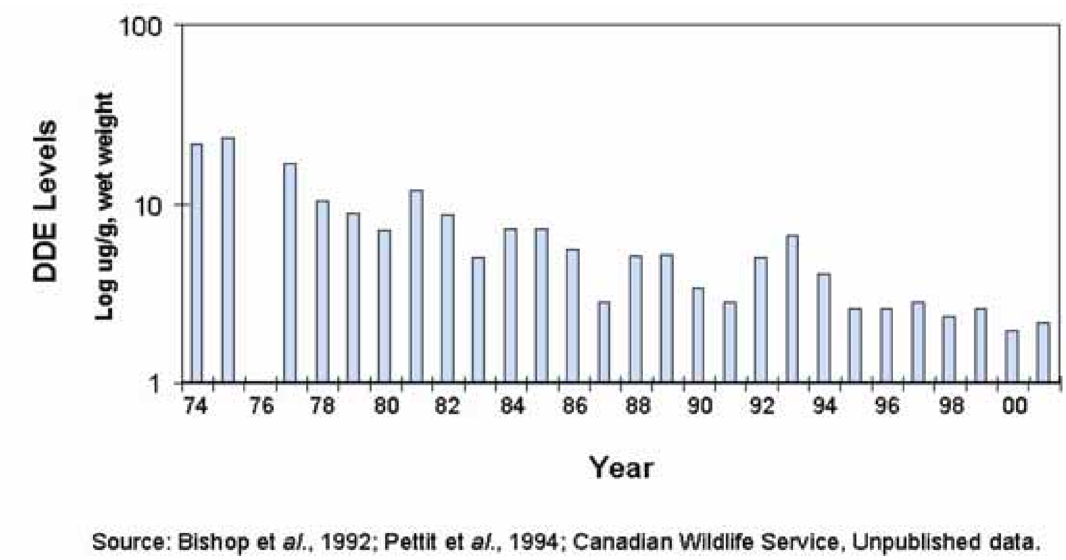
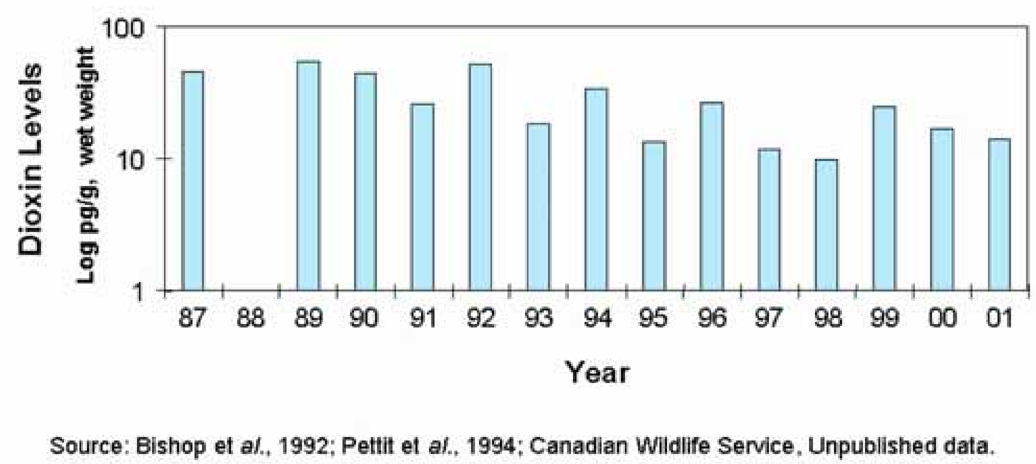


Figure 3.3 Dioxin Levels in Herring Gull Eggs from Toronto Harbour, 1987-2001



Critical Pollutants in Lake Trout Tissue

Objective: consumption of fish should not be restricted due to contaminants of human origin
Measure: concentrations of pollutants in edible fish tissue responsible for advisories
Purpose: to measure critical pollutants in fish and to evaluate the potential exposure of humans to these substances through fish consumption
Target: contaminants in fish tissue are below the existing standards and criteria designed to protect human health, as shown by the elimination of fish advisories

The Lake Ontario LaMP has identified a number of critical pollutants that have impaired beneficial uses on a lakewide basis. These persistent contaminants (i.e., PCB, DDT, mirex, dioxin/furans, mercury, dieldrin) tend to bioaccumulate in biological tissue (of fish, animals and humans). Monitoring contaminant levels in tissue, therefore, facilitates the assessment of spatial and temporal trends in water quality and contaminant availability.

Overall, the fish community has experienced a dramatic reduction in contaminant levels since the mid-1970s. Concentrations of PCBs, DDT and mirex in lake trout tend to be higher in the western basin of Lake Ontario than the eastern basin. This reflects the magnitude of contaminant inputs from the upper lakes and the Niagara River and the industrialized nature of the western end of the lake.

In addition to lake trout, contaminant trends monitored in other fish species can also provide useful indicators of current contaminant trends. Long-term trends in contaminant concentrations are illustrated using data collected by the Ontario Ministry of Environment (OMOE) for 50-centimetre coho salmon from the Credit River spawning run (Figures 3.4 to 3.7). Coho salmon data are well suited to analysis of trends over time since they spend most of their time in the Lake and different individuals of similar age return to the same location each year to spawn. In the mid-1990s, coho salmon stocks in the Credit River were low and no samples were obtained. Concentrations of total PCB, mirex, mercury, and total DDT in Credit River coho salmon have been decreasing steadily since monitoring commenced in the late-1970s. Total PCB concentrations have decreased from greater than 1.5 ppm in late-1970s to approximately 0.5 ppm in 2000 (Figure 3.4). Over the same time period, concentrations of mirex have decreased from greater than 0.1 ppm to less than 0.05 ppm (Figure 3.5). Similar trends have been observed for mercury and DDT, as can be seen in Figures 3.6 and 3.7, respectively.

Figure 3.4 Total PCB Levels in 50 cm Coho Salmon from the Credit River, 1976-2001

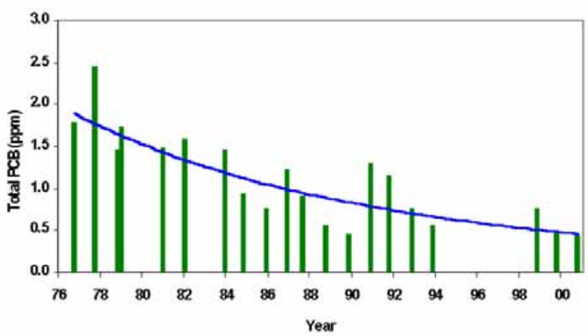


Figure 3.5 Mirex Levels in 50 cm Coho Salmon from the Credit River, 1976-2001

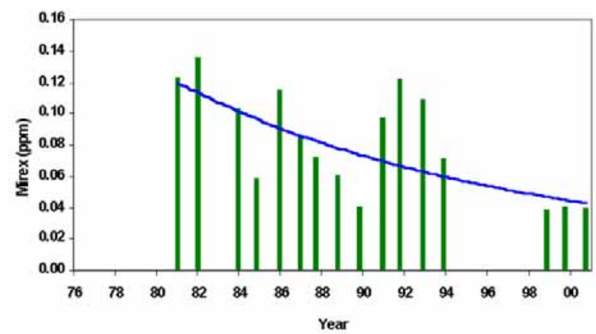


Figure 3.6 Mercury Levels in 50 cm Coho Salmon from the Credit River, 1976-2001

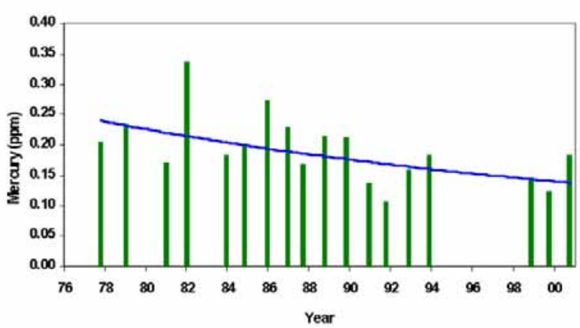
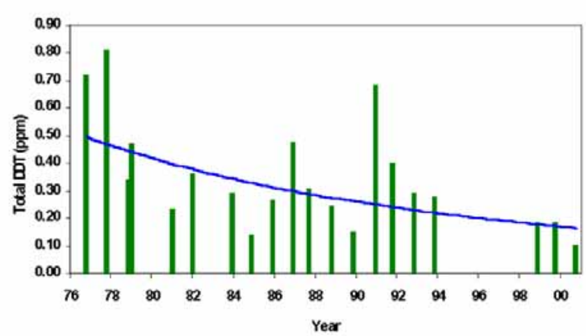


Figure 3.7 Total DDT Levels in 50 cm Coho Salmon from the Credit River, 1976-2001



3.3.2 Lower Foodweb Indicators

Lower foodweb indicators track the status of nutrients, zooplankton and prey fish (such as alewife and smelt). These indicators reflect the ability of the ecosystem to support higher level organisms (such as lake trout and waterbirds).

Nutrients in Open Waters

Objective: nutrient levels should be sufficient to support aquatic life without causing persistent water quality problems (such as the depletion of dissolved oxygen in bottom waters, nuisance algal blooms or accumulations, and decreased water clarity)
Measures: total spring phosphorus levels (micrograms per litre), chlorophyll-a, and water clarity
Purpose: to follow trends in open lake nutrients
Target: nutrient levels allow attainment of fishery management objectives without exceeding the GLWQA phosphorus-loading target for Lake Ontario

Zooplankton Populations

Objective: zooplankton populations should be sufficient to support a healthy and diverse fishery
Measures: (1) mean individual size, and (2) biomass
Purpose: to directly measure changes in mean individual size and biomass of zooplankton populations in order to indirectly measure changes in food-web dynamics due to: changes in vertebrate or invertebrate predation, changes in system productivity, the type and intensity of predation, and energy transfer within a system
Targets: zooplankton populations are sufficient to maintain prey and predator fish at levels consistent with existing binational fishery objectives; mean individual size of approximately 0.8 millimeters (mm) is generally considered an optimal size when the water column is sampled with a 153 micron mesh net; specific biomass targets will be developed as the state of knowledge permits

Preyfish

Objective: a diverse array of preyfish populations should be sufficient to support healthy, productive populations of predator fishes
Measures: abundance, age and size distribution of preyfish species (such as deepwater ciscoes, sculpins, lake herring, rainbow smelt and alewives)
Purpose: to directly measure the abundance and diversity of preyfish populations and to indirectly measure the stability of predator species necessary to maintain biological integrity
Target: given the rapid changes that have occurred in the Lake Ontario foodweb, a specific target in terms of average annual biomass cannot be set at this time; a specific target will be set once fishery managers have a better understanding of preyfish dynamics

3.3.3 Upper Foodweb Indicators

Upper foodweb indicators monitor the health of herring gull, lake trout, bald eagle, mink and otter populations. These top level predators are dependent on quality habitat and sufficient prey populations, free of problematic contaminant levels.

Herring Gull

Objective: Lake Ontario should support healthy populations of colonial waterbirds
Measure: total number of active herring gull nests counted per year (with additional species counted, as necessary)
Purpose: to directly measure numbers of breeding gulls on Lake Ontario in order to detect changes in population status that may reflect stresses due to contaminants, disease or insufficient food supply
Target: reproduction and fledging rates of herring gulls are normal (that is, similar to unaffected background areas)

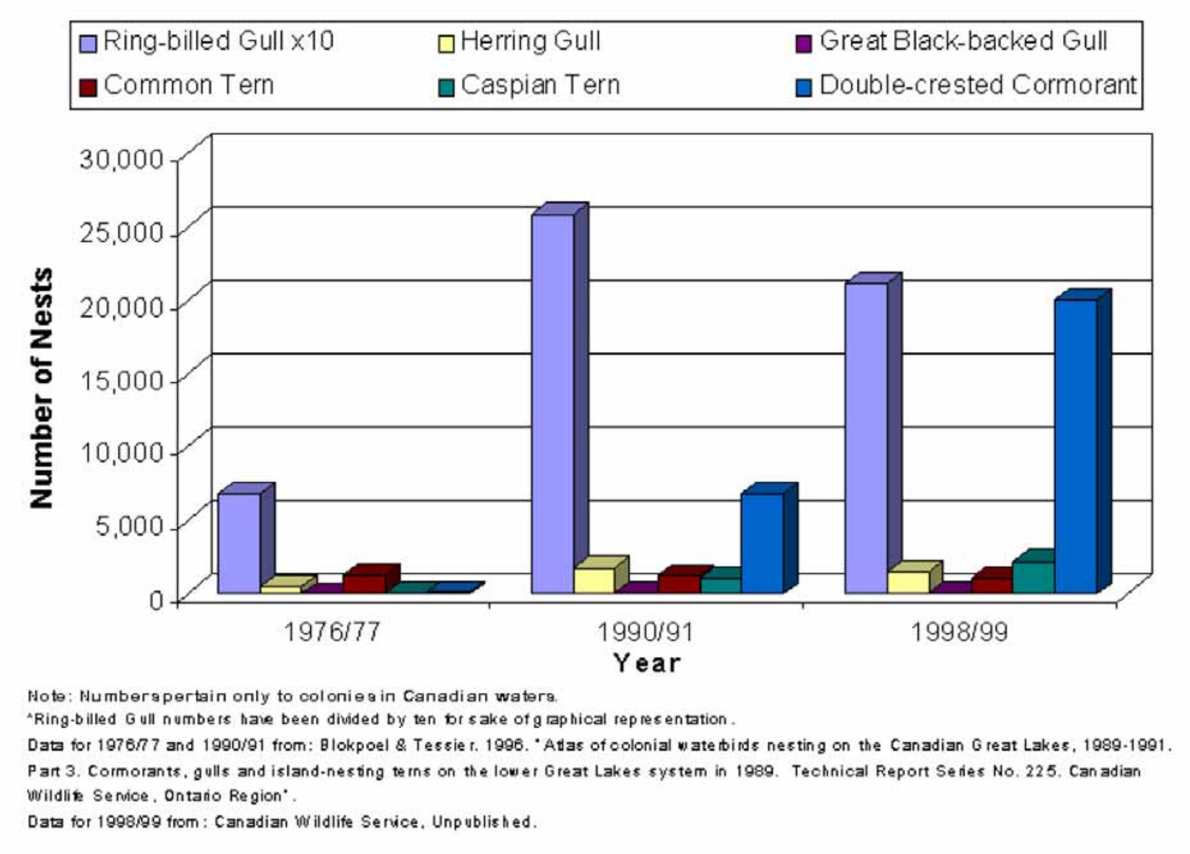
The herring gull is the most widespread colonial waterbird nesting on the Great Lakes. As a native, non-migratory species that relies heavily on aquatic prey organisms the herring gull provides an excellent indicator species. In 1998-99 it nested at 18 different locations on Lake Ontario, with a population of almost 1,500 nests. In 1990-1991, 21 colonies were counted, with about 1,800 nests. In 1976-77 there were 448 nests on 13 colonies. After growing at an average annual rate of 11 percent from 1976-77 to 1990, this population also declined by two percent per year overall between 1990 and 1999.

Lake Ontario is home to hundreds of thousands of colonial nesting water birds. Biologists from the Canadian Wildlife Service, the Ontario Ministry of Natural Resources and the New York State Department of Environmental Conservation completed the third Lake Ontario-wide census of nesting colonial water birds in 1999, a survey that is conducted approximately once every ten years.

Information collected from these surveys, along with the results of other studies carried out over a number of years in the Lake Ontario basin, is summarized here to provide an indication of improvements to the ecosystem. Surveys have shown that: Caspian tern numbers are increasing; common terns, though their numbers are declining, are adapting to man-made sites in the face of large ring-billed gull populations; both herring and ring-billed gull populations appear to have leveled off during the last decade; cormorant populations have greatly expanded; and black-backed gulls represent a new nesting species on Lake Ontario.

Lake Ontario-wide surveys of colonial waterbirds were conducted in 1976-1977, 1990-1991 and 1998-1999 for six species of colonial water birds: double-crested cormorant, ring-billed gull, herring and great black-backed gulls, and common and Caspian terns (Figure 3.8).

Figure 3.8 Number of Gull, Tern and Cormorant Nests on Lake Ontario, 1976 - 1999



Double-crested cormorants have increased tremendously on Lake Ontario during the last quarter-century. As cormorant populations increased so did public concerns that cormorants were depleting nearshore fish populations and reducing fishing opportunities. In 1977, there was one cormorant colony on Lake Ontario, which contained 96 nests. In 1999, there were over 20,000 nests on 17 colonies. The two largest colonies, each with more than 4,500 cormorant nests, were located in the eastern half of the lake.

NYSDEC completed a detailed diet assessment of Little Galloo cormorants in 1999 that determined that cormorant predation on smallmouth bass had significantly reduced numbers of smallmouth bass large in eastern Lake Ontario. In response to this threat to smallmouth bass and other nearshore fish populations, a large scale, sanctioned cormorant control program was initiated on Little Galloo Island in 1999. All cormorant eggs in ground nests were sprayed with non-toxic corn oil to prevent them from hatching and to eliminate any production of young. Reducing the number of cormorants is also desired because of their potential impact on other species of colonial birds with which they nest, especially the blackcrowned night heron.

The ring-billed gull is the most numerous colonial waterbird on Lake Ontario and the Great Lakes. During 1998-99, over 200,000 nests were tallied on 18 colonies on Lake Ontario. Between the first two census periods, the population grew by ten percent per year, but between 1990-1991 and 1998-99 it declined by two percent per year. By 1999, ring-billed gulls had also completely abandoned seven colony sites that were active in 1990-1991. Natural habitat change and gull control activities were responsible for some of this decline, but nesting cormorants and great black-backed gulls also may be exerting an influence.

Of the six species of colonial waterbirds discussed here, the great black-backed gull is the least numerous. During the 1976-77 census, it was not found nesting on Lake Ontario. In 1990, there were 15 nests on three sites and in 1998-99, there were 33 nests on six sites. This large gull, which has only started nesting on Lake Ontario regularly since the early 1980s, may be a serious competitor and predator with some of the other species of colonially nesting birds.

Since 1990, the lakewide population of common terns has declined by 11 percent. However, it is encouraging that the number of nesting sites in Canadian waters increased from 6 to 14 between 1990 and 1998. Most of these sites were located on man-made islands, shoals or "tern rafts", and two were re-established colonies at sites that had been abandoned. Artificial nest sites seem to be an attractive alternative for this species. Average annual growth rates of Caspian tern populations were 24 percent for 1976-77 to 1990-1991 and eight percent for 1990-1991 to 1997-98. Substantial cormorant colonies do not seem to be having a negative impact on the growth of the Caspian tern colonies with which they are located. For example, on Little Galloo, nests increased from 4,072 to 7,591 during the same period. However, the large black-backed gull may be preying on terns; in 1995, 21 fresh Caspian tern carcasses were found within black-backed gull nesting territories. The results of the recent population surveys are mixed but encouraging; contaminants do not appear to be limiting any of the colonial bird populations.

Lake Trout

Objective: lake trout populations should be sustained through natural reproduction
Measures: (1) abundance of naturally produced fish, (2) number of mature females, and (3) number harvested
Purpose: to measure progress and identify obstacles to the successful rehabilitation of naturally reproducing populations of lake trout
Targets: abundance of at least 2.0 mature female lake trout larger than 3,000 grams per standard gillnet; abundance of naturally-produced mature females greater than 0.2 in U.S., and 0.1 in Canadian waters per standard gillnet; harvest not to exceed 30,000 fish per nation; and abundance of naturally produced age 2 fish of at least 26 juveniles from July bottom trawls in U.S. waters and increased over current levels in Canadian waters

Mink and River Otter

Objective: naturally reproducing populations of mink and river otter should be established throughout the Lake Ontario basin
Measure: number of tributaries and wetlands with established mink and river otter populations
Purpose: to evaluate mink and otter populations in the Lake Ontario basin
Target: all suitable habitats have established, healthy and naturally reproducing populations

Mink and river otter are making a comeback in the Lake Ontario basin. Their populations were severely reduced in the 1800s due to habitat loss, water pollution and excessive trapping. Prior to these changes the river otter had the largest geographic range of any North American mammal.

Mink live on a diet of fish, muskrats, mice and other small creatures, while otters consume fish almost entirely. Given the position of mink and otter – high in the foodweb - their health could be impacted if the fish they rely on are highly contaminated. The presence of sufficient quality and quantity of habitat is also essential to their successful reproduction and survival. These qualities make them a good indicator of Lake Ontario ecosystem health. While increasing populations would be a positive sign of a recovering ecosystem, decreasing populations would indicate a negative change in the biological, chemical or physical status of the ecosystem.

The secretive nature of these animals makes them difficult to study in the wild. American and Canadian trapping statistics have been the primary source of information on mink and otter. The LaMP, working closely with wildlife experts, collected these statistics and reviewed trapping records, sighting reports and other information to develop a basinwide picture of their distribution and relative abundance.

The review showed that more than 1200 river otters and 5000 mink were trapped during the 1999-2000, harvest season, providing good evidence that significant numbers of these animals are present in the basin. Mink are located throughout the basin and their populations are stable. River otter populations are increasing, expanding into areas where they have not been seen in decades.

River otter, found around the eastern end of Lake Ontario, in central Ontario and along the St. Lawrence River, are now moving into western and central New York as more and more abandoned agricultural land returns to natural conditions. Their expansion has been aided by initiatives like the New York River Otter project that released nearly 300 river otters at several locations in central and western NewYork.

The LaMP will continue to work with its partners to protect habitat and water quality to ensure that mink and otter continue to call the Lake Ontario basin home. For more information on efforts to restore river otter populations, see www.nyotter.org/.

Bald Eagle

Objective: shoreline and inland bald eagle nesting territories should be established and sustained through natural reproduction throughout the basin
Measures: (1) total number of established bald eagle nesting territories within the Lake Ontario basin, (2) total number of established shoreline nesting territories, and (3) average number of eaglets per nest successfully produced
Purpose: to measure trends in the recovery and reestablishment of bald eagles within the basin
Targets: all suitable habitat for bald eagle nesting is successfully utilized; average basinwide fledging rates per occupied territory are one eaglet per nest or greater; and shoreline nesting territories are defined as those less than seven kilometers from the lake.

The Bald Eagle is considered by many to be one of the premier ecological indicators of the Great Lakes. In the 1970s there were no active Bald Eagle nesting territories in the Lake Ontario basin. Two eagle nesting territories were artificially established in the basin during the 1980s through the introduction of adult eagles captured in Alaska. Since that time the number of nesting territories has increased at a rate of approximately 20% a year. There are now eight established nesting territories in the basin (New York tributaries of Lake Ontario). The combined long term average successful reproduction rates for these nests is 1.4 eaglets per nesting attempt. A reproduction rate of 1.0 eaglets per occupied nesting territory is generally believed to be necessary to maintain stable Bald Eagle populations.

Although good to excellent bald eagle nesting habitat exists along the eastern shoreline of the lake, there are as yet no shoreline or island nests. The eagles are expected to occupy shoreline nesting sites as their numbers steadily increase. Human disturbance has already slowed the return of eagles to the shoreline. A few years ago a young hunter shot and killed the female of a Bald Eagle pair engaged in nest building behavior along the lake shore west of Oswego, New York. Restoration of shoreline nesting territories will depend in part on protection of eagle nesting habitats and preventing further human disturbance.

Examples of the data collected to assess whether targets for ecosystem objectives are being met are presented in Figures 3.9 and 3.10. These figures show the average number of eaglets produced per nest and the number of nesting territories in the Lake Ontario basin, respectively. Since the 1980s, a positive trend has been observed in both categories.

Figure 3.9 Indicator: Bald Eagle Measure: Eaglets Produced Per Nest.

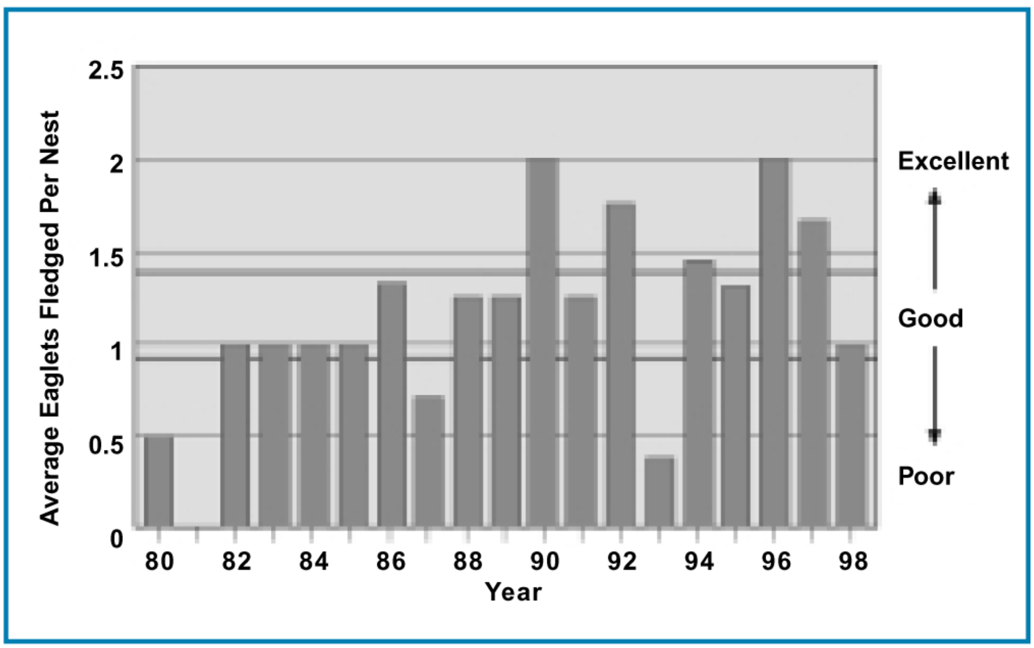
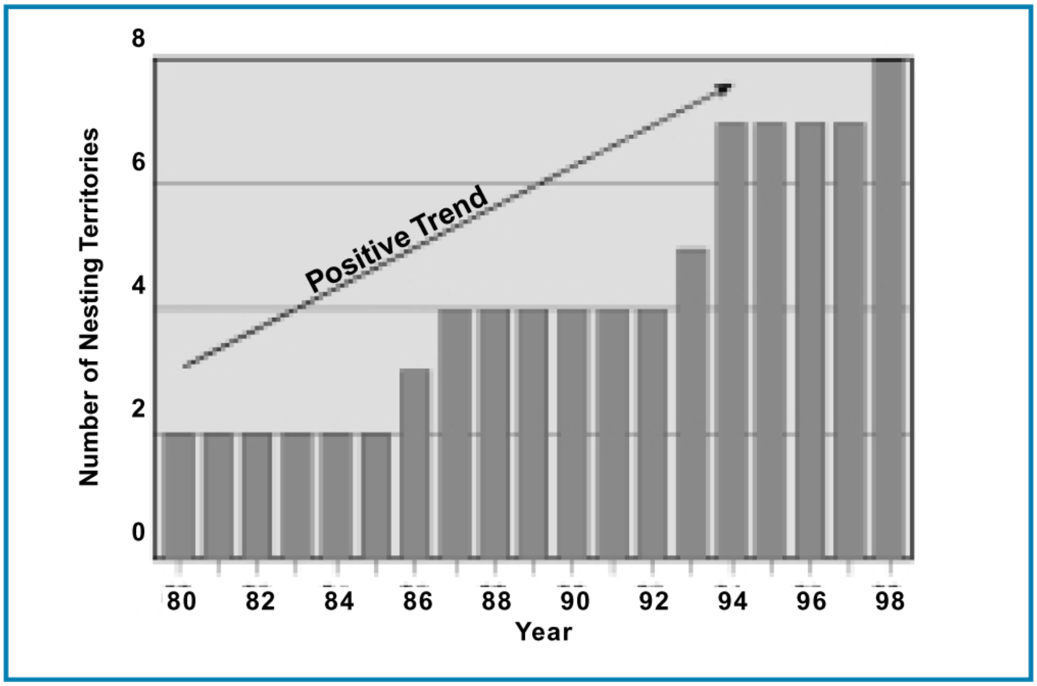


Figure 3.10 Indicator: Bald Eagle Measure: Number of Nesting Territories.



3.4 Cooperative Monitoring Progress Towards Meeting LaMP Goals and Indicators

With the adoption of this initial suite of ecosystem indicators, attention now shifts to data collection and synthesis. Fortunately, much of this work is already being done through existing federal, state and provincial Great Lakes water quality, biomonitoring and fisheries programs and organizations, such as the Great Lakes Fishery Commission's Lake Ontario Lake Committee, consisting of New York and Ontario fishery managers.

Although the LaMP's primary focus is the development of strategies and actions designed to restore impaired lakewide uses, effective monitoring is required to track progress in achieving its goals. Whenever possible, the LaMP promotes cooperative U.S.-Canadian monitoring efforts in Lake Ontario's open waters, nearshore areas and tributaries. Increased communication and coordination of existing programs are encouraged. The LaMP's cooperative monitoring approach has three components: (1) promoting increased communication and coordination among monitoring programs; (2) developing special monitoring projects to answer specific LaMP-related questions; and (3) building on existing monitoring initiatives.

The LaMP is working to better coordinate U.S and Canadian monitoring related to LaMP beneficial uses and ecosystem indicator data needs. The LaMP's information needs can be classified into four general categories:

- evaluating the status of beneficial use impairments;
- monitoring environmental levels of critical pollutants;

- measuring progress through the use of ecosystem indicators; and
- providing input to mass balance modeling.

Existing U.S. and Canadian monitoring programs meet most of the LaMP's beneficial use and ecosystem indicator monitoring needs. The findings of these programs are highlighted in LaMP reports and will be used in reporting on selected ecosystem indicators. The LaMP is now working to promote and encourage existing U.S. and Canadian programs to coordinate their efforts, and where possible, expand their efforts as needed to develop a more complete lakewide assessment of current conditions. The LaMP will support these efforts by identifying available equipment, boats and other resources that can support these activities. Additional information regarding U.S. and Canadian tributary monitoring and sediment sampling is provided in Chapter 6.

Lake Ontario fishery researchers have a well-developed binational approach to monitoring and reporting through the efforts of the Great Lakes Fishery Commission's binational Lake Ontario Committee. NYSDEC and OMNR conduct joint hydro-acoustic surveys at key times of the year to evaluate the status of alewife and smelt populations. Binational investigations of eel populations are also being conducted. The findings of these studies, as well as other individual agency studies (such as warm water fish population monitoring and lake trout restoration) are presented at annual Lake Ontario Committee meetings. The Lake Ontario Technical Committee (LOTC) of U.S. and Canadian fishery researchers maintains close contact through an informal network that allows them to efficiently address monitoring issues.

Monitoring programs are often impacted by equipment failure, staffing and budgetary cuts, and/or severe weather events all of which can derail sampling plans. Similar to the LOTC, the LaMP is developing an informal network of contacts involved in monitoring critical pollutants in water, sediment and biota that may be able to assist each other when problems arise. Increased communication will also lead to a better understanding of each other's sampling methods and recognition of opportunities to collaborate. Binational reporting on LaMP ecosystem indicators will further promote communication between various monitoring programs.

Much of the monitoring done in Lake Ontario would not be possible without the support of U.S. and Canadian research vessels. Cooperative monitoring projects in 2003 were supported by:

- ***Lake Guardian*** (180 ft / 54 m)
  U.S. EPA Great Lakes National Program Office
- ***CCGS Limnos*** (148 ft / 45 m)
  DFO vessel operated by the Canadian Coast Guard
- ***Great Lakes Guardian*** (45 ft / 14 m)
  Ontario Ministry of the Environment
- ***Lake Explorer*** (82 ft / 25 m)
  U.S. EPA Office of Research & Development

3.5 Major 2003 Cooperative Monitoring Projects

The Lake Ontario Lakewide Management Plan (LaMP) coordinated a number of binational cooperative monitoring efforts in 2003 to improve our understanding of the Lake Ontario ecosystem. In addition to promoting projects that address key LaMP information needs, emphasis has been placed on improving communication and data sharing between US and Canadian monitoring programs. Often the hardest part of this type of work is pulling together key researchers to interpret the data and to effectively communicate the "big picture" to stakeholders. This type of coordination and data synthesis takes time and effort and the LaMP is committed to making this happen.
In promoting cooperative monitoring the LaMP has broadened its base of partners to help support and strengthen existing efforts. For example, the LaMP's partnership with the Great Lakes Fishery Commission (GLFC) has brought together water quality and fishery managers. The LaMP and the GLFC have identified common information needs that helped guide the development of this year's projects. This may be the first step in developing a long-term binational strategy for Lake Ontario that meets the needs of both water quality and fishery managers.

Three major binational cooperative monitoring projects are summarized in the following sections.

3.5.1 Lake Ontario Atmospheric Deposition Study (LOADS)

Understanding Sources of Atmospheric Contaminants
Atmospheric deposition is one of the important sources of critical pollutants entering Lake Ontario. This project is developing a more detailed understanding of atmospheric deposition processes within the Lake Ontario basin and may provide information on the relative importance of local and long distance sources of atmospheric contaminants. The results of this study will support the development of contaminant loading mass balance models that are being used to predict how changes in contaminant loadings will impact contaminant levels in fish tissue.

The partners involved in this study include:

- Clarkson University
- EC Meteorological Services Canada
- U.S. EPA Region 5
- U.S. EPA Great Lakes National Program Office
- U.S. EPA Office of Research & Development
- Fredonia College
- State University of New York, Oswego
- University of Michigan
- Lake Ontario LaMP Four Parties (EC, EPA R2, OMOE, NYSDEC)

PCBs, pesticides, dioxins/furans and mercury are being measured in air and wet and dry precipitations samples collected from sampling platforms on land and on the lake. Lake water samples are also being collected. This work will give the LaMP a better understanding of how contaminants enter and leave the lake via atmospheric processes.

Some of the major questions to be addressed by this study include:

- How important are the amounts of contaminants entering the lake via atmospheric deposition compared to other sources, such as upstream lakes and in-basin tributaries?
- Does the nature or rates of atmospheric contaminant deposition differ between land & lake sampling locations?
- How significant are urban sources of atmospheric contamination?

3.5.2 Lake Ontario Lower Aquatic Foodweb Assessment (LOLA)

Understanding Changes in a Post-Zebra Mussel Foodweb

This project is developing a better understanding of the changes that are occurring in Lake Ontario's lower aquatic foodweb and its ability to support fish populations. The introduction of exotic species such as zebra & quagga mussels have changed the way nutrients and energy are cycled through Lake Ontario's foodweb impacting the productivity of fisheries and threatening efforts to restore naturally reproducing populations of native fish. Recently introduced exotic zooplankton, namely *Cercopagis pengoi*, may also negatively impact native zooplankton communities. The LaMP recently listed two new lakewide impairments, degraded benthos and degraded nearshore phytoplankton, probably related to the disruption of the foodweb by zebra & quagga mussels. The LaMP and the GLFC both agree that the need for better information on the lower foodweb is a high priority.

Partners involved in this project include:

- Great Lakes Fishery Commission
- Ontario Ministry of Natural Resources
- Department of Fisheries & Oceans Canada
- National Oceanic & Atmospheric Administration
- Cornell University
- U.S. EPA Great Lakes National Program Office
- U.S. EPA Office of Research & Development, Duluth
- University of Toronto
- State Univ. of New York, Environmental Sciences & Forestry
- Lake Ontario LaMP Four Parties (EC, EPA R2, OMOE, NYSDEC)

Four sampling cruises (April, August, September & October) were conducted with the assistance of U.S. EPA's vessel Lake Guardian and the Canadian Coast Guard's vessels CCGS Limnos and CCGS Simcoe. Approximately 30 stations per cruise were sampled along four north-south transects. Nutrient, phytoplankton, zooplankton, mysid (a type of freshwater shrimp) and benthic samples were collected in order to characterize the status of Lake Ontario's lower foodweb. The use of optical plankton counters, a new remote sensing technology, is also being explored as a tool to collect information on the status of zooplankton communities. Data interpretation and report writing will be coordinated among U.S. & Canadian partners. Pre-zebra mussel lower aquatic foodweb surveys conducted in the 1980s will provide a historical point of comparison for these results.

Some of the questions to be addressed by this projects are:

- What types of organisms make-up the lower aquatic foodweb?
- Have exotic species had negative impacts on native benthic organisms and zooplankton?

- Can the lower aquatic foodweb continue to support existing recreational and sport fisheries?

3.5.3 Interagency Laboratory Comparison Study

Understanding Differences in Analytical & Sampling Methods

Accurately measuring extremely low, parts per trillion, concentrations of critical pollutants is very difficult. The use of different sampling methods and laboratory techniques may provide different results for the same sample due to slight differences in the ability of various methods to capture and measure contaminants. This project was designed to give the LaMP a better understanding of how well the analytical results produced by U.S. and Canadian monitoring programs compare with each other and will allow the Four Parties to combine their data sets with confidence to better characterize the lakewide environmental conditions.

Partners involved in this project include:

- Environment Canada
- U.S. EPA Region 2
- Ontario Ministry of the Environment
- New York State Dept. of Environmental Conservation

Samples containing PCBs, pesticdes and PAHs were carefully prepared in the lab and split four ways and analyzed by laboratories that perform analytical work for the Four Parties. The results are now being carefully reviewed to identify any data comparability issues. Later stages of this study will include the collection and analysis of actual field samples at Niagara-on-the-Lake.

Some of the major questions to be addressed through this study include:

- How well do analytical results produced by U.S. and Canadian laboratories compare?
- Does the use of different sampling methods produce similar results?

3.6 Other Indicator Initiatives

This section will be updated as information becomes available.

3.7 Actions and Progress

The information contained in this chapter has been compiled based on documents produced up to January 2003. Additional input from technical experts and the public will be considered over the years to come. Further study will be necessary to define specific targets for zooplankton populations and prey fish. In the meantime, data collection and reporting on basic measures for these populations will provide some measure of how well these components of the ecosystem are faring.

The status of these indicators will be reported on in future LaMP reports and public meetings.
The need for any additional indicators will be considered as part of the data collection and reporting process.

3.8 References

No references were identified for inclusion in this section.

CHAPTER 4 IDENTIFICATION OF BENEFICIAL USE IMPAIRMENT ASSESSMENTS

4.1 Summary

This chapter provides a record of the LaMP's original determination of the status of lakewide beneficial use impairments (BUIs), presenting the views and available information at that time. The majority of this material has been taken directly from the 1998 LaMP Stage 1 report. Material for two more recently identified impairments, degradation of benthos and degradation of nearshore phytoplankton populations was taken from the LaMP's 2002 biennial report. An evaluation of these two impairments was not included in the Stage 1 report due to insufficient information.

The information contained in this chapter has been compiled based on documents produced up to January 2003. Information on current environmental conditions and issues is provided in Chapter 1, State of the Lake, and Chapter 3, Ecosystem Indicators.

4.2 Beneficial Use Impairments Defined by the Great Lakes Water Quality Agreement

Significant changes have occurred in the Lake Ontario ecosystem over the last century due to the effects of toxic pollution and habitat loss resulting from the rapid development of the Lake Ontario basin. The extent of these changes was fully realized in the 1960s and 1970s, when Lake Ontario colonial waterbirds experienced nearly total reproductive failures due to high levels of toxic contaminants in the food chain. In 1972, Canada and the United States took actions to ban and control contaminants entering the Great Lakes, and, in 1987, renewed the Great Lakes Water Quality Agreement (GLWQA) with the goal to restore the overall health of the Great Lakes ecosystem. Today, as a result of these actions, levels of toxic contaminants in the Lake Ontario ecosystem have decreased significantly, and colonial waterbird populations have overcome most of the recognized contaminant-induced impacts of 25 years ago (i.e., their eggshells show normal thickness, they are reproducing normally, and most population levels are stable or increasing). However, bioaccumulative toxics persist in sediment, water, and biota at levels of concern for some fish species, such as lake trout and salmon, and for higher order predators, such as bald eagles, snapping turtles, mink and otters, and humans.

This chapter summarizes the original determination of lakewide impairments of beneficial uses in Lake Ontario caused by chemical pollutants and other factors. These impairments reflect those beneficial uses of the Great Lakes which cannot presently be realized, as laid out in the GLWQA. The same process is being used to identify problems within the other Great Lakes and in Areas of Concern (AOC). Given the rapid environmental changes that have occurred over the last 20 years, emphasis was placed on using the most recent information available at the time to identify problems facing the Lake Ontario ecosystem. Local impairments found in Lake Ontario AOCs and other nearshore areas are also discussed.

The GLWQA provides fourteen indicators of beneficial use impairments (identified in the text box below) to help assess the impact of toxic chemicals and other factors on the Great Lakes ecosystem. These indicators provide a systematic way to identify pollutant impacts on the entire ecosystem, ranging from phytoplankton to birds of prey and mammals, including humans.

As defined by the Great Lakes Water Quality Agreement, "impairment of beneficial use(s)" is a change in the chemical, physical, or biological integrity of the Great Lakes System sufficient to cause any of the following:

1. Restrictions on fish and wildlife consumption
2. Tainting of fish and wildlife flavor
3. Degradation of fish and wildlife populations
4. Fish tumors or other deformities
5. Bird or animal deformities or reproductive problems
6. Degradation of benthos
7. Restrictions on dredging activities
8. Eutrophication or undesirable algae
9. Restrictions on drinking water consumption, or taste and odor problems
10. Closing of beaches
11. Degradation of aesthetics
12. Added costs to agriculture or industry
13. Degradation of phytoplankton and zooplankton populations
14. Loss of fish and wildlife habitat

4.3 Beneficial Use Impairment Identification Process and Problem Definition

The LaMP process uses a broad range of ecological factors, in addition to regulatory standards, to identify critical pollutants. The GLWQA defines critical pollutants as "substances that persist at levels that, singly or in synergistic or additive combination, are causing, or are likely to cause, impairment of beneficial uses despite past application of regulatory controls due to their:

1. presence in open lake waters;
2. ability to cause or contribute to a failure to meet Agreement objectives through their recognized threat to human health and aquatic life or;
3. ability to bioaccumulate".

In preparing the Stage I binational problem assessment, Canada and the United States first independently evaluated 13 of the Lake Ontario beneficial use impairments for those geographic areas within their jurisdictions (Rang et al., 1992; USEPA and NYSDEC, 1994). The agencies proceeded to integrate their separate evaluations into the binational assessment of the status of beneficial use impairments in Lake Ontario. The fourteenth beneficial use impairment, loss of fish and wildlife habitat, was evaluated using Lake Ontario habitat reports compiled by the United States Fish & Wildlife Service (USF&WS) as part of the LaMP evaluation process (Busch et al., 1993) and others (Whillans et al., 1992). The LaMP recognizes the importance of appropriate linkages to other natural resource management initiatives such as fishery management plans, lake-level management, wetlands protection, watershed management plans, and control strategies for exotic species.

The beneficial use impairment assessment identified the lakewide use impairments in Lake Ontario and the toxic substances contributing to these impairments (i.e., those substances for which we have "direct" evidence that they are impairing beneficial uses). It is also important for the Lake Ontario LaMP to consider toxic substances which are likely to impair beneficial uses (i.e., there is "indirect" evidence that these chemicals are impairing beneficial uses if they exceed the most stringent U.S. or Canadian standard, criteria, or guideline). The Four Parties reviewed fish tissue contaminant concentrations and found that mercury concentrations in smallmouth bass and walleye exceeded Ontario's 0.5 parts per million (ppm) guideline for fish consumption throughout the lake. Mercury is also responsible for local impairments in Canada. In addition, dieldrin was also found to exceed the most stringent water quality and fish tissue criteria lakewide. Although mercury and dieldrin were not causing lakewide impairments of beneficial uses, these contaminants have been included as LaMP critical pollutants given the lakewide nature of these criteria exceedences.

4.4 Beneficial Use Impairments in Lake Ontario

The rapid development of the Lake Ontario basin prior to the 1970s was accompanied by habitat loss, over-harvesting of fisheries, and the release of excessive nutrients and toxic pollution that caused major changes in the Lake Ontario ecosystem. The extent of these changes was fully realized in the 1960s and 1970s, when Lake Ontario waters were choked with algae and colonial water birds experienced nearly total reproductive failure due to the presence of high levels of toxic contaminants in the food chain. In 1978, Canada and the United States took action to control inputs of nutrients and persistent toxic contaminants entering the Great Lakes, and in 1987, renewed the Great Lakes Water Quality Agreement (GLWQA) in order to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin ecosystem.

Today, as a result of these actions, levels of toxic contaminants in the Lake Ontario ecosystem have decreased significantly. Colonial waterbird populations have recovered and are reproducing normally. However, bioaccumulative toxics persist in sediment, water and biota at levels of concern for higher order predators (such as bald eagles, snapping turtles, mink, otters and humans).

Polychlorinated biphenyls (PCBs), DDT, mirex, dieldrin, mercury and dioxins/furans have been identified as critical pollutants linked to lakewide impairments in Lake Ontario. In addition to the historical loss of significant habitats, artificial lake level controls were identified as a significant cause of degraded habitats. (Refer to the 1998 "Lakewide Management Plan for Lake Ontario - Stage 1 Report" for a detailed discussion on the evaluation of these lakewide impairments.) Although there have been positive changes related to these impairments, their overall status of "impaired" remains unchanged.

The following is a summary of the technical basis for the beneficial use impairment assessment and the identification of the chemical, physical, and biological factors contributing to these impairments. A general list of references is provided in Section 4.7. Detailed references for information sources are provided in the individual United States and Canadian assessment reports that were used for this evaluation. In the development of the LaMP, the lakewide impairment status (impaired, degraded, insufficient information, or unimpaired) was determined after consideration of the Ecosystem Goals for Lake Ontario (see Section 3.2.1) and the preliminary ecosystem objectives.

The LaMP 1998 report identified the following four lakewide beneficial use impairments related to persistent toxic substances and habitat loss:

1. restrictions on fish and wildlife consumption;
2. degradation of wildlife populations;
3. bird or animal deformities or reproductive problems; and
4. loss of fish and wildlife habitat.

Two new impairments were added to the list in 2002:

5. degradation of benthos; and
6. degradation of nearshore phytoplankton populations.

These impairments were also used to identify critical pollutants and biological/physical stressors. PCBs, DDT, dioxins, and mirex are the critical pollutants associated with one or more of these lakewide impairments (Table 4.1). Loss of fish and wildlife habitat is due primarily to physical and biological factors rather than toxic contaminants. All Lake Ontario AOCs, except the Port Hope AOC, also list these six impairments as local concerns. The LaMP process will be coordinated with the development of Remedial Action Plans in these local areas to ensure the development of effective strategies for lakewide critical pollutants and other lakewide issues. Through the LaMP process, other existing programs that address these issues will also be supported and coordinated.

4.4.1 Restrictions on Fish and Wildlife Consumption

The Four Parties agreed that fish and wildlife consumption advisories due to PCBs, dioxins and furans, and mirex are lakewide beneficial use impairments. Most human exposure to many persistent and bioaccumulative contaminants is through eating fish and other aquatic organisms, which far outweighs contaminant exposures related to drinking water, air, or other terrestrial sources. Consumption advisories are developed to help protect people from the potential health impacts associated with long term consumption of contaminated fish and wildlife.

Fish Consumption Advisories

In general, consumption advisories are based on contaminant levels in different species and ages of fish. Both Ontario and New York fish consumption advisories account for the fact that contaminant levels are generally higher in older, larger fish. There are some differences in the fish tissue monitoring processes of the two governments; for example, New York State analyzes entire fillets which include belly-flap and skin (catfish, bullhead, and eels are exceptions since skin is removed before analysis) and Ontario analyzes muscle fillets. These two types of fish samples are not directly comparable. Muscle fillets have lower fat content. Since organochlorine chemicals, such as PCBs and DDT, tend to concentrate in fatty tissue, muscle fillet samples will generally show lower levels of these contaminants than the levels found in the fattier fillets.

Although not responsible for consumption advisories on a lakewide basis, mercury in larger smallmouth bass and walleye was considered likely to exceed Ontario's 0.5 ppm criteria for human consumption and was therefore considered a critical pollutant.

In Ontario, a Sports Fish Contaminant Monitoring Program is administered by the Ministry of the Environment (MOE) and the Ontario Ministry of Natural Resources (MNR). New York State operates a statewide fish tissue monitoring program. USEPA's Great Lakes National Program Office coordinates a fish tissue monitoring effort as part of a long term contaminant trends monitoring project. Fish tissue

Table 4.1 Lake Ontario Lakewide Beneficial Use Impairments, Impacted Species and Pollutants

Lakewide Impairments	*Impacted Species*	*Lakewide Critical Pollutants and Other Factors*
Restrictions on Fish and Wildlife Consumption	Trout, Salmon, Channel catfish, American eel, Carp, White sucker	PCBs, Dioxins, Mirex
	Walleye, Smallmouth Bass[a]	Mercury[a]
	All waterfowl[b]	PCBs, DDT, Mirex[b]
	Snapping Turtles[b]	PCBs[b]
Degradation of Wildlife Populations	Bald Eagle[c]	PCBs, Dioxin, DDT
	Mink and Otter[c]	PCBs
Bird or Animal Deformities or Reproductive Problems	Bald Eagle[c]	PCBs, Dioxin, DDT
	Mink and Otter[c]	PCBs
Loss of Fish and Wildlife Habitat	A wide range of native fish and wildlife species	Lake Level Management Exotic Species Physical Loss, Modification, and Destruction of Habitat
Degradation of Benthos	*Diporeia* populations[d]	Exotic Species (Zebra Mussels, Quagga Mussels) suspected and other factors to be confirmed
Degradation of Phytoplankton Populations	Nearshore Phytoplankton	Exotic Species (Zebra Mussels, Quagga Mussels) suspected and other factors to be confirmed

[a] Canadian advisories only
[b] U.S. advisories only
[c] Indirect evidence only (based on fish tissue levels)
[d] Dramatic decline in abundance in eastern Lake Ontario and disappearance of the species from large areas of the Lake.

Notes: Dieldrin, although listed as a LaMP critical pollutant, is not associated with an impairment of beneficial use.
"DDT" includes all DDT metabolites; "Dioxin" refers to all dioxins/furans.

samples are also collected by the Canadian Department of Fisheries and Oceans (DFO) as part of its long term contaminant trends monitoring program.

In Ontario, sportfish advisories are published every two years in the Guide to Eating Ontario Sport Fish, which includes tables for the Great Lakes. Advisories were reported for 19 species: salmon (chinook, coho), trout (rainbow, brown, lake), white bass, yellow and white perch, whitefish, rainbow smelt, freshwater drum, channel catfish, white and redhorse suckers, brown bullhead, American eel, black crappie, gizzard shad, and carp. The contaminants responsible for advisories are PCBs (50%), dioxins and furans (1%), and mirex (27%). The regular evaluation of commercial catches by DFO's fish inspection program has led to some restrictions on the commercial harvest of carp, large walleye, and channel catfish.

The New York State Department of Health issues annual fish consumption advisories for New York State waters which include specific and general advisories for Lake Ontario. NYSDEC collects and analyzes fish for contaminants. "Eat none" advisories are in place for Lake Ontario American eel, channel catfish, carp, lake trout, rainbow trout, chinook salmon, coho salmon over 21 inches, brown trout over 20 inches, and white perch (west of Point Breeze). "Eat no more than one meal per month" advisories are in effect for Lake Ontario white sucker, coho salmon less than 21 inches, brown trout less than 20 inches, and white perch (east of Point Breeze). "Eat no more than one meal per week" advisories are in effect for many Lake Ontario fish species not listed above. In addition, an "Eat none" advisory, which applies to all Lake Ontario fish, is in effect for all women of childbearing age and children under the age of 15. This stringent advisory is designed to protect these sensitive human populations from any increased exposure to toxic contaminants.

In addition to these lakewide consumption advisories caused by organic contaminants, it is worth noting that a considerable number of local advisories have existed in Canadian waters due to mercury. Mercury advisories were reported for nine species of fish, including walleye, in fourteen locations. Walleye is an important recreational fishery in the eastern end of Lake Ontario. Fish consumption advisories are periodically reconsidered if new information suggests that more restrictive advisories are necessary to fully protect human health or if contaminant levels have dropped below guidelines.

<u>Wildlife Consumption Advisories</u>

Diving ducks, such as mergansers, feed on fish and other aquatic organisms and, as a result, tend to be the most heavily contaminated waterfowl. New York has a statewide advisory recommending that mergansers not be eaten and that the consumption of other types of waterfowl be limited to no more than two meals per month. The New York State Health Department also advises that wild waterfowl skin and fat should be removed before cooking and that stuffing be discarded. The contaminants of concern for Lake Ontario mergansers in New York are PCBs, DDT, and mirex.

Snapping turtles are another example of a high level predator that is near the top of the food chain. Over their relatively long life span, snapping turtles can accumulate significant levels of persistent toxic substances in their fatty tissues. New York's statewide advisory recommends that women of childbearing age, and children under the age of 15, "eat no" snapping turtles, and recommends that others who choose to consume snapping turtles should reduce their exposure by trimming away all fat and discarding the fat, liver, and eggs prior to cooking the meat or preparing the soup. This advisory is based on PCBs, as the primary contaminants of concern.

Studies conducted by the Canadian Wildlife Service of Environment Canada have shown contaminant levels in ducks and turtles to be below guidelines. There are no consumption advisories for wildlife species in the Canadian portion of the Lake Ontario basin.

4.4.2 "Degradation of Wildlife Populations" and "Bird or Animal Deformities or Reproduction Problems"

The two impairments, "degradation of wildlife populations" and "bird or animal deformities or reproduction problems", are addressed together in this section since past declines in some wildlife populations have been directly related to contaminant-related reproduction problems. The Four Parties have agreed that wildlife population and reproduction impairments are lakewide impairments caused by PCBs, dioxin equivalents, and DDT. Wildlife used in the evaluation of this beneficial use indicator included mink, otter, bald eagles, and colonial water birds. These species were chosen because of historical, documented problems associated with contaminants or other non-chemical stressors. These species are useful indicators of environmental conditions because of their high level of risk due to being at or near the top of the food chain or requiring special habitat in order to reproduce successfully.

At the time of the BUI determination, there was indirect evidence that bald eagle, mink, and otter populations remained degraded along the Lake Ontario shoreline. Levels of PCBs, dioxins, and DDT and its metabolites in the food chain were thought to be important factors limiting the recoveries of these wildlife populations. There was no indication at that time that existing levels of contaminants in the open waters were degrading fish populations.

<u>Bald Eagles</u>
Bald eagle populations began to decline in the early 1900s due to hunting and loss of habitat. In the decades following the introduction of DDT in 1946, contaminant-induced eggshell thinning lowered reproductive success throughout North America, including the Lake Ontario basin. During the 1980s, after DDT and other pesticides were banned, a few successful bald eagle nesting territories were re-established in the Lake Ontario basin. By 1995, bald eagles had recovered to the point that they were moved from the U.S. endangered species list to the threatened species list. There were at least six successful bald eagle nesting territories in the Lake Ontario basin at that time that fledged more than sixty eaglets since 1980 (Nye, 1979, 1992). Although there were no nesting territories located close to the Lake Ontario shore, it was expected that bald eagles would reoccupy historical shoreline nesting territories as their population steadily expanded, provided appropriate nesting habitat was available. In 1992, a survey of the entire Lake Ontario shoreline (both Canadian and U.S. sides) for suitable breeding habitat for bald eagles was conducted by Environment Canada, the Ontario Ministry of Natural Resources, and U.S. bald eagle experts.

There was indirect evidence that bald eagle reproduction in the Lake Ontario basin was impacted by persistent toxic contaminants. Studies of bald eagles nesting on other Great Lakes shorelines suggested that levels of PCBs, dioxins, and DDT in the Lake Ontario food web may have caused lowered reproductive success, increased eaglet deformities, and early adult mortality (Best, 1992; Bowerman et al., 1991). This could be a concern as shoreline nesting territories become re-established and the eagles feed on contaminated fish during the nesting and breeding season.

<u>Colonial Waterbirds</u>
Colonial waterbirds have a long history of being used as indicators of contaminant effects on Lake Ontario and throughout the Great Lakes (Gilbertson, 1974; Mineau et al., 1984). In the 1970's, Gilbertson (1974, 1975) and Postupalsky (1978) found highly elevated contaminant levels in eggs, severe eggshell thinning, elevated embryonic mortality, high rates of deformities, declining population levels, and total reproductive failure among several species of colonial waterbirds on Lake Ontario. Although many of these conditions had improved substantially at the time of the BUI determination, [e.g., concentrations of PCBs, dieldrin, total DDT, mirex, mercury, and dioxins had declined significantly in herring gull eggs and, to a lesser extent, in cormorants and Common and Caspian Terns (Weseloh et al.,

1979, 1989; Ewins and Weseloh, 1994; Bishop et al., 1992; Pettit et al., 1994), eggshell thickness had returned to normal (Price and Weseloh, 1986; Ewins and Weseloh, 1994), and population levels had increased (Price and Weseloh, 1986; Blokpoel and Tessier, 1996)], the status of some of these conditions was unknown at that time and some new issues had arisen (physiological biomarkers, endocrine disruption, genetic deformities) in birds as well as in other classes of wildlife. These issues will be the subject of future studies, the results of which will be considered by the LaMP.

Mink & Otter

As with the bald eagle, there was indirect evidence at the time of the BUI determination which suggested that reproduction of Lake Ontario mink in nearshore areas was affected by persistent toxic contaminants. Laboratory studies corroborated that levels of PCBs and dioxin-like contaminants in the food chain may have been limiting the natural recovery of both mink and otter populations.

Settlement, trapping, and habitat losses during the eighteenth century are believed to have contributed to major population declines for both species. Prior to these changes, the river otter had one of the largest geographic ranges of any North American mammal and was found in all major U.S. and Canadian waterways.

In the 1960s, reproductive failures of ranch mink that had been fed Great Lakes fish led to the discovery that mink are extremely sensitive to PCBs (Hartsough, 1965; Aulerich and Ringer, 1977). Laboratory experiments had shown that a diet of fish, with PCB or other dioxin-like contaminant levels comparable to those found in some Lake Ontario fish, can completely inhibit mink reproduction. However, the fact that mink are highly opportunistic and may rely on muskrat, rabbits, and mice for the bulk of their diet in some locales made it difficult to estimate the impact that environmental contaminants were having on the populations of this species. Otters, on the other hand, rely almost exclusively on fish for their diet, but there was little information on the sensitivity and exposure of otters to PCBs and other contaminants.

Information on mink and otter population trends and reproductive rates was extremely limited, which made it difficult to evaluate their status. Harvest statistics from trappers was the only indicator of population trends. This is a poor indicator as it is influenced by weather, fur prices, disease, and other factors that are not related to health and population status. Field studies of mink and otter populations are extremely labor intensive and not always successful given the secretive nature of these animals. Investigators often need to rely on secondary indicators of presence in an area, such as tracks and scat.

4.4.3 Loss of Fish and Wildlife Habitat

The Four Parties agreed that loss of fish and wildlife habitat is a lakewide impairment caused by artificial lake level management, the introduction of exotic species, and physical loss, modification, or destruction, such as deforestation and damming of tributaries. Binational evaluations were initiated to evaluate potential options to mitigate these impacts. An evaluation of habitat conditions from 1980 to 1990 did not identify persistent toxic substances as a significant cause of lakewide habitat loss or degradation.

Artificial Lake-Level Management

There is considerable evidence that the management of lake levels has inadvertently reduced the area, quality, and functioning of some Lake Ontario nearshore wetlands. Nearshore wetlands are important to the ecology of the lake because they provide habitat necessary for many species of fish and wildlife to successfully live and reproduce. These wetlands may be unique or of limited quantity in the number and types (diversity) of plants and soil benthic type (i.e., rocks, sand, or silt). Without wetlands of suitable quality and quantity, many species of fish and wildlife would be at risk. There is also significant concern among the citizens living along the shoreline of Lake Ontario that lake level management is causing increased erosion and property loss. High lake levels are associated with accelerated rates of erosion and property loss in areas susceptible to lake-induced erosion.

Lake level management was first recommended to limit flooding and erosion in the Lake Ontario basin and to prevent flooding of major metropolitan areas along the St. Lawrence River, such as Montreal. Lake Ontario level and St. Lawrence River flow regulations are also used to benefit commercial navigation and hydropower production. The International Joint Commission (IJC) was established in 1909 by the Boundary Waters Treaty to serve as an impartial group with jurisdiction over boundary water uses. The IJC consists of three U.S. members appointed by the President of the United States and three Canadian members appointed by the Prime Minister of Canada. Plans to artificially manage Lake Ontario water levels began in 1952 when the IJC issued an Order of Approval to construct hydropower facilities in the international reach of the St. Lawrence River at Cornwall, Ontario and Massena, New York. The hydropower facilities were completed in 1960. The IJC amended its order in 1956 to include regulation criteria designed to reduce the range of lake levels and to protect riparian and other interests downstream in the Province of Quebec. This amended order also established the International St. Lawrence River Board of Control to ensure compliance with provisions of the Orders. The St. Lawrence Board consists of ten members chosen by the IJC for their technical expertise.

Lake levels are currently regulated by Plan 1958-D. This plan sets maximum and minimum flow limitations which change week to week to provide adequate hydropower production and, at the same time, maximize depths for navigation and provide protection against flooding in the St. Lawrence River. Authorization may be requested by the Board to deviate from Plan 1958-D when supplies are greater or less than those upon which the plan was developed. During the development of this plan, environmental and recreational factors were not considered. As recommended by the IJC’s Levels Reference Study Board, the St. Lawrence Board has been investigating the possibility of changing the current plan and/or procedures to better address environmental and recreational concerns.

Several environmental issues have been identified in studies completed by the Levels Reference Study Board in 1993. As a result of lake level management, Lake Ontario wetlands are no longer experiencing the same range of periodic high and low water levels. This reduction in range has resulted in some wetlands becoming a monoculture of cattails -- a greatly reduced biodiversity of nearshore areas. In addition, the current four foot range in fluctuation for Lake Ontario is too narrow to preclude cattail overpopulation by modifying the timing of water level highs and lows from their natural cycle. This can have a devastating effect on wetlands, often resulting in too little water for fish and wildlife reproduction purposes, but has provided benefits to recreational and commercial boating.

Further studies, which will take a number of years to complete, are underway to identify possible ways to improve the lake level management scheme, to be more sensitive to environmental needs, as well as public health and economic needs. Regulation of lake levels is difficult because changes in precipitation rates and winter ice cover are unpredictable and limit our ability to manage water levels. Shoreline erosion is a natural occurrence caused by the energy present in water at the shoreline. The nature of erosion that may occur is related to the soil type and elevation, wind, current, and water level at the time. Where the energy in the water can be absorbed, erosion will be slow, but where the makeup of the shoreline is unstable, the effects of erosion take place more quickly. Erosion of certain areas of Lake Ontario’s shoreline is a natural process that will inevitably occur.

<u>Exotic Species</u>
It is difficult to assess the interactions between newly introduced exotic species, naturalized exotic species, and native species. This evaluation is further complicated by other chemical and physical changes that are taking place in the basin. It was clear, however, at the time of the BUI assessment, that exotic species were having a significant impact on the Lake Ontario ecosystem.

The Lake Ontario ecosystem has endured several waves of invasions of exotic species. Some of these species, such as the sea lamprey, have clearly had a negative impact on native species. In fact, sea lamprey predation on lake trout is recognized as one factor that contributed to the demise of that species. The United States-Canadian Great Lakes Fishery Commission was established primarily to control the sea lamprey. Through its efforts, the observed rate of lake trout woundings or mortalities by sea lamprey is now sufficiently low to allow achievement of other fishery management objectives. Currently, with the continuation of control efforts, the sea lamprey is not considered a major limiting factor for the recovery of native fish.

Unlike the sea lamprey, other exotic species have become important components of the Lake Ontario food chain. These species include smelt and alewife, which are now the dominant forage fish. More recently invading exotic species that have potentially significant adverse impacts on the ecosystem include zebra mussels, ruffe, round goby, blueback herring, *Bythotrephes* and *Cercopagis* (the spiny and fish-hooked water flea). Although the ruffe, round goby, and blueback herring were present in the Great Lakes basin at the time of the BUI assessment, they had not yet reached Lake Ontario. At the time, it was believed that the round goby and blueback herring would likely be reaching Lake Ontario in the near future.

Zebra and quagga mussels have altered the Lake Ontario ecosystem by redirecting nutrients flowing through the system from the pelagic to the benthic food web. This shunting of energy to the benthic food web can reduce productivity in the open lake. Although these changes may resemble natural historical conditions, they are having a negative impact on the naturalized open lake forage fish (alewife and smelt) and predators that are dependent upon those species as a food source. Zebra mussels appear to increase the bioaccumulation of toxic chemicals into food chains and decrease macroinvertebrate prey of whitefish and slimy sculpin. They also negatively impact beach use, and they appear responsible for declines in native clam populations. In addition, there are increased maintenance costs associated with keeping drinking water and cooling water intakes free of these mussels. Zebra mussels do have some positive effects, including improved water clarity; the development of mussel shell bottoms favorable to certain macroinvertebrates; increases in native benthic forage fish; and increased survival in young native lake trout, lake whitefish, and potentially lake herring.

It is exceedingly difficult and costly to control exotic species after they have been introduced to an ecosystem, so control programs have concentrated on preventing new introductions and inhibiting the spread of existing species. An important component of these control programs is the regulation that requires ocean-going ships to exchange their ballast water at sea before entering the St. Lawrence Seaway. This requirement seeks to ensure that any exotic species present in the ballast water will not be released into the Great Lakes. It is believed that zebra mussels, the round goby, and the ruffe were all introduced to the Lakes in this way.

The United States and Canadian Coast Guards are working to limit the introduction of non-indigenous species through transoceanic shipping. In addition to the ballast water exchange requirement, chemical treatment measures may be necessary to deal with any organisms that may be left in the tanks after ballast water exchange.

<u>Physical Loss or Destruction of Habitat</u>

The early colonists began to alter the seasonal flows of Lake Ontario tributaries by clearing land. As the land was cleared, water temperatures began to rise, siltation increased, and aquatic vegetation (which provides cover for young fish) was lost. Further, the damming of Lake Ontario tributaries and streams impeded migration of salmon and other native species to their spawning and nursery grounds. The combined impacts of all these factors were devastating to nearshore, tributary, and wetland habitats.

Wetlands provide vital habitat to many species of Lake Ontario's wildlife. It has been estimated that about 50 percent of Lake Ontario's original wetlands throughout the watershed has been lost. Along the intensively urbanized coastlines, 60 to 90 percent of wetlands have been lost. These losses are a result of the multiple effects associated with urban development and human alterations, such as draining wetlands to establish agricultural land, marina construction, dyking, dredging, and disturbances by public utilities. Natural processes, such as erosion, water level fluctuations, succession, storms, and accretion, contribute to the loss of wetlands as well.

At the time of the BUI assessment, approximately 80,000 acres of Lake Ontario's wetlands remained. The largest expanses are still located in the eastern portion, along the coastline of Presque'ile Bay's Provincial Park in Ontario and in Mexico Bay in New York. The pressures of urban and agricultural development continue to threaten wetlands as the public wishes to locate along the lakeshore, have larger marinas in river mouths, achieve more efficient stormwater removal from streets and properties, or till marginal wetlands in the watershed during dry years. Major government initiatives, including education and regulatory controls, have done much to reduce or prevent the loss of wetlands. More than 20 percent of Lake Ontario's wetlands are fully protected (parks) while additional areas are subject to a variety of municipal, state/provincial, or federal rules, regulations, acts, or programs. Stemming continued losses of wetlands requires action at the most efficient level of organization, and opportunities to protect, restore, or replace these valuable habitats need to be explored.

4.4.4 Degradation of Benthos

Benthic macroinvertebrates are small insect-like organisms that live in the bottom sediments of the lake and are an important food source for many types of fish. Dramatic changes have occurred within Lake Ontario's benthic community since the 1950s due primarily to significant reductions in nutrient loadings and changes in the numbers and types of fish that feed on benthic organisms. These impacts may have overshadowed any past or present lakewide impacts from toxic contaminants.

Studies completed shortly before the second BUI assessment in 2002 have given us a better picture of the potential impacts of the contaminants in Lake Ontario sediment on benthic communities. Sediment samples were collected throughout Lake Ontario in 1997. Pollution sensitive benthic organisms were then exposed to these sediments under laboratory conditions to evaluate sediment toxicity. Results showed that contaminant concentrations in lake bottom sediments posed little to no acute toxic threat to these sensitive test organisms. Additional information will be needed to assess the potential for contaminants to have long-term chronic impacts on these organisms.

Although contaminant-related impacts on benthos are not a concern for the open lake, localized toxic contaminant impacts on benthic organisms have been documented in some Lake Ontario Areas of Concern with elevated levels of sediment contamination. These problems are being addressed through local Remedial Action Plans.

It is clear that the introduction of the zebra mussel in the late 1980s has had a detrimental impact on Lake Ontario benthos. The Quagga mussel, a more recent arrival, is capable of living in colder, deeper waters than the zebra mussel. These mussels filter water to feed on microscopic phytoplankton and other organic material, thereby reducing the amount of food available to other benthic organisms. The filtering action of the mussels has contributed to the dramatic improvements in water clarity. At the same time, populations of important native benthic organisms have generally declined. Section 10.2.1 provides further information regarding the zebra and Quagga mussels.

Prior to the arrival of the zebra mussel, populations of *Diporeia* were the dominant benthic organisms in the lake. Typically, a few thousand of these organisms were present in a square meter of lake bottom and provided an important source of food for fish. A decade after the zebra mussel invasion, fewer than ten of these organisms can be found per square meter in waters up to 200 meters deep. This means there is less food to support lake trout, white fish and other fish. Although the mussels are suspected to be the cause of these declines, a clear cause-effect relationship has yet to be established.

Some less important nearshore native benthic species have benefited from the zebra mussel invasion. Populations of some shallow water (less than 10 meters-deep) native benthic organisms that prefer the habitat created by zebra mussel shells and can feed on the mussel's waste products have increased. Nearshore fish, such as perch and smallmouth bass that feed on these organisms, are benefiting from the increase in these benthic populations.

Following the 2002 BUI assessment, additional studies of Lake Ontario benthic organisms, phytoplankton, and zooplankton were initiated to develop a better understanding of the rapid changes occurring in Lake Ontario's foodweb.

4.4.5 Degradation of Nearshore Phytoplankton Populations

Healthy and balanced communities of phytoplankton and zooplankton are essential components of all normal aquatic ecosystems. Without these microscopic plants and animals, there would be no fish in lakes. Lake Ontario phytoplankton and zooplankton data have been collected during the past few decades as part of Canadian and U.S. monitoring programs. Changes in the structure of plankton communities and their relationship to nutrient levels have been examined in nearshore, offshore, and embayment habitats in order to better understand whole-lake processes.

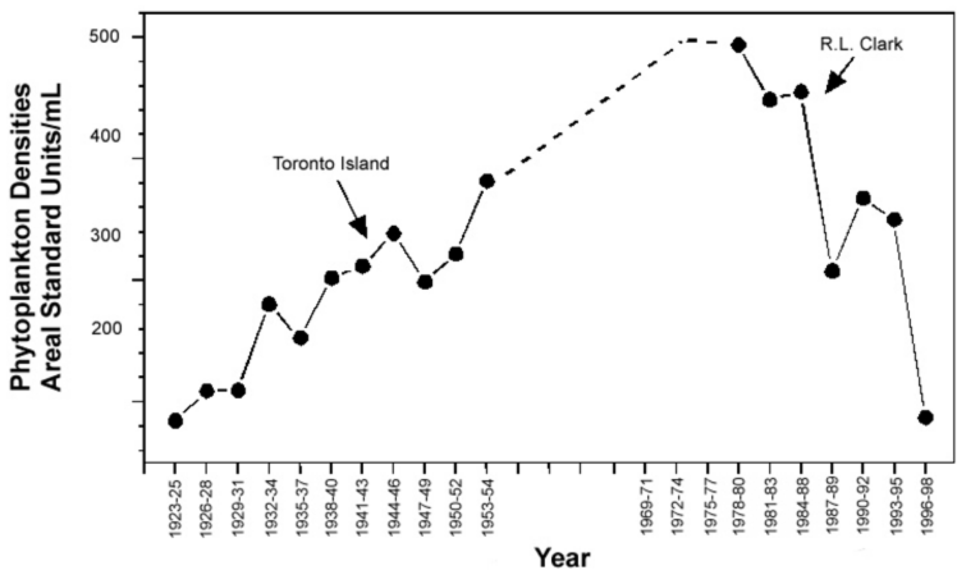
In recent decades in Lake Ontario, these communities have been influenced by reductions in inputs of phosphorus from municipal waste treatment facilities, invasions by exotic species and changes in fish communities. As with the benthic community, these changes may have overshadowed any impacts that contaminants may have had on phytoplankton and zooplankton populations in the past. There is no indication that current levels of contaminants pose a concern for phytoplankton and zooplankton populations. However, through bioaccumulation even low concentrations of contaminants in phytoplankton and zooplankton can pose concerns for higher level predators such as fish and waterbirds. At the time of the 2002 BUI assessment, the potential impacts of exotic mussels and predatory zooplankton were recognized as the greatest threat to these native populations.

Phosphorus and Phytoplankton

The Lake Ontario phytoplankton community is controlled by both nutrient supply, typically measured in terms of total phosphorus, and by the size of zooplankton populations that feed on phytoplankton. During the 1940s to the 1970s excessive discharges of nutrients from agriculture and wastewater discharges resulted in abnormally high Lake Ontario phosphorus levels. The result was an explosion in the growth of phytoplankton and algae creating severe water quality problems. The U.S. and Canada implemented phosphorus controls at wastewater treatment plants beginning in the 1970s and reduced total phosphorus levels in the open lake by 30 percent over a 15-year period. Nearshore waters that had the highest nutrient levels saw declines in phosphorus levels well over 50 percent.

Several long-term studies have documented changes in phytoplankton. Collections of phytoplankton samples from Toronto drinking water intakes provide a historical perspective on long-term trends and their response to changing nutrient levels (Figure 4.1). These collections show that phytoplankton densities doubled between the 1920s and the 1950s in response to increasing and excessive nutrient levels. Beginning about 1980, this trend was reversed reflecting the success of phosphorus controls which have maintained open lake total phosphorus concentrations at or below a level designed to prevent nuisance growths of algae.

Figure 4.1 Phytoplankton Densities from Toronto-based Lake Ontario Water Treatment Plant Intakes, 1923 – 1998



Source: Nicholls 2000.

Since the arrival of the zebra mussel, there has been concern that this species could alter the Lake Ontario foodweb in a number of ways. The impacts of the filtering action of zebra mussels on nearshore phytoplankton densities were seen as early as 1992. By 1998, zebra mussel feeding apparently had reduced phytoplankton densities by more than 90 percent in some inshore areas. The composition of phytoplankton communities also changed, with edible types of algae decreasing and less edible forms increasing.

Normally chlorophyll-a concentrations are directly proportional to nutrient levels. However, at the time of the 2002 BUI assessment, an apparent “decoupling” of chlorophyll-a and nutrients was observed in some nearshore waters where increases in nutrients were not accompanied by expected increases in chlorophyll-a. It was suspected that this decoupling reflected grazing activity by zebra and quagga mussels.

Research continues to provide a better understanding of seasonal changes in phytoplankton populations in nearshore and offshore waters and embayments. Studies undertaken in the mid-1990s in Canadian waters found that nearshore spring phytoplankton densities were six to eight-times higher than summer densities at the eastern end of the lake. Offshore stations showed much less difference between spring and summer phytoplankton biomass. Spring phytoplankton density peaks were confined to April and May at eastern Lake Ontario nearshore sampling locations, but often extended into June at western sampling sites, indicating higher nutrient levels related to Niagara River inputs. With continued declines in nutrients entering Lake Ontario via the Niagara River, recent studies now find little difference between eastern and western Lake Ontario nutrient levels.

Zooplankton

The structure and population levels of zooplankton communities are strongly controlled by phytoplankton levels and by the size and distribution of prey fish that feed on them (such as alewife and smelt). Prey fish may have been the most important controlling factor in the 1980s and early 1990s when their populations were much higher than current levels. Declining nutrient levels also played a role. Although the total zooplankton biomass decreased significantly between 1981 and 1987 as nutrient levels fell, the composition of the zooplankton community changed very little in the main lake.

The transport of exotic zooplankton by oceangoing freighters to the Great Lakes remains an on-going threat to Lake Ontario. *Bythotrephes* longimanus (the spiny water flea) was discovered in Lake Ontario in 1982, followed by the zebra mussel in 1989. A decade later in 1998, Cercopagis pengoi (also known as the fishhook flea, a zooplankton native to the Ponto-Caspian region of Europe) was discovered in Lake Ontario. Both *Bythotrephes and Cercopagis* are predatory cladocerans that feed on smaller native zooplankton. *Bythotrephes* is generally very rare in the lake; however, *Cercopagis* populations develop each summer throughout the surface waters of the lake. The potential impact that these predatory zooplankton will have on Lake Ontario zooplankton communities is not well understood at this time. In addition, it is anticipated that reductions in phytoplankton densities due to zebra and quagga mussel filtering may result in smaller zooplankton populations, particularly in nearshore regions.

Research has provided a better understanding of seasonal changes in zooplankton populations in nearshore, offshore and embayments. Studies carried out around the time of the 2002 BUI assessment in U.S. waters of Lake Ontario indicated that embayments are very productive habitats compared to nearshore and offshore areas. Embayment phosphorus concentrations were nearly twice those in nearshore and three times those in offshore areas. Embayment chlorophyll-a and zooplankton density were higher than both nearshore and offshore habitats. This suggests that embayments may be an important source of food for developing fish.

4.5 Unimpaired Lakewide Beneficial Uses in Lake Ontario

The LaMP's Stage 1 beneficial use assessment determined that the following beneficial uses were unimpaired on a lakewide basis:

- Tainting of fish and wildlife
- Degradation of fish populations
- Fish tumors
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Drinking water restrictions or taste and odor problems
- Beach closings
- Added costs to agriculture and industry

The following sections provide the basis for these determinations.

4.5.1 Tainting of Fish and Wildlife Flavor

The contamination of surface waters by certain types of organic contaminants, such as the class of chemicals known as phenols, can taint fish and wildlife flavor. During the 1950s, 1960s, and 1970s, levels of phenols near the mouth of the Niagara River often exceeded standards designed to prevent tainting of fish and wildlife flavor. Since that time, improvements in wastewater treatment systems have dramatically reduced the amounts of these substances being discharged to surface waters. Today, levels of phenols are well below levels of concern.

At the time of the Stage 1 beneficial use assessment, there were no existing reports that indicated tainting of fish and wildlife flavor was a concern for the open waters of Lake Ontario. Neither was this potential impairment identified as a problem in any nearshore areas of the lake. Evaluating this type of impairment is difficult given the very subjective nature of taste. Studies have shown that fish consumers cannot consistently detect the difference between tainted and non-tainted fish. The length of time and preservation methods used before cooking fish can also contribute to taste problems.

4.5.2 Degradation of Fish Populations

The loss of several fish species and reductions in native fish populations between the early 1800s and the 1960s are attributed primarily to overfishing, loss of habitat, and the impact of exotic species, such as the sea lamprey and alewife. The loss of some species, such as the blue pike, an important predator, has permanently altered the Lake Ontario ecosystem. The contribution of persistent toxic contaminants to the loss of certain fisheries is unclear because fish populations were already severely degraded by the time that significant levels of contaminants began to be released to the environment. At the time of the BUI assessment, levels of contaminants in Lake Ontario did not appear to have had a measurable impact on fish reproduction, as fish culture facilities obtained eggs from Lake Ontario salmon and trout to support stocking programs. Successful culture of these species in the hatchery environment suggested that they were capable of natural reproduction in the wild. However, a sustained population of lake trout had been difficult to re-establish naturally. This was due to excessive predation by alewife on lake trout eggs and fry; degradation of spawning habitats; unsuitable genetic backgrounds of some stocked fish; excessive harvest; and potential sub-lethal impacts of toxic substances. A possible vitamin deficiency problem impacting lake trout and salmon, due to their reliance on alewife as their principal prey, was also a factor inhibiting the natural reproduction of these fish. With declining nutrient levels and decreasing alewife populations, record numbers of naturally reproduced lake trout yearlings were observed in 1995.

Although levels of toxic contaminants, such as dioxin, were generally acknowledged at the time of the IBU determination to be below toxic levels for lake trout fry, some research suggested that Lake Ontario dioxin concentrations in water and sediment during the 1940s and 1950s may have been sufficiently high to prevent lake trout reproduction. Research will help us to recognize and better understand any potential synergistic or additive effects of contaminants on current fish populations.

At the time of the assessment, populations of walleye, lake whitefish, and burbot were continuing to increase, and there were several year classes of lake herring. There had been increasing reports of native fish catches that were thought to be extinct or severely depleted (e.g., deep water sculpin, lake sturgeon, and stickleback). This information suggested that the ecological stage was set for significant recovery of native Lake Ontario fish species, barring any major unforeseen changes in the food web.

4.5.3 Fish Tumors

Fish tumors are more common in some species of nearshore fish, such as brown bullheads and white suckers, than others; however, it is very difficult to determine what the natural tumor incidence rate is for a particular location (Hayes et al., 1990). Relatively high levels of tumors can be found in fish from both clean and polluted water bodies. For example, skin and liver tumors have been documented in fish taken from relatively pristine drinking water reservoirs in New York and Pennsylvania, where no elevated levels of carcinogens [such as polycyclic aromatic hydrocarbons (PAHs)] have been detected in sediments or water (Bowser et al., 1991). This fact complicates the process of selecting a control or background site to which the incidence of fish tumors in a contaminated area can be compared. Viruses, genetic differences, and naturally occurring carcinogens, in addition to chemical contaminants, are thought to have a role in fish tumor development.

The presence of tumors in Lake Ontario fish was first noted in the early 1900s before persistent toxic contaminants became a problem in the lake. Liver tumors were first identified in wild fish in the 1960s. However, a temporal correlation between any change in the incidence of fish tumors and the onset of the severe environmental contamination problems of the 1960s cannot be firmly established because the first detailed studies of fish tumors in Lake Ontario were not conducted until the 1970s.

A 1996 collection of spawning walleye in the Salmon River, a tributary of the Bay of Quinte, found that the frequency of liver tumors increased with the age of the fish and was more prevalent (87.5%) in female walleye greater than 14 years of age. The frequency-age relationship is comparable to previous walleye collections in the St. Lawrence River. The tumors are non-invasive and it is possible that the tumors are a naturally occurring phenomenon in old walleye. However, before any interpretation of probable cause can be made, it will be necessary to determine the rates of liver tumors in similarly aged walleye from other more pristine habitats.

Contaminant-related fish tumors would be expected to be most prominent in Lake Ontario AOCs where there are generally higher contaminant levels than in open water areas. To date, Hamilton Harbour is the only Lake Ontario AOC which lists this impairment. The Oswego Harbor AOC completed a fish tumor study shortly before the BUI assessment that found no impairment. The Toronto and Region, Bay of Quinte, and Eighteenmile Creek AOCs have each indicated that additional information is necessary to fully evaluate the status of this impairment. As there were few reports of tumors in open water fish, fish tumors were not considered to be a lakewide impairment in the Stage 1 beneficial use assessment. The lakewide status of this impairment will need to be periodically evaluated as new information is developed on the incidence of tumors in open water fish as well as the role of contaminants and other factors involved in fish tumor development.

4.5.4 Restrictions on Dredging Activities

Localized areas of sediments with elevated levels of persistent toxic contaminants are found in some Lake Ontario harbors and river mouths. Periodic dredging of these sediments is necessary to maintain shipping and small craft channels. This beneficial use impairment is not considered to be a lakewide impairment because dredging restrictions do not pertain directly to open water areas; however, this impairment is a concern in a number of localized nearshore areas and AOCs.

Criteria that are used to assess dredging activities are not based on whether or not dredging should take place, but rather the mode of dredged material disposal. There are five main ways to dispose of dredged sediments. Clean, uncontaminated sediments can either be placed on beaches or reused along shorelines as fill. The other three methods of disposal, offshore, upland, and confined, are based on the degree of contamination of the sediments. The most highly contaminated sediments require confined disposal in special contaminated sediment facilities. Less contaminated sediments can be stored in landfills or disposed in deep offshore waters.

The Canadian Department of Public Works maintains the register for Canadian dredging data. The register records location of dredging, volume of sediments dredged, disposal methods, and chemical analysis data. Information on dredging activities was registered from 1975 until a few years prior to the Stage 1 assessment, when navigational dredging activities declined in the region. From 1980 to 1985, PCBs exceeded the "marginally polluted level" at Hamilton, Toronto, Oshawa, Whitby, and Point Traverse. Dredging was undertaken from 1985 to 1991 at Grimsby, Whitby, Trenton, Kingston, and four times in Oshawa. Based on Ontario's sediment quality guidelines (1992), PCBs exceeded the "severely polluted level" at Oshawa in 1985, the "slightly polluted level" in 1986, and the "marginally polluted level" in 1991. In 1991, the dredged material was disposed in a closed harbor disposal cell. The Hamilton Harbour, Toronto and Region, Port Hope, and Bay of Quinte AOCs all identify dredging restrictions as an impairment. In addition to organic pollutants, sediment concentrations of heavy metals and conventional parameters, such as nitrogen, phosphorus, and oil and grease, have also been identified as a concern in a number of nearshore areas.

In the United States, the Army Corps of Engineers (USACE) oversees and approves dredging projects in coordination with USEPA. At the time of the Stage 1 beneficial use assessment, there were no restrictions on dredging or dredged material disposal activities in the U.S. waters of Lake Ontario due to contaminated sediments. Sediment dredged from major Lake Ontario harbors met USEPA and USACE guidelines for open water disposal. No dredging restrictions were identified by the RAPs for Rochester Embayment or Oswego Harbor. The only U.S. dredging restriction applied to the type of dredging methods that could be used on the Genesee River. In response to local concerns regarding excessive turbidity levels, dredging techniques that caused excessive turbidity in the river were not allowed. Critical pollutants were not a cause of these limitations.

In February 1998, USEPA and USACE finalized the Inland Testing Manual, which layed out stringent testing protocols for dredged material disposal in inland waters. Then, over the next 12 to 18 months, USEPA and USACE worked with their partners to develop a regional manual to implement the national testing protocol in the New York State portions of Lakes Ontario and Erie. The status of this beneficial use could change if future dredging projects encounter sediments that exceed these new, more stringent testing requirements.

4.5.5 Eutrophication or Undesirable Algae

Eutrophication is a process in lakes that is characterized by an overload of nutrients. It is often accompanied by algal blooms, low oxygen concentrations, and changes in food web composition and dynamics. In Lake Ontario, persistent eutrophication and undesirable algae are no longer causes of lakewide problems. The elimination of eutrophication problems in Lake Ontario during the 1950s and 1960s is largely due to the success of the binational phosphorus reduction programs and improvements in wastewater treatment plants throughout the entire Great Lakes basin. In the summer of 1993, the average Lake Ontario total phosphorus level was 9.7 ug/L, near the GLWQA objective of 10 ug/L for open lake spring conditions (IJC, 1980 and Thomas et al., 1980).

In the 1950s and 1960s, algal blooms and fish die-offs occurred throughout Lake Erie and Lake Ontario, raising concerns about the environmental impacts of excessively high phosphorus levels. In an attempt to remedy this problem, the GLWQA set a target load of 7,000 metric tonnes of phosphorus per year. To measure the success of the reduction programs, additional targets were set: phosphorus concentration (10 ug/L), chlorophyll a (2.6 ug/L), and water clarity (5.3 m in open waters).

In response to the phosphorus control programs, open lake phosphorus concentrations declined from a peak of about 25 ug/L in 1971 to the 10 ug/L guideline in 1985. By 1991, Lake Ontario phosphorus levels were well below the guideline. In addition, at the time of the Stage 1 beneficial use assessment, water clarity had increased by 20 percent, compared to the early 1980s. Likewise, photosynthesis had declined approximately 18 percent, and late summer zooplankton production had declined by 50 percent. All of these were positive changes reflecting an overall shift of the lake back towards its original condition of low nutrient levels.

Although significant progress has been made in reducing eutrophication problems in nearshore areas, this is still a concern in local areas. Each of the Lake Ontario AOCs, with the exception of Port Hope, has identified eutrophication as a local impairment. In New York State, Braddock Bay, Irondequoit Bay, Sodus Bay, East Bay, Port Bay, Little Sodus Bay, Chaumont Bay, and Mud Bay are showing signs of eutrophication. Nutrients from agricultural runoff and on-site waste disposal systems (septic systems) are the most frequently identified sources of the problem. County level environmental planning efforts are providing the lead on controlling these localized eutrophication problems in the U.S.

In conclusion, it appears that eutrophication is no longer a problem in offshore waters. This is largely due to the success of the binational phosphorus reduction programs and improvements in wastewater treatment plants throughout the entire Great Lakes basin. Although substantial improvements have been made in the nearshore areas, eutrophication may still be a significant issue in some local areas.

4.5.6 Restrictions on Drinking Water Consumption, or Taste and Odor Problems

Regular monitoring of the quality of water supplies drawn from Lake Ontario shows that water quality meets or exceeds public health standards for drinking supplies. Open lake surveillance monitoring conducted as part of Canadian and United States research efforts also confirms the high quality of Lake Ontario water.

The largest category of consumer complaints about drinking water, worldwide, is taste and odor problems (AWWA, 1987). Changes in the taste of drinking water may indicate possible contamination of the raw water supply, treatment inadequacies, or contamination of the distribution system. Although there are standards for some parameters that may cause taste and odor problems, such as phenolic compounds, there is considerable variation among consumers as to what is acceptable. Aesthetically acceptable drinking water supplies should not have an offensive taste or smell.

Although there are no drinking water restrictions on the use of Lake Ontario water, some nearshore areas, such as Rochester and the Bay of Quinte, report occasional taste and odor problems. Lake Ontario water suppliers most commonly receive consumer complaints regarding an "earthy" or "musty" taste and odors. Studies conducted by Lake Ontario water suppliers have shown that these problems are related to naturally occurring chemicals, such as geosmin (trans, trans-1,10-dimethyl-9- decalol) and methylisoborneol (MIB), produced by decaying blue-green algae and bacteria. Using chlorine to clear water supply intakes of zebra mussels may also stimulate the production of these taste and odor-causing chemicals. Geosmin and MIB can cause taste and odor problems for sensitive individuals at levels as low as one part per trillion (ppt), well below the detection limits of the analytical equipment currently available to water authorities (2 to 3 ppt). Once identified, taste and odor problems can be eliminated at water treatment plants by the use of powdered activated carbon or potassium permangenate.

Taste and odor problems are more common during algal blooms. Additionally, storm events precipitate these problems by breaking up mats of the green algae Cladophora from their rocky substrate in nearshore areas. Floating mats of Cladophora located in warm shallow water are ideal habitats for blue-green algae and bacteria growth. The presence of these floating mats contributes to taste and odor problems. Localized eutrophication problems in some nearshore areas may also contribute to taste and odor problems.

In summary, taste and odor problems are considered to be a locally impaired beneficial use in some areas. The causes, however, are poorly understood. Naturally occurring algae, eutrophic conditions, and zebra mussel controls may all be important contributing factors.

4.5.7 Beach Closings

Beach closings are restricted largely to shorelines near major metropolitan centers or the mouths of streams and rivers. These closings follow storm events when bacteria-rich surface water runoff is flushed into nearshore areas via streams, rivers, and combined sewer overflows (CSOs). In some instances beaches may be closed based on the potential for high bacteria levels to develop following storm and rain events. Beaches are also closed for aesthetic reasons, such as the presence of algal blooms, dead fish, or garbage. Given the localized nature of beach closings and their absence along much of the Lake Ontario shoreline, they are not a considered lakewide problem.

In Ontario, beaches are closed when bacterial (E. coli) levels exceed 100 organisms/100mL. During recent years (1995 to 1997) beach closings have continued in heavily urbanized areas in the western part of the basin due to storm events, but are less frequent in the central and eastern regions. Examples of ongoing problems include the beaches of the Bay of Quinte, Toronto, Burlington, Hamilton, Niagara, Pt. Dalhouse, and St. Catherines. Upgrading stormwater controls through the installation of collection tanks so stormwater from CSOs can be treated in Toronto and Hamilton should reduce beach closings in these areas.

At the time of the Stage 1 assessment, the only U.S. beach with recent closings was Ontario Beach within the Rochester AOC. These closings were posted due to rain events, storm runoff, excessive algae, waves greater than four feet, or visibility less than one-half meter. At that time, Ontario Beach was routinely closed as a precaution during storm and rain events because these conditions had the potential to cause high bacteria levels along the beach shore. Ontario Beach summer fecal coliform levels were well below the state's action level of 200 fecal coliforms/100mL. The implementation of a combined sewer overflow abatement program resulted in significant decreases in fecal coliform levels in the Genesee River and adjacent shoreline areas. Actions had also been initiated to address stormwater problems that impact other areas of the Rochester Embayment.

4.5.8 Degradation of Aesthetics

At the time of the Stage 1 beneficial use assessment, there were no aesthetic problems in the open waters of Lake Ontario. This can be attributed to the elimination of widespread eutrophication problems and the restoration of water clarity. However, some Lake Ontario AOCs have identified this impairment. Evaluating aesthetic problems is subjective, often based on individual value judgments. Localized aesthetic problems along Lake Ontario shorelines include algal blooms, dead fish, debris, odor, silty water, improper disposal of boat sewage wastes, and litter problems at parks and scenic highway stops.

On the U.S. side, the Rochester AOC has listed silt, odors related to alewife dieoffs, and decaying algae as aesthetic problems. A water quality survey conducted at the Oswego Harbor AOC around the time of the Stage 1 assessment indicated that this beneficial use was not impaired.

On the Canadian side, the Toronto and Region RAP listed debris and litter, turbidity in the vicinity of tributary mouths and landfilling operations, and weed growth along shorelines as aesthetic problems. In addition, the Royal Commission for Toronto's Waterfront noted the continued loss of Toronto area historical buildings and landscapes and the lack of adequate public access to the lake as aesthetic concerns. The Bay of Quinte RAP identified algal blooms as the primary cause of aesthetic concerns. Major causes of aesthetic impairment in Hamilton Harbour included oil sheens, objectionable turbidity, floating scum, debris, putrid matter, and reduced water clarity in shallow areas.

4.5.9 Added Costs to Agriculture or Industry

This is not a lakewide impairment as Lake Ontario waters do not require any additional treatment costs prior to agricultural or industrial use. The Rochester Embayment AOC was the only Lake Ontario AOC to identify this impairment, based on the additional maintenance costs associated with the physical removal of zebra mussels from water intake pipes.

Many industries and municipalities adjacent to Lake Ontario are experiencing zebra mussel infestation in their water intakes. The main treatment for this problem is to use various chlorine compounds, together with other chemicals such as calcium permanganate, to kill the mussels -- an ongoing maintenance cost.

4.6 Actions and Progress

The information contained in this chapter has been compiled based on documents produced up to January 2003. This chapter has not been updated for the LaMP 2004 Report. The LaMP process is a dynamic one and therefore the status will change as progress is made. This chapter will be updated in future LaMP reports as appropriate.

4.7 References

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CHAPTER 5 HABITAT ASSESSMENT AND RESTORATION

5.1 Summary

This chapter provides an overview of the types of habitat in the Lake Ontario basin, status of the habitat, and the restoration and protection activities that have been completed or are still ongoing in the U.S. and Canada. The material presented is based on information that existed as of January 2003.

5.2 Habitat Types of the Lake Ontario Basin

Clean water alone cannot restore the Lake Ontario ecosystem. Habitat of sufficient quality and quantity is essential to achieve the restoration and protection of a fully functioning ecosystem. The Lake Ontario LaMP will work with its partners to identify priority lakewide habitat issues and will work to coordinate government and voluntary efforts so that degraded habitat will not limit the restoration of the Lake Ontario ecosystem.

5.2.1 Habitat Zones and Foodwebs

Habitats that are critical to the health and functioning of Lake Ontario's aquatic foodweb are: (1) nearshore fish spawning grounds; (2) nearshore wetland and coastal bird and fish nesting and spawning grounds; and (3) tributaries. In turn, the lake can be partitioned into two major overlapping and interacting habitat zones: the nearshore and the offshore. The boundary between these two zones is loosely defined as the 15-metre depth contour.

The feeding relationship among the fish and other organisms within each zone is called a foodweb. All aquatic foodwebs depend on the production of microscopic algae (Phytoplankton) that require adequate light and nutrients to thrive. Algae are fed upon by microscopic zooplankton or by bottom-dwelling benthic organisms (that depend on living and dead material that settles to the bottom). Zooplankton and the benthos provide the link from algae to fish and ensure that material is cycled through the foodweb.

5.2.2 Nearshore Habitat

The nearshore zone includes the shallow coastal waters adjacent to shore and all embayments. Within this zone, the degree of wind and wave exposure varies from very shallow protected embayments with little water exchange with the open lake, to exposed coastal areas. Similarly, nutrient levels and the impact of shoreline development varies widely along the coast. The type of aquatic plants, bottom characteristics, water flow, light and temperature found in nearshore zones determines where fish can find food, avoid predation, or spawn.

The importance of the nearshore zone to Lake Ontario fish communities cannot be over-emphasized. With very few exceptions, most Lake Ontario fish species spend part of their life cycle in the nearshore zone. For many species, the earliest and most critical life stages of egg, larvae and juveniles depend on nearshore habitat. The nearshore resident fish community varies with season, the degree of nutrient enrichment, temperature and available habitat. Dominant fish species spending most of their life cycle in the nearshore include walleye, smallmouth and largemouth bass, freshwater drum, yellow perch, white perch, gizzard shad, various minnows, and several sunfish species.

5.2.3 Offshore Habitat

Temperature is a dominant influence on fish distribution in the offshore zone. The development and expansion of the thermal bar in spring (a band of warm nearshore water), the establishment of the thermocline in mid-summer, and the wind driven mixing and movement of water results in large variations in temperature over depths and regions. Mixing of offshore waters results in more uniform water quality, compared to the nearshore. Many fish species associated with the offshore rely on the nearshore zone or tributaries for spawning and nursery habitat for young.

5.2.4 Nearshore Wetlands

Sixty-eight species of fish use coastal wetlands of Lake Ontario, either as permanent residents or for spawning, nursery or feeding during their lifecycle. The ecosystem and fish and wildlife values associated with wetlands are difficult to quantify systematically. However, protection and rehabilitation of wetlands offers improved habitat for fish and wildlife species. Throughout Lake Ontario, water level regulation is a major stress on remaining wetlands. Low levels of variation in water levels are thought to have lead to cattail dominance and reduced species diversity in coastal wetlands. More variable water levels can lead to greater diversity of wetland plant communities and improve fish and wildlife habitat. Other wetland rehabilitation techniques include planting of aquatic vegetation, creating channels in cattail marshes, excluding carp, and local control of water levels through diking.

Since 1960, Lake Ontario's water level has been regulated by a series of dams on the St. Lawrence River. Water levels are determined by the International Joint Commission (IJC) under a formula that seeks to balance a number of interests. Many biologists believe that water level regulation has had serious and lasting impacts on Lake Ontario's natural resources, including fish and wildlife (particularly shorebirds and spawning fish), shoreline habitat and dune barrier systems, and the numerous wetland complexes that line the shoreline. The full range of these impacts, however, has never been documented. The IJC is now in the second year of a five-year binational study to estimate the impacts that water level regulation has had on shipping, riparian property owners, boating and natural resources.

5.2.5 Tributaries

Recent observations of large numbers of wild chinook salmon and rainbow trout in tributaries have increased the recognition of the potential for greater contribution from wild fish. The main spawning and nursery habitats for approximately one-third of the fish species in the Great Lakes are located within tributaries. The value of most tributaries to Lake Ontario, for migratory trout and salmon spawning and nursery use, has been limited by barriers blocking access, poor water and habitat quality, and unsuitable flow regimes. Stream rehabilitation programs, management of fish passage, and storm water management can improve the spawning and nursery habitat for cold water fish species and increase wild production. Land use practices that better control erosion can reduce run-off of sediments and associated nutrients and contaminants into streams, and act in concert with other water quality control programs.

5.3 Current Status of Basin Habitat

It has been estimated that since colonial times about 50 percent of Lake Ontario's original wetlands have been lost. Along intensively urbanized coastlines, 60 to 90 percent of wetlands have been lost. These losses are a result of the multiple effects associated with urban development and human alterations, such as draining wetlands to establish agricultural land, marina construction, diking, dredging, and disturbances by public utilities. Currently, approximately 80,000 acres of Lake Ontario's wetlands remain. The largest expanses are located in the eastern portion, along the coastline of Presqu'ile Bay and Bay of Quinte in Ontario and Mexico Bay in New York. More than 20 percent of Lake Ontario's wetlands are fully protected in parks, while additional areas are subject to a variety of municipal, state/provincial or federal rules, regulations, acts or programs. Opportunities to protect, restore or replace these valuable habitats need to be explored.

Several Lake Ontario basin habitat assessments and inventories have been conducted by U.S. and Canadian governments over the last few decades.

On the U.S. side, the 24,720-square mile U.S. portion of the Lake Ontario basin, from the St. Lawrence River and including the Niagara River corridor, is diverse in fish and wildlife habitat. The St. Lawrence River supports habitat for the lake sturgeon. Along the shoreline are sand beaches, sand dunes, and wetlands including fens and coastal marshes, significant habitats for shorebirds, raptors, passerines, and waterfowl. Black terns and common terns nest and forage in the marshes. Sprinkled at the western end of the lake, alvars, which are areas of flat limestone bedrock where soils have been scraped away by ice, wind, and water, are habitats for grasses, wildflowers, mosses, lichens, stunted trees, and specialized birds and invertebrates. Upland are forests of oak, ash, white cedar, and hickory.

Threats to fish and wildlife habitats are physical, biological and chemical. Controlled lake levels are having a profound impact on shoreline habitats. For example, sand transport mechanisms needed to nourish sand beaches, dunes, and coastal wetlands have been disrupted. Shoreline development has impacted terrestrial and aquatic habitats. Non-indigenous invasive species are replacing native species in both terrestrial and aquatic habitats. Swallo wort, for example, an invasive weed, is threatening the native plants of limestone communities. Urban and agricultural runoff may impact tributary and harbor habitats.

The current status of fish and wildlife habitats that takes into account natural resource values and threats is incomplete. Efforts are now underway to assess particular habitats by a number of agencies and organizations. The U.S. Fish and Wildlife Service is continuing to update endangered species, wetland inventory, and aquatic habitat information and inventories. Regional bird conservation mapping being undertaken by Vermont University will help to characterize habitat used by songbird migrants. The Nature Conservancy is completing its second iteration of ecoregional planning that defines habitat protection and restoration needs for a number of Lake Ontario sites. Local watersheds and partnerships, such as the Ontario Dunes Coalition, are conducting assessments of local natural resources and threats.

On the Canadian side, a recently completed assessment of the status of Canadian habitat in the Lake Ontario basin developed the following findings:

- Nearshore terrestrial habitats in a natural state (such as forests, dunes, beaches and shorecliffs) are in very limited supply and are continuing to decline further. There are many examples of specialized lakeshore natural communities lacking long-term protection. Coastal wetlands have been heavily impacted by historic development activities and remaining wetlands are threatened by habitat alteration, water level controls and sedimentation. The regulation of lake levels since 1960, together with hardening of shoreline areas, have degraded natural shoreline processes (such as erosion and sand transport) affecting the health of nearshore habitats.
- One area of improvement relates to tributary habitats: suspended sediment loadings have declined in most tributaries over the past 26 years. On the other hand, an increasing variability of streamflow is being measured in watersheds associated with intensive agricultural and urban land uses.

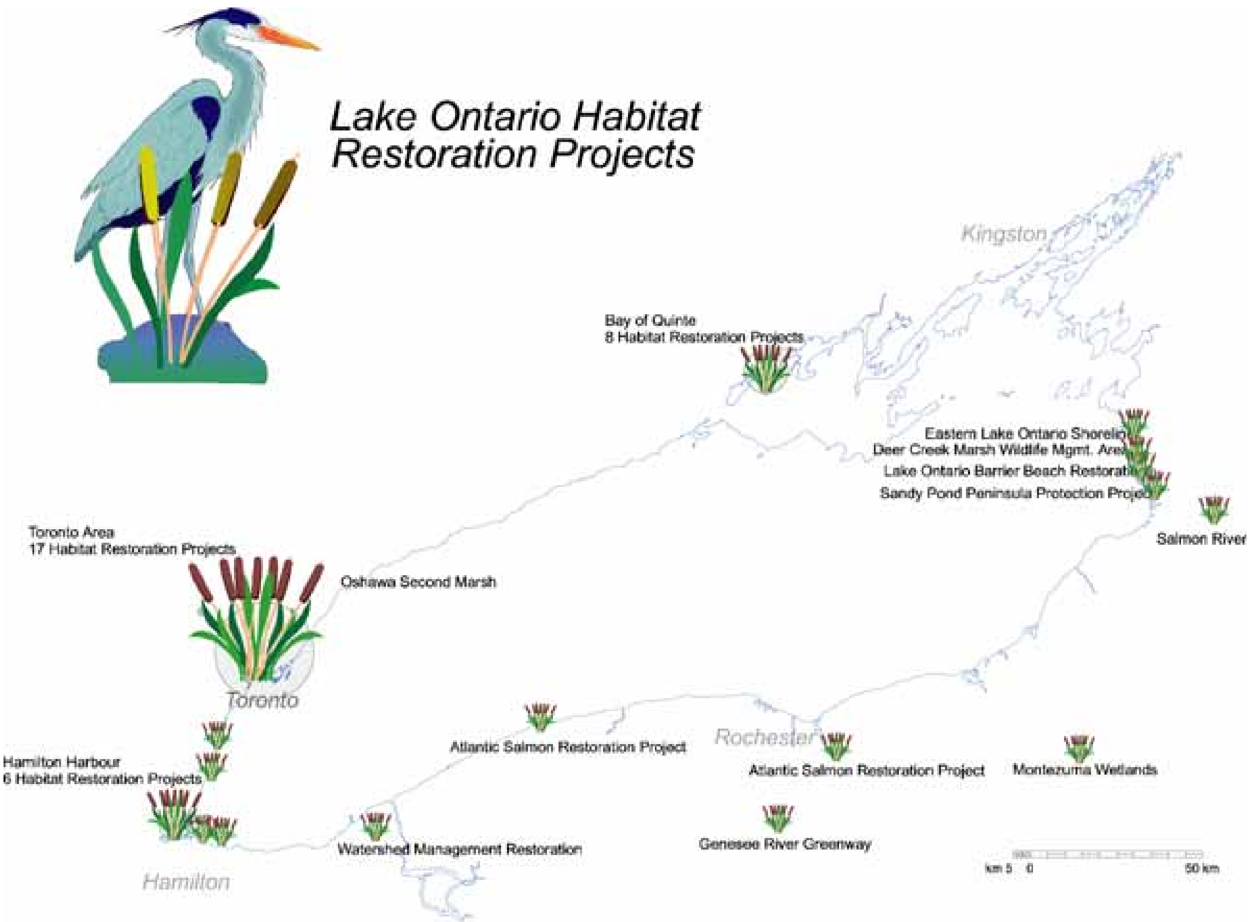
- Historic wetland losses have been significant, and the remaining concentrations of wetlands are associated with the Peterborough drumlin field, the edge of the Canadian Shield, and the Niagara Escarpment. Rare vegetation communities also tend to be clustered, but rare species are broadly distributed with a particular concentration in the Niagara area.
- Human population growth is a major stressor, especially in the urban fringe areas of the Greater Toronto Area and the Hamilton to Niagara corridor. Land uses are changing rapidly as a result of urban sprawl. Rural areas are also changing relatively quickly, with the most intensive agricultural practices and the greatest rates of farmland loss in the western parts of the watershed. The number of active farmers is rapidly decreasing, as are the number of farms and total area farmed.
- Protective policies through municipal official plans and habitat areas of provincial interest (such as the Niagara Escarpment and Oak Ridges Moraine) are in place for about half of the regions and counties within the watershed. Private land stewardship programs and property tax incentives have been important factors in encouraging habitat conservation in some areas. Overall, however, the Canadian Lake Ontario watershed is deficient in protected areas that represent the full range of its habitat types.
- A broad mix of government and non-government activity has also taken place to address the rehabilitation of various habitats. Many rehabilitation projects are associated with the four Remedial Action Plans along the Canadian Lake Ontario shore. Wetland, shoreline and stream rehabilitation projects are the most common types, with agricultural programs receiving particular attention. Many rehabilitation projects feature community and volunteer involvement, often with the support of federal or other funding.

5.4 Ongoing Work

Many habitat restoration and protection projects are underway in the Lake Ontario basin (Figure 5.1). The following information provides some highlights of the projects supported, in part, by federal, provincial, and state agencies as well as various county, conservation authority, municipal, and private organizations.

Over the last two decades, governmental regulations protecting lake-connected wetlands, shorelines, and littoral zones have significantly reduced the rate of loss of these valuable habitats. Since the loss of significant wetland and shoreline habitats has been curtailed, more attention is now being given to identifying the opportunities to restore and replace degraded or lost habitats.

Figure 5.1 Lake Ontario Habitat Restoration Projects [Many local restoration projects are in progress or proposed in the Lake Ontario basin which are not highlighted in this figure.]



5.4.1 Binational Activities

Fish population restoration activities are managed jointly by the natural resource agencies with jurisdiction for Lake Ontario. These include the Ontario Ministry of Natural Resources (MNR), the Department of Fisheries and Oceans (DFO), the U.S. Fish and Wildlife Service (USF&WS), and the NYSDEC. A binational process to develop Fish Community Objectives was completed in 1999, led by MNR and NYSDEC, and including public consultation (Stewart et al., 1999). This process produced long term directions for management actions such as fish stocking and habitat protection. The development of Fish Community Objectives by the Lake Ontario Committee took into consideration a variety of interests including commercial and recreational fisheries, stocking policies, and food web dynamics. The Fish Community Objectives are reviewed and updated every five years. The rehabilitation of lake trout is guided by the Joint Plan for Rehabilitation of Lake Ontario Lake Trout (Schneider et al., 1983). Some progress has been achieved. By 1994, natural production of lake trout in the Kingston Basin had been documented for several years (Rawson et al., 1994). NYSDEC and USGS have also documented natural reproduction in several areas in New York waters since 1994 (Lantry et al. 2001). The survival rate of adult lake trout in 1994 and 1995 exceeded the rehabilitation target of 60 percent per year. In addition, mortality induced by sea lamprey wounding has been reduced.

Efforts to restore partial self-sustainability of Atlantic salmon populations have been limited due to the damming, deforestation, and stream modification of tributaries used for spawning, as well as competition with rainbow trout.

There has been a dramatic recovery of lake whitefish and walleye populations in the east end of the lake. More active management could contribute to the further recovery of these native species.

The multi-partner International Alvar Initiative inventoried alvar sites and proposed direct actions to preserve habitats. The binational Marsh Monitoring Program utilizes citizen volunteers to monitor coastal wetlands and their amphibian and marsh bird populations. Another binational committee, the Great Lakes Fishery Commission's Lake Ontario Committee (LOC) is also making progress in Lake Ontario ecosystem restoration. See Sections 3.4 and 8.2.1 of this report for information regarding the LOC.

5.4.2 U.S. Activities

Several New York State habitat restoration and protection projects are being conducted through the cooperative efforts of county, city, local, and private organizations as well as state and federal agencies. The New York State Open Space Conservation Plan provides a statewide process to identify and acquire undeveloped habitats. The state works in partnership with local governments, non-profit conservation organizations, and private landowners to establish and achieve land conservation goals. Funding for the program is provided by the state's Environmental Protection Fund and, where possible, leveraged by federal and other sources of funding. Ongoing habitat acquisition programs include: Salmon River Corridor, Northern Montezuma Wetlands, Genessee Greenway, and Eastern Lake Ontario shoreline.

The USEPA's Great Lakes National Program Office provides funding for a variety of Great Lakes habitat restoration projects. Projects include: wetland creation in the Lower Genessee River/Irondequoit Bay; barrier beach and wetlands habitat restoration on the Lake's shoreline; barrier beach restoration and stabilization; public education; creation of wildlife nesting habitat and exotic vegetation control at Deer Creek Marsh Wildlife Management Area; and protection and restoration of Sandy Pond Peninsula.

There are many habitat restoration and protection projects currently underway in the U.S. Lake Ontario basin, by both government and private partners.

- A community-based conservation program to protect the wetlands, rivers, streams, and working forests of the Tug Hill Plateau in New York is being carried out by The Nature Conservancy (TNC).
- An evaluation of lake sturgeon habitat by USGS and USFWS is underway in the Genessee River, a major tributary to Lake Ontario. The early history of the Genesee River records the existence of giant sturgeon in the lower portions of the river, but sturgeon population has declined over the years. Now there is great interest in restoring the sturgeon to the river.
- On the Oswego River, a shoreline restoration incentive program is being implemented.
- An education program on shoreline stewardship practices for private landowners has recently begun.
- Protection efforts in the Finger Lakes area are focused especially on the watersheds of the three western Finger Lakes (Hemlock, Canadice, and Honeoye), which remain largely intact and unfragmented. Hemlock Lake and Canadice Lakes are both part of the City of Rochester's water supply system; the city owns 7,200 acres of land within the watershed of the lakes, including their entire shorelines. South of Honeoye Lake lies the Bristol Hills, a relatively intact forest system that stretches east to Naples. This area is the largest documented Appalachian oak-hickory forest in New York. The site also includes a large swamp and wetland complex at the south end of Honeoye Lake. TNC and the Finger Lakes Land Trust are both working to expand protection of

the western Finger Lakes by identifying and acquiring important lands and conservation easements in the Bristol Hills, and in the Hemlock, Canadice, and Honeoye watersheds. TNC has protected nearly 1,400 acres in the western Finger Lakes within the last several years. Future strategies will include land acquisition to protect key tracts; land management to restore native forests; and outreach programs to build awareness of the importance of safeguarding watersheds and preventing forest fragmentation.

- The Montezuma wetlands complex, located between Syracuse and Rochester, once comprised more than 40,000 acres of contiguous marshland. Although agricultural activities have drained nearly half of these wetlands, Montezuma is still considered one of the state's premier wetland conservation areas and is one of the most important sites in the state for migratory birds. Every spring and fall, hundreds of thousands of ducks, geese, and shorebirds utilize the complex as a staging area. Both the U.S. Fish & Wildlife Service (USFWS) and the NYSDEC are protecting and restoring wetlands at Montezuma, with a goal of returning the complex to its original size. TNC is working in partnership with both agencies and with Ducks Unlimited to protect key parcels for transfer or donation to NYSDEC or USFWS. Montezuma is a laboratory for invasive species control, where USFWS officials are releasing beetles to control purple loosestrife and experimenting with fire and herbicides to control phragmites.
- At Eighteenmile Creek, an ongoing wetlands protection project of the Western New York Land Conservancy, partially funded by the USEPA, is coordinating the towns in the watershed to help design best management practices and zoning ordinances; conduct decision making exercises in each town; produce outreach materials; and prepare criteria for prioritizing acquisition areas and produce a land use/wetland map of the area. Portions of the streambank have been physically re-established and re-vegetated to reduce erosion and instream sedimentation from man-made disturbances.
- Efforts are currently underway to assist the recovery of river otter populations in the Lake Ontario basin. In 1995, the non-profit New York River Otter Project began the process of introducing nearly 300 river otters to the Lake Ontario basin.
- The Nearshore Habitat Priorities for Migratory Songbirds (Vermont University and State Agricultural College) project is identifying concentrations of songbirds in nearshore Lake Ontario and eastern Lake Erie habitats using a new remote sensing technique.
- The Landscape-Level Conservation on Tug Hill project (The Nature Conservancy) is launching a community-based conservation program to protect the wetlands, rivers, streams, and working forests of the Tug Hill Plateau in New York.
- The Collaborative Restoration and Education at Eastern Lake Ontario project (The Nature Conservancy, New York Sea Grant, Oswego County, Lake Ontario Dunes Coalition) is implementing a coordinated Dune Steward Program for the beaches and dunes of eastern Lake Ontario, restoring and re-vegetating damaged dunes using locally-grown native beachgrass, protecting dunes with sensitive public access, and engaging the local community through a dune/wetland education program.
- The Contributing Factors in Habitat Selection by Lake Sturgeon project (Research Foundation of State University of New York) is determining the preferred prey types of St. Lawrence River juvenile and adult lake sturgeon, and examining the relationship between feeding characteristics of juvenile and adult lake sturgeon and the benthic invertebrate community.
- The Identification of Lake Sturgeon Habitat in the St. Lawrence River (State University of New York College of Environmental Sciences and Forestry) project is obtaining new information about specific habitat preferences by the critical juvenile stage lake sturgeon in the St. Lawrence River near Massena, New York.
- The Controlling the Spread of Swallowort project (The Nature Conservancy) is developing new techniques for controlling the non-indigenous invasive plant swallowort, which is threatening limestone communities from New York to Wisconsin.

- The Restoration of Rush Oak Openings project (The Nature Conservancy) is working with state, local, and regional partners to develop and effect a joint restoration plan to unite ownerships, and to use volunteer and paid staff to implement restoration of the relict oak savannah community.
- The Sand Transport in the Barrier Beach Ecosystem of Eastern Lake Ontario project (The Nature Conservancy and U.S. Army Corps of Engineers) is addressing the issue of changes in the coastal processes affecting distribution and transport of beach sands along the barrier beaches of eastern Lake Ontario.
- The Conversion of Dry Basins to Created Wetlands for Mitigation of Runoff Water Quality project (Monroe County Environmental Health Laboratory) is demonstrating conversion of suburban dry retention basins into wetland detention ponds to provide treatment and thermal moderation of storm runoff, reducing hydraulic, thermal, and nutrient loading of receiving bodies while providing wetland habitat functions.
- The Eastern Lake Ontario Conservation Initiative (The Nature Conservancy) identified key resources and ecosystem stresses, initiated land protection activities, developed partnerships with state, local, and citizen's groups active in the area, conducted outreach, and developed an initial conservation plan with specific protection, stewardship, and outreach programs for the Eastern Lake Ontario 29,000-acre dune/wetland/alvar system.

In the Sandy Pond Beach Natural Area along 17 miles of eastern Lake Ontario shoreline, a broad range of public and private partners have worked together to conserve highly significant dune and wetland habitats. The ecological function of the dunes is to shelter the wetlands and protect them from being encroached upon by blowing sand and by high energy wave action from Lake Ontario. The fragile dune barrier is threatened by sand loss caused by a variety of harmful activities.

Numerous private holdings lie amidst 6,500 acres of land protected as a state park, three NYSDEC wildlife management areas, a state unique area, and three Nature Conservancy preserves. Collaborating through The Ontario Dune Coalition, agencies, conservation organizations, local and county governments, and private landowners convened a Coordinated Dune Management Conference in October 1998. As one important outcome, the group will expand a pilot Dune Steward program to station seasonal stewards on all public access beaches. The Nature Conservancy will manage the program, which aims to encourage willing compliance with use guidelines and address problems in a comprehensive, cross-agency fashion.

Stewards have also worked with The Friends of Sandy Pond Beach, NY State Parks, DEC, private landowners, and The Nature Conservancy to restore about five acres of degraded dunes on four protected sites and two private sites with the rare native Champlain beachgrass. With advice and support from the United States Department of Agriculture, NY Natural Heritage Program, and the University of Vermont, The Friends expanded that effort in 1999, with native material cultured by local farmers to supply local needs.

Other efforts include development of an interactive dune education website, developed by NY Sea Grant, the Nature Conservancy and local school districts. In addition, four NY universities and a Canadian agency have undertaken research to define the sources, transport, and fate of sandy sediments that supply the beaches, to explain apparent sand loss and make informed management decisions. Researchers are working with Coalition members, the US Army Corps of Engineers, and the shoreline towns of Sandy Creek, Richland, and Ellisburg.

5.4.3 Canadian Activities

Environment Canada through its Great Lakes Sustainability Fund (formerly known as the Cleanup Fund) and in conjunction with its many partners, has supported a large number of habitat rehabilitation projects in the Lake Ontario watershed. These projects, primarily in Toronto, Hamilton, and the Bay of Quinte, focused on creating various nesting and loafing areas for birds such as eagles, ospreys, and terns; enhancing fish spawning habitats; improving littoral and deep water habitats; improving fish access; rehabilitating and creating riparian habitat; and placing structural fish habitat in the form of shoals, reefs, brush bundles, and log cribs. Other projects focused on coastal wetland rehabilitation and reforestation activities on flood plains and stream banks.

As reported in the Stage 1 Report, by March of 1996, 45 km of riparian and 40 hectares (ha) of wetland habitats had been rehabilitated in the Lake Ontario basin as a result of project activities supported by the Sustainability Fund and its partners. Since that time these figures have expanded considerably as a result of continued commitment to these and other rehabilitation projects. Throughout Lake Ontario, initiatives are underway that will benefit other rehabilitation projects such as techniques for the control of exotic species, creating nesting platforms, reestablishing native plant species, erosion control using bioengineering techniques, and techniques to prevent wildlife from consuming newly planted vegetation.

Canada's Great Lakes Wetlands Conservation Action Plan (GLWCAP), a plan that focuses on the conservation of coastal wetlands, developed a priority acquisition list for coastal wetland sites along the lower Great Lakes (Great Lakes Wetlands Conservation Action Plan, 1995a). Specific actions and priority areas for protection and rehabilitation were also identified along the western Lake Ontario shoreline between the Niagara River and Hamilton, along the northern shore, and in eastern Lake Ontario (Great Lakes Wetlands Conservation Action Plan, 1995b). The GLWCAP is being implemented through a cooperative partnership between governments and non-governmental organizations in Canada. As of 1998, nearly 900 hectares of wetlands had been protected at priority Lake Ontario sites.

Working with a steering committee consisting of representatives of waterfront municipalities, conservation authorities, provincial and federal ministries, and community groups, the Waterfront Regeneration Trust prepared and published the Lake Ontario Greenway Strategy in 1995. This strategy described the actions needed to regenerate the waterfront from Burlington Bay to Trenton by protecting and restoring ecological health, and developing community and economic vitality. Between 1993 and 1995, the Waterfront Regeneration Trust conducted a natural heritage study, identifying significant natural areas and corridors along the north shore of Lake Ontario. This natural heritage system has been mapped on GIS, and a database of associated sources of information has been tagged to each area ("A Natural Heritage Strategy for the Lake Ontario Greenway"). The Trust has also conducted an analysis of coastal processes along the north shore ("Shore Management Opportunities for the Lake Ontario Greenway").

Oshawa Second Marsh

Nestled between the urban setting of the City of Oshawa and the shores of Lake Ontario, Second Marsh is one of the few remaining coastal wetlands in the area that provides habitat for fish and wildlife. This 123 hectare wetland is home to a variety of wetland plant species and provides recreational and educational opportunities for the local community. The health of Second Marsh has been in decline since the early 1930's due to a combination of human activities including alterations upstream of the marsh which have increased sedimentation and turbidity.

In response to the stresses on the wetland, Friends of Second Marsh, a community-based action group, and partners from all sectors, implemented the Second Marsh Management Plan, and rehabilitation initiatives were undertaken. These partners included the Great Lakes Sustainability Fund, Environment Canada, Ontario Ministry of the Environment, Ontario Ministry of Natural Resources, City of Oshawa, Central Lake Ontario Conservation Authority, Ducks Unlimited Canada, Ontario Federation of Anglers and Hunters, Durham Board of Education, Trent University, Waterfront Regeneration Trust, General Motors of Canada Limited and many others.

Habitat restoration activities have concentrated on improving habitat for fish and birds. Log barriers were installed to facilitate plant growth by limiting wind and wave action. Techniques were implemented to prevent wildlife from consuming newly planted vegetation. Fish migration was improved by the removal of a log jam and root-wads and cribs were designed and constructed to improve fish habitat. An original outlet to Lake Ontario was restored and islands were created to redirect flow and provide habitat. Artificial nesting platforms for osprey were erected and actions were taken to control purple loosestrife.

The promotion of the project in the community fostered a sense of stewardship and school groups, residents and tourists have been visiting the Marsh for its aesthetic and educational values. Volunteers, a key component of the Second Marsh Project, devoted their time to planting aquatic vegetation and building a secondary trail. Others assisted with the monitoring program by listening for calling birds and amphibians, calculating vegetation cover, and sampling water quality. Teachers and students from Durham Region also helped by growing wetland seedlings for planting.

An important component of the project was information sharing and technology transfer. Many of the lessons learned as well as the monitoring protocols that were developed, have been used in other projects on Lake Ontario.

The Second Marsh Project took a proactive step in managing the Marsh by implementing a watershed stewardship program. The purpose of this program was to improve the quality of water entering the Marsh by encouraging landowners upstream to adopt environmentally sound land management practices.

5.5 Actions and Progress

The information contained in this chapter has been compiled based on documents produced up to January 2003. This chapter has not been updated for the LaMP 2004 Report. The LaMP process is a dynamic one and therefore the status will change as progress is made. This chapter will be updated in future LaMP reports as appropriate.

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CHAPTER 6 SOURCES AND LOADS OF CRITICAL POLLUTANTS

6.1 Summary

This chapter provides information on the inputs, both sources and loadings, of critical pollutants (i.e. DDT and its metabolites, dieldrin, dioxins/furans, mercury, mirex and PCBs) to Lake Ontario, based on information that existed as of January 2003. Chemicals previously not identified as critical pollutants, but noted in previous LaMP documents as emerging as potential chemicals of concern to Lake Ontario, are also identified. This chapter also describes the status of selected actions by the Four Parties as of January 2003 to address known and potential sources of critical pollutants throughout the Lake Ontario Basin, in keeping with the LaMP's sources and loadings strategy.

6.2 Identifying Lakewide Problems and Critical Pollutants

The beneficial use impairment assessment identifies the lakewide use impairments in Lake Ontario and the toxic substances contributing to these impairments (i.e., those substances for which we have "direct" evidence that they are impairing beneficial uses). It is also important for the Lake Ontario LaMP to consider toxic substances which are likely to impair beneficial uses (i.e., there is "indirect" evidence that these chemicals are impairing beneficial uses if they exceed the most stringent U.S. or Canadian standard, criteria, or guideline). The results of the 1999 review are summarized below:

Mercury - identified as a LaMP critical pollutant because Four Parties' review of fish tissue contaminant concentrations found mercury concentrations in smallmouth bass and walleye to exceed Ontario's 0.5 parts per million (ppm) guideline for fish consumption throughout the lake. Mercury is responsible for local impairments in Canada. Although mercury is not causing lakewide impairments of beneficial uses, it is included as a LaMP critical pollutant given the lakewide nature of these criteria exceedences.

Dieldrin - identified as a LaMP critical pollutant because it was found to exceed the most stringent water quality and fish tissue criteria lakewide. Although dieldrin is not causing lakewide impairments of beneficial uses, it is included as a LaMP critical pollutant given the lakewide nature of these criteria exceedences.

PCBs - identified as a LaMP critical pollutant because levels of PCBs in Lake Ontario fish and wildlife continue to exceed human health standards and because PCB levels in the Lake Ontario food chain may pose health and reproduction problems for bald eagles, mink, and otter.

Mirex - identified as a LaMP critical pollutant because levels in some Lake Ontario fish continue to exceed human health standards; a number of fish consumption advisories exist.

Dioxins and Furans -identified as LaMP critical pollutants because levels of these contaminants exceed human health standards in some Lake Ontario fish and because these chemicals may limit the full recovery of the Lake Ontario bald eagle, mink, and otter populations by reducing the overall fitness and reproductive health of these species.

DDT and its metabolites - identified as LaMP critical pollutants because they are responsible for wildlife consumption advisories and are identified as a potential problem contaminant for bald eagles once they re-establish their shoreline nesting territories.

Previous LOTMP reports had also identified three other contaminants as exceeding standards and criteria: octachlorostyrene (OCS), chlordane, and hexachlorobenzene (HCB). A review of information showed that none of these contaminants persist as a lakewide issue. OCS, chlordane, and HCB are well below applicable water quality criteria.

It is the intent of the Four Parties to prevent the development of additional lakewide use impairments that may be caused by other persistent, bioaccumulative toxics entering the lake. Therefore, the LaMP will identify actions that will address the critical pollutants identified above as well as the broader class of chemicals known as persistent, bioaccumulative toxics.

Lakewide Critical Pollutants are bioaccumulative and persistent toxic substances that are known or suspected to be responsible for lakewide impairments of beneficial uses: PCBs, DDT & its metabolites, mirex, dioxins/furans, mercury, and dieldrin. These substances will be the focus of the Lake Ontario LaMP source reduction activities.

6.3 Identifying Sources and Loadings of Critical Pollutants

Critical pollutants can enter Lake Ontario via a number of routes, including rivers, precipitation, point sources (e.g. sewage treatment plants, industrial facilities, waste sites) and non-point sources (e.g. stormwater, agricultural runoff). Being the last in the chain of the Great Lakes, Lake Ontario receives a large percent of its known contaminant loadings from upstream lakes. The levels of contaminants are also constantly changing in response to many known and unknown factors. As a result, loading data are often limited and rely on numerous assumptions. Although quantitative loadings information may be difficult to obtain, qualitative indicators provided by the environmental monitoring of water, sediment, and aquatic organisms can often provide sufficient information to identify those contaminant sources that need to be controlled.

Improving the database on sources and loadings of critical pollutants is a high priority, as is determining effective ways to virtually eliminate these critical pollutants from Lake Ontario. One of the challenges of the LaMP is to understand the state of Lake Ontario 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. 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.

6.3.1 Data Sources and Limitation

Sources Within the Lake Ontario Basin

Point Sources

The location of point sources (Figure 6.1) and qualitative or quantitative loading information for each (Tables 6.1 and 6.2) are presented for those that discharge directly to the lake.

Estimates of loadings of critical pollutants from direct point source dischargers are limited by a lack of data and confounded by jurisdictional differences. New York State requires dischargers whose wastewater is known or suspected to contain significant levels of critical pollutants to monitor for these contaminants. For sources in the U.S., the annual Toxics Release Inventory (TRI) summarizes on an annual basis the emissions of approximately 650 pollutants from facilities nationwide.

There is no current data on Ontario point sources since no Ontario industrial point source discharges the critical pollutants in sufficient quantities to require regulation under the province's MISA (Municipal/Industrial Strategy for Abatement) Program. Information on releases to the environment of critical pollutants and other contaminants is available to the public in publications developed and released on a regular basis by governmental agencies. Canada's National Pollutant Release Inventory (NPRI) is one such inventory, and provides information on the onsite releases to air, water, and land; on transfers offsite in waste; and on the three R's (recover, reuse, and recycle).

Tributaries

For the purposes of this report, the amounts of critical pollutants entering Lake Ontario via all Lake Ontario basin tributaries were based on representative point and non-point sources within each tributary's watershed. The 22 tributaries with the highest flow rates were included in the 2002 review, and the amounts of critical pollutants entering Lake Ontario via Lake Ontario basin tributaries were estimated based on the best available information (Table 6.3). However, in general there is insufficient data to accurately estimate critical pollutant loadings to Lake Ontario from tributaries. As a result, quantitative and qualitative monitoring techniques, as well as biological monitoring results, were used to estimate loadings, or the relative presence or absence of critical pollutants within each tributary watershed.

These are very preliminary estimates and are subject to significant changes as monitoring and loading calculation techniques improve. The data are drawn from a number of information sources and monitoring programs that often use different criteria, methods, and loading calculation methods. Because critical pollutants entering tributaries may originate from a number of sources or activities (such as point sources, atmospheric deposition onto the watershed, contaminated industrial sites, landfills, historic use of pesticides, storm drainage, combined sewer overflows, etc), pollutant levels can be highly variable. The loading estimates for tributaries should be considered qualitative and approximate, as sampling in most cases was not event-based (during a storm).

In-place Sediments

This assessment does not include information on loadings to Lake Ontario water from in-place sediments. Information on loadings from in-place sediments may be included in future assessments.

Other In-Basin Sources

This assessment does not include information on combined sewer overflows (CSOs), stormwater and other non-point sources that discharge directly to the lake, nor is there an assessment of the contribution to the loadings from air emissions within the basin. Information on CSOs, stormwater, and other non-point sources may be included in future assessments.

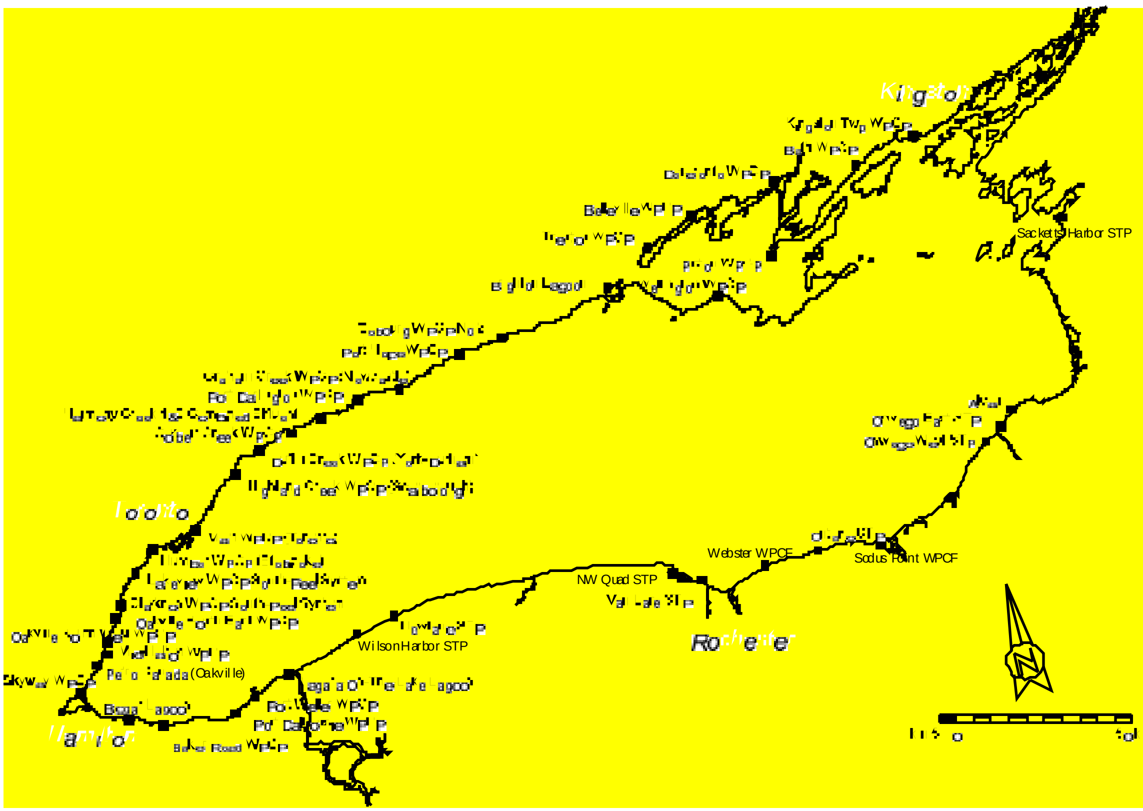
Sources Outside the Lake Ontario Basin

Long-term water quality monitoring programs are conducted by Environment Canada at Fort Erie, Niagara-on-the-Lake (at both ends of the Niagara River) and at Wolfe Island at the head of the St. Lawrence River. These programs use similar sampling and analytical methods and the loading calculation methodologies have been agreed to by the Four Parties. The data provides a good estimate of the critical pollutant loadings that originate from upstream Great Lakes basins, those that originate in the Niagara River basin, and the amounts of critical pollutants that leave Lake Ontario via the St. Lawrence River.

Atmospheric Deposition

Estimates of atmospheric loadings of critical pollutants to Lake Ontario were developed by the Integrated Atmospheric Deposition Network (IADN) for PCBs, DDT and dieldrin. The IADN network for Lake Ontario consists of a master station at Point Petre (near the eastern end of Lake Ontario), and a satellite station located in Burlington, Ontario (at the west end of the lake). A similar network, the National Atmospheric Deposition Program, Mercury Deposition Network, is the source of information for atmospheric mercury deposition. The dioxin estimates are based on data provided from numerous agencies at a Canada/U.S. binational workshop in 1992. Estimates for the amounts of critical pollutants volatilizing to the atmosphere are also provided where available. In general, estimating atmospheric deposition is difficult, and these estimates contain a significant degree of uncertainty.

Figure 6.1 Point Sources Discharging Directly to Lake Ontario in 1998



Notes:

STP = Sewage treatment plant
WPCF = Water pollution control facility
WPCP = Water pollution control plant

Table 6.1 Preliminary Estimate of Lakewide Critical Pollutants Entering Lake Ontario via Direct Discharges in the U.S. (1989-1995)

Point Sources	Country	Discharge Flow (1000 m^3 per day)	PCBs (Kg/yr)	Total DDT (Kg/yr)	Dioxins/ Furans* (g/yr)	Dieldrin (Kg/yr)	Mirex (Kg/yr)
Alcan	US	32.2	0.02	ND	ND	ND	?
Newfane STP	US	5.6	ND	ND	ND	ND	ND
NW Quad STP	US	52	ND	ND	ND	ND	ND
Ontario STP	US	2.3	ND	ND	ND	ND	ND
Oswego East STP	US	11	ND	ND	ND	ND	ND
Oswego West STP	US	15.1	ND	1.5	ND	ND	ND
Sackets Harbor STP	US	0.02	?	?	?	?	?
Sodus Point WPCF	US	0.02	?	?	?	?	?
Van Lare STP	US	401	ND	ND	?	4.3	?
Webster WPCF	US	28.0	ND	ND	ND	ND	ND
Wilson Harbor STP	US	0.01	?	?	?	?	?

WPCF = Water Pollution Control Facility
STP = Sewage Treatment Plant
* = dioxin/furan loadings reported in grams per year
? = No information available
ND = Not detected

Data Sources: New York State SPDES program
Litten, NYSDEC 1996

Note: Estimates are based on standard monitoring performed by the POTW operators as well as non-standard research methods used by NYSDEC investigators that can detect lower levels of contaminants than standard methodologies. As a result, contaminants reported to be "not detected" by standard analytical methods might be "detected" if non-standard research methods are used. Therefore, the details of a specific POTW's operation, flow rate, and the analytical methods used need to be carefully considered before the significance of a reported "non-detect" can be completely understood.

Note: This table only includes the more significant wastewater point source dischargers. Discharges related to power generation plants and small dischargers are not included in this table. A more complete review of these dischargers will be performed as part of future LaMP activities.

Table 6.2 Preliminary Estimate of Lakewide Critical Pollutants Entering Lake Ontario via Direct Discharges in Canada (1989-1995). Taken from the LaMP Stage 1 Report.

Point Sources	Country	Discharge Flow (1000 m^3 per day)	PCBs (Kg/yr)	Total DDT (Kg/yr)	Dioxins/ Furans* (g/yr)	Dieldrin (Kg/yr)	Mirex (Kg/yr)
Baker Road WPCP (Grimsby)	Canada	14.7	ND	ND	ND	ND	ND
Bath WPCP	Canada	1.2	?	?	?	?	?
Belleville WPCP	Canada	30.5	?	?	?	?	?
Bigger Lagoon	Canada	1.1	?	?	?	?	?
Brighton Lagoon	Canada	2.6	?	?	?	?	?
Clarkson WPCP (Mississauga)	Canada	99.6	ND	ND	ND	ND	ND
Cobourg WPCP No 1	Canada	9.9	?	?	?	?	?
Cobourg WPCP No 2	Canada	5.8	?	?	?	?	?
Corbett Creek WPCP (Oshawa)	Canada	34.9	?	?	?	?	?
Deseronto WPCP	Canada	1.4	?	?	?	?	?
Duffins Creek WPCP (Pickering)	Canada	237.6	ND	ND	ND	ND	ND
Graham Creek WPCP (Newcastle)	Canada	2.01	?	?	?	?	?
Harmony Creek 1&2 (Oshawa)	Canada	52.8	?	?	?	?	?
Highland Creek WPCP (Scarborough)	Canada	160.2	ND	ND	ND	ND	ND
Humber WPCP (Etobicoke)	Canada	337.7	ND	ND	ND	ND	ND
Kingston Twp WPCP	Canada	22.1	ND	ND	ND	ND	ND
Lakeview WPCP (Mississauga)	Canada	268.1	ND	ND	ND	ND	ND
Main WPCP (Toronto)	Canada	680.1	ND	ND	ND	ND	ND
Mid-Halton WPCP	Canada	11.4	?	?	?	?	?
Niagara-On-The-Lake Lagoon	Canada	4.02	ND	ND	ND	ND	ND
Oakville South East WPCP	Canada	72.4	ND	ND	ND	ND	ND
Oakville South West WPCP	Canada	33.1	?	?	?	?	?
Petro Canada Ltd (Oakville)	Canada	?	?	?	?	?	?
Petro Canada Ltd (Mississauga)	Canada	9.5	?	?	ND	?	?
Picton WPCP	Canada	3.7	?	?	?	?	?
Port Dalhousie WPCP	Canada	72.3	?	?	?	?	?
Port Darlington WPCP	Canada	8.3	?	?	?	?	?
Port Hope WPCP	Canada	5.5	?	?	?	?	?
Port Weller WPCP	Canada	49.3	?	?	?	?	?
Skyway WPCP (Burlington)	Canada	76.5	?	?	?	?	?
Trenton WPCP	Canada	12.4	?	?	?	?	?
Wellington WPCP	Canada	0.5	?	?	?	?	?

WPCP = Water Pollution Control Plant

STP = Sewage Treatment Plant

* = dioxin/furan loadings reported in grams per year

? = No information available

ND = Not detected

Data Source: Ontario Ministry of the Environment

Note: This table only includes the more significant wastewater point source dischargers. Discharges related to power generation plants and small dischargers are not included in this table. A more complete review of these dischargers will be performed as part of future LaMP activities.

Table 6.3 Estimates of Critical Pollutants Entering Lake Ontario Via Major Tributaries from Atmospheric, Point, and Nonpoint Sources (2002)

Source	Average flow (1000m³ per day)	PCBs (Kg/Yr)	Total DDT (Kg/Yr)	Dioxins/ Furans (g/Yr)	Dieldrin (Kg/Yr)	Mirex (Kg/Yr)	Mercury (kg/yr)
Burlington Canal	NA	2.8(1) Y(8, 10)	Y(8)	Y(8)	Y(10)	ND Y(8)	NA
Cataraqui River	444	Y(12)	ND(12)	NA	ND(12)	ND(12)	NA
Credit River	537	Y(8, 12)	Y(8, 12)	NA	ND(12)	0.004(11) Y(8, 12)	0.0044(11)
Don River	425	1.0(3) Y(12)	0.5(3)	Y(10)	0.1(3)	ND(12)	ND(12)
Duffins Creek	292	Y(8, 12)	Y(8)	NA	ND(12)	ND(12)	ND(12)
Etobicoke Creek	193	0.6(3)	0.0367(3)	NA	0.018(3)	NA	NA
Humber River	798	1.7(3) Y(8, 12)	0.4(3)	NA	0.1(3)	Y(8)	Y(8, 12)
Napanee River	723	NA	NA	Y(7)	NA	NA	NA
Oakville Creek	136	Y(8)	Y(8)	NA	NA	NA	NA
Trent River	17,107	Y(4, 12)	ND(12)	Y(7, 10)	ND(12)	ND(12)	ND(12)
Twelve Mile Creek	15,466	Y(8, 12)	Y(8)	Y(7)	ND(12)	ND(8, 12)	0.0045(11)
Welland Ship Canal	2,245	Y(8, 12)	Y(8)	Y(7)	ND(12)	Y(8)	NA
Atmospheric (2)		32	13.2	0.005	4.2	NA	133
Upstream (9) ▪ Niagara River ▪ Other Great Lakes	492,000	25 155	12.75 42.7	NA NA	2.185 29.57	1.095 0.000	73.0 838.5
Black River	10,129	52.2(5)	0.02(5)	Y(7)	1.1(5)	Y(5)	10.40(5)
Eighteen mile creek	240	7.3(5)	0.01(5)	Y(5)	0.1(5)	Y(5)	0.47(5)
Genesee River	6,363	14.2(5)	0.03(5)	Y(5)	1.1(5)	0.03(5)	12.20(5)
Irondequoit Creek	259	0.003(5)	0.002(5)	Y(5)	0.002(5)	NA	0.23(5)
Johnson Creek	309	Y(6)	Y(6)	Y(6)	NA	NA	NA
Oak Orchard Creek	822	Y(5)	Y(5)	Y(5)	Y(5)	Y(5)	0.53(5)
Oswego River	16,340	17.1	1.5	Y(5)	1.2(5)	0.9(5)	13.11(5)
Sandy Creek	220	1.01(5)	NA	NA	NA	NA	0.03(5)
Wine Creek	20	0.001(6)	ND(6)	NA	ND(6)	NA	0.02(6)

NA- no information available
Y- Detected in qualitative monitoring
ND- Not detected

Sources:
1- Fox et Al, 1988
2- Hoff et al, 1996
3- D'Andrea and Anderson, 1996
4- Poulton, 1990
5- Litten, 1996
6- Estabrooks et al, 1994
7- MOE, MISA, 1994
8- MOE Spottail Shiner data
9- Niagara River Upstream/ Downstream Program, 1997-1999
10- Canviro consultants, 1988
11- Boyd and Biberhofer, 1999
12- Unpublished Water Data, MOE, 2002

6.3.2 Loadings - General

Table 6.4 presents four major categories of critical pollutant loadings estimates based on the best data available in 2002 for: 1) loadings from sources outside the Lake Ontario basin; 2) loadings from sources inside the Lake Ontario basin; 3) atmospheric loadings; and, 4) releases from Lake Ontario to the St. Lawrence River and volatilization to the atmosphere. As a result of the limitations described previously, the loading numbers in Table 6.4 are only estimates.

Based on the limited loadings data available, it appears that the most significant source of critical pollutants to Lake Ontario comes from outside the Lake Ontario basin. Upstream sources are responsible for most of the PCBs, DDT (and its metabolites) and dieldrin that enter the lake. Most of the mirex entering Lake Ontario comes from the Niagara River basin. The Niagara River is the largest tributary to Lake Ontario, providing over 83 percent of all the tributary water that flows into the lake. Since 1986, significant reductions in the concentrations and loadings of critical pollutants, in most cases greater than 60 percent, have been measured in the Niagara River. The reductions are due to, in part, the effectiveness of remedial activities at Niagara River sources in reducing chemical inputs to the river. The river is becoming less polluted; however the rate of improvement has slowed, because the majority of pollutants now come from upstream sources outside of the Niagara River Basin.

The loading estimates also indicate that the volume of some contaminants leaving the lake, such as PCBs, DDT and dieldrin, may be greater than the amount entering Lake Ontario. One explanation for this may be that contaminants are slowly being released from sediments in the Lake Ontario system. Volatilization may be another significant process by which critical pollutants are leaving the Lake Ontario system.

Table 6.4 Estimates of Critical Pollutant Loadings to Lake Ontario (from the LaMP 2002 Biennial Report)

Note: Loadings in this table are only ESTIMATES. The data are drawn from a number of different sources and monitoring programs which use different criteria, methods, and loading calculation methodologies. As a result, these estimates contain a significant degree of uncertainty and should only be considered as general indications of the relative significance of loadings from various sources.

	Loadings from Sources Upstream of the Lake Ontario Basin (Kg/yr)			Loadings from Water Discharges Within the Lake Ontario Basin (Kg/yr)				Atmospheric Loadings (Kg/yr)	Amounts Leaving Lake Ontario (Kg/yr)			Net Change (Kg/yr)
	Other Great Lakes	Niagara River Basin	Total	Point and Non-Point Via Tributaries	Direct Point Source Discharges U.S.	Direct Point Source Discharges Can.	Total		Via St. Lawrence River	Volatilization to Atmosphere	Total	
PCBs	155	25	180	97	1.6	ND	98.6	32	261.5	330	594	-283.4
Total DDT	42.7	-12.75 see footnote	29.95	16	1.7	ND	17.7	15.2	11.6	NA	NA	NA
Mirex	0.006	1.095	1.101	0.9	ND	ND	0.9	ND	NA	NA	NA	NA
Dieldrin	29.57	2.185	31.75	5.0	0.15	ND	5.2	4.9	39.7	220	260	-218.54
Dioxins/ Furans	ND	ND	ND	NQ	<.0001	NQ	NQ	0.005	ND	NA	NA	NA
Mercury	689.5	-73.0 see footnote	760.5	37.0	3.61	86.2	127	138	ND	NA	NA	NA

NA - no information available   ND - not detected/not measurable   NQ - present but not quantified

Sources:

Niagara River and Upstream Great Lakes

Williams, D. J. et al., 2000. The Niagara River Upstream/Downstream Program, 1986/87 – 1996/97. Report and Appendices. Ecosystem Health Division, Environment Canada – Ontario Region. Loadings calculated based on latest available data. Values are for 1996/97. Values for Niagara River Basin estimated based on measured results at Niagara-On-The-Lake (total) minus Fort Erie (other Great Lakes). For total DDT results suggest that the Fort Erie site is subject to contamination by a source upstream and close to the Fort Erie station (Environment Canada, unpublished data). Mercury results should be used with caution as all samples were below the detection limit (Environment Canada, unpublished data).

Tributaries

Litten, S., 1996. Trackdown of Chemical Contaminants to Lake Ontario from New York State Tributaries. Bureau of Watershed Assessment and Research, Division of Water, NYSDEC, Albany, N.Y. 12233-3502.

Boyd, D., and H. Biberhofer, 1999. Large Volume Sampling at Six Lake Ontario Tributaries During 1997 and 1998: Project Synopsis and Summary of Selected Results.

Boyd, 1999. Assessment of Six Tributary Discharges to the Toronto Area Waterfront. Volume 1: Project Synopsis and Selected Results. Report prepared for the Toronto and Region RAP.

Point Sources

Litten, 1997. NYSDEC

New York State SPDES program.

Khatry, R., 1999. Draft Report on the Sewage Treatment Plant Monitoring Studies Conducted in 1997 and 1998 in Support of the Canada-Ontario Agreement. Prepared for Environment Canada and the Ontario Ministry of the Environment.

Ministry of the Environment MISA data.

Atmospheric

National Atmospheric Deposition Program, Mercury Deposition Network. Data from website: http://nadp.sws.uiuc.edu/mdn/. Data for two closest stations (Dorset, Ontario and Tioga County, Pennsylvania) were averaged for 1997 and 1998 to obtain a value of 7.0ug/m^2 for mercury deposition to Lake Ontario. The mercury loading was then calculated based on lake area of 19,000 km^2.

Galarneau et al., 2000. Atmospheric Deposition of Toxic Substances to the Great Lakes: IADN Results to 1996. U.S./ Canada IADN Scientific Steering Committee. Values for PCBs, DDTs and Dieldrin are means for 1995 and 1996. Volatilization losses for DDT compounds could not be calculated for 1995-96 due to lack of water chemistry data.

Eisenreich, S.J., and W.M.J. Strachan, 1992. Estimating Atmospheric Deposition of Toxic Substances to the Great Lakes- An Update. Proceeding of a workshop held at the Canada Centre for Inland Waters, Burlington, Ontario. Value of 5.2g/yr for TCDD wet deposition only (does not contain dry deposition or air-water exchange values).

St. Lawrence River

Merriman, J., 1998. Trace Organic Contaminants in the St. Lawrence River at Wolfe Island. Report No. EHD 98-02/I. Loadings calculated based on latest published data 1994-1995.

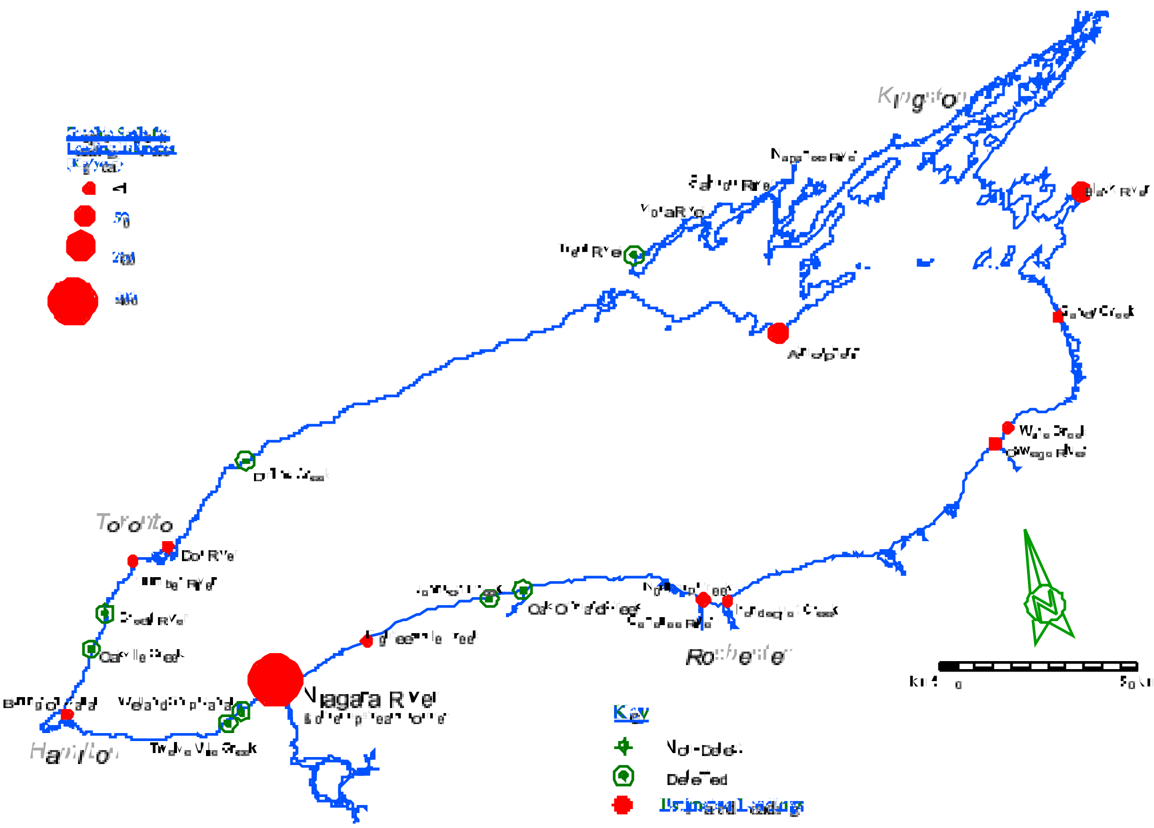
6.3.3 Loadings – Critical Pollutants

6.3.3.1 PCBs

Polychlorinated biphenyls (PCBs) were manufactured between 1929 and 1977. PCBs were considered an important industrial safety product for conditions where high heat or powerful electric currents posed explosive and fire hazards. For example, PCB oil-filled electric switches eliminated electric sparking problems that could trigger explosions at petroleum refineries. PCB oils were used in electrical transformers as a nonflammable electrical insulating fluid. PCBs were also used as industrial lubricating oils to replace earlier types of hydraulic oils that could more easily catch fire under conditions of high pressure and temperature.

The production of PCBs was halted following the discovery that PCBs released into the environment were bioaccumulating to levels of concern in a wide range of organisms. The hazards posed by PCBs were discovered in the 1960s when ranch mink, that had been fed a diet of Great Lakes fish, experienced reproductive failures. The investigations that followed determined that Great Lakes fish were contaminated with PCBs at levels that warranted human fish consumption advisories. Since that time, production of PCBs in North America has been banned, and the use of PCBs is being systematically eliminated.

Figure 6.2 Summary of Nonpoint Source Loading Information for PCBs (1990 to 1995)

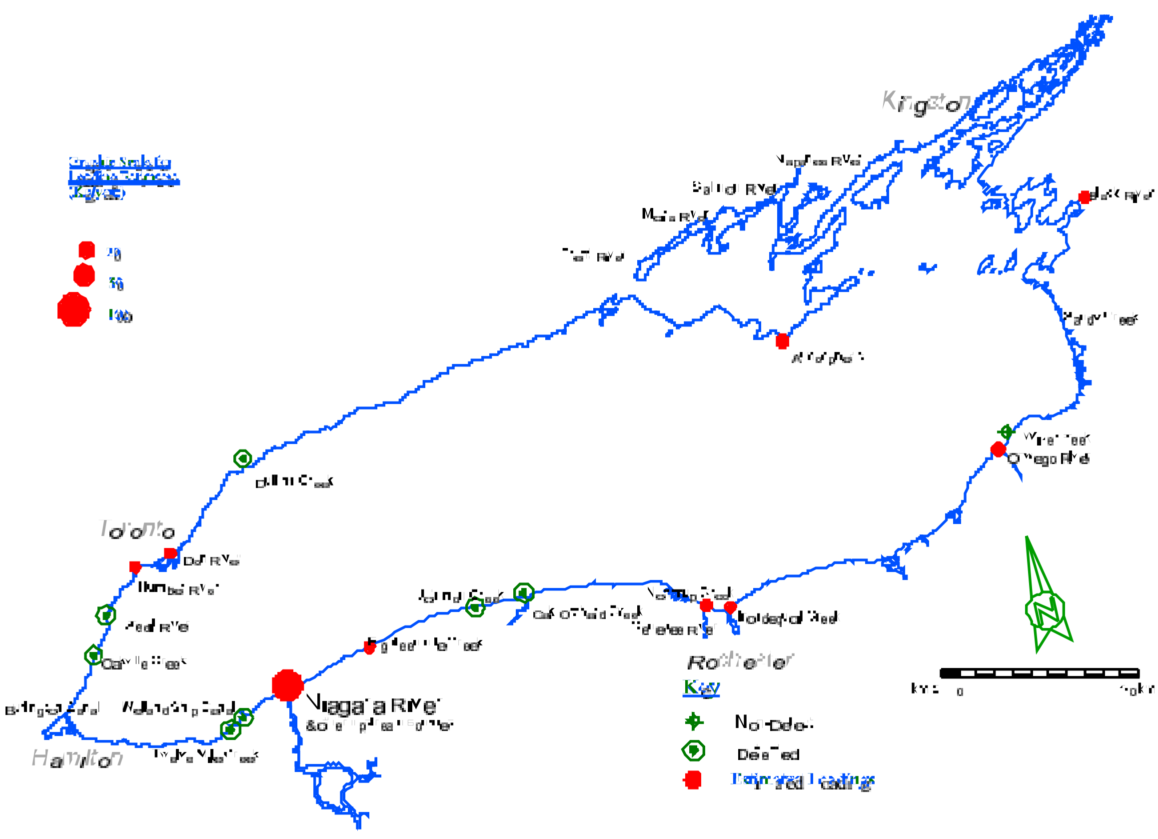


Levels of polychlorinated biphenyls in the environment have decreased in response to the banning and phasing out of the various uses of PCBs. Analysis of the 2002 data available indicates that most of the estimated PCB loadings to Lake Ontario originate outside the Lake Ontario basin. Data suggest that upstream sources are responsible for approximately 60 percent of the inputs, while sources within the basin contribute 30 percent (most of which enters the lake via tributaries). Atmospheric loadings contribute the remainder of the estimated loadings directly to the lake surface. When the loss of PCBs from the lake basin via volatilization and the St. Lawrence River is considered, it appears that the total amount of PCBs within Lake Ontario is decreasing.

6.3.3.2 DDT and its Metabolites

The development of the pesticide DDT in the 1940s was considered a major breakthrough in the battle against diseases, such as malaria, and in controlling crop pests. Highly effective and cheap to produce, DDT was the most widely used pesticide in North America and other countries from 1946 to 1972. Agricultural use of DDT has since been banned in North America following the discovery that DDT and its breakdown products were causing widespread reproductive failures in eagles and other wildlife species. Although DDT continues to be used in other parts of the world, levels of DDT in the North American environment have decreased significantly since this pesticide was banned.

Figure 6.3 Summary of Nonpoint Source Loading Information for Total DDT (1990 to 1995)

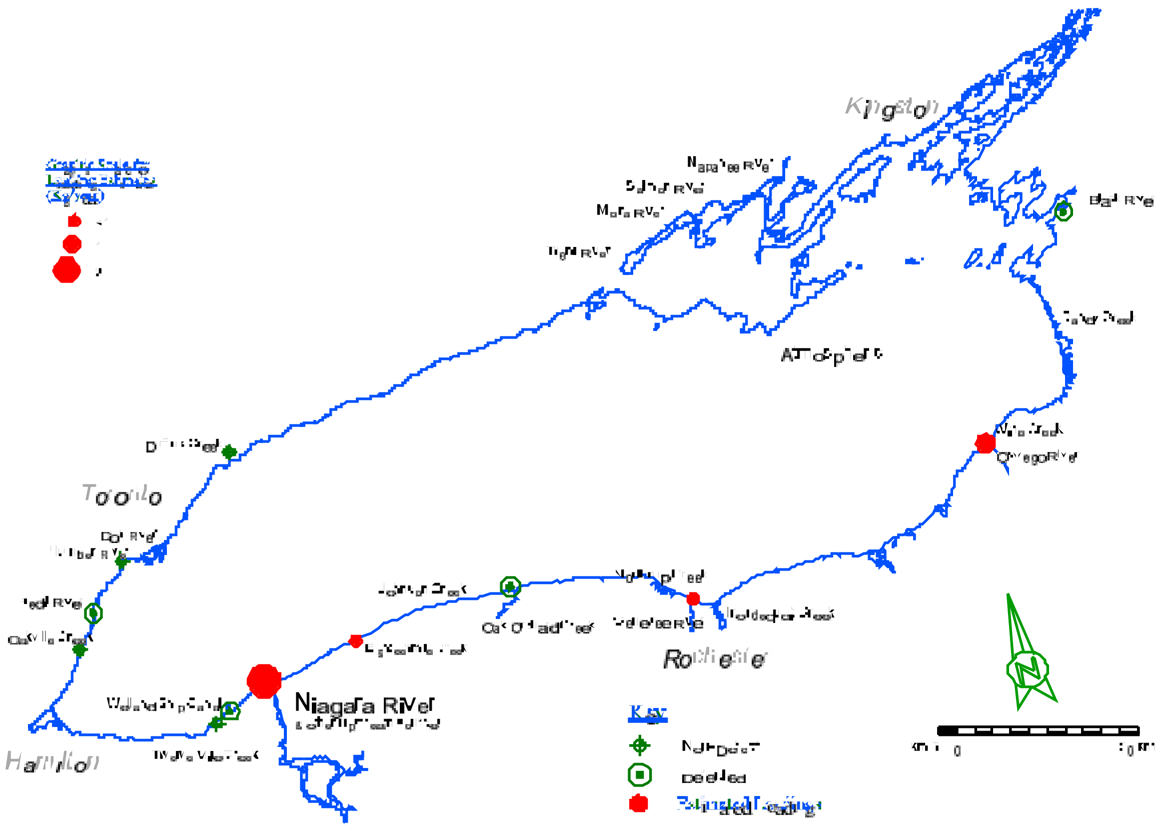


Approximately half of the DDT that enters Lake Ontario reported in 2002 was from upstream sources. Atmospheric deposition and tributary sources contribute to the remainder. Although use of DDT has been banned, monitoring indicates that there may be local sources in some tributaries. As expected, DDT levels in point source discharges are negligible. Previous estimates indicate that the amount of DDT leaving the lake (primarily through volatilization) may be greater than the amount coming in.

6.3.3.3 Mirex

Mirex was used in the Lake Ontario basin primarily as a flame retardant in manufacturing and electrical applications. Use and production of mirex is now banned in North America. Most of the mirex that enters Lake Ontario originates in the Niagara River basin. During the 1970s, a manufacturer discharged large quantities of mirex-contaminated wastewater to the Niagara River, resulting in widespread contamination of Lake Ontario sediment and fish. Two facilities located on the Oswego and Credit Rivers, which used mirex in the 1970s, have been extensively investigated as there were concerns regarding known or potential mirex releases to these rivers.

Figure 6.4 Summary of Nonpoint Source Loading Information for Mirex (1990 to 1995)



A review of 1999 information, including mirex levels in resident fish, indicated that the Oswego and Credit Rivers are not significant sources of mirex to the lake. No reliable estimates of atmospheric deposition or volatilization of mirex were available.

The Upstream/Downstream water sampling program operated by EC shows substantial decreases in the concentrations of mirex. These data can be used as indicators of progress in reducing the concentrations of chemical pollutants in the river. The 2002 data showed decreases, not only in overall concentrations, but also in the number and magnitude of the "spikes".

6.3.3.4 Dioxins and Furans

Dioxins and furans are a group of unwanted chemical by-products that are created by a variety of chemical and combustion processes. Laboratory studies have shown some wildlife species to be extremely sensitive to the toxic effects of these contaminants. The potential impacts of the very low levels of these contaminants found in Lake Ontario fish, wildlife, and humans are poorly understood. Therefore, health standards for these contaminants have been set very low. Steps have been taken to control and limit those processes that produce high levels of dioxins and furans, resulting in a significant decrease in environmental levels of these chemicals over the last two decades. Some of the processes that can produce dioxins and furans include the use of wood burning stoves, internal combustion engines, incinerators, and a variety of other chemical processes, which are part of our way of life and may be difficult to eliminate altogether. Forest fires also produce dioxins and furans.

Dioxins and furans exist at very low levels in the environment and, as a result, are difficult and costly to detect and accurately quantify. Historically chemical manufacturing sources in the Niagara River Basin were significant sources of these contaminants to Lake Ontario. These sources have been effectively controlled, although some low-level releases from these sites will occur for years to come. Sediment samples from the mouth of the Niagara River show that dioxin levels have decreased by more than 90 percent since control actions were implemented in the 1970s. Although the Niagara River upstream-downstream program did not detect dioxins and furans in Niagara River water, information from other media (mussels, spottail shiners) suggest that there are some low-level releases of dioxins and furans occurring along the Niagara River. Using the same types of qualitative water and biological sampling methods, dioxins and furans have also been detected in some Lake Ontario tributaries and harbours. Air emissions are recognized as an important source of these contaminants to the environment, however, no reliable estimates of atmospheric deposition or volatilization of dioxins/furans are available. As a result there is insufficient information to draw any conclusions on the relative significance of the various loading pathways.

6.3.3.5 Mercury

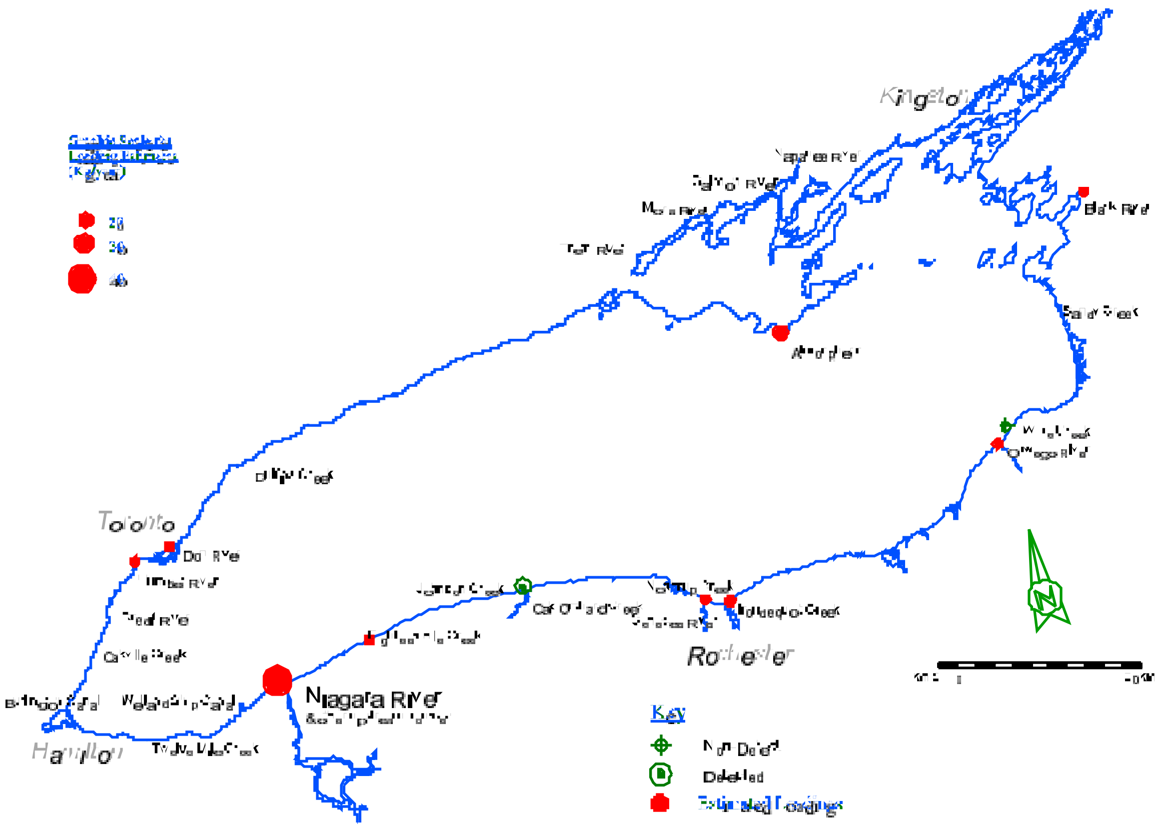
Mercury is a naturally-occurring metal, which is found in small amounts in most soils and rocks. Mercury is used in thermometers, medical and dental products, batteries and in the production of various synthetic materials, such as urethane foam. Estimates of mercury loadings to Lake Ontario should be viewed as preliminary.

The data presented for 2002 suggest that mercury that enters Lake Ontario comes from upstream sources (approximately 75 percent), direct point source dischargers (10 percent), inputs from tributaries (5 percent) and atmospheric deposition (10 percent). Given the special difficulties with measuring low levels of mercury in the environment, there are no estimations of how much mercury leaves Lake Ontario via the St. Lawrence River or through volatilization.

6.3.3.6 Dieldrin

Dieldrin is a formerly used pesticide that is now banned from use in the Lake Ontario basin and throughout North America. Aldrin, another formerly used pesticide, transforms into dieldrin through natural breakdown processes. Dieldrin is identified as a LaMP critical pollutant because dieldrin concentrations in water and fish tissue exceed the U.S. Great Lakes Water Quality Initiative (GLI) criteria throughout the lake.

Figure 6.5 Summary of Nonpoint Source Loading Information for Dieldrin (1989 to 1995)



The GLI criterion for water is 0.0000065 parts per billion and Lake Ontario water averages 0.17 parts per billion. The corresponding GLI fish tissue criterion is 0.0025 parts per million. Most Lake Ontario fish clearly exceed this criterion as dieldrin is detectable at concentrations ranging from approximately 0.005 to 0.030 parts per million. Although the GLI criteria are being exceeded, dieldrin concentrations in the environment have been steadily declining

Based on information collected by Environment Canada, dieldrin concentrations in water have declined from 0.33 ppt in 1986 to 0.14 ppt in 1998. Most of the dieldrin that enters the lake comes from upstream sources (80%). Dieldrin inputs from sources within the Lake Ontario basin and from atmospheric deposition are low. When the rate of loss of dieldrin in Lake Ontario due to volatilization and via the St. Lawrence River is factored in, it appears that the amount of dieldrin in the lake is decreasing.

6.4 Emerging Chemicals of Concern

6.4.1 Overview

In addition to pursuing the elimination of critical pollutant inputs, the LaMP tracks information on other bioaccumulative contaminants that may potentially cause lakewide impairments. The LaMP will continue to be on the alert and will evaluate any other new bioaccumulative contaminants that may potentially cause lakewide impairments.

6.4.2 PBDEs

Polybrominated diphenyl ethers (PBDEs) are a class of bioaccumulative chemicals that have been widely used over the last two decades as flame retardant in textiles, polyurethane foam, acrylonitrile butadiene styrene plastic (ABS) and electrical components. These materials can contain between 5 to 30 percent PBDE by weight. PBDEs are used in many types of electrical equipment, such as computers and televisions, and in building materials greatly reducing risks. Unfortunately, PBDEs are also highly mobile in the environment and are now recognized as a globally persistent organic pollutant found even in the marine foodweb of remote Arctic regions.

Concentrations of polybrominated-diphenyl ethers (PBDEs) in the Great Lakes system are increasing dramatically. Based on levels detected in lake trout and herring gull eggs from Lake Ontario, it appears that local emissions from large urban/industrial areas are the major sources.

As an emerging issue, PBDEs have not been well studied to date. For example, there are currently no water quality or fish tissue criteria for PBDEs. There is also no definite information known about their effects on humans

A number of actions are underway that will help evaluate the potential risk PBDE may pose to fish, wildlife and human health. Studies have been initiated by both federal governments to assess the potential effects of PBDE on human health. Environmental sampling by Canadian and U.S. investigators of Lake Ontario water, fish and gulls eggs is developing a more complete picture of PBDEs in the Lake Ontario foodweb. A major study being conducted by Environment Canada researchers will provide a preliminary mass balance assessment of all inputs of PBDEs to Lake Ontario, and as well results from a DFO study will describe concentrations in tissues throughout the foodweb. Work is also underway to better understand how PBDEs move around in the foodweb.

6.5 Actions and Progress

The information contained in this chapter has been compiled based on documents produced up to January 2003. This chapter has not been updated for the LaMP 2004 Report. The LaMP process is a dynamic one and therefore the status will change as progress is made. This chapter will be updated in future LaMP reports as appropriate.

The focus of the LaMP's contaminant reduction efforts is to identify those opportunities within the Lake Ontario basin where critical pollutant sources can be further controlled. Areas with concentrations of population and industry, such as the greater metropolitan area of Toronto-Hamilton and Rochester, are obvious locations to be included in the LaMP's review of potential opportunities. To restore Lake

Ontario's beneficial uses, contaminant reduction activities need to be implemented through upstream LaMP and RAP efforts.

It should be recognized however that 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. 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. This time lag must be considered when evaluating data which were often collected several years before being reported and which reflect loadings which occurred many more years before data collection.

6.5.1 Binational Activities

6.5.1.1 Lake Ontario Sources and Loadings Strategy

The binational goal of the Lake Ontario LaMP is to reduce inputs of designated critical pollutants (PCBs, DDTs, mercury, mirex, dieldrin and dioxins/furans) in order to meet LaMP ecosystem objectives and restore associated beneficial use impairments.

Due to the scale and complexity of pollutant sources within the basin, the Four Parties agreed that a load reduction schedule based on a percent reduction target is not practical. Instead, the Parties are taking a focused and strategic approach to identify, assess and mitigate sources of critical pollutants through regulatory or voluntary measures.

Recognizing that the Four Parties have regulatory mandates, the LaMP uses a cooperative approach, working closely with regulatory programs, local governments, industry and individuals to develop and coordinate an effective critical pollutant reduction strategy to address known and potential sources of critical pollutants throughout the Lake Ontario Basin. The LaMP critical pollutant reduction strategy has three main elements: (1) data/information synthesis; (2) coordination with regulatory actions; and (3) promoting voluntary actions.

Data/Information Synthesis:

- Information on the concentrations, sources, loadings and pathways of critical pollutants are being evaluated, with the aim of identifying source reduction actions. The actions could include, for example, watershed evaluations, further monitoring, and source reduction activities.
- Qualitative information is acknowledged as an important component of the LaMP critical pollutant source identification process and decision making. Available regulatory monitoring information often does not include critical pollutants in routine monitoring, or may have used methods which could not detect low levels of contaminants of concern.

Coordination with Regulatory Actions:

- The LaMP is identifying and highlighting specific remedial and other regulatory program efforts underway that are contributing to LaMP pollutant reduction goals that LaMP strategies can build upon.
- Regulatory programs are also being kept apprised of any information relevant to their enforcement interests or monitoring requirements, so that regulatory tools can be applied as appropriate to address specific LaMP priority sources.
- Significant amounts of critical pollutants from the upstream Great Lakes and connecting channels enter Lake Ontario via the Niagara River and from out of basin atmospheric sources. Restoring

beneficial uses in Lake Ontario depends in part on the successful implementation of LaMPs and RAPs in upstream and out of basin programs that also address persistent toxics reduction.

Voluntary Actions:

- The LaMP is promoting voluntary efforts to reduce inputs of critical pollutants by: encouraging community and local government pollution prevention programs (such as pesticide "clean sweeps" and mercury equipment/thermometer collections); communicating and highlighting the LaMP goals and objectives and the importance of voluntary efforts (through success stories); and encouraging accelerated product phase-outs, pollutant minimization plans or other actions by industry or local governments.

The LaMP's critical pollutant reduction strategy may go beyond existing programs to address significant sources identified by the LaMP as a binational priority. The U.S. and Canada are using compatible approaches to source reduction strategies in order to best utilize current initiatives, historic actions and individual human and information sources. The U.S. has evaluated critical pollutant information and related actions in all watersheds within its portion of the basin. Canada has focused on actions within priority watersheds, based on available ambient monitoring information and emissions data from industrial, municipal and other non-point source discharges (such as combined sewer overflows/stormwater, waste sites). Local strategies will be developed to address identified sources of critical pollutants in these watersheds.

6.5.1.2 Niagara River Toxics Management Plan

Because of this critical link between Lake Ontario and the Niagara River, the Four Parties agreed in 1987 to implement the Niagara River Toxics Management Plan (NRTMP). The NRTMP works to "reduce toxic chemical concentrations in the Niagara River by reducing inputs from sources along the river with a goal of achieving water quality that will protect human health, aquatic life, and wildlife, and while doing so, improve and protect water quality in Lake Ontario as well." Eighteen priority toxics were identified and 10 (including Lake Ontario LaMP critical pollutants dioxin, mercury, mirex, and PCBs) were selected for 50 percent reduction. To do this, the Four Parties committed to: 1) reduce point and nonpoint sources of pollution to the river 2) monitor the water quality and health of the river and 3) report progress to the public.

Since 1987, significant improvements in the river have been made by completing site specific clean-up activities, controlling point source discharges, encouraging pollution prevention techniques and restoring critical habitat areas along the river. These improvements are documented by the results of sampling and analyzing water quality, testing contaminant levels in the tissues of fish or mussels and collecting and analyzing sediments. Some specific examples include:

- Substantial reductions in the concentrations and loads for most of the NRTMP priority contaminants. Reductions, in most cases have been 50% or greater.
- USEPA and NYSDEC have completed remediation at 13 of 26 hazardous waste sites in New York that were identified as major contributors of contaminants to the Niagara River. This has resulted in an estimated reduction of inputs to the river by over 80%.
- Environment Canada, Ontario Ministry of Environment and others have jointly removed 10,500 cubic meters of sediments contaminated with heavy metals, oil and grease from the Welland River.

A Letter of Support was signed by the Four Parties on December 3, 1996, to continue the commitment to the Declaration of Intent and to further actions to reduce loadings of toxic chemicals to the Niagara River.

NRTMP Letter of Support – The Four Parties reaffirmed their commitment and set a new goal of reducing toxic chemicals in the river in order to achieve water quality that protects human health, aquatic life, and wildlife.

6.5.1.3 Lake Ontario Air Deposition Study (LOADS)

In 2002 the LaMP began a major cooperative monitoring project to study the levels of mercury, polychlorinated biphenyls (PCBs), dioxins, mirex and dichloro-diphenyl-dichloroethylene (DDE) that deposit from the air into the lake. These pollutants can affect the safety of eating fish caught in the lake.

As part of the LOADS, samples of air and water were taken from the Environmental Protection Agency (EPA) research vessel Lake Guardian during its April and September cruises. Additional samples were collected at the land-based site at Sterling, NY. EPA scientists sampled tributaries and Environment Canada (EC) scientists took samples fromthe existing Toronto buoy and the Integrated Atmospheric Deposition Network monitoring station at Pt. Petre, Ontario. Results from the stationary sites will be correlated with those obtained on the Lake Guardian. The study has three main objectives:

- It will estimate the contaminant loadings (derived from knowing the volume and concentration) being deposited from the air into the lake. This information will be plugged into the Lake Ontario Mass Balance Model, a mathematical model that predicts what effect reducing pollution will have on the lake and its fish;
- It will assess any differences in concentrations and deposition over land and over water; and,
- It will examine the effect of urban areas on deposition to the lake.

The LaMP partners continued sampling in the summer of 2003. Results of the effort will be synthesized to form a report on air deposition to the lake.

6.5.1.4 Great Lakes Binational Toxics Strategy

The GLBTS, signed by Canada and the U.S. in 1997, represents the most comprehensive effort by the two countries to achieve virtual elimination of persistent toxic substances in the Great Lakes. Under the Strategy, Environment Canada and the U.S. Environmental Protection Agency work together with industries, municipalities, and environmental and community groups on both sides of the border to address substances targeted for virtual elimination. These substances include mercury, polychlorinated biphenyls (PCBs), dioxins and furans, dichloro-diphenyltrichloroethane (DDT), and mirex, among others.

The goals and objectives of the Binational Toxics Strategy are compatible with those of the Lake Ontario LaMP because the list of GLBTS target pollutants includes all of the LaMP critical pollutants. Contaminant reduction efforts initiated under the GLBTS will directly support the LaMP's goals to virtually eliminate Lake Ontario critical pollutants. Unlike the Lake Ontario LaMP, which has a limited geographic focus on critical pollutant sources within the Lake Ontario basin, the GLBTS includes the entire Great Lakes basin and also will seek to reduce sources of atmospheric contamination located outside the Great Lakes basin. The GLBTS aims to reduce current releases of target pollutants from a range of industrial, manufacturing and agricultural activities through voluntary actions. The LaMP also supports the development of voluntary actions, but in addition includes a strong focus on the identification and control of contaminant problems related to historical releases of critical pollutants.

Under the Great Lakes Binational Toxics Strategy (GLBTS), Canada and the U.S. are working together to eliminate potential sources of contamination to the Great Lakes. Some examples include:

- reducing home sources of dioxin and furan emissions through the "Burn It Smart Campaign"; preventing mercury from going down the drain and into the lakes by encouraging "Household Hazardous Waste" collection events and recycling programs for thermostats, thermometers, fluorescent lamps and button batteries;
- reducing the threat of tire fires and the noxious fumes they produce by reducing tire piles through the "Tire Pile Campaign";
- recognizing municipalities and industries that have made extraordinary efforts to reduce and eliminate PCBs, going beyond compliance with the law;
- supporting the steel industry's efforts to monitor reductions in emissions of dioxins and furans, and preventing mercury from being introduced in scrap metal, to reduce emissions to the environment
- supporting National Wildlife Federation (NWF), Great Lakes United, and the Council of Great Lakes Industries to assist with both Strategy implementation and reduction activities. NWF, for example, is involved with on the- ground mercury reduction projects in the hospital/medical sector. These groups are also working with their constituencies both in the Great Lakes basin and beyond, to raise awareness, document toxic reductions, and spur actions to implement the Strategy.
- EPA and the American Hospital Association signing an agreement to virtually eliminate mercury-containing hospital wastes and to reduce total hospital waste one-third by 2005. In partnership with the Ontario Hospital Association, a pollution prevention training program has been delivered to over 80 Ontario hospitals. Several have signed-on to develop action plans for the reduction of mercury under Pollution Probe's MERC challenge.
- The U.S. chlor-alkali industry committing to reduce mercury use 50 percent by 2005. The industry reported that their use of mercury fell by one-quarter during 1996-1997.
- The Canadian Automotive Manufacturers Pollution Prevention Project, begun in 1992, reporting voluntary reductions of toxic substances annually. To date, 333,000 tonnes have been removed from the waste streams.
- The General Motors Southern Ontario destroying PCBs in 90 tonnes of liquid, 800 tonnes of solid material/equipment and 180 tonnes of contaminated soils have been destroyed to date using a new gas phase reduction process. Ambient air monitoring conducted by the Ontario Ministry of the Environment show PCBs below detectable levels during the destruction process.

Under the Binational Toxics Strategy, the jurisdictions have accepted challenges of reaching significant milestones on the path to virtual elimination. Confirmation that five bioaccumulative pesticides, alkyl-lead and octachlorostyrene are no longer released from current industrial, manufacturing and agricultural activities in the Great Lakes basin was reported in three challenge reports released in 1998.

For more information, please visit http://www.binational.net

6.5.1.5 Lake Ontario Mass Balance Models

Mass balance models are developed to relate loadings of toxic contaminants to the lake to levels in water, sediment, and fish. These models provide an initial technical basis for determining load reduction targets, estimating how long it will take to meet these targets, and planning for additional measures necessary to achieve load reduction goals. One of the benefits of a Lake Ontario mass balance modeling effort is an improved ability to quantify the relationship between the mass loading of contaminants of concern to the lake and their concentration in water, sediments and biota. This information could then be used by the LaMP to help determine the most effective source reduction strategies. Some of the management questions include that could be addressed include: What is the relative significance of each major type of source discharging toxic contaminants into Lake Ontario? How will contaminant levels in the lake and its biota respond to changes in contaminant loads and how long will it take? What is the effect of toxic contaminants in the sediments? Can observed trends in toxic contaminants over time be explained?

With USEPA support, a group of researchers led by Dr. Joseph V. DePinto of the University at Buffalo are conducting the "Lake Ontario Toxics Modeling Project" in coordination with the LaMP. A mass balance and bioaccumulation computer model called LOTOX2 is being used to help check the accuracy of the load estimates. The model is also being used to assess the effectiveness of various load reduction scenarios in reducing contamination in the lake water, sediments, and sportfish.

Because contaminant loads are required inputs to the model, substantial effort has been expended to develop a database of load estimates. The first year results of the LOTOX project provided preliminary estimates of contaminant loads from all major source categories. When possible, these were calculated from primary data (i.e., monitoring data such as the Niagara River Upstream-Downstream Program); but usually it was necessary to use published literature sources. Recognizing the uncertainty of many of the estimates, work on Lake Ontario contaminant load estimation has continued into the second year of the project, aiming at reducing the uncertainty of the load estimates.

Efforts to reduce uncertainty in load estimates have proceeded along three tracks. Initial work focused on developing a history of tributary contaminant loading based on sediment cores collected by New York State Department of Environmental Conservation near the mouths of Lake Ontario tributary streams. Dated sediment cores provide a time history of contaminant accumulation at the location of the core. Using such cores, we developed a method to interpret the sediment accumulation data in a way that yields an estimate of the history of contaminant loading from the associated tributary. Additional information on current loadings from Canadian tributaries from the Ministry of the Environment/Environment Canada tributary monitoring program was used to update tributary loading estimates.

Recognizing the importance of atmospheric deposition as a source of critical pollutants to Lake Ontario, air monitoring program over the lake supplemented ongoing monitoring supported by Environment Canada at Point Petre, Ontario (one of the Great Lakes International Atmospheric Deposition Network (IADN) sites). In September 1998, Dr. Keri Hornbuckle, with support from USEPA as part of the LOTOX project, used the USEPA research vessel Lake Guardian to sample air and water at seven locations around the lake. This survey detected generally higher air and water PCB concentrations in the western end of the lake than in the east. This suggests the presence of PCB sources in the urbanized areas on the western end of the lake.

The third track of load estimation work focused on data from New York point sources that report their discharges pursuant to New York State Pollutant Discharge Elimination System (SPDES) requirements. This analysis assesses the contribution of 1) point sources; 2) non-point sources; and, 3) Lake Ontario watersheds. In other words, it provides an estimate the fraction of a given tributary's loading that originates from point sources within its watershed.

The progress in improving estimates of loading of critical pollutants has allowed the LOTOX models to make more accurate assessments of the lake's response to historical load reductions, and thus make more informed forecasts of the response of water, sediment and fish concentrations to further load reductions.

Using these load estimates in the LOTOX2 model, historical declines in lake trout PCB concentrations in response to the reduced loading are simulated. Having done that, the model can them forecast the future levels of PCBs in lake trout under a variety of load reduction scenarios. A base forecast was developed to predict future levels of PCBs in Lake Trout, assuming no future load reductions occur after 1995. This "base" forecast, which shows the average adult lake trout PCB concentration dropping below 1 part per million in the late 1990s, can then be compared to various load reduction alternatives being considered through the LaMP process. Thus managers can assess the most effective strategies to reduce contamination in fish.

Researchers also calibrated the model by comparing the model output with data on suspended solids and PCB concentrations in the lake. This means that the concentrations of solids and PCBs calculated by the model accurately reflect the concentrations of solids and PCBs measured in the lake, given the conditions under which the data was collected. The research team then used the improved model to predict future PCB concentrations in Lake Ontario water and sediments, under various scenarios of hypothetical future PCB loadings.

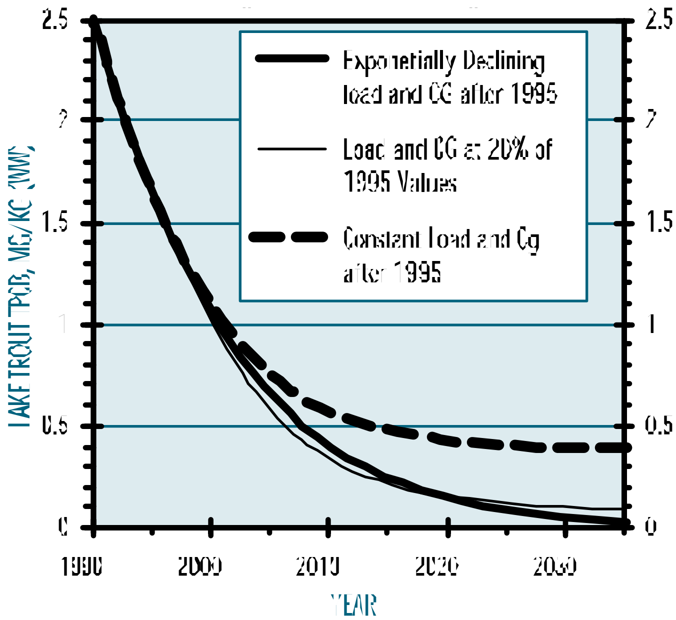
The results of these studies provide important insights into the possible effects of PCB load reductions beyond what has already been achieved. The load reductions are reflected in the response of the lake, including how much the PCB concentrations in the lake decrease, and the response time (how long it takes). Figure 6.6 shows the forecasts for levels of PCBs in lake trout under three different PCB loading scenarios: 1) Assuming no further load reductions. The loadings input to the model are held constant at recent (i.e. 1995) levels. This includes the atmospheric gas-phase PCB concentration (Cg). 2). Assuming the load continues to decrease at the same rate it has been decreasing. The load and Cg input to the model are decreased at the same rate that has been observed over the past 15 years. The rate of decrease is expressed using an exponential factor (0.125 per year). 3) Assuming an immediate load reduction, and then a constant load. In this case, the loads input to the model are instantaneously decreased to 20% of their values in 1995, and then held constant at the new level.

The key insights gained from comparing these loading scenarios are that continued PCB load reductions are expected to produce in-lake benefits, in this case exemplified by lower PCB concentrations in lake trout; but also that it will take some time for those benefits to be realized (see figure on this page).

The scenarios indicate the importance of historical PCB loads in determining the rate of decline in PCB concentrations in response to load reductions. As illustrated in the figure, the results suggest that it will take 10 to 20 years for the benefits of PCB load reductions to be realized. As the load is held constant, PCB concentrations in the lake trout stop declining (i.e. achieve a steady state) after about 20 years. However, the benefits of the load reductions become apparent after about ten years, the point at which the lines in the figure have diverged substantially. This delayed response is due primarily to the fact that the lake sediments act as a reservoir for the contamination. Over time, the more contaminated sediments, reflecting the higher historical loading, are buried under newer, cleaner sediment.

But despite the fact that PCB concentrations in fish are still responding to the historical inputs of PCBs, the results suggest the importance of banning PCB production and use in the 1970s. The figure illustrates the substantial decline in PCB concentrations in the lake because of the large reductions in load over the past 15 to 20 years. On average, lake trout in Lake Ontario today have PCB levels below 2 ppm (parts per million). Furthermore, the scenarios indicate that continued load reductions will produce additional benefits to the lake, as reflected in the differences in the ultimate lake trout PCB concentrations among the scenarios.

Figure 6.6 Lake Trout PCB Concentrations: Forecasting Under Different Loading Scenarios



LOTOX2 Prediction of lake trout total PCB concentration in Lake Ontario after 1995 under different loading scenarios

6.5.2 U.S. Activities

6.5.2.1 New York's Water Comprehensive Assessment Strategy

NYSDEC's Comprehensive Assessment Strategy uses watersheds as the basic organizing unit in developing water pollution control strategies. Five-year cycles of monitoring and problem identification, leading to the development of management and restoration activities are initiated in 2 or 3 of New York's 14 major watershed units each year. Once completed, the cycles begin again. Assessment of the Seneca-Oneida-Oswego and the Genesee River watersheds began in 2001 and 2002 respectively.

Watershed assessments developed through this strategy are used to update New York's Priority Waterbodies List which summarizes water quality information and identifies priority problems in rivers and lakes across the state. These assessments also provide a starting point for the development of Watershed Restoration and Protection Action Strategies (WRAPS). WRAPS involve all appropriate agencies and stakeholders to focus grant monies, technical assistance, regulatory efforts and other resources to address identified priority water quality and natural resource needs of a watershed. Information developed by the LaMP's contaminant trackdown efforts directly supports the development of WRAPS for Lake Ontario watersheds.

6.5.2.2 Contaminant Trackdown Activities

An understanding of significant sources of critical pollutants is essential to effectively control and minimize critical pollutant inputs. Information on potential critical pollutant sources and related problems has been synthesized and used to plan environmental sampling needed to identify and confirm suspected pollutant sources.

Since 1993, NYSDEC and USEPA have conducted a wide variety of environmental investigations across the Lake Ontario basin, evaluating critical pollutant concentrations in water, sediment and biological samples. Much of this sampling has been guided by reviews of existing information and recommendations provided by other environmental programs. For example, inactive hazardous waste sites in the basin were ranked based on their potential risk to nearby surface waters. Surface waters adjacent to sites with the highest potential were sampled to identify any sites requiring additional attention. Similar approaches have been used to evaluate potential areas of sediment contamination, contaminants in surface water discharges, fish tissue contamination and the effectiveness of remedial actions.

Other types of contaminant trackdown activities include sampling the Lake Ontario basin sewage treatment plant (STP) wastewaters using state-of-the-art technology capable of achieving extremely low (parts per quadrillion) detection limits for PCBs, pesticides and dioxins. These projects included participation by STP operators, local governments, NYSDEC and USEPA. Wastewater samples were also collected at strategic points within the sewer collection system in an effort to identify where the majority of critical pollutants originate within these systems. This information assisted sewage treatment plants in the Lockport and West Carthage in qualifying for more than two million dollars of New York's Environmental Bond Act funding to upgrade their treatment systems to improve the quality of their wastewater.

Although there is more to do, the work over the last decade has developed a good picture of the location and extent of critical pollutant sources and problems in the US portion of the basin. Key highlights of investigation results and critical pollutant control actions completed or underway in each of New York's Lake Ontario basin watersheds are summarized below.

Lake Ontario Western Watershed

Barge Canal and Eighteenmile Creek Sediments — Levels of dioxin/furans in Barge Canal sediments and related tributaries were highest near the City of Lockport downtown area. The creek flows beneath the canal near the center of the city. The periodic de-watering of the canal during the non-navigational season flushes contaminated sediments into the creek where they are trapped behind the Newfane Dam (where some of the highest levels of sediment dioxins and furans are found). Other Eighteenmile Creek contaminant trackdown efforts utilizing sediment and water samples identified the Flintkote Site (Williams Street Island), an undocumented waste dump located in the bed of the creek, as a potential PCB source. A preliminary site investigation has been completed.

Lockport Sewage Collection System —Three phases of wastewater sampling focused on identifying sources of PCBs and other contaminants to the Lockport wastewater collection system by sampling wastewaters at key points in the sewer collection system.

Slater Creek — The 1996 sampling of young of- the-year (YOY) fish measured relatively high concentrations of PCBs in Slater Creek fish, compared to other Lake Ontario sampling locations. Follow-up sediment and water sampling was conducted in 1998 and 1999 at several points along the creek in an attempt to identify any PCB sources. Hexane-filled passive samplers were used to evaluate creek water quality over a two-week period that included rainstorms that would mobilize contaminants in sediments or other uncontrolled sources. Water and sediment sampling showed that PCB concentrations in sediment and water to be low with no evidence of significant inputs of PCBs to the creek. Dieldrin was found to be slightly elevated in YOY, water and sediment samples. The source of dieldrin may be historical use of this pesticide in orchards located in the headwaters of Slater Creek. A more complete analysis of follow-up sampling results will be completed this year. Contaminant sampling of resident creek targeted by anglers is recommended.

Genesee River Watershed

The Genesee River watershed has its headwaters in Pennsylvania and flows north (approximately 157 miles) across the width of the western arm of New York State to Lake Ontario. It collects water from 52 tributaries and six lakes on the way to Lake Ontario. The watershed includes the four most westernmost *Finger Lakes: Conesus, Hemlock, Canadice, and Honeoye*. - The mouth of the Genesee River is approximately 75 miles east of the mouth of the Niagara River and six miles north of the City of Rochester. The Genesee River sub-basin consists of 2,400 square miles in New York and is inhabited by approximately 400,000 persons. A major portion of this population resides in the Rochester metropolitan area, which also contains much of the industrial and commercial activity in the U.S. portion of the Lake Ontario basin. The river is used for hydroelectric power generation, industrial and municipal wastewater discharge, limited commercial shipping, and recreation. The rest of the sub-basin is lightly populated and primarily rural-agricultural with small population centers.

Monroe County's Sewer Collection System — A cooperative federal, state and county contaminant trackdown project was carried out in Monroe County's Frank E. Van Lare Water Pollution Control Facility's (WPCF's) sewer collection system, which serves the greater the Rochester metropolitan area. Concentrations of PCBs and pesticides were measured at key points within the sewers to help identify which sections of the city had wastewaters with higher than average contaminant concentrations. One section of the western metropolitan area of Rochester (Lake Ontario LaMP 2002 Report, page 58) was identified as having wastewaters with PCB concentrations ten times higher than other locations. The Delphi automobile parts manufacturing facility was confirmed as one PCB source in the western metropolitan area contributing to these elevated concentrations of PCBs. Delphi is remediating a groundwater PCB contamination problem and discharges treated groundwater to the sewer system.

Taylor Instruments — Wastewater sampling in the sewers down gradient of Taylor Instruments, a former mercury thermometer manufacturer in the Rochester metropolitan area, confirmed that this site was a source of mercury to the Monroe County sewer collection system.

Hospital and Dental Clinic Wastewaters — Sampling of wastewaters from hospital and dental clinics demonstrated that high levels of mercury were present in these wastewaters. This information supported the development of voluntary mercury phase out and prevention efforts at these facilities.

Lake Ontario Central Watershed

Sodus Bay and Creek — Poor management of pesticides at the Sodus Fruit Farm led to contamination of on-site soils and buildings. Sampling at the site detected DDT, DDD and DDE in surface soil. Located on Sodus Point, next to Sodus Bay, contaminated runoff from this site has the potential to directly impact the lake. Earlier lakewide investigations of dioxin sediment contamination had detected relatively high levels of dioxin offshore of Sodus Point. Analysis of Sodus Bay sediment samples did not find problematic concentrations of pesticides or dioxins. YOY fish samples collected from Sodus Creek showed total DDT levels exceeded criteria designed to protect fish-consuming wildlife. The source of the total DDT appears to be historical use, as less than one percent consisted of the parent product DDT.

Seneca-Oneida-Oswego River Watershed

Oswego River — A detailed assessment of sediment contamination in the Oswego Harbor, Oswego River and the Seneca River was carried out in 1994 in response to data needs identified in the Oswego RAP Stage II report. One particular area of interest was the status of historical releases of mirex to the Oswego River from an inactive hazardous waste site. Information on benthic community structure richness, biological impairment and sediment toxicity, as well as sediment contaminant levels, was collected at key points along the river and depositional areas behind dams. With the exception of Oswego River's Battle Island area, sediment contaminant levels were found to be low, with little to no evidence of toxicity to benthos. Based on these findings, a more detailed sediment evaluation was conducted in the Battle Island area.

Armstrong World Industries — The inactive hazardous waste site, Armstrong World Industries, near Battle Island, is known to have released mirex and other contaminants to the river before this site was remediated. The study found some small lenses of mirex contamination remain buried in river sediments adjacent to and immediately downstream of the waste site. A follow-up study conducted in 2000 developed detailed information on sediment contamination in the immediate vicinity of the Armstrong World Industries site (Lake Ontario LaMP 2002 Report, page 61). Levels of mirex in Oswego Harbor young-of the- year fish and Oswego River resident fish are similar to other parts of the Lake Ontario basin, suggesting that remaining contaminated sediments may not be a major concern.

Skaneateles Creek —The discovery of elevated PCB concentrations in Skaneateles Creek brown trout triggered a series of contaminant trackdown efforts that collected water, macro-invertebrate and fish tissue samples along the creek in order to isolate the PCB source or sources. Skaneateles Lake flows into the Seneca River via Skaneateles Creek. These investigations identified the former Stauffer Chemical facility, an inactive hazardous waste site located directly on the creek, as a source of PCBs.

Keuka Lake — Contaminant trackdown investigations were conducted in 1997, 1998 and 1999 in an attempt to identify the source of DDT responsible for Keuka Lake DDT fish consumption advisories. Soil, sediment and water samples were collected at key locations around the lake. Results indicated that Brandy Bay Creek is a very low level source of DDT. A former disposal area located along this tributary is one potential source. Historical sources may no longer be significant given the steady decline of DDT in Keuka Lake fish. Only two of fifty-three fish collected and analyzed in 1997 exceeded the FDA limit of 2.0 ppm total DDT.

Lake Ontario Eastern Watershed

Wine and White Creeks — Wine Creek enters Lake Ontario approximately two miles east of the mouth of the Oswego River. White Creek flows into Wine Creek approximately one mile upstream of the lake. Two potential sources of PCBs are the Pollution Abatement Services inactive hazardous waste disposal site, located at the junction of Wine and White Creeks, and the Niagara Mohawk Fire Training Area located on White Creek. The fire training facility is required to monitor PCBs in its storm water. An abandoned landfill is also located upstream of the re training facility. Contaminant trackdown water sampling showed that the majority of PCBs enter Wine Creek from White Creek sources. Preliminary results indicate that continuing PCB sources exist at both the PAS and Niagara Mohawk facilities although the significance of these releases will require further evaluation.

Black River Watershed

Black River PCB Trackdown — Surface water samples were collected at key points to evaluate PCB inputs from smaller tributaries and from communities with concentrations of paper mills and hydroelectric plants. River surface water PCB concentrations were highest below the Village of Carthage, suggesting a localized PCB source.

Carthage/West Carthage Municipal Sewage Treatment Plant — The treatment plant's effluent was sampled in 1997 as part of an evaluation of sewage treatment plants in the Great Lakes basin using low level detection methods. Of four Lake Ontario basin sewage treatment plants sampled, the Carthage WPCF had the highest concentrations of PCB and DDT indicating the presence of contaminant sources within its wastewater collection area. Consistent with these observations, NYSDEC sediment studies found some of the highest levels of PCBs and total DDT in sediments below the WPCF outfall. Wastewater samples collected within the sewer collection system showed that two large paper mills contributed approximately 90 percent of the PCB loadings over the two-week sampling period. PCB contaminated wastewaters from these mills may be related, in part, to historical paper recycling activities when PCBs were used in inks and carbonless copy paper. A second round of wastewater sampling, following improvements and changes in mill operations, found significantly lower PCB wastewater concentrations.

Black River Sediment Sampling — Sediment cores and surficial sediment samples were collected at more than 40 sites on the Black River, its major and minor tributaries, and other tributaries discharging directly into the eastern Lake Ontario drainage basin. Sediment samples were evaluated for heavy metals, PCBs, chlorinated pesticides, PAHs, and dioxins and furans. Toxicity and bioaccumulation tests were performed using surficial sediment samples collected for chemical analyses. A bioassessment of the study area using benthic organisms was also conducted. Some of the key findings include: extremely high DDT concentrations in the sediments from the Fulton Chain of Lakes (the highest concentration measured was 14,300 ppb in the Gray Lake Outlet, a small tributary to the channel connecting Old Forge Pond with First Lake; high DDT concentrations (990 ppb) in sediment cores taken from Fourth Lake; and elevated dioxin and furan concentrations (2,3,7,8 TEQ = 65 ppt) at the Delano Island site that warrant additional investigation to evaluate the spatial extent of contamination.

Kelsey Creek — Water, sediment and biota sampling conducted in Kelsey and Oily Creeks confirmed that PCB and other contaminant releases were occurring from the inactive hazardous waste disposal site, New York Air Brake.

6.5.2.3 USEPA/New York State Performance Partnership Agreement

On November 26, 1996, the New York State Department of Environmental Conservation (NYSDEC) and USEPA entered into a cooperative partnership to protect and enhance the water resources of New York State for the benefit of its citizens. While NYSDEC and USEPA have always worked cooperatively to protect New York's water resources, this new Agreement, under the National Environmental Performance Partnership System, provided an opportunity for the state and USEPA to jointly establish priorities, direction, and accountability for water resource management in New York. The Agreement includes mutual understandings of the state and USEPA regarding environmental projects to be pursued as well as the lead agencies responsible for the successful implementation of these projects.

The Performance Partnership Agreement (PPA) is built on two principles:

- Maintaining the efficiency and effectiveness of existing programs in the state.
- Taking more action, beyond these ongoing programs, as necessary to solve particular problems in particular places - through "Community-Based Environmental Protection".

The Agreement contains an environmental and programmatic self assessment, individual strategies for each of the existing programs and for all identified community-based environmental protection efforts, agreed upon indicators of success, fiscal accountability, public involvement procedures, and a process for reporting success.

Through the Agreement, USEPA and NYSDEC continue their commitment to implement the existing regulatory programs in order to reduce the load of critical pollutants to the lake from point and non-point sources. The Agreement then lays out commitments specific to the Lake Ontario Community-Based Environmental Protection Initiative.

The 1997/1998 Agreement was entered into by USEPA, NYSDEC, and the New York State Department of Health (NYSDOH). This PPA was expanded in scope to include programs under the Safe Drinking Water Act that are under the purview of NYSDOH.

6.5.2.4 Great Lakes Water Quality Guidance

In February 1998, NYSDEC completed the adoption process and began to implement the regulations, policies, and procedures contained within the Great Lakes Water Quality Guidance (GLWQG). The implementation of the GLWQG will result in consistent state water pollution control programs throughout the U.S. Great Lake States and will lead to substantial reductions in the loading of LaMP critical pollutants and other pollutants.

The GLWQG will play a major role in addressing all of the lakewide impairments identified in this document. The following illustrates how the implementation of the GLWQG by the eight Great Lakes States will significantly address these concerns.

- **Restrictions on Fish and Wildlife Consumption:** The GLWQG requires that the eight Great Lakes States adopt human health criteria based on the consumption of aquatic life, which will result in the eventual elimination of restrictions on fish and wildlife consumption by humans. The GLWQG includes numeric human health criteria for 16 pollutants, and methodologies to derive cancer and non-cancer human health criteria for additional pollutants.
- **Degradation of Wildlife Populations and Bird or Animal Deformities or Reproductive Problems:** The GLWQG requires that the eight Great Lakes States adopt wildlife criteria, which, once achieved, will result in the eventual elimination of degraded wildlife populations and bird or animal deformities or reproductive problems. The GLWQG includes numeric criteria to protect wildlife from four pollutants (PCBs, DDT and its metabolites, dioxin, and mercury) and a methodology to derive criteria for additional bioaccumulative chemicals of concern (BCCs) discharged to the Great Lakes system.
- **Targeting the Pollutants of Concern, which are Bioaccumulative and Persistent:** The GLWQG focuses on the reduction of 22 known chemicals of concern, including PCBs, dieldrin, DDT and its metabolites, and dioxin. In addition to requiring the adoption of numeric water quality criteria for BCCs and other pollutants, as well as the detailed methodologies to develop criteria for additional pollutants, the GLWQG also includes implementation procedures that will result in loading reductions of BCCs to the Great Lakes basin. These include requirements for

the development of more consistent, enforceable water quality-based effluent limits in discharge permits (including requirements for pollution minimization plans to track down and eliminate sources of BCCs); the development and implementation of total maximum daily loads for pollutants that can be allowed to reach the Great Lakes and their tributaries from all sources; and antidegradation policies and procedures which further restrict new or increased discharges of BCCs.

- **The Majority of the Loadings of these Pollutants are from other Great Lakes:** Since the GLWQG will be implemented in all eight Great Lakes States, the loadings of the identified pollutants of concern will be significantly reduced throughout the entire Great Lakes basin. Therefore, the major source of the loadings of the pollutants of concern to Lake Ontario will be substantially reduced.

6.5.2.5 Clean Sweep Projects

USEPA is continuing its commitment to reduce inputs of agricultural pesticides into Lake Ontario, by funding the County of Erie to expand its Clean Sweep project throughout the Lake Ontario basin. Erie County will use the strategies that were successful in previous Clean Sweep projects to solicit new participating counties and will provide local project management teams with the guidance and technical expertise necessary for successful implementation of this program.

6.5.2.6 Clean Water/Clean Air Bond Act

In 1996, the citizens of New York passed a $1.75 billion Clean Water/Clean Air Bond Act. Over the next five to ten years, the Bond Act will fund capital projects that will result in the protection of and improvements to the environment. Approximately $125 million has been targeted for Clean Water projects in the Great Lakes basin, including $25 million specifically intended to implement NYSDEC's Great Lakes Program, which includes Remedial Action Plans (RAPs) and LaMPs. Funding will support point source, non-point source, and pollution prevention initiatives, as well as activities to restore aquatic habitat and preserve open space.

6.5.2.7 Hazardous Waste Site Report

NYSDEC will use the findings of a July 1995 report, entitled "Preliminary Review of New York State Inactive Hazardous Waste Disposal Sites in the Lake Ontario Basin", as a first step in identifying which sites contribute significant amounts of critical pollutants to the lake. Where possible, NYSDEC will accelerate schedules for cleaning up these sites. NYSDEC will complete its sources and loadings report for Lake Ontario, documenting the existing knowledge of U.S. sources and loadings of contaminants to the lake.

6.5.2.8 Fish Advisory Project

USEPA and NYSDEC implement outreach programs in the Lake Ontario basin to more effectively communicate the risk of consuming contaminated fish. This project involves translating public outreach pamphlets and brochures into different languages and training citizens to effectively communicate risk in various languages.

6.5.2.9 PISCES Sampling

USEPA and NYSDEC are conducting a "Source Trackdown" project in order to facilitate the identification and remediation of contaminant sources to the lake. "Trackdown" involves the use of qualitative tools (Passive In-Situ Chemical Extraction Samplers, or "PISCES") for organic sampling in order to find tributaries that have the highest concentrations of PCBs. Once these tributaries are identified, the PISCES are moved upstream to trackdown the source of the contamination. The findings of the initial sampling are provided in NYSDEC's April 1996 report entitled "Trackdown of Chemical Contaminants to Lake Ontario from New York State Tributaries". USEPA and NYSDEC are forming a federal/state workgroup to use the findings of this report to focus source reduction efforts on the most contaminated sub-basins throughout Lake Ontario, as well as to confirm unknown sources, determine the effectiveness of remediation activities, and plan follow-up sampling activities. NYSDEC has conducted similar sampling efforts in the Niagara River. Additionally, NYSDEC developed and maintains a Great Lakes Sediment Inventory to identify hot spots of contaminated sediments and to prioritize remediation efforts.

6.5.2.10 Sewage System Sampling

Metropolitan areas warrant special attention given their higher concentrations of industry, manufacturing and waste sites. Sewage systems in urban areas collect wastewater from many industries that used or produced critical pollutants in the years before they were controlled and some may still be sources of these pollutants. Storm water runoff from waste sites can also enter sewer systems. As standard monitoring of sewage treatment plant wastewaters provides little information on critical pollutants, the true magnitude of loadings entering the Great Lakes from these plants is not well understood. Strategic sampling of wastewater at key points in sewage collection systems can help identify previously unidentified sources.

Ideally critical pollutants should be stopped at their sources as, trapped in sewage sludge, they create other environmental problems once disposed of on land or incinerated.

A cooperative federal, state and county wastewater sampling project conducted in Rochester's municipal wastewater collection system illustrates how this simple approach is being used to locate unrecognized, potentially significant PCB sources. Phase one measured dissolved PCB levels in major sewer lines delivering wastewaters from different parts of the city to the sewage treatment plant. Wastewaters from west Rochester were found to have higher PCB levels (330 parts per trillion (ppt)) compared to those from other parts of the city (<40 ppt). Phase two sampling focused on west Rochester sewers and found one sewer line to have high PCBs (140 ppt) compared to other west Rochester sewers (<20 ppt). Analysis of land use information along this sewer identified manufacturing and waste sites that may be PCB sources. Phase three collected sewer wastewater samples near each potential source in the Fall of 1999 with the hope of identifying the specific source. Similar studies are underway in Carthage and Lockport to help the Lake Ontario LaMP and related RAPs to identify and control sources of critical pollutants entering Lake Ontario.

6.5.2.11 TMDL for Lake Ontario

USEPA and NYSDEC are currently working together on the development of a watershedbased, pollutant management tool known as a "total maximum daily load" (TMDL). The Clean Water Act requires that TMDLs, which identify point and nonpoint sources of a pollutant, be developed for impaired waters such as Lake Ontario. The TMDL also identifies reductions in point and nonpoint loadings necessary to restore impairments. Presently, USEPA and NYSDEC are collecting and analyzing data, and refining a water quality modeling tool that will support the development of a TMDL. The schedule for TMDL development will be made available to the public through LaMP documents such as the Update and Biennial Report.

6.5.2.12 Pollution Prevention Activities

Medical and Dental Projects

Mercury pollution prevention activities in hospitals and dental offices are underway in both Canada and the U.S. In the Rochester Embayment watershed, the Monroe County, New York, Department of Health implemented a mercury pollution prevention program for hospitals and dental offices. The project, made possible by a grant from the U.S. Environmental Protection Agency, was undertaken in cooperation with the University of Rochester's Strong Memorial Hospital, Department of Dentistry and Eastman Dental Center. The project was a response to concerns about the health impacts of mercury and new federal regulations that greatly reduce the amount of mercury that can be discharged from a municipal wastewater system or an incinerator.

The U.S. Environmental Protection Agency Region 2 presented one of its 1999 Environmental Quality Awards to the Monroe County Health Department and the University of Rochester for their mercury pollution prevention project.

Health Care

In New York State, Strong Memorial Hospital replaced mercury thermometers with electronic thermometers, mercury-filled sphygmomanometers with aneroid devices, and mercury-filled GI tubes with tungsten filled tubes. Strong also discontinued using mercury containing laboratory reagents unless there is no adequate substitute. Non-medical products that contain mercury are being phased out. A specialized training program for hospital staff was developed. The experiences at Strong and extensive research led to the preparation of a how-to manual that was distributed to other hospitals in the Rochester Embayment watershed and, by request, to other parts of the U.S. and Canada. The manual is entitled Reducing Mercury Use in Health Care: Promoting a Healthier Environment (1998). It is available on the web at www.epa.gov/glnpo/bnsdocs/merchealth/.

Dentistry

In New York State, techniques for handling and recycling dental amalgam were developed by the Health Department and University of Rochester dental facilities. A booklet and poster, "Prevent Mercury Pollution: Use Best Management Practices for Amalgam Handling and Recycling", were distributed to dental offices in the Rochester Embayment watershed. The booklet contents are also included in the hospital manual.

6.5.3 Canadian Activities

6.5.3.1 Obsolete Pesticide Collection Program

In 2000, CropLife Canada initiated a two-year province-wide collection program for obsolete pesticides from the agricultural and commercial sectors. The program was developed with funding from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Ontario Healthy Futures for Ontario Agriculture Program, and with assistance from the Ontario Ministry of the Environment.

The program has collected thousands of litres/ kilograms of outdated, unusable, or unregistered pesticides from agricultural and commercial pesticide users in the Lake Ontario Basin. A licensed contractor was hired to dispose of the pesticides at approved facilities in Quebec and Alberta.

6.5.3.2 Ontario Air Regulation

On May 1, 2001, the Ontario Ministry of the Environment implemented a regulation that requires the mandatory monitoring and reporting of 358 airborne pollutants from all industrial sectors. Critical pollutants identified by the Lake Ontario LaMP (PCBs, dioxin/furans and mercury) are included.

The application of O. Reg. 127/01 to various facilities is being phased in. Phase I requires electricity generation facilities and facilities with large source emissions, including iron and steel manufacturers and petroleum refineries, to monitor and report emissions in accordance with the regulation. Phase II began January 1, 2002, and covers facilities with small source emissions, including food manufacturers and bulk dry-cleaning facilities.

6.5.3.3 Ontario Hazardous Waste Plan

In December 2001, the Ontario Ministry of the Environment announced the following hazardous waste initiatives and laws to increase public accountability and protect human health:

- Phase out the existing Ontario hospital incinerators, a major source of mercury emissions and one of the province's largest emitters of dioxins and furans;
- Set requirements for the handling, transportation and treatment of biomedical waste;
- Require the destruction of PCBs currently in storage at sites throughout Ontario (as part of the phase-out schedule, all PCBs currently stored at sensitive sites, such as schools and hospitals, will be eliminated within one year of the regulation becoming law); and
- As of January 1, 2002, hazardous waste generators were required to pay for the Ministry's cost of managing hazardous and liquid industrial waste in the province.

6.5.3.4 Data Synthesis

As part of Environment Canada's commitment to the Lake Ontario LaMP to reduce toxic discharges to the lake, a study was undertaken in 2002 to update loading estimates on the Canadian side of the lake. Pollutant loadings were estimated for tributary streams, air and water point source discharges, atmospheric deposition, and for combined sewer overflow and storm discharge events. In addition, the study summarized the available sediment data. The estimated loadings are a compilation based on the best available information and provide general indications of the relative significance of loadings from various sources to the lake.

The report confirmed that upstream sources are responsible for most of the loadings of critical pollutants to Lake Ontario and that atmospheric deposition is the next largest pollutant source to the lake. Other major findings are that:

- PCB concentrations in most of the major tributaries to Lake Ontario, on the Canadian side, are above the Provincial Water Quality Objectives (PWQOs);
- Stormwater runoff may be a significant source of PCB loadings to the lake; and

- Municipal inputs (from sewage treatment plant effluents, combined sewer overflows and stormwater discharges) may contribute significant loadings of mercury to the lake, although concentrations are generally below PWQOs.

6.5.3.5 Tributary Priority Pollutant Monitoring Study

Canada and Ontario initiated a Lake Ontario Tributary Priority Pollutant Monitoring Study beginning in the spring of 1997. The objectives of the collaborative study were to:

- Identify those tributary discharges along the Canadian shore of Lake Ontario that contribute significant loadings of Priority Pollutants (including all LaMP critical pollutants).
- Establish the range of concentrations of priority pollutants present in the most significant tributaries.
- Where feasible, use the concentration data in conjunction with federal and federal/provincial flow data to estimate the mean annual mass discharge of priority pollutants for those Lake Ontario tributaries that have been selected for monitoring.
- Provide the degree of certainty associated with estimates of the mean concentration and mass discharges.
- Provide recommendations for targeted action within watersheds identified as significant sources of priority pollutants, such as source trackdown and load reduction activities.

6.5.3.6 Tributary Source Trackdown

As reported in the “LaMP Update 2000”, results of the joint 1997-98 OMOE and EC tributary sampling program for priority pollutants revealed a relatively uniform background concentration of total PCB at the mouths of six Lake Ontario tributaries across a range of different land uses.

Since concentrations of total PCB in some Lake Ontario tributaries have been found to exceed the Provincial Water Quality Objective of 1.0 ng/L (nanogram per litre) in the 1997-98 study as well as other investigations, a commitment was made by OMOE to confirm these findings using an integrated high-frequency sampling approach to characterize typical concentrations of PCB along with other priority pollutants including polynuclear aromatic hydrocarbons (PAHs), and organochlorine compounds (including DDT and mirex). This approach involves the collection of four-week composite samples made up of subsamples collected every six hours throughout the entire year, rather than relying on 10 to 15 grab samples to characterize annual conditions. In this way, a more complete range of seasonal hydrological conditions within the watershed is taken into account. This approach was applied to several Lake Ontario tributaries from July 2000 through June 2001.

In addition to this refinement in the sampling approach, OMOE is also developing and applying a tributary “trackdown” strategy to answer the questions:

1. Are concentrations of PCB and other priority pollutants significantly elevated at Lake Ontario tributary mouths relative to headwaters? and
2. Is there evidence of significant, local sources of PCB and other priority pollutants within Lake Ontario tributaries?

In essence, the goal is to determine whether observed concentrations of PCB and other priority pollutants are attributable to locally controllable sources, or whether they reflect recycled contaminants from diffuse historical sources.

These questions will be answered for selected tributaries by: (a) quantifying upstream-downstream differences in total concentrations (and congener patterns where possible) of PCB in water, sediment, and juvenile fish tissue; and (b) quantifying differences in biomonitored (caged mussel) tissue PCB concentrations and congener patterns at selected points throughout the watershed.

Three pilot watershed projects were selected from Lake Ontario tributaries where elevated PCB levels were found and good screening level data was available from both provincial and federal studies. These included water quality and juvenile fish data from the 2000-01 and 1997-98 studies described above, along with previous data from the 1991-92 Toronto area six tributary study.

Based on these criteria, Twelve Mile Creek was selected as the first of these pilot projects in the western part of the Lake Ontario basin; field work for the PCB trackdown started here during the summer of 2000 and was completed during summer of 2001. Work on the other two pilot projects, Etobicoke Creek and Cataraqui River, located in the central and the eastern part of the basin, commenced during the summer of 2001. Sampling for the projects continued in the summer and fall of 2002 and resumed in the spring of 2003. Analysis of data is ongoing. Environment Canada and the Ministry of the Environment are assessing the effectiveness of the initiative so that the experience gained can be applied to future contaminant trackdown projects.

The project involves extensive sampling for PCBs in water, sediment, fish and caged mussels at various locations along the tributaries to determine the sources of critical pollutants. The project will also try to determine whether sources of PCBs are historical or ongoing and locally controllable. Results will help determine the need for future measures and/or remediation actions that will ultimately reduce the amount of critical pollutants entering Lake Ontario.

The preliminary results of these trackdown activities are presented below.

Twelve Mile Creek

Fieldwork for the PCB trackdown started during the summer of 2000; sediment and water samples were collected at upstream and downstream sites of Twelve Mile Creek, including Lake Gibson. Mussels were deployed in the creek upstream of the confluence with Lake Gibson, downstream of Lake Gibson (in the vicinity of two outfalls discharging into the creek), at the power dam (Martindale Pond), and at a combined sewer outflow drainage ditch downstream of the power dam. Young-of-the-year shiners were collected from the upstream location, Lake Gibson and the downstream location (Martindale Pond). Caged mussels were also deployed at three sites along the Old Welland Canal: above and below a pulp and paper mill, and downstream close to the confluence with Twelve Mile Creek.

PCBs were bioavailable to the mussels at all of the sample locations. The concentration of bioavailable PCBs increased in Twelve Mile Creek with increasing distance downstream of Lake Gibson and the confluence with the Old Welland Canal. PCB concentration in the mussel tissue was highest at an outfall used jointly by GM and the municipality of St Catharines. PCB tissue concentrations were similar between the upstream and downstream stations in the Old Welland Canal; however, congener pattern analysis suggests that there may be additional sources of PCBs entering the Old Welland Canal. The congener patterns observed in the Old Welland Canal were different from those observed in the mussels deployed at the municipal outfall by the GM plant, which had the highest PCB tissue concentrations. Downstream congener patterns from Martindale pond suggest a mixture of the Old Welland Canal and GM/municipal congener patterns. Although these preliminary biomonitoring results have succeeded in identifying potential sources of PCBs to Twelve Mile Creek, they are not sufficient to quantify their significance. Follow-up investigation of these areas is planned in order to determine whether these differences reflect significant local sources or are attributable to diffuse urban runoff.

Young-of-the-year fish from Martindale Pond indicated an increase in PCB tissue concentrations compared to the upstream locations in Twelve Mile Creek and Lake Gibson. Interestingly, when the fish were normalized on a lipid weight basis, the PCB concentrations were similar to those in the mussels. Although sediment PCB concentrations were not elevated at locations sampled in Martindale Pond (i.e., less than 0.2 ppm), they were elevated compared to concentrations observed at the upstream station on the southern side of Lake Gibson (i.e., less than 0.04 ppm). This reinforces the findings with the juvenile fish and confirms previous observations that biota in the lower river have a greater exposure to PCBs than those higher up the system. Once again, however, follow-up work based on further analysis of these results will be required to determine the existence of any significant local sources.

Summary reports of the mussel biomonitoring and large volume water sampling are currently being completed, and will contain recommendations for further monitoring. Additional sediment has been collected by Environment Canada from: Lake Gibson; various locations along the Old Welland Canal; the Welland Canal, upstream of Lake Gibson; Twelve Mile Creek, upstream of Lake Gibson; and Martindale pond. As part of a study by Ontario Power Generation, YOY fish will be collected from Lake Gibson.

Etobicoke Creek

Field work for the PCB trackdown started during the summer of 2001. A total of 11 sampling locations along Etobicoke Creek were initially sampled, the majority of which were located at the mouths of the major tributaries into the main branch of the creek. The trackdown project included biomonitoring (fish and mussels), sediment collection, and large volume water samples integrated over a ten-week period. Environment Canada collected surficial sediment samples in July from the 11 sites selected for the study.

Juvenile fish were collected from 9 of the 11 sites and caged mussels deployed at the locations where no fish were observed, as well as at the upstream and downstream locations. As a result of the initial sediment screening, additional caged mussels were deployed at the mouths of two minor tributaries entering the main creek in the areas of elevated PCB levels.

Cataraqui River

Previous studies indicated that PCB contamination in the sediments of the Cataraqui River was greatest on the west side of the river, where urban growth and industrialization historically occurred. As a result of these findings, the trackdown study focused on the west side of the river, and included: biomonitoring (using caged mussels); large volume water samples integrated over a ten-week period and collected directly from the municipal sewer pipes; and sediment cores. Arrangements were made with the City to collect water samples directly from the municipal sewer pipes twice a week for the ten-week period. The final samples were split; one litre of the sample was sent to an external laboratory by the City for total PCB analysis, while the remainder of the water is being processed by the OMOE laboratory for congener analysis. The external laboratory uses a method detection limit of 50 ng/L. At this level, no PCBs were detected.

Caged mussels were deployed at the mouth of six municipal sewers discharging into the west-side of the river. An additional four caged mussel experiments were deployed in other areas of concern and at an upstream reference location. Sediment cores were collected in July 2001 by Kingston OMOE District staff from 6 storm sewers on the west side of the river, and 26 cores were collected from south west side of the landfill, in an attempt to spatially quantify PCB levels in this area. The cores were analyzed by Environment Canada for total PCBs. Elevated PCB levels were observed in the area immediately south of the landfill. Combined sewers discharge into the southwest corner of the landfill and an old tannery site located adjacent to the landfill on the south side of the creek. Further sediment samples were collected upon retrieval of the caged mussels from all of the caged mussel locations, as well as from three other discharge locations. More intensive sediment sampling in the area immediately south of the landfill and adjacent to the old tannery property was also carried out by Environment Canada. The data are being analyzed.

6.5.3.7 Pollution Prevention Activities

Green Venture - Home Audits

Green Venture is a non profit community organization in the Hamilton area which conducts home energy audits. In January, 2000 Green Venture initiated a program in cooperation with the Region of Hamilton Wentworth, Honeywell and Environment Canada to conduct home mercury audits at the same time. Non-mercury, energy saving, programmable thermostats will be promoted to the householder and mercury thermostats and other mercury containing devices will be collected by Green Venture and recycled through the regional household hazardous waste program. If this program is successful, it will be encouraged in other green communities that offer the energy audit program. Communities that have household hazardous waste facilities would be best suited for this program. In 1999, the Association of Municipal Recycling Coordinators completed a survey which indicated that 50% of the household hazardous waste programs in Ontario are currently set up to accept mercury containing devices such as thermometers and thermostats. Some municipalities are also collecting fluorescent lamps and switches.

Health Care

In Ontario, Pollution Probe, the Ontario Hospital Association, Environment Canada and the Ontario Ministry of the Environment have encouraged hospitals to reduce or eliminate the use and release of mercury. Information and programs which have been developed include: a Memorandum of Understanding that individual hospitals can sign, a healthcare pollution prevention training program, a guide to sources of mercury and alternatives, a cost of alternatives report prepared by Pollution Probe, and a Web site to provide ongoing, current environmental information.

Approximately 80 health care facilities in Ontario have completed the pollution prevention training course and a 1999 survey indicated that 80% of Ontario hospitals had initiated some form of mercury reduction program.

Dentistry

A Best Management Practices manual for dental offices is being developed by the Ontario Dental Association with input from Environment Canada, the Ontario Ministry of the Environment and the Region of Hamilton Wentworth.

Mercury Awareness in Schools

The Toronto District School Board is developing a curriculum resource that addresses BTS toxic substances. It will include a module on mercury.

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CHAPTER 7 HUMAN HEALTH

7.1 Summary

This Chapter introduces human health issues on a global scale, and then focuses on the binational concerns relating to the human health beneficial uses for Lake Ontario and how the Lake Ontario LaMP addresses the related use impairment indicators. The three key human beneficial uses for the waters of Lake Ontario are for fish consumption, drinking water, and bathing beaches (including recreational use). Only fish consumption has been identified as impaired on a lakewide basis. The chapter describes the pathways through which pollutants can affect human health. Through binational cooperation, a binational Great Lakes Human Health Network has been established to more comprehensively address human health impacts in the Great Lakes as a whole and for the Lake Ontario Lakewide Management Plan. The material presented is based on information that existed as of January 2003.

7.2 Background

There is concern about the effects that Great Lakes' contaminants, and in particular persistent, bioaccumulative toxic chemicals, may have on human health. The 1987 Protocol to the Great Lakes Water Quality Agreement of 1978 (GLWQA) states that Lakewide Management Plans (LaMPs) for open lake waters shall include: "A definition of the threat to human health or aquatic life posed by Critical Pollutants, singly or in synergistic or additive combination with another substance, including their contribution to the impairment of beneficial uses." Critical pollutants are those persistent bioaccumulative toxic chemicals that have caused, or are likely to cause, impairments of the beneficial uses of each Great Lake. Three of these beneficial uses (fish consumption, drinking water consumption and recreational water use) are directly related to human health. The goal of this Lake Ontario LaMP 2004 section is to fulfill the human health requirements of the GLWQA, including:

- to define the threat to human health and describe the potential adverse human health effects arising from exposure to critical pollutants and other contaminants (including microbial contaminants) found in the Lake Ontario basin;
- to address current and emerging human health issues of relevance to the LaMP but not currently addressed in the other components of the LaMP; and
- to identify implementation strategies currently being undertaken to protect human health.

The World Health Organization defines human health as "state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity" (World Health Organization, 1984). Therefore, when assessing human health, all aspects of well-being need to be considered, including physical, social, emotional, spiritual and environmental impacts on health. Human health is influenced by a range of factors, such as the physical environment (including environmental contaminants), heredity, lifestyle (smoking, drinking, diet and exercise), occupation, the social and economic environment the person lives in, or combinations of these factors. Exposure to environmental contaminants is one among many factors that contribute to the state of our health (Health Canada, 1997).

In defining the threat to human health from exposure to the Lake Ontario LaMP critical pollutants, this assessment applies a weight of evidence approach, which uses the overall evidence from wildlife studies, experimental animal studies, and human studies in combination.

7.3 Human Health and the Lake Ontario LaMP

The Lake Ontario LaMP is concerned with human health issues related to water quality. Other human health issues, such as air pollutants, infectious diseases, and pesticide residues on food are not addressed as part of the LaMP and are under the jurisdiction of other programs. Three of the Great Lakes Water Quality Agreement (GLWQA) impairments of beneficial uses are directly related to human health issues: Restrictions on Drinking Water Consumption, Fish and Wildlife Consumption, and Beach Closings. Of these three, only fish and wildlife consumption advisories have been identified as a lakewide problem.

Localized beach closings due to occasional high bacteria levels are a problem in some areas and are being addressed by several Remedial Action Plans. While some taste and odor problems have been observed, there are no restrictions on drinking water consumption. The LaMP will work with U.S. and Canadian health agencies to assure that health issues are being adequately addressed.

7.4 Human Health Pathways

Potential environmental pathways of human exposure to Great Lakes pollutants include inhalation of air, ingestion of water, foodstuffs, or contaminated soil, and dermal contact with water or airborne particulates. Multimedia analyses indicate that the majority (80 to 90%) of human exposures to chlorinated organic compounds and mercury comes from the food pathway, a lesser amount (5 to 10%) from air, and minute amounts (less than 1%) from water (Birmingham et al., 1989; Newhook, 1988; Fitzgerald et al., 1995).

Most of the available data on human exposure to toxic substances in the Great Lakes comes from the analyses of contaminant levels in water and sport fish. The consumption of contaminated sport fish and wildlife can significantly increase human exposure to Lake Ontario critical pollutants. The risks associated with fish consumption are greatly reduced if people follow consumption advisories. Those who are unaware of or do not follow these advisories are at greatest risk. Investigators have demonstrated that blood serum levels of these contaminants are significantly increased in consumers of contaminated Great Lakes sport fish as compared to non-fisheaters (Humphrey, 1983a,b; Kearney et al., 1995; Health Canada, 1997; Fitzgerald et al., 1995).

Even though residents of the Great Lakes basin are exposed to toxic substances from many sources originating within and outside the region, the main routes of human exposure to contaminants from the waters of the Great Lakes are ingestion of fish and, to a lesser extent, ingestion of drinking water (Department of Fisheries and Oceans and Health and Welfare Canada, 1991). Also, several investigators have shown that exposure from fish far outweighs atmospheric, terrestrial, or water column sources (Swain, 1991; Humphrey, 1983b; Fitzgerald et al., 1995). These patterns may vary for populations living in the vicinity of industrialized areas.

Several epidemiologic investigations have been conducted on the association between water pollutants in the Great Lakes and the health of people in the Great Lakes basin. These studies have demonstrated increased tissue levels of toxic substances in these populations that may be associated with or potentially result in reproductive, developmental, behavioral, neurologic, endocrinologic, and immunologic effects (Fitzgerald et al., 1995).

Some studies have reported subtle effects in children of mothers who consumed large amounts of Great Lakes fish. At birth, some of the children most highly exposed to the mixture of contaminants present in the fish were slightly smaller, showed slightly delayed neuromuscular development during infancy, and had a reduced ability to deal with stressful situations. A small percentage of such children showed slightly delayed or reduced intellectual development during their school years. Recent epidemiologic and laboratory studies complement and continue to build upon the scientific data gathered over the last two decades that document health consequences associated with exposures to persistent toxic substances. The findings of elevated polychlorinated biphenyl (PCB) levels in human populations, together with findings of developmental deficits and neurologic problems in children whose mothers ate PCB-contaminated fish, have significant health implications. Additional research is necessary to better understand the human health impacts that persistent toxic substances may have on sensitive populations (Johnson et al., draft 1997).

Endocrine disruption has emerged as a major issue in regulatory toxicology with significant human health implications. While human health effects due to endocrine disruption remain controversial, some pesticides and certain industrial chemicals, as well as some naturally occurring substances have been shown to mimic the action of estrogen in tissue cultures and laboratory animal studies. Laboratory and animal studies reveal that fetuses and infants are especially susceptible to bioaccumulating and endocrine disrupting chemicals because exposure occurs during critical periods of early tissue and organ development and growth.

7.5 Beneficial Use Impacts

The critical pollutants and chemical pollutants of concern in Lake Ontario include organochlorines and metals that are known to cause adverse health effects in animals and humans. These chemicals do not break down easily, persist in the environment and bioaccumulate in aquatic biota, animal and human tissue - thus they are called persistent bioaccumulative toxic chemicals (PBTs). Organochlorines tend to accumulate in fat (such as adipose tissue and breast milk), and metals tend to accumulate in organs, muscle and flesh. Food is the primary route of human exposure to these PBT chemicals, and consumption of Great Lakes' fish is the most important source of exposure originating directly from the lakes.

Fish and Wildlife as a Sentinel for Human Health

The health of fish and wildlife provides a good indication of the overall condition of an ecosystem. The dramatic reproductive failure of cormorants on Lake Ontario due to DDT in the 1960s provided a clear indication that something was wrong. Since that time, contaminant reduction programs have succeeded in banning and controlling many toxic substances and, as a result, environmental levels have declined and the cormorants and other sensitive species are reproducing normally. This would suggest that the potential risks to human populations posed by these persistent environmental contaminants have also declined.

Ongoing fish and wildlife populations can provide an important tool to identify any currently unrecognized contaminant risks that may develop in the future. Given that the metabolisms and diets of fish and wildlife are very different from humans and that these species are exposed to much higher contaminant levels than the general human population, caution must be used when interpreting the significance of fish and wildlife problems for human populations. For example, tumors in fish may reflect high levels of contaminants in sediment or may be the result of natural causes such as viruses or genetic factors. Nonetheless, Canadian and U.S. health agencies [Health Canada and the Agency for Toxic Substances and Disease Registry (ATSDR)] have concluded that the weight of evidence based on the findings of wildlife biologists, toxicologists, and epidemiologists clearly indicates that populations continue to be exposed to PCBs and other chemical contaminants and that significant health consequences are associated with these exposures (Johnson et al., draft 1997; Health Canada, 1997).

In additions to the presence of tumors, other use impairment indicator can be useful as a warning to scientists that beneficial uses are being affected. These Lake Ontario LaMP indicators include degradation of fish and wildlife populations, degradation of benthic communities, degradation of plankton populations and other bird or animal deformities or reproductive problems.

Indicators of Human Health Trends

Ideally, indicators of human health would gauge trends in any adverse human health effects related to environmental contaminants. Contaminant concentrations in fish tissue, human tissue, and other environmental media can be used as an indication of changes in contaminants levels and that certain human populations are being exposed. However, except in cases where individuals are exposed to relatively high levels of contaminants that can cause clearly recognizable health effects, it may not be possible to separate out any adverse effects due to environmental contaminants from other human health factors, such as diet, lifestyle, work environment, and genetic factors.

There are a number of U.S. and Canadian stakeholders collaborating to define indicators for the basin and the individual Great Lakes. The development of these human health indicators may provide the basis for future monitoring and data gathering efforts.

Sources of persistent toxic substances from Lake Ontario are known to contribute very little to the exposure of the general population. For the general population, a general market diet contributes to over 95% of their contaminant intake and drinking water, recreational water contact and air pollution constitute very minor exposure. Consequently, the approach taken by the responsible agencies has been to examine groups at higher risk of exposure to persistent toxic substances from Great Lakes sources, such as high consumers of sportfish: recreational anglers, certain ethnic groups, subsistence anglers and others.

7.5.1 Fish Consumption Advisories

Fish are low in fat, high in protein, and may have substantial health benefits when eaten in place of high-fat foods. However, chemicals such as mercury and PCBs enter the aquatic environment and build up in the food chain. People need to be aware of the presence of contaminants in sport fish, and in some cases, take action to reduce exposure to chemicals while still enjoying the benefits of catching and eating fish. Contaminants usually persist in surface waters at very low concentrations. They can bioaccumulate in aquatic organisms and become concentrated at levels that are much higher than in the water column. This is especially true for substances that do not break down readily in the environment, like the Lake Ontario LaMP critical pollutants PCBs and mercury. As contaminants bioaccumulate in aquatic organisms, this effect biomagnifies with each level of the food chain. As a result of this effect, the concentration of contaminants in the tissues of top predators, such as lake trout and large salmon, can be millions of times higher than the concentration in the water.

Both the Province of Ontario and New York State issue fish consumption advisories for fish caught in Lake Ontario waters. In general, the consumption advisories are based on contaminant levels in different species and ages of fish, taking into account that contaminant levels are generally higher in older, larger fish. While there are some differences in the fish tissue monitoring methodologies used by the two governments, both jurisdictions agree that PCBs, dioxin, and mirex are responsible for lakewide fish consumption advisories. The LaMP is coordinating binational efforts to control and reduce inputs of these contaminants to the lake.

Ontario anglers should refer to the Guide to Eating Ontario Sport Fish, published every two years by the Ministry of Natural Resources and the Ontario Ministry of the Environment, for size and species-specific consumption advice. *www.ene.gov.on.ca.*

U.S. anglers should refer to New York State Department of Health's Chemicals in Sportfish and Game, which includes specific and general advisories for Lake Ontario. *www.health.state.ny.us/nysdoh/environ/fish.htm.*

Various jurisdictions around the Great Lakes carry out sport fish monitoring programs that provide consumption advice. The LaMP recognizes there are differences in reporting and consumption advisories between jurisdictions in Canada and the U.S. As part of Ontario's Sport Fish Contaminant Monitoring Program, sport fish from the Canadian waters of Lake Ontario are monitored on an annual basis. The results are published every other year - along with consumption advice for sport fish from Ontario's inland lakes, rivers and Great Lakes - in the Guide to Eating Ontario Sport Fish. The guide offers size-specific consumption advice based on health protection guidelines developed by Health Canada for approximately 1,700 species.

Between 4,000 and 6,000 fish per year are tested through the Sport Fish Contaminant Monitoring Program. Staff involved in the program, a partnership between the Ontario Ministries of Natural Resources and the Environment, have been testing Ontario sport fish for more than 25 years. Staff from both ministries collect fish and send them to the Ministry of the Environment laboratory in Toronto. The skinless, boneless dorsal fillets of the fish are analyzed for a variety of substances, including mercury, PCBs, mirex/photomirex, and dioxins/furans – contaminants identified by the LaMP as critical pollutants.

In Ontario, consumption restrictions on Lake Ontario sport fish are the result of PCBs (47 percent of advisories), mercury (26 percent), mirex/photomirex (24 percent), toxaphene (2 percent) and dioxins/furans (1 percent). Other chlorinated organic contaminants such as DDT, hexachlorobenzene, octachlorostyrene, chlordane and lindane are regularly detected in Lake Ontario sport fish but do not result in consumption restrictions.

It is well known that sport fishing has nutritional, social and cultural benefits. However, because of the detection of PCBs and other contaminants found in Lake Ontario sportfish, both the New York State Department of Health as well as the Ontario Ministry of the Environment issue fish advisories recommending restrictions for several fish species depending on their degree of contamination. The advisories also explain how to minimize exposure to contaminants in sportfish and reduce the health risks associated with those contaminants. It is critical that women of childbearing age, young children and the elderly pay close attention to these advisories, as there are concerns that they are more sensitive to potential developmental, reproductive, immunological and neurological health risks posed by these contaminants.

Further information on persistent toxic substances and human health, and other Great Lakes health and environment issues can be found on the following internet Web sites:

- http://www.hc-sc.gc.ca/ehp.index.htm
- http://www.atsdr.cdc.gov/grlakes.html
- http://www.ene.gov.on.ca/water.htm
- http://www.epa.gov/OGWDW/
- http://www.health.state.ny.us/nysdoh/environ/fish.htm

7.5.2 Drinking Water

Access to clean drinking water is essential to good health. The average adult drinks about 1.5 liters of water a day. Lake Ontario is the primary source of drinking water for people who live in the Lake Ontario basin. Fortunately Lake Ontario is a very high quality source of drinking water with most contaminants, such as bioaccumulative contaminants, at levels well below drinking water criteria. Raw and treated surface water are monitored for a variety of contaminants, including micro-organisms (e.g. bacteria, viruses and protozoa), chemical contaminants (both naturally occurring, synthetic and anthropogenic), and radiological contaminants, including naturally-occurring inorganic and radioactive materials, to ensure that water treatment systems are effective and functioning properly.

Before the mid 1900s microbial contamination of drinking water posed a serious public health risk in terms of acute outbreaks of disease such as typhoid and cholera. Today bacterial contamination of municipal water supplies has been largely eliminated by adding chlorine or other disinfectants to drinking water to prevent waterborne disease. When used with multiple barrier systems (i.e. coagulation, flocculation, sedimentation and/or filtration), chlorine is effective against most infective agents. Diseases such as typhoid and cholera have been virtually eliminated.

Research is on-going on how to improve our ability to detect and prevent potential outbreaks of microbes resistant to drinking water disinfection, especially encysted forms of protozoan parasites such as Cryptosporidium. Potential human health impacts of chlorination by-products of drinking water disinfection such as trihalomethanes are also being studied. Although important areas of research, neither of these issues have been identified as a significant concern for residents of the Lake Ontario basin.

7.5.3 Bathing Beach (Closings) and Recreation

Local beach closings along some of the more populated shorelines due to elevated levels of E. coli (or fecal coliform bacteria) are indicative of fecal contamination and the possible presence of enteric (intestinal) pathogens which can pose a potential health risk. Microbiological water quality indicators are used as surrogates for the presence of pathogenic organisms that may cause illness. In Lake Ontario, a number of local beach closings occur due to microbial contaminants, primarily along the more populated shorelines. Exceedence of microbial standards and criteria typically occurs following a storm event when the treatment capacity of some sewage treatment plants can be exceeded. Given the localized nature of beach closings and their absence along much of the Lake Ontario shoreline, they are not considered a lakewide problem. The frequency of beach closings is expected to decrease as sewage treatment plants continue to improve and upgrade their systems. It should be noted that beaches may also be closed due to other factors such as storm events, excessive turbidity, or lack of funding.

Beach closings are restricted largely to shorelines near major metropolitan centers or the mouths of streams and rivers. These closings follow storm events when bacteria-rich surface water runoff is flushed into nearshore areas via streams, rivers, and combined sewer overflows (CSOs). In some instances beaches may be closed based on the potential for high bacteria levels to develop following storm and rain events. Beaches are also closed for aesthetic reasons, such as the presence of algal blooms, dead fish, or garbage. Given the localized nature of beach closings and their absence along much of the Lake Ontario shoreline, they are not a considered lakewide problem.

In Ontario, beaches are closed when bacterial (E. coli) levels exceed 100 organisms/100mL. During recent years (1995 to 1997) beach closings have continued in heavily urbanized areas in the western part of the basin due to storm events, but are less frequent in the central and eastern regions. Examples of ongoing problems include the beaches of the Bay of Quinte, Toronto, Burlington, Hamilton, Niagara, Pt. Dalhouse, and St. Catherines. Upgrading stormwater controls through the installation of collection tanks so stormwater from CSOs can be treated in Toronto and Hamilton should reduce beach closings in these areas.

The only U.S. beach with recent closings is Ontario Beach within the Rochester AOC. These closings have been posted due to rain events, storm runoff, excessive algae, waves greater than four feet, or water clarity less than one-half meter. Ontario Beach is routinely closed as a precaution during storm and rain events because these conditions have the potential to cause high bacteria levels along the beach shore. Ontario Beach summer fecal coliform levels have been well below the state's action level of 200 fecal coliforms/100mL. The implementation of a combined sewer overflow abatement program resulted in significant decreases in fecal coliform levels in the Genesee River and adjacent shoreline areas. Actions are also underway to address stormwater problems that impact other areas of the Rochester Embayment.

The Great Lakes are an important resource for recreation, including activities such as swimming, water-skiing, sail-boarding and wading that involve body contact with the water. Apart from the risks of accidental injuries, the major human health concern for recreational waters is microbial contamination by bacteria, viruses, and protozoa. Many sources or conditions can contribute to microbiological contamination, including sewer overflows after heavy rains. On-shore winds can stir up sediment or sweep bacteria in from contaminated areas. Animal/pet waste may be deposited on the beach or washed into storm sewers. Agricultural runoff, such as manure, is another source. Stormwater runoff in rural and wilderness area watersheds can increase densities of fecal streptococci and fecal coliforms as well. Other contaminant sources include infected bathers/swimmers; direct discharges of sewage from recreational vessels; and malfunctioning private on-site sewage disposal systems (e.g. cottages, resorts).

Human exposure to micro-organisms occurs primarily through ingestion of water, and can also occur via the entry of water through the ears, eyes, nose, broken skin, and through contact with the skin. Gastro-intestinal disorders, respiratory illness and minor skin, eye, ear, nose and throat infections have been associated with microbial contamination of recreational waters. Studies have shown that swimmers and people engaging in other recreational water sports have a higher incidence of symptomatic illnesses such as gastroenteritis, otitis, skin infection, and conjunctivitis, and acute febrile respiratory illness (AFRI) following activities in recreational waters. Although current studies are not sufficiently validated to allow calculation of risk levels, there is some evidence that swimmers/bathers tend to be at a significantly elevated risk of contracting certain illnesses (most frequently upper respiratory or gastro-intestinal illness) compared with people who do not enter the water. In addition, children, the elderly, and people with weakened immune systems are those most likely to develop illnesses or infections after swimming in polluted water. Chemical contaminants such as PAHs have been identified as a possible concern for dermal (skin) exposure in recreational waters. Dermal exposure may occur when people come into contact with contaminated sediment or contaminated suspended sediment particulates in the water.

7.6 Great Lakes Human Health Network

Information sharing is the focus of the newly created Great Lakes Human Health Network. Annex 2 of the Canada-U.S. Great Lakes Water Quality Agreement requires that Lakewide Management Plans (LaMPs) "include a definition of the threat to human health posed by critical contaminants". In order to facilitate better communication and information sharing between governments on human health issues directly related to Great Lakes water quality, a Great Lakes Human Health Network has been formed.

Working through the existing LaMP and RAP processes, the Network is intended to focus on ongoing and emerging human health issues in the Great Lakes basin. The Network is a voluntary partnership of federal, provincial, state and local health agencies, being supported by the U.S. Environmental Protection Agency and Health Canada.

Great Lakes Human Health Network (Network) was established to improve the exchange of environmental- related health information across the Great Lakes basin. The Network was formed in December 2002 under the guidance of the Binational Executive Committee (BEC), a body comprised of senior Canadian and U.S. officials, to create a forum or mechanism to discuss human health issues directly related to Great Lakes water quality. The Network addresses health issues related to the ecosystem of the Great Lakes basin, including drinking water and recreational water quality, and fish consumption. The Network is a voluntary partnership of representatives of both US and Canadian governments and their agencies whose purpose is to exchange information, facilitate communication and support the coordination of public health and environmental agencies. Network members will be able to return to their organizations and relay shared information to the communities they serve. The network is also designed to support the LaMP and Remedial Action Plan (RAP) process. Currently, the Network has representatives from six federal government agencies, five tribal government agencies, and eleven state and provincial government agencies, and one county government agency. Network membership continues to build. To learn more about the Great Lakes Human Health Network, visit the USEPA website http://www.epa.gov/glnpo/health.html. Contact information and links to related human health topics are provided.

7.7 Actions and Progress

The Great Lakes Water Quality Agreement (GLWQA) states that Lakewide Management Plans shall include “a definition of the threat to human health or aquatic life posed by critical pollutants”. Lake Ontario LaMP Stage 1 Report provided an overview of the human health issues for Lake Ontario, especially with respect to the health-related beneficial uses of the Lake (recreational/drinking water quality and restrictions on fish and wildlife consumption). At present the LaMP is in the process of gaining a better understanding of human health impacts by working through the Human Health Network in close partnership with health agencies.

The information contained in this chapter has been compiled based on documents produced up to January 2003. This chapter has not been updated for the LaMP 2004 Report. The LaMP process is a dynamic one and therefore the status will change as progress is made. This chapter will be updated in future LaMP reports as appropriate.

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CHAPTER 8 PARTNERSHIPS

8.1 Summary

Working together through partnerships has become a priority of the LaMP in its effort to restore and protect Lake Ontario and its biological resources. Whether it is providing input into the International Joint Commission's water level study, developing and coordinating a lakewide cooperative monitoring project, or working with the Great Lakes Fishery Commission, partnership is the key to restoring and protecting Lake Ontario. In addition, the ongoing partnerships within the Areas of Concern, that focus on Remedial Action Plans, are just a few of the many links and working relationships that have been formed between all levels of governments, non-government organizations, citizens, and industry in both the United States and Canada.

8.2 Binational Partnerships

This section summarizes cooperative efforts of governments, organizations, citizens, and industry in the United States and Canada.

8.2.1 Lake Ontario Committee

Partnership is the key to restoring, protecting and conserving the Great Lakes. With the cooperation and collaboration of governments, organizations, citizens and industry on both sides of the border, we are making progress towards understanding and protecting Lake Ontario.

The partnership between the Lake Ontario LaMP and the Great Lakes Fishery Commission's Lake Ontario Committee (LOC) has led to increased information sharing and the development of common aquatic ecosystem goals and objectives to help track progress in restoring the Lake Ontario ecosystem. Where possible, the LaMP and LOC are working together to manage changes occurring in the ecosystem.

The LaMP and LOC conducted a 2003 cooperative monitoring project that included intensive sampling of water, zooplankton and other aquatic organisms to better understand the impact that exotic species are having on the Lake Ontario ecosystem.

The 2003 State of Lake Ontario conference is another example of the value of the LaMP and LOC partnership. Working with other government partners, such as the Department of Fisheries and Oceans (DFO) and the United States Environmental Protection Agency, the LOC and LaMP organized a conference of experts who shared information on existing conditions and emerging trends in Lake Ontario. Cooperative efforts such as this illustrate that partnership is indeed the key to protecting and conserving the Great Lakes!

The Great Lakes Fishery Commission was established in 1955 by the Canadian/U.S. Convention on Great Lakes Fisheries. The Commission coordinates fisheries research, controls the invasive sea lamprey and facilitates cooperative fishery management among the state, provincial, tribal, and federal management agencies.

The LOC has representatives from the New York State Department of Environmental Conservation (NYSDEC) and the Ontario Ministry of Natural Resources (OMNR), organizations with the authority over fish management issues in Lake Ontario. Their responsibilities include setting allowable catch limits, stocking fish and managing the recovery of native fish populations.

Each year the LOC and its partners conduct surveys using net trawls and other techniques to estimate populations of alewives, smelt, lamprey, lake trout and other fish. This information is carefully considered in making management decisions aimed at maintaining and where necessary, restoring a healthy fishery. The results of these studies are reported out each spring at the LOC's annual meeting. For more information, see http://www.glfc.org/.

8.2.2 Lake Ontario-St. Lawrence Water Level Study

The International Lake Ontario-St. Lawrence River Study Board was established by the International Joint Commission (IJC) in December 2000 and is coordinating a five-year study to assess and evaluate the current rules for the water level regulation of Lake Ontario, and the outflow from Lake Ontario through to the St. Lawrence River.

The IJC formed the Study Board to evaluate the impacts of changing water levels on all affected interests including environmental factors, shore erosion, flood damages, recreational boating and tourism. A binational team of experts from government, Native communities, academia, and interest groups, has been assembled to examine the geographic, scientific, economic and community concerns within the Lake Ontario - St. Lawrence River system.

Extensive public consultation is a major component of the water level study, and is provided through a Public Interest Advisory Group (PIAG). After completion of the five-year study, the Board will, based upon the results of the Study and consultations with the public, deliver recommendations to the IJC for possible amendments or additions to the present criteria and the recommended regulation plan, that gives effect to those criteria.

The Lake Ontario LaMP has been participating in the IJC study by attending round table discussions and sessions of both the Public Interest Advisory Group and the Environmental Technical Work Group to offer comments on how to include LaMP goals and objectives when considering the effects of changing water levels on the ecosystem of Lake Ontario.

For additional information on the IJC water level study, go to www.ijc.org

The Boundary Waters Treaty, between Canada and the United States, established the **International Joint Commission** in 1909. This six person Commission has three members appointed by the President of the United States, with the advice and approval of the Senate, and three who are appointed by the Governor in Council of Canada, on the advice of the Prime Minister. The Commissioners must follow the Treaty and act impartially as they review problems, resolve disputes and decide on issues related to mutual boundary waters throughout Canada.

8.2.3 Cooperative Monitoring

In 2003, the Lake Ontario LaMP and the Lake Ontario Committee coordinated a number of monitoring efforts to help understand how changes to the ecosystem have altered the flow of nutrients and contaminants through the aquatic foodweb. Building on routine long term programs and adding new components where needed, water sediment, and lower foodweb organisms were collected across the lake. This binational effort (partnership) will promote improved communication and data sharing amongst monitoring programs and staff will pull together key researchers to interpret the data and to effectively communicate the "big picture" to stakeholders. The 2003 year of intensive lake sampling was the first step in developing a long term binational monitoring strategy that meets the needs of both water quality and fishery managers. (See Sections 3.4 and 3.5 for more details.)

8.2.4 Remedial Action Plans

The International Joint Commission has identified seven "Areas of Concern" in the Lake Ontario basin based on their potential to be significant sources of critical pollutants to the lake. These are: Eighteen Mile Creek, Rochester Embayment, and Oswego River in New York State; and Hamilton Harbour, Toronto and Region, Port Hope and Bay of Quinte in Ontario. In addition, both of the Lake's connecting channels, the St. Lawrence River and the Niagara River (for which separate RAPs have been developed on the Canadian and U.S. sides) have also been designated as "Areas of Concern." RAPs concentrate on identifying and addressing local environmental problems. The successful implementation of RAPs in these AOCs is a key component of the overall LaMP strategy.

The RAP process is a continuing and iterative process that: identifies environmental problems (Impaired Beneficial Uses), as well as the pollutants causing the problems and their sources; recommends remedial activities to restore beneficial uses; conducts and influences remedial activities to achieve an ecosystem approach; and documents progress towards the restoration and protection of beneficial uses in the AOCs.

All New York RAPs have completed and certified to USEPA, as part of the State's 1997 Water Quality Plan, their problem definition and action plan reports. RAP Remedial Advisory committees continue to meet on a regular basis to focus efforts on the implementation of priority remedial measures and provide periodic status reports. Funding opportunities in New York State provide stakeholders a means to implement selected projects. Such support may include financing from the New York State 1996 Clean Water/Clean Air Environmental Bond Act, the NYS Environmental Protection Fund, the Great Lakes Protection Fund, and USEPA/other federal grant agencies.

Similarly, the Ontario RAPs have all completed their problem definition and action plan reports, and implementation is on-going through various funding sources. A summary of progress on the Lake Ontario RAPs is presented in Chapter 11.

8.3 Public Partnerships

This section will be completed as information becomes available.

8.4 Actions and Progress

The information contained in this chapter has been compiled based on past documents and was updated as of December 2003. The LaMP process is a dynamic one and therefore the status will change as progress is made. This chapter will be updated in future LaMP reports as appropriate.

8.5 References

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CHAPTER 9 PUBLIC INVOLVEMENT AND COMMUNICATION

9.1 Summary

This chapter discusses the Public Involvement and Communication component of the Lake Ontario LaMP. It highlights the goals for public involvement and talks about the three-tier strategy for implementation. The chapter focuses on the activities that have been conducted over the past number of years and gives contacts for further information.

9.2 Public Involvement Goals

The goals of the public involvement program, as set out in the Lake Ontario LaMP Stage 1 Report, are to: (1) increase public understanding and awareness of Lake Ontario LaMP planning and activities; (2) provide opportunities for meaningful public consultation; (3) promote environmental stewardship actions; and (4) build partnerships with others who are working to preserve and protect Lake Ontario.

The Lake Ontario LaMP provides a variety of opportunities for people to keep informed about the LaMP projects and progress, and to provide their input and ideas. Information and public participation are encouraged at three levels of interest or involvement:

- The LaMP reaches out to individuals and groups that are already involved and working to conserve and restore Lake Ontario, by attending their meetings or inviting them to speak at LaMP meetings and by mailing information to these groups or their members.
- The LaMP maintains a mailing network of some 1,500 Canadian and U.S. contacts and responds to requests for input and comments on Lake Ontario LaMP documents.
- The LaMP provides information to the general public through the media, the LaMP Web sites and public meetings. Individuals can add their names to the LaMP mailing list for more regular contact.

Since the release of the LaMP Stage 1 Report, the LaMP has been updating the mailing list and looking at additional ways to reach the public. An annual public meeting is held to provide updates on the Lake Ontario LaMP and Niagara River Toxics Management Plan (NRTMP). The meeting location alternates between Niagara Falls, Ontario, and Niagara Falls, New York.

In 1998, the Four Parties created a binational Lake Ontario LaMP Web site, accessible from either the U.S. Environmental Protection Agency's Web site or from Environment Canada's site. Since then, the site has been moved to binational.net - a collaborative Web site which includes information on programs that are binational in nature. The LaMP site includes information on Lake Ontario and the LaMP, and provides access to LaMP publications. An on-line "postcard" has been added for those who want to join the mailing list. The site can be accessed at www.binational.net.

In 1999, the LaMP produced a brochure describing the LaMP and encouraging public participation. That same year, the first *Lake Ontario LaMP Update* was released, providing information on projects and progress in an informative newsletter style. *Update* was mailed to contacts on the mailing list, distributed at the annual Lake Ontario LaMP/NRTMP public meeting, and posted on the Web site. Editions were also distributed in 2000, 2001 and 2003. With the decision to produce a document reporting on highlights of the progress of the LaMP every two years, *Update* has become a biennial publication.

The highlight document just referred to is the companion piece to the report that you are reading. It has been designed to be distributed to keep the public abreast of progress as described in the main report. It is to be sent to the mailing list, distributed at meetings and posted on the Web site.

For copies of these LaMP publications, visit the LaMP websites or contact the LaMP addresses below.

9.3 Stewardship

An ultimate goal of the Lake Ontario LaMP is to restore the chemical, biological and physical integrity of the waters, coastal wetlands, and upland habitats of the Lake Ontario basin so it may support and perpetuate healthy, diverse and self-sustaining wildlife communities. To achieve this goal, human activities and decisions affecting the Lake Ontario basin must embrace an environmental ethic and a commitment to responsible, sustainable stewardship by current and future generations. The following are recent examples of stewardship initiatives promoted by the LaMP.

In 2003, a stewardship poster was created and distributed to schools on the Canadian side of the Lake Ontario basin. The reverse side of the poster points out how the individual can help to conserve and protect Lake Ontario. Tips are presented on a number of topics including: "In Your Home", "In Your Yard", "On Your Street", "In Your Community", "At Your Cottage", and "On Your Farm". The LaMP is currently looking to see how this information can best be spread further around the basin.

Also in 2002-2003, a series of training for educators in coastal communities bordering both Lake Erie and Lake Ontario, referred to as "Enlightening Educators on LaMPs," was conducted by New York Sea Grant. The project, which incorporated Lake Ontario LaMP public information materials, taught teachers about the problems facing the Great Lakes and helped increase their awareness of what they, their students, and their peers can do to support the priorities of the LaMP in order to restore the ecological health of the ecosystem. The project involved multiple educational outreach activities including the development of a Lake Erie and Lake Ontario LaMP educational compendium; a CD-ROM presentation on LaMPs for teachers; and a series of training workshops for teachers, non-formal educators, and stakeholders.

9.4 Information Connections

If you would like to receive information regarding Lake Ontario LaMP public meetings, please contact one of the names below.

In Canada:

Ms. Marlene O'Brien
Environment Canada
867 Lakeshore Road
Burlington, Ontario
L7R 4A6
Phone: (905) 336-4552
Fax: (905) 336-6272
e-mail: marlene.obrien@ec.gc.ca

In the United States:

Mr. Mike Basile
U.S. Environmental Protection Agency
Public Information Office
345 Third Street, Suite 530
Niagara Falls, NewYork 14303
Phone: (716) 285-8842
Fax: (716) 285-8788
e-mail: NFPIO@sysr.com

9.5 Actions and Progress

The annual joint public meeting of the Lake Ontario LaMP and the Niagara River Toxics Management Plan (NRTMP) was held in Niagara Falls, Ontario on June 10, 2003.

These meetings are held every year as a means of reporting to the public on the progress of the Lake Ontario LaMP and the NRTMP. This year the focus was on the Niagara River Toxics Management Plan with a brief presentation on the status of the Lake Ontario LaMP. Next year, at the meeting to be held in Niagara Falls, New York, the emphasis will shift to the Lake Ontario Lakewide Management Plan.

LaMP agency staff have also participated in other meetings including SOLEC 2002 in Cleveland, the State of the Lake Conference 2003 in Niagara Falls and the IJC Biennial 2003 in Ann Arbor.

Aboard USEPA's research vessel The Lake Guardian, EPA scientists were joined by researchers from Environment Canada, National Oceanic Atmospheric Administration (NOAA) Clarkson University, State Universities at New York - Oswego and Fredonia on research cruises numerous times in 2002 and 2003. The cruises focused on taking air deposition samples over 16-24 hour periods, collecting water samples, and evaluating changes that are occurring in the lake's lower foodweb and its ability to support fish populations known as (LOLA). On each of these research cruises EPA held successful working media events aboard the vessel taking media from Rochester, Oswego and the Buffalo/Niagara region including Canadian media to witness first hand how scientists and academia partner together conducting a variety of sampling activities on Lake Ontario. These programs continue to augment the community outreach efforts undertaken to keep the public informed about the lakewide management plan.

9.6 References

No references were identified for inclusion in this section.

CHAPTER 10 SIGNIFICANT ONGOING AND EMERGING ISSUES

10.1 Summary

This section provides insight into some of the significant ongoing and emerging issues facing Lake Ontario including: invasive species; Type E botulism; emerging chemicals of concern; lake levels and climate change. Some of the issues are ongoing, and have been the subject of much research and reporting, while others are newer issues that will present challenges for the Lake Ontario LaMP and lake managers in future. The material presented is based on information that existed as of January 2003.

10.2 Invasive Species

Invasive species are successfully reproducing organisms which have been transported by humans into an area outside of their historic or geographic range and can include exotic species (foreign) or transplanted species (ie. those outside their natural geographic range, but within the country of origin). Some of the key invasive species impacting the Lake Ontario ecosystem have been highlighted in the subsections below (also see section 4.4.3).

10.2.1 Zebra and Quagga Mussels

It is clear that the introduction of the zebra mussel in the late 1980s has had a detrimental impact on Lake Ontario benthos. The Quagga mussel, a more recent arrival, is capable of living in colder, deeper waters than the zebra mussel. These mussels filter water to feed on microscopic phytoplankton and other organic material, thereby reducing the amount of food available to other benthic organisms. The filtering action of the mussels has contributed to the dramatic improvements in water clarity. At the same time, populations of important native benthic organisms have generally declined. It is anticipated that reductions in phytoplankton densities due to zebra and quagga mussel filtering may result in smaller zooplankton populations.

Prior to the arrival of the zebra mussel, populations of *Diporeia*, a small amphipod, was the dominant benthic organism in the lake. Typically, a few thousand of these organisms were present in a square meter of lake bottom and provided an important source of food for fish. A decade after the zebra mussel invasion, fewer than ten of these organisms can be found per square meter in waters up to 200 meters deep. This means there is less food to support lake trout, white fish and other fish. Although the mussels are suspected to be the cause of these declines, a clear cause-effect relationship has yet to be established.

Some less important nearshore native benthic species have benefited from the zebra mussel invasion. Populations of some shallow water (less than 10 metres-deep) native benthic organisms that prefer the habitat created by zebra mussel shells and can feed on the mussel's waste products have increased. Nearshore fish, such as perch and smallmouth bass that feed on these organisms, are benefiting from the increase in these benthic populations.

Additional studies of Lake Ontario benthic organisms, phytoplankton, and zooplankton are underway to develop a better understanding of the rapid changes that are occurring in Lake Ontario's foodweb. (see Cooperative Monitoring- Binder Section 3.4).

10.2.2 Cercopagis and Spiny Water Flea

The structure and population levels of zooplankton communities are strongly controlled by phytoplankton levels and by the size and distribution of prey fish that feed on them (such as alewife and smelt). Prey fish may have been the most important controlling factor in the 1980s and early 1990s when their populations were much higher than current levels. Declining nutrient levels also played a role. Although the total zooplankton biomass decreased significantly between 1981 and 1987 as nutrient levels fell, the composition of the zooplankton community changed very little in the main lake.

The transport of exotic zooplankton by oceangoing freighters to the Great Lakes remains an on-going threat to Lake Ontario. *Bythotrephes longimanus* (the spiny water flea) was discovered in Lake Ontario in 1982, followed by the zebra mussel in 1989. A decade later in 1998, Cercopagis pengoi (also known as the fishhook flea, a zooplankton native to the Ponto-Caspian region of Europe) was discovered in Lake Ontario. Both *Bythotrephes* and *Cercopagis* are predatory cladocerans that feed on smaller native zooplankton. *Bythotrephes* is generally very rare in the lake: however, *Cercopagis* populations develop each summer throughout the surface waters of the lake. The potential impact that these predatory zooplankton will have on Lake Ontario zooplankton communities is not well understood at this time.

Research continues to better understand seasonal changes in zooplankton populations in nearshore, offshore and embayments. Recent studies in U.S. waters of Lake Ontario indicate that embayments are very productive habitats compared to nearshore and offshore areas. Embayment phosphorus concentrations were nearly twice those in nearshore and three times those in offshore areas. Embayment chlorophyll-a and zooplankton density were higher than both nearshore and offshore habitats. This suggests that embayments may be an important source of food for developing fish.

In contrast to the 1970s when excessive levels of nutrients from Lake Erie were entering Lake Ontario via the Niagara River, today nutrient loadings from upstream lakes have been greatly reduced.

10.2.3 Round Goby

This section will be completed as information becomes available.

10.2.4 Asian Carp

This section will be completed as information becomes available.

10.3 Type E Botulism

Concerns about a major outbreak of Type E botulism spreading into Lake Ontario continue, following the fourth straight year of high fish and waterbird mortality in Lake Erie. U.S. and Canadian natural resource scientists are keeping a close watch for diseased fish and waterbirds along Lake Ontario's shoreline.

Type E botulism can be harmful or even fatal to humans and other animals if they consume infected birds or fish. The botulism problem is of particular concern to the Lake Ontario LaMP because healthy populations of gulls, bald eagles and lake trout are key ecosystem indicators. During the summer and autumn of 2002, at least five dead gulls and four ducks found along New York's Lake Ontario shoreline were confirmed to have died from the toxin. It was unknown whether the birds had contracted the disease in Lake Ontario. A small number of dead gulls was reported found between Burlington and Niagara-on-the-Lake, but their death due to the botulism toxin could not be confirmed. Type E botulism has not been found in any fish from Lake Ontario. There have been no reports of any human illnesses associated with this outbreak.

In response to the Type E botulism outbreak, which has been occurring in Lakes Erie and Huron since 1999, the U.S. Environmental Protection Agency, Environment Canada, and the New York State Great Lakes Protection Fund have funded research projects to help understand the sources and conditions, exposure pathways, and possible predictive indicators of the toxin.

Any discovery of dead or dying water birds and fish showing clinical signs of botulism such as an inability to walk, fly or swim, should be reported to the New York State Department of Environmental Conservation or Ontario Ministry of Natural Resources officials immediately. For information on local offices see your phone book or check the Web site in the United States at www.dec.state.ny.us/ or in Canada at www.mnr.gov.on.ca/MNR/ .

Field Code Changed

Field Code Changed

10.4 Emerging Chemicals of Concern

In addition to pursuing the elimination of critical pollutant inputs, the LaMP tracks information on other bioaccumulative contaminants that may potentially cause lakewide impairments.

10.4.1 Polybrominated diphenyl ethers (PBDEs)

Polybrominated diphenyl ethers (PBDEs) are a class of bioaccumative chemicals that are added to plastics (such as those used in televisions, computer monitors, textiles and plastic foams) in order to make them flame resistant. (see Binder section 6.4.2.2 for more complete details).

Environmental sampling in Lake Ontario has shown that PBDE concentrations in fish and wildlife tissue have been increasing dramatically in recent years. Based on levels detected in lake trout and herring gull eggs from Lake Ontario, it appears that local emissions from large urban/industrial areas are the major sources. However, this problem is not confined to Lake Ontario-PBDEs are found throughout the world.

As an emerging issue, PBDEs have not been well studied to date. For example, there are currently no water quality or fish tissue criteria for PBDEs. There is also no definite information known about their effects on humans. Human health studies are now being conducted by scientists on both sides of the border. Work is also underway to better understand how PBDEs move around in the foodweb.

10.5 Lake Ontario Water Levels

Since 1960, Lake Ontario's water level has been regulated by a series of dams on the St. Lawrence River. Water levels are determined by the International Joint Commission (IJC) under a formula that seeks to balance a number of interests. Many biologists believe that water level regulation has had serious and lasting impacts on Lake Ontario's natural resources including fish and wildlife (particularly shorebirds and spawning fish), shoreline habitat and dune barrier systems, and the numerous wetland complexes that line the shoreline. The full range of these impacts, however, has never been documented.

The artificial control of lake level affects water level changes in coastal wetlands and dune areas. This change can be a threat to natural ecosystems through the alteration of wetland plant communities and habitat quality. In addition, throughout Lake Ontario, water level regulation is a major stress on remaining wetlands. More variable water levels can lead to greater diversity of wetland plant communities and improve fish and wildlife habitat.

The IJC is currently in the third year of a five year U.S and Canadian study to examine the impacts that water level regulation has on shipping, riparian property owners, boating, power generation, water use, and the environment (see Binder Section 8.2.2 Lake Ontario St. Lawrence Water Level Study).

10.6 Climate Change

Appropriate text for this section to be inserted at a later point.

10.7 Actions and Progress

The information contained in this chapter has been compiled based on documents produced up to January 2003. This chapter has not been updated for the LaMP 2004 Report. The LaMP process is a dynamic one and therefore the status will change as progress is made. This chapter will be updated in future LaMP reports as appropriate.

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CHAPTER 11 SUMMARY OF AREA OF CONCERN STATUS

11.1 Summary

There are nine Areas of Concern (AOCs) identified around Lake Ontario. Two of these AOCs are binational and are located at the inlet (Niagara River) and outlet (St. Lawrence River.) For each AOC, a Remedial Action Plan (RAP) has been developed and is being implemented. The table lists the status of the fourteen use impairment indicators developed by the International Joint Commission (IJC) to assess beneficial uses in the Areas of Concern. This chapter provides a summary of progress as of December 2003.

11.2 Background and Current Status

These same fourteen use impairment indicators have been applied in the Lake Ontario Lakewide Management Plan to assess lakewide beneficial uses. In addition to lakewide impairments, the AOCs served to identify problems found in localized nearshore areas, embayments, and tributary watersheds. This is not surprising as industrial and municipal contamination can become concentrated at the mouths of rivers or harbors. Remedial Action Plans (RAPs) serve as the primary mechanism for addressing these localized contaminant problems and other issues unrelated to lakewide impairments. Additional nearshore problems (e.g. temporary beach closings, and eutrophication / algae) beyond the scope of specific AOCs are being addressed through a variety of other environmental management programs. Table 11-1 summarizes the status of these use impairment indicators for the Lake Ontario LaMP and AOCs. Lakewide and nearshore areas, two binational AOCs (the Niagara and St. Lawrence Rivers), and the seven other Areas of Concern for which RAPs have been developed in Lake Ontario are included. Contact information is listed at the end of RAP summary reports for each AOC located on websites by USEPA and Environment Canada.

Each AOC is required to develop and implement a Remedial Action Plans (RAP) as called for in the 1987 amendments to the Great Lakes Water Quality Agreement, signed by the federal governments of the United States and Canada. The federal governments, in cooperation with state and provincial governments, committed to developing and implementing RAPs in 43 Areas of Concern (AOCs). The RAP process strives to identify environmental problems (beneficial use impairments); identify pollutants and other causes of the problems; identify the sources of the pollutants; recommend and implement remedial activities to restore the beneficial uses and document progress towards restoration. The ultimate goal, therefore, is to restore the area's beneficial uses and be able to delist the AOC. Read on to find out about what's happening with all the AOCs associated with the Lake Ontario LaMP. The following Table 11.1 provides useful comparison information from which common beneficial use impairments can be identified.

Table 11.1 Summary of Beneficial Use Impairments for Lake Ontario Lakewide, Nearshore, and Areas of Con
(Based on the 14 IJC Use Impairment Indicators)

Use Impairment Indicator	Lake-wide Lake Ontario	Niagara River (U.S.)	Niagara River (Canada)	Saint Lawrence at Massena + (U.S.)	Saint Lawrence at Cornwall (Canada)	Eighteen-mile Creek	Rochester Embay-ment	Oswego River	Hamilton Harbour		
1. Restrictions on Fish and Wildlife Consumption	I	I	I (fish) (wild life?)	I	I	I	I	O	I		
2. Tainting of Fish and Wildlife Flavor							?				
3. Degradation of Fish and Wildlife Populations	I(wild life)	?	I (fish) (wild life?)	?	I	?	I	O	I		
4. Fish tumors or Other Deformities		I	?	?	?	?	?		I		
5. Bird/Animal Deformities or Reproductive Problems	I	?	I	?	?	?	I		I		
6. Degradation of Benthos	I	I	I	?	I	I	I-		I		
7. Restrictions on Dredging Activities		I			I	I	I**		I		
8. Eutrophication or Undesirable Algae			I		I		I	R	I		
9. Drinking Water Restrictions or Taste and Odor Problems				?			I*				
10. Beach Closings			I		I		I		I		
11. Degradation of Aesthetics							I		I		
12. Added Costs to Agriculture or Industry							I		I		
13. Degradation of Phytoplankton and Zooplankton Populations	I		?	?	?		I-		I		
14. Loss of Fish and Wildlife Habitat	I	I	I	I	I		I	O	I		

See key next page

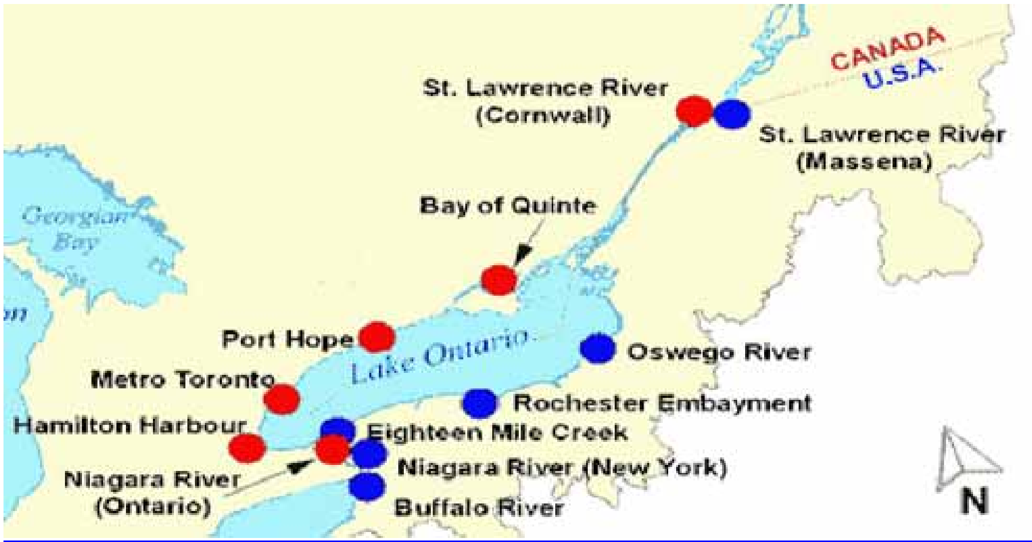
Key: Use Impairment Status for Table 11.1

I	=	Impaired
R	=	Beneficial Use Restored
O	=	Resolution by Other Responsibility
?	=	Further Assessment Needed
(Blank)	=	Not Impaired

Key: Other Notations for Table 11.1

I*	=	Taste and Odor Problems unless otherwise not marked for indicator #9 only
I-	=	Lower Genesee River Impaired; Rochester Embayment Needs further study
+	=	"Transboundary Impacts" is an added indicator in this RAP
I**	=	Stage 1 impairment identified as an issue of navigational dredging method and to be resolved by agreement to eliminate overflow dredging in the Rochester Harbor

Figure 11.1 Lake Ontario Areas of Concern (AOCs)



11.3 Binational Areas of Concern

Canada and the United States have agreed to develop Remedial Action Plans for the Binational AOCs independently within a broader context of intergovernmental cooperation. Separate RAP documents have been developed and are being implemented for the two binational AOCs. Joint participation on technical and public participation activities is part of this RAP Process for these shared waterbodies.

11.3.1 Niagara River Area of Concern

The Niagara River flows 60 kilometres from Lake Erie to Lake Ontario. Downstream from Niagara Falls the river flows for a 15 kilometre stretch through a 100 metres deep and 1 kilometre wide gorge. The binational AOC extends the entire length of the Niagara River and includes the Welland River and other tributary watersheds on the Canadian side. The Niagara River passes through heavily industrialized areas, residential and parkland interspersed with remnant natural areas, and drains extensive farmland on the Canadian side. It borders Erie and Niagara counties in western New York. Here, the AOC extends from Smokes Creek near the southern end of the Buffalo Harbor, north to the mouth of the Niagara River at Lake Ontario.

Past municipal and industrial discharges and waste disposal sites have been a source of contaminants to the Niagara River. A long history of development has also changed the original shoreline along much of the river, affecting fish and wildlife habitat. More than half of the flow of the river is diverted for electric power generation on both sides of the river. The gorge and cliff face are habitat for some of the highest concentrations of rare plant species in Ontario. The Niagara River annually supports one of the largest and most diverse concentrations of gulls in the world.

Joint participation includes the Niagara River Toxics Management Plan (NRTMP), the Important Bird Area Program and the International Board of Control. Environment Canada and MOE, working in partnership with the Niagara Peninsula Conservation Authority (NPCA), are responsible for the delivery of the Canadian RAP. USEPA Region 2 and NYSDEC deliver the US portion of the RAP. Both RAPs were established in 1989. Summaries of the Remedial Actions plans follow.

11.3.1.1 Niagara River (U.S. Side)

Background: A representative group of Niagara River stakeholders was appointed by NYSDEC as an advisory committee to help develop the RAP. The committee persons and NYSDEC direct RAP development. Goals were established, a workplan was developed, responsibilities were defined to complete the RAP document. This RAP document, that effectively combines the Stage 1 and Stage 2 RAP elements, was completed September 1994. A Status Report for the Niagara River RAP that updates remedial actions was published in June 2000. The RAP addresses use impairments, sources, and existing remediation programs, and recommends future remedial strategies. A multiple committee approach was utilized to address the complexities of implementation. A technical subcommittee was formed to develop ways to quantify concerns and to communicate progress to address the impaired uses. A public outreach subcommittee was created to develop a binational strategy to address the many issues involved with achieving sustainable development, and an International Advisory Committee was established to foster binational cooperation.

Impairments: The Remedial Action Plan (RAP) identifies five use impairments based on the fourteen possible International Joint Commission (IJC) impairments. Two other use impairments are listed that will require further investigation to determine the extent of their existence. The major impairment is restrictions on fish and wildlife consumption, primarily due to PCB and dioxin contamination. Mirex and chlordane also are chemicals of concern contributing to the consumption restriction use impairment. These restrictions are part of a lakewide advisory for Lake Ontario. Based on the presence of contaminated sediment pockets at certain tributary mouths and nearshore areas, the sediments were evaluated as contributing to a degradation of benthos use impairment at these areas. Existing restriction on open lake disposal of contaminated sediments from the Niagara River cause the AOC to have a dredging restrictions use. In the upper Niagara River, fish tumors have been reported and the loss of fish and wildlife habitat due to human activities has been dramatic. Degradation of fish and wildlife populations and the presence of bird or animal deformities or reproductive problems will require further investigations.

RAP Structure: Most recently the combined committee of the Friends of the Buffalo/Niagara Rivers (FBNR) advises and assists NYSDEC on the Niagara River RAP implementation. Committee members include local government, academia, public and economic interest groups, and private citizens. The RAP process involves various components: periodic progress status reports with remedial strategy identification; regular Remedial Advisory Committee meetings; project and plan reviews as part of ongoing activities; monitoring and tracking progress; and, public participation coordinated through the RAC. In the Niagara River RAP, priority activities and strategies address: stream water. quality; inactive hazardous waste site remediation; contaminated river sediments; point source control programs; fish and wildlife habitat improvements; and, enhanced environmental monitoring activities.

RAP Status and Progress: A Niagara River RAP public information video was completed by the RAC members. This accomplishment of a video by the RAC was based on earlier international cooperation in the development of a slide show. A major recent activity benefiting the RAP is: the Bond Act funding of a $1 million habitat restoration project for Strawberry Island. The International Joint Commission has completed the RAP Status Assessment for the Niagara River Area of Concern. The findings and recommendations report notes significant progress in documentation for the Niagara River under the Niagara River Toxics Management Plan identifies challenges and opportunities for the binational community to accomplish RAP goals under the Great Lakes Water Quality Agreement.

***RAP Outlook For The U.S. Side*:** Implementation of the Niagara River RAP is a continuous improvement process that include periodic updates and improvements as knowledge of the use impairments, sources and the effectiveness of remedial actions increases. Remedial actions will be evaluated and coordinated as to the impacts on restoration of beneficial uses. Within the AOC and watershed, a number of studies and assessments will continue to be priorities. These include fish and wildlife consumption restrictions, habitat evaluation, sediment investigation and contaminant trackdown. Restoring and maintaining an improved quality of life in the ecosystem of the Niagara River and its watershed is the goal.

11.3.1.2 Niagara River (Canada Side)

***Environmental Issues*:** Much of the impact to the river is from the U.S. side, specifically from past industrial management practices. Efforts on the US side are addressing these issues. Most of the environmental issues on the Canadian side of the river are associated with non-point sources within the rural watersheds of the Niagara-Welland basin. Former industrial activities have resulted in contaminated sediment in the Welland River (remediated) and Lyons Creek (strategy under development). Pesticide use, nutrient runoff, wetland and habitat loss, riparian zone impacts and the health of fisheries all remain concerns

***Impairments*:** There are seven impaired beneficial uses in the Canadian portion of the AOC. These include restrictions on fish consumption, degradation of fish populations, bird or animal deformities and reproductive problems, degradation of benthos, eutrophication, beach closings, and loss of fish and wildlife habitat. The status of the following four impairments requires further assessment: restrictions on wildlife consumption, degradation of wildlife populations, fish tumours and deformities, degradation of phyto/zooplankton populations. Taste and odor problems persist in drinking water, however, this impairment is not due to local sources.

***RAP Structure*:** Through an agreement signed in 1999, the Niagara Peninsula Conservation Authority (NPCA) has assumed responsibility for coordinating the implementation of the RAP and has developed an Implementation Annex that provides a practical strategy for doing this.

***RAP Status and Progress*:** A rural watershed heritage strategy is being implemented for the Welland River. Actions have included the planting of more than 96,000 trees, rehabilitation of 10.5 hectares of wetland habitat, the installation of over 18 kilometres of fencing to protect riparian habitat adjacent to watercourses and the reduction of phosphorus entering local watercourses by more than 1,500 kilograms per year. By 2002, 135 projects were completed. These activities to date have increased forest cover on 90 hectares of land, restored 21 kilometres of riparian habitat and seven hectares of wetlands. The NPCA has also been actively involved with local landowners since 1994 to improve water quality in streams. Nutrient and bacterial loadings have been reduced through livestock fencing and manure storage projects. Through a grant program, the NPCA will provide incentives to local landowners within the Niagara-Welland basin in order to foster best management practices for agriculture, create habitat and protect ecologically sensitive land.

Urban stormwater and combined sewer overflows (CSOs) are also being addressed. In the City of Niagara Falls, 4300 urban homeowners were asked to disconnect their roof downspouts. The City also continues to actively promote water conservation through a newly developed corporate water conservation strategy and is now proceeding with full scale implementation of innovative technology for

High Rate Treatment of combined sewer overflows. Another large scale initiative is an ongoing program to separate domestic and storm sewers to reduce combined sewer overflow events. Fort Erie and Welland have also initiated projects intended to reduce combined sewer overflows.

The extensive loss of fish and wildlife habitat in the AOC is being addressed by the NPCA and the Niagara Restoration Council. Habitat restoration is ongoing and significant progress has been made towards meeting delisting criteria. The Niagara River corridor was named as a binationally Important Bird Area (IBA) in 1996. A conservation plan for this IBA is being developed through a coalition of interested groups. The Niagara Restoration Council is undertaking a project to remove all barriers to fish passage in the watersheds within the Niagara AOC. In 2001, all barriers to fish passage were identified, mapped and classified by type and size. It is anticipated that the majority of barriers will be removed or mitigated by 2005, thus making hundreds of kilometres of upstream fish habitat available to spawning fish.

Progress has also been made in addressing contaminated sediments. Based on the contaminated sediments sites identified in the Stage 2 Niagara River RAP report, the NPCA has submitted a management proposal for all known sites. In 1995, approximately 10,000 cubic metres of contaminated sediments were remediated in a section of the Welland River adjacent to Atlas Specialty Steels. Biological sampling since the sediments were remediated indicates that this section of the river is recovering as anticipated. A sediment management strategy is being developed for Lyons Creek.

Very substantial progress has also been made jointly with the U.S., especially in reducing toxic chemicals. Monitoring results in the Niagara River show that the concentrations for most of the 18 priority toxics targeted by the NRTMP have been significantly reduced, in many cases by more than 50 percent. On the Canadian side, monitoring results for point sources between 1986 and 1995 show loading reductions of 99 percent for the 18 chemicals of concern.

***Delisting Outlook For The Canadian Side*:** Full implementation of remedial actions in the Niagara River AOC will require many years and is contingent on federal, provincial and/or municipal funding availability and in some cases private sector involvement. MOE has lead responsibility for the RAP and Environment Canada and the Niagara Peninsula Conservation Authority will continue to work in partnership as they move towards delisting. Remediation of CSO discharges is essential to complete RAP implementation and several large infrastructure needs have been identified. Infrastructure costs are estimated at $26M for high rate treatment of combined sewer overflows for the cities of Niagara Falls and Welland. Developing and implementing a contaminated sediment strategy for Lyons Creek will also require significant funding.

11.3.2 St. Lawrence River Area of Concern

The St. Lawrence River drains the Great Lakes and is among the largest rivers in the world. The AOC is an 80 kilometre stretch of the river that extends upstream from the Moses-Saunders power dam in Cornwall, Ontario, downstream to the eastern outlet of Lake St. Francis in Quebec. This AOC is a complex jurisdictional area involving Canada, the United States, Ontario, Quebec, New York State and Mohawks of Akwesasne interests. Separate RAPs were developed for the Canadian (Cornwall) and U.S. (Massena) sides of the St. Lawrence River, however a binational joint Problem Statement document was prepared in 1994.

11.3.2.1 St. Lawrence River at Massena, New York

***Background*:** NYSDEC began development of the St. Lawrence River at Massena RAP in 1988. This process is assisted by the Massena Remedial Advisory Committee (RAC) which consists of members from industry, local government, environmental groups, sporting interests, academia, and business. The Stage 1 report was completed in 1990 and identifies use impairments, their causes, and sources. The Stage 2 RAP, completed in 1991, includes the development of remedial strategies to restore water quality and beneficial uses of the tributary rivers and the St. Lawrence River and to eliminate adverse impacts to the AOC from sources of pollutants at major local hazardous waste sites as well as from other sources within the Area of Concern watershed. A comprehensive RAP Update document was published in April 1995 which established a format to identify remedial strategies and track progress.

***Impairments*:** The waters and river bottoms of the AOC have been impacted by industrial discharges sources including Lake Ontario, municipal treatment facilities, atmospheric deposition, non-point source discharges and physical disturbances as a result of the power dam and seaway construction. The Stage 1 RAP identified industry as a major source of contaminants to the AOC. Stage 1 also confirmed two use impairments (fish consumption advisories, and fish habitat) and identified five other use impairments that will require further evaluation. A "transboundary impacts" use impairment indicator was added to the standard fourteen indicators developed by the International Joint Commission's (IJC) listing/delisting guidelines . A transboundary impact assessment is needed for a complete evaluation of this AOC.

***RAP Structure*:** Because of the international aspect of this RAP, an evaluation of the possible transboundary effects associated with the downstream interests and jurisdictions (Canadian, Provincial, and Mohawk Nation at Akwesasne) is an important consideration for this binational connecting channel Area of Concern. The St. Regis Mohawk Tribe has received New York State Environmental Bond Act funding to implement an erosion and nonpoint source pollution protection project. As New York State has taken the lead to address the Massena area impairments, Canadian jurisdictions have taken responsibility for RAP implementation concerning the Ontario and Quebec side of the river.

***RAP Status and Progress*:** Priority strategies involve completing the land-based and contaminated river sediment remediation, conducting further investigations, and reassessing use impairment status in light of remedial progress and additional study results. The latest RAP Status Report published in May 2000, identifies remedial progress and includes delisting criteria for the AOC. Efforts are underway to produce a Status Report update in 2004. Significant progress has been made with land-based remediation at the ALCOA (west), Reynolds Metals (now ALCOA east), and General Motors industrial sites, as well as with the contaminated sediment removal in the St. Lawrence River at General Motors and Reynolds Metals. Major dredging of the St. Lawrence River at the Reynold Metals site was conducted in 2001. Cleanup requirements now provide for contaminated dredged materials to be removed from the property instead of receiving on-site treatment and disposal.

***RAP Outlook For The U.S. Side*:** In addition to the Stage 1 Binational Summary document, International cooperation has been fostered by producing a joint monitoring statement and the current development of delisting criteria by each RAP's advisory committees. An annual ecosystem conference is conducted each spring to maintain information sharing for this important St. Lawrence River area. Significant funding opportunities are under development for the construction of the St. Lawrence Aquarium and Ecological Center (SLAEC) as well as an accompanying Great Rivers Institute (GRI). Further, the International Joint Commission has completed a RAP Status Assessment of the Area of Concern. The document notes the accomplishments in the AOC and makes recommendations to further address the use impairments including contaminated sediments. The Massena RAC is currently focusing on the identification of endpoints for establishing delisting criteria and goals. Following the completion of remedial activities, a reassessment of the use impairment indicators and the causes and sources is needed.

11.3.2.2 St. Lawrence River at Cornwall, Ontario

Environmental Issues**:** The Cornwall waterfront has been the site of industrial activities for more than 100 years. Although many of the contaminant sources have been eliminated, historical inputs have continued to impact the aquatic environment as contaminated sediment and organisms transfer and cycle mercury and other metals. Local contaminant sources include industrial and municipal discharges, and diffuse sources such as urban stormwater and agricultural runoff. Contaminants also enter the AOC from upstream and from the Great Lakes via Lake Ontario and from air deposition. Land use practices, shipping and the extensive shoreline and water flow alteration that resulted from the construction of the St. Lawrence Seaway, continue to alter the natural ecosystem. Major environmental issues of concern in the area include:

- mercury, PCBs and other contaminants in water, sediments and fish;
- fish and wildlife health effects related to contaminants;
- bacterial contamination leading to beach closings;
- habitat destruction and degradation;
- excessive growth of nuisance aquatic plants;
- exotic species.

Impairments: The RAP has identified seven impaired beneficial uses in the Canadian portion of the AOC. Three more, fish tumours and other deformities, bird and animal deformities, and degradation of plankton populations require further assessment.

RAP Structure: There were 64 RAP recommendations for improving the aquatic environmental conditions in the AOC most of which have been implemented or are in progress. The St. Lawrence River Restoration Council provides the local lead for RAP implementation. The group has representatives from Environment Canada, the Ontario Ministry of the Environment, the Ontario Ministry of Natural Resources, the Mohawk Council of Akwesasne, local municipalities, environmental groups, the Raisin Region Conservation Authority (RRCA) and other groups.

RAP Status and Progress: Since 1990, the GLSF has provided over $2.3 million towards 25 restoration projects in the AOC. Partnerships have achieved over $5.6 million in direct partner funding including $3.8 million for urban infrastructure improvements, $1.8 million in-kind contributions and citizen participation valued at $900,000.

There have been several notable implementation actions in the St. Lawrence AOC:

- The City of Cornwall's Fly Creek Stormwater pond has been retrofitted to reduce contaminant loads to the river.
- There are no longer any significant sources of mercury or other heavy metals to the river in the Cornwall area.
- The littoral zone habitat strategy has been implemented along an eight kilometre stretch on the Cornwall waterfront. Sixteen projects were completed between 1994 and 2002. Preliminary monitoring indicates a dramatic increase in fish abundance and diversity.
- The first phase of the Cooper Marsh Enhancement Project has been completed. The result is an increase the amount of spawning and nursery habitat for fish and breeding habitat for migratory birds.

Outstanding issues in the St. Lawrence AOC include: the development of a sediment management strategy; assessing the status of zooplankton and phytoplankton populations; the restoration and protection of fish and wildlife habitat; a review of sources and levels of bacterial pollution in waters used for body contact recreation.

Cornwall Sediment Strategy - Environment Canada and the Ontario Ministry of the Environment are currently working in partnership with local municipalities, the Mohawks of Akwesasne, industry and environmental groups to develop a strategy for managing contaminated sediment in the AOC.

Fish Habitat Management Plan - Activities under this project will include research and compilation of existing information on fish and wildlife species, habitat types, shoreline alteration, nearshore currents, erosion and water quality into a GIS-based database to identify and prioritize data needs.

Municipal Wastewater Issues - Candidate projects include: 1) facilitating upgrades of smaller, downstream sewage treatment plants by providing technical assistance or assistance in obtaining infrastructure financing; 2) the completion of pollution prevention and control plans to manage stormwater and combined sewer overflows for communities within the AOC; 3) assisting small and rural communities in the AOC address issues of potential water contamination caused by inadequate septic systems.

Delisting Outlook: When a sediment management plan is developed and implemented, the RAP will be well on its way towards meeting its goals. A targeted approach over the next few years to complete all non-point source and habitat projects, and a dedicated effort to put mechanisms in place to maintain environmental quality is critical. Municipal infrastructure upgrades will also be required to address the management of sewage and wastewater in some communities within the AOC. When RAP implementation actions have been successfully completed, it will be imperative to monitor the recovery. This may be one AOC which becomes an Area in Recovery while the environment needs time to respond to the actions that have taken place.

11.4 U.S. Areas of Concern

11.4.1 Eighteenmile Creek

The Eighteenmile Creek Area of Concern (AOC) is located in the town of Newfane, Niagara County, in western New York state. The creek flows from the south and discharges into Lake Ontario, approximately 18 miles east of the mouth of the Niagara River, through Olcott Harbor. The AOC includes Olcott Harbor at the mouth of the creek and extends upstream to the farthest point at which backwater conditions exist during Lake Ontario's highest monthly average lake level. This point is just downstream of the Burt Dam located about two miles from the harbor.

***Background and RAP Structure*:** Development of the Eighteenmile Creek RAP was initiated in March 1994. The Area of Concern includes Olcott Harbor on Lake Ontario and Eighteenmile Creek upstream to a point just below the Burt Dam in the Hamlet of Burt. A combined final Stage 1 and Stage 2 RAP document was completed and published in August 1997 by NYSDEC in cooperation with the Eighteenmile Creek Remedial Advisory Committee. Efforts to complete this publication included conducting two RAP review workshops, public information and comment meetings, field trips, as well as numerous committee meetings

***Impairments*:** Past industrial and municipal waste disposal practices have contributed to the causes of use impairments in Eighteenmile Creek. Fish consumption restrictions exist because of PCBs and dioxins found in fish flesh. This is linked to Lake Ontario. The health of the benthos has been impaired by PCBs and metals in sediments. Bird and animal health is likely impaired by the PCBs, dioxins, DDT and its metabolites, and dieldrin found in fish flesh. PCB and metal contamination prevents open lake disposal of dredged sediment material. Additional investigations need to be conducted concerning fish and wildlife populations and the presence of fish tumors or other deformities.

RAP Status and Progress: A RAP Status Report document was completed in June 2001. An investigative study of the plankton community was conducted by SUNY College at Brockport under an EPA grant. The report was published and distributed. The results of the Plankton Study establish that the plankton use impairment indicator is not impaired. A presentation by the author was provided to the Remedial Advisory Committee in June 2002. The upgrading and addition of wastewater treatment facilities at Lockport is to be funded by the New York State Environmental Bond Act.

RAP Outlook: At an October 2003 RAP Workshop, Remedial Advisory Committee members decided to explore opportunities on how the committee can better address RAP implementation in conjunction with DEC and EPA. Currently, RAP activities are focused on continuing the investigation and assessment of creek sediments; evaluating possible sources of PCBs and other contaminants in the watershed; remediating inactive hazardous waste sites; correcting combined sewer overflows (CSOs); and, continuing surveillance activities. A recent USACE grant award to Niagara County Dept. of Panning, Development, and Tourism focuses various project components on habitat restoration and watershed management to benefit the AOC. The projects provide for streambank stability, sediment assessment, best management practices, and community outreach. A separate New York State Department of State grant will develop and implement a monitoring plan to document restoration activities. Other RAP implementation addresses: continued trackdown sampling for PCBs; assessment and remedial considerations for sediment sites such as the Barge Canal at Lockport and the William Street Island; an evaluation of potential pollutant sources within the sewer system in the City of Lockport; and, continued fish flesh analyses for contamination.

11.4.2 Rochester Embayment

The Rochester Embayment is an area of Lake Ontario formed by the indentation of the Monroe County (New York) shoreline between Bogus Point in the town of Parma and Nine Mile Point in the town of Webster, both in Monroe County. The northern boundary of the embayment is delineated by the straight line between these two points. The southern boundary includes approximately 9.6 km (6 miles) of the Genesee River that is influenced by lake levels, from the river's mouth to the Lower Falls. The drainage area of the embayment is more than 7,770 km^2 (3,000 square miles) in area. This area consists of the entire Genesee River Basin and parts of two other drainage basins; the easternmost area of the Lake Ontario West Basin and the westernmost area of the Lake Ontario Central Basin.

***Background and RAP Structure*:** Starting October 2003, the Monroe County Department of Health received EPA funding to provide RAP management. The focus is on research, priority project implementation, and delisting considerations. A number of initiatives need RAP reporting and coordination including Monroe County's source trackdown and CSO abatement, and the funded studies of local aquatic conditions. Monroe County is to develop RAP related programs and seek funding for RAP gaps and needs to address watershed improvements including nonpoint sources, habitat restoration and watershed open space. The Monroe County Water Quality Management Advisory Committee (WQMAC) and its subcommittees provide advice and oversight on general water quality, public participation, and RAP implementation activities. Further, the Monroe County Water Quality Coordinating Committee (WQCC), continues to provide guidance contributing to RAP progress. The Stage 1 document was completed in August 1993.

***Impairments*:** Twelve of the fourteen IJC use impairments were identified as existing in the Area of Concern. The development of the Stage 2 RAP was completed and published in September 1997. The Area of Concern includes a 35 sq.mi. portion of Lake Ontario and a six mile reach of the lower Genesee River. RAP remedial measures address lawn care practices, wetland education, pollution prevention for auto recyclers and dentists, volunteer stream and wetland monitoring programs, advancement of phosphorus removal at small wastewater treatment facilities, and a streambank erosion assessment program.

RAP Status and Progress: Watershed planning projects are in various phases of implementation. A Stormwater Coalition was formed to plan for compliance with new stormwater regulations. Completed projects include several point and nonpoint source pollution abatement projects, extensive combined sewer overflow abatement, and a mercury pollution prevention project. Publications include manuals for hospital mercury pollution prevention, auto recyclers, volunteer stream monitoring, and volunteer wetland monitoring; biannual newsletter; two watershed plans; a watershed developers packet; and a report on a water quality opinion survey.

RAP Outlook: Delisting criteria and monitoring methods for use impairments have been developed. Grants have been received for hyperspectral imaging of algae beds along the Lake Ontario shoreline, a study of the benthic health of the Rochester Embayment, and further development of monitoring methods for toxic-related use impairments. The RAP reporting was updated by a Status Report update in March 2001 and a RAP Addendum at the end of 2002. To address algae and nutrients, Monroe County sponsored a "Lake Ontario Algae Cause and Solution Workshop" in 2002 and later participated in a conference entitled "New York's North Coast: A Troubled Coastline". Reorganization of RAP oversight and sub-committees by Monroe County is likely now that the EPA grant has been received for RAP coordination in 2003. A Water Education Collaborative exists to coordinate all public participation activities regarding water quality in the County. The US Army Corps of Engineers has been proposed to assist funding a sediment transport study led by SUNY at Geneseo.

11.4.3 Oswego River

The Oswego River/Harbor Area of Concern (AOC) is located on the southeastern shore of Lake Ontario and is centered in the City of Oswego, New York. The AOC includes the harbor area and the lower segment of the Oswego River up to the Varick power dam. The harbor itself is characterized as a multiple-use resource and over 1.2 million people live in the drainage basin. The Oswego River watershed includes the Finger Lakes, industries, municipalities, and extensive areas of farmland and forest that expand an area of over 5,000 square miles. The Oswego River is second only to the Niagara River in size as a tributary to Lake Ontario. Upstream pollutants are known to have traveled through the river and harbor, and impacted the Lake Ontario ecosystem, thereby forming the basis for the Area of Concern designation.

***Background and RAP Structure*:** The Oswego River RAP process began in 1987 and the Stage 1 RAP was completed in 1990. Use impairments that were observed involved fish habitat and population loss, fish consumption restrictions, and undesirable algae. The impairments were linked to Lake Ontario and upstream sources. The Stage 2 RAP, completed in 1991, identified remedial strategy activities necessary to restore water quality in the lower river and harbor and to eliminate adverse impacts to Lake Ontario from sources of pollutants carried by the Oswego River. The advisory committee consisted of a multi-stakeholder group included persons from industry, environmental organizations, government agencies, academia, and private interests.

RAP Status and Progress: A comprehensive RAP Update document was published in December 1996 that established a format to identify remedial strategies and track progress. Because of the RAP, additional water quality and sediment investigations, as well as a fish pathology study, were performed in the Oswego River AOC. Significant upstream hazardous waste site remediation and point source pollution control measures have been accomplished. New York State Environmental Bond Act funding has assisted the City of Oswego in addressing sewer infiltration and overflows. A two-day technical workshop was conducted in June 1998 to evaluate study results and assess use impairment impacts and needs. A Workshop Summary and RAP Update report was published in May 1999 that documents workshop proceedings, study results, and RAP implementation strategies. AOC delisting criteria were developed based on IJC and EPA guidance. In May 2002, a draft Stage 3- Delisting Proposal was completed by NYSDEC and the Remedial Advisory Committee (RAC). A "power point" presentation (also developed by NYSDEC and the RAC) on the delisting of the AOC was delivered four times in the local area. Group meetings (some open to the public) addressed by the presentations included: the RAP Remedial Advisory Committee, the Great Lakes Basin Advisory Council, the Oswego County Water Quality Coordinating Committee, the Oswego County Environmental Management Council, and the Oswego County Soil and Water Conservation District.

Beneficial Use Status and RAP Outlook: Resolution of the Oswego RAP use impairments is based on no contamination source specific to the AOC and a 40 year Federal Energy Regulatory Commission (FERC) power dam license. The delisting strategy relies on handing off the responsibility for resolving the larger (non-AOC) concerns to the appropriate oversight agency programs. Because the fish consumption advisory is lakewide and not specific to the AOC, it is to be addressed by the Lake Ontario Lakewide Management Plan. The fish habitat and population concerns are to be addressed by the FERC license. This is consistent with federal delisting criteria and supported by NYSDEC's Priority Waterbody Listing (PWL) in conjunction with the 303(d) listing, the new Watershed Restoration and Protection Strategies (WRAPS) initiative, and the Fish Health Advisory. Together, these responsible and appropriate agency programs will address the non-AOC sources and larger watershed concerns that are beyond the RAP scope. The Stage 3- Delisting Proposal has completed internal NYSDEC and other state agency review is now under further review by IJC, USEPA Region 2, and the Great Lakes National Program Office (GLNPO). A formal public comment period is planned. Delisting comments are to be incorporated with a responsiveness summary in a final delisting document. NYSDEC will then seek formal delisting action with EPA Region 2 through the United States Department of State. With the delisting proposal and limited resources for further activity, members of the Oswego RAC decided to discontinue regular meetings and the committee effective September 6, 2002. Certificates of Appreciation have been awarded to the RAC members, two of which are original members participating in the process since 1987. Committee members remain available for future consultation and necessary action to complete formal delisting.

11.5 Canada Areas of Concern

11.5.1 Hamilton Harbour

Hamilton Harbour is a 2,150 hectare embayment located at the western tip of Lake Ontario. The Area of Concern includes the harbour, Cootes Paradise wetland and open water, and the surrounding watershed drained by three main tributaries: Grindstone Creek; Red Hill Creek; and Spencer Creek, covering a total of 50,000 hectares. The urban population, which includes Hamilton, Burlington, Stoney Creek, Dundas and Ancaster, is growing rapidly and now is approaching 700,000.

Environmental Issues: The ecosystem of the harbour reflects its natural conditions (a small water body with a long retention time), a high volume of sewage treatment plant discharges, large scale industrial activities and extensive land use changes. The water and sediments are contaminated by metals, pesticides, PCBs, and PAHs. The sediments of Randle Reef and industrial boat slips are highly contaminated with PAHs and have an adverse effect on the local ecosystem. In addition, the shoreline has been radically transformed with 75 percent of wetlands eliminated and 25 percent of the harbour filled in. Habitat for fish and wildlife is greatly reduced and resident species are exposed to toxic contaminants. The water quality of the harbour continues to be characterized by poor water clarity, low oxygen levels, high nutrient levels and high bacterial levels.

Impairments: Hamilton Harbour AOC has twelve beneficial use impairments: restrictions on fish consumption; degradation of fish and wildlife populations; fish tumours; animal (snapping turtle) deformities; degradation of benthos; restrictions on dredging activities; eutrophication and undesirable algae; beach closures; degradation of aesthetics; added costs to agriculture and industry; degradation of phyto/zooplankton populations; and the loss of fish and wildlife habitat.

RAP Structure: In 1991, stakeholders organized into two distinct groups: the Bay Area Restoration Council (BARC) and the Bay Area Implementation Team (BAIT). BARC maintains a balanced voice for all stakeholders of the harbour, performs a watchdog role by monitoring RAP progress, and keeps the public informed. The BAIT is composed of the major implementors of the RAP. The RAP Office has recently completed a RAP Stage 2 Update that provides the current status of the RAP and identifies recommendations from the public. The Update was reviewed by the public, approved by the governments and sent to the IJC in 2003.

RAP Status and Progress: Very positive, visible progress has been made in restoring fish and wildlife habitat. Work at six sites has resulted in: restoration of 340 hectares of habitat; secured habitat for 670 nesting pairs of Caspian and common terns; considerable shoreline rehabilitation; the return of amphibians and reptiles at Cootes Paradise, and increased diversity of native plants and waterfowl partially due to a successful program of carp exclusion. Furthermore, as a result of the Hamilton Harbour Watershed Stewardship Project, over 6500 hectares of land have been protected since 1994 through verbal stewardship agreements in the Spencer and Grindstone Creek watersheds including 120 kilometres of riparian habitat and 2900 hectares of significant wetland and upland habitat.

Sediment remediation remains one of the priorities for Environment Canada in this AOC. Efforts will continue on Randle Reef and the Dofasco boat slip to clean up known sediment hotspots. Environment Canada is working with its government and industrial partners on the Randle Reef Sediment Remediation Project to dredge and contain approximately 500,000 cubic metres of contaminated sediment from Hamilton Harbour.

Progress has also been made on improving water quality by reducing the phosphorus, chlorophyll and bacteria levels in the harbour. Reduction of bacterial contamination was achieved by the installation of CSO tanks which store and channel excess storm and sanitary sewage to the Woodward Wastewater Treatment Plant . Further reductions have resulted from low-cost optimization techniques introduced at Halton's Skyway Wastewater Treatment Plant. As a result of these improvements, two beaches were opened in 1993 after a 50-year long swimming prohibition in Hamilton Harbour.

Another notable achievement of the RAP has been the substantial increase in public access to the shoreline and watershed. The Hamilton Harbour Waterfront Trail was opened in 2000 and has increased access to the shoreline to 21 percent. This is a considerable achievement considering that there was essentially no public access to the harbour when the RAP began.

Delisting Outlook: The Hamilton Harbour AOC cannot be delisted in the short-term since many of the issues affecting the harbour require significant capital costs and 10-15 years or longer to complete. The total funding required between now and 2015 to achieve delisting of the AOC has been estimated at $650M. This includes $543M for upgrades to Hamilton and Halton's Waste Water Treatment Plants and the Hamilton CSOs to meet RAP water quality targets. The other major capital cost is to remediate PAH contaminated sediments in the area of Randle Reef estimated at $31M. Smaller capital costs are: $9M for City of Hamilton water metering: $9M for further creation and maintenance of fish and wildlife habitat: and an additional $10M for recreational trail development of and enhancement of lands recently transferred from the Port Authority to the City of Hamilton.

11.5.2 Toronto and Region

The Toronto and Region AOC extends from the Rouge River in the east to the Etobicoke Creek in the west and includes six tributary watersheds which drain into Lake Ontario: Etobicoke Creek, Mimico Creek, Humber River, Don River, Highland Creek and Rouge River. The drainage basin of these watersheds covers 2 000 square kilometres, and over 40 percent of the AOC is still classified as rural. The AOC includes the City of Toronto and encompasses 11 other municipal jurisdictions within the neighbouring Regions of Peel and York. More than four million people reside in the Greater Toronto Area.

***Environmental Issues*:** Over the years, urban growth in the AOC has resulted in extensive physical restructuring of the shorelines, watersheds and landscapes. In the process, wetlands, forests, fish and wildlife habitat in the urbanized portion of the AOC were lost. Most of the stormwater in the city is discharged into rivers, creeks and Lake Ontario. The discharge contains high levels of bacteria and nutrients, heavy metal and organic chemical contamination, and this remains the single biggest cause of a degraded aquatic environment. In addition, the many industries of the region discharge into municipal sewage systems which are not designed to removed chemical contaminants. Agricultural non-point sources of sediments, nutrients and pesticides contribute to the loads measured at the river mouths.

***Impairments*:** The RAP has designated the following eight beneficial uses of the waters of the AOC as impaired: fish consumption restrictions, degraded fish and wildlife populations, degradation of benthos, restrictions on dredging, elevated nutrient levels, beach closures, degradation of aesthetics, and habitat loss. It has also designated the following three as requiring further assessment: fish tumours or other deformities, bird or animal deformities or reproductive problems, degradation of phyto/zooplankton populations.

***RAP Structure*:** A five year Memorandum of Understanding (MOU) between Environment Canada, the Ontario Ministry of the Environment, and the Toronto and Region Conservation Authority (TRCA) was signed in 2002. The TRCA is now taking the lead in the implementation of the RAP and will develop a five year plan. Through the MOU, the RAP is continuing to support the various watershed alliances and councils that are working to improve key watersheds.

***RAP Status and Progress*:** There have been notable successes in the Toronto and Region AOC. Bacterial conditions have improved in the Eastern Beaches with the installation of two stormwater detention tanks that hold the water until it can be treated at the Ashbridge's Bay STP. Construction of a detention tunnel and treatment facility for combined sewer/stormwater has partly relieved the bacterial problems at the Western Beaches. In addition, various innovative and cost effective stormwater treatment systems such as exfiltration and flow balancing systems, were installed in the City of Toronto.

Other promising signs of progress include: removal of stream barriers returning historical access for salmon to the upper reaches of the Don River; the creation of 20 hectares of new waterfront fish and wildlife habitats during the 1990s; the presence of rainbow trout in the East Humber; and the first Ontario nesting of Canvasback Ducks.

Most of the causes of environmental degradation, however, remain in place--the Toronto Region loses 24 hectares of land to development every day. Urbanization and the large population base of the AOC are the largest challenge to restore the beneficial uses which are impaired.

Implementation of the RAP requires a long-term commitment, and one important component of this commitment will be the City of Toronto's Wet Weather Flow Management Master Plan (WWFMMP). This plan is based on the hierarchy of source control, pollution prevention and infrastructure improvement, and its implementation will require a paradigm shift in wastewater management. The Master Plan will identify the most effective means to introduce controls into the stormwater regime (both remedial and preventative) and will take advantage of new technologies for sewage/stormwater treatment. It focuses on swimable waterfront beaches; eliminating discharges of CSOs; protection against basement flooding and meeting the province's CSO policy; protection of the City's infrastructure from stream erosion; restoration of degraded local streams and improvement of stream water quality; reducing the extent of algal growth along the waterfront and in streams; and the restoration of aquatic habitat.

Another important component is the revitalization of the Toronto Waterfront. This will significantly rehabilitate fish and wildlife habitats and populations if it is undertaken in the context of ecological sustainability. The Toronto Waterfront Revitalization Corporation has made a commitment to sustainability. The RAP hopes to work with the Corporation and other partners to further incorporate the benefits of aquatic and terrestrial ecosystem restoration in the overall revitalization plan.

***Delisting Outlook*:** Implementation of the Toronto and Region RAP will be a decades-long undertaking. The City of Toronto is now considering a 100 year plan for the control of water pollution sources. The preliminary projection of capital costs for implementation of the wet weather flow recommendations of the Toronto RAP (excluding industry) is $1 billion over a 25 year period.

The RAP program is only one participant in a complex of agencies, large scale plans and external forces affecting Canada's largest city. The challenge facing the RAP and its management is to coordinate participation from others in achieving RAP goals while not being subsumed by larger scale economic activities and social trends.

11.5.3 Port Hope Harbour

Port Hope Harbour is located at the mouth of the Ganaraska River on the north shore of Lake Ontario, and 100 kilometres east of Toronto. The Town of Port Hope is located north of the Harbour. The AOC includes the harbour area and extends 300 metres from the lower Ganaraska River to the confluence area bounded by breakwalls.

Environmental Issues: Radioactive wastes were generated at a refinery (Eldorado Nuclear Limited) in Port Hope beginning in 1933. Low level radioactive wastes were initially stockpiled or disposed of in ravines and vacant lots in Port Hope during the 1930s. During the 1940s and 50s low level radioactive wastes were also placed in waste management facilities in two municipalities just outside of Port Hope. There is an estimated total of 1 to 1.5 million cubic metres of low-level radioactive waste and contaminated soils in the Port Hope area. The immediate health and safety risks have been assessed as minimal.

Within the harbour, most of the contaminant input occurred between 1933 and 1953 resulting from operations and waste management practices of the Eldorado refinery Process wastes were stored at the site and it is likely that surface runoff was the route of contamination for the harbour. An estimated 85,000-90,000 cubic metres of sediment containing low-level radioactive material is located within the turning basin and west slip of the harbour. Contaminants include uranium and thorium series radionuclides, heavy metals and PCBs.

In recent years, leaching of radioactive wastes and overflows at drainage ponds has occurred during heaving rains and has resulted in contamination entering the groundwater and Lake Ontario.

Impairments: Port Hope was initially designated as an AOC due to restrictions placed on dredging activities. There have been no other impaired beneficial uses identified.

Implementation Structure: Previously, Environment Canada was responsible for coordination of the Port Hope RAP. However, remediation of Port Hope Harbour is now following a different process, with progress dependant upon the selection and approval of an appropriate waste facility. Natural Resources Canada is working in cooperation with Environment Canada to develop the remediation of the Port Hope AOC within the larger low-level radioactive waste clean up in the Port Hope area.

In 1982 the federal government created the Low-Level Radioactive Waste Management Office (LLRWMO) to assume the responsibility of managing historic wastes in Port Hope and elsewhere in Canada. The office in Port Hope has assisted the RAP in developing costs estimates for cleanup, handles public information requests and offers assistance to residents to assess and remediate their properties. The LLRWMO has been designated by Natural Resources Canada as the proponent of the Port Hope Area Initiative.

Implementation Status and Progress: In March 2001, the Government of Canada (represented by Natural Resources Canada) and the three communities of the Town of Port Hope, the Township of Port Hope and the Municipality of Clarington, entered into a legal agreement for the clean up and long term management of local historic low-level radioactive wastes, including wastes found within Port Hope Harbour. The legal agreement is based on community-developed concepts for the local, long-term management of the wastes.

With the signing of the legal agreement, the Government of Canada began a 10 year, $260 million dollar plan called The Port Hope Area Initiative, to develop and implement a long term solution. Since that time, the Town of Port Hope and the Township of Port Hope have been amalgamated into one community, the Municipality of Port Hope.

Implementation of the legal agreement for the Port Hope clean up is now underway. The Low-Level Radioactive Waste Management Office (LLRWMO) is seeking the necessary approvals for development of management facilities for the long-term management of the wastes from the Port Hope area, including those found within Port Hope Harbour..

Delisting Outlook: Natural Resources Canada is the lead for the clean up of all historic radioactive wastes found within the local municipalities, including those within Port Hope Harbour, and will work with Environment Canada to ensure that the requirements of the RAP are met. The development of low-level radioactive waste facilities will require licenses from the Canadian Nuclear Safety Commission and are subject to the Canadian Environmental Assessment Act. It is expected that the regulatory review process will be completed by 2006. An additional five years will be required for the physical clean up and emplacement of wastes in the newly constructed long-term management facilities.

11.5.4 Bay of Quinte

The Bay of Quinte is a narrow z-shaped inlet, 100 kilometres in length, located on the north shore of Lake Ontario's eastern basin. The Area of Concern contains the Bay and its tributaries and the drainage basin is the largest in Southern Ontario (17,520 square kilometers). The Trent River is the largest tributary entering the Bay of Quinte, influencing its water quality and water flow regimes. Parks Canada manages the Trent-Severn Waterway, of which the Trent River is a part.

Environmental Issues: The Bay of Quinte is a unique ecosystem within the Lake Ontario basin. Shallow, and flushed up to 10 times per year, in some respects the Bay behaves like a riverine estuary. The Bay has historically supported a large sportsfishery based primarily on walleye and valued at over $3 million dollars annually. In recent years the ecosystem of the Bay has been greatly influenced by invasive species, such as the zebra mussel, which, by ingesting plankton, have diverted this food source from fish species. Further, the aquatic environment has been altered decreased nutrient loadings, all of which has impacted the sustainability of the walleye.

The shoreline of the Bay contains 22 provincially significant wetlands, some of which are under pressure from urban development in the cities of Belleville, Trenton and the Towns of Napanee, Picton and Deseronto. Four First Nations are also located within the drainage basin.

Impairments: Nutrient loadings from sewage treatment plants and surface water runoff from agricultural and rural lands lead to cultural eutrophication, which was one of the main reasons why the Bay was listed as an Area of Concern. The Remedial Action Plan for the Bay identifies 10 Impaired Beneficial Uses that result from 4 main issues: i) excessive nutrients, ii) habitat loss (particularly coastal wetlands), iii) contaminated sediment from historical mining and industrial activities, and, iv) bacterial contamination from sewage treatment plants, stormwater discharge and agricultural runoff (which lead to beach closures). In addition, the incidence of fish tumours and other deformities is an issue which requires further assessment

RAP Structure: In 1997, a Restoration Council, with membership from Federal and Provincial Government agencies (EC, MOE, DFO, MNR, OMAF), local conservation authorities and Quinte Watershed Cleanup was formed to oversee the implementation of the 80 recommendations from the Remedial Action Plan (RAP). The Department of National Defense and the Mohawks of the Bay of Quinte have joined the Restoration Council since that time. In addition, Quinte Watershed Cleanup originated from a public advisory group set up to advise the Provincial and Federal Government during the development of the RAP. The Quinte Watershed Cleanup is a local community based group that works to promote the restoration and protection of the Bay of Quinte.

In 2000, a major public consultation was undertaken to establish restoration targets for the Bay of Quinte. The public was supportive of the proposed delisting targets which formed the basis for a Five Year Action Plan and 24 recommended environmental actions which when completed, should lead to delisting.

RAP Status and Progress: Substantial progress toward delisting the Bay of Quinte Area of Concern has been made. Over 27,000 hectares of farmland have been converted from conventional to conservation tillage, and phosphorous inputs from rural sources have been lowered at source by more than 16,000 kilograms annually. At sewage treatment plants bordering directly on the Bay of Quinte, phosphorous loads have been reduced from 50 kg/day in 1986 to less than 25 kg/day in 1997 with cost savings of $1.75 million resulting from sewage treatment plant optimization for four facilities within the watershed. Within the Bay of Quinte, phosphorous concentrations are approaching the Bay of Quinte RAP target of 30-40 g/L. Water clarity is improving and the algal blooms are less severe. Direct discharges of industrial wastes have been substantially lowered. Beach closings occur less frequently. Over 50 kilometres of shoreline have been planted with native trees, shrubs and grasses to reduce erosion and improve habitats. Three hundred and fifty-four hectares of wetlands has been rehabilitated and protection of an additional 482 hectares of wetland.

Delisting Outlook: A Phosphorus loading model is under development that will assist the Restoration Council in determining and implementing a phosphorus management strategy for the Bay which could include changes to municipal phosphorus loading "caps". Detailed delisting criteria for fish and wildlife communities and habitats are still to be developed. Also, based on existing natural heritage strategies and a fish habitat management plan (under development), additional habitat conservation and protection measures may be required.

11.6 Actions and Progress

The information contained in this chapter has been compiled based on past documents and was updated as of December 2003. The RAP process is a dynamic one and therefore the status will change as progress is made. This chapter will be updated in future LaMP reports as appropriate.

11.7 References

Environment Canada, Remedial Action Plan Web site: *http://www.on.ec.gc.ca/water/raps/*

Government of Canada, *Canada's RAP Progress Report 2003, Restoration Programs Division,* Environmental Conservation Branch, Environment Canada-Ontario Region, 2003.

Great Lakes National Program Office (GLNPO) Web site: *http://www.epa.gov/glnpo/aoc/*

Field Code Changed

CHAPTER 12 LAMP WORKPLAN ACTIONS AND PROGRESS

12.1 Summary

The Four Parties developed a new 5-year binational workplan for the Lake Ontario LaMP which became effective in January 2003. The workplan outlines binational efforts to restore and protect Lake Ontario and its biological resources. The LaMP workplan is a fundamental component which directs and determines the progress towards achieving this goal.

The workplan contains many activities relating to the chemical, biological and physical integrity of the lake, and also the LaMP's public outreach efforts; however, in the upcoming years, special attention will be concentrated on the following activities:

- Coordination of binational monitoring efforts and programs to better assess the health of Lake Ontario and its ecosystem.
- Reducing critical pollutant loadings to the lake.
- Reporting on the status of adopted ecosystem indicators, habitat, source trackdown and invasive species.
- Broadening partnerships with other scientific groups to share data, conduct analyses, and assist with peer review.
- Conducting public outreach on pollution prevention, LaMP activities and encouraging partnering opportunities.

Table 12.1 is a summary of the actions and progress made in all the workplan activities as of December 31, 2003. The full 5-year workplan can be found in Appendix D of this report.

Table 12.1 Status of Actions and Progress (as of December 31, 2003) in all of the 5-Year Binational LaMP Workplan Activities (for the full 2003-2007 Lake Ontario Workplan, see Appendix D).

LaMP Activities	Products 2003/2004	Status of Activity
A. Chemical. Reduce inputs of LaMP's six critical pollutants		
1. Goals, objectives and targets		
a. Update adopted ecosystem indicators and make progress on additional indicators and target levels for critical pollutants.	LaMP to report update on adopted indicators in LaMP 2004 Biennial Report.	
2. Problem identification		
a. Update current total lake contaminant problem.		
Update estimates of Lake Ontario critical pollutant loadings	LaMP to refine loadings estimates with new data in LaMP 2004 Biennial Report	Data collection phase underway.
US Sediment monitoring	2003-EPA to produce final report. Data to be used in Binational Sediment Workshop.	Final Report on EPA data completed July 2003. Results to be used in Binational Sediment Workshop in 2004. NYSDEC to provide evaluation of available NY data; EPA to prepare presentation of NY data for workshop.
Canadian Sediment quality	2003-EC to produce final reports. Data to be used in Binational Sediment Workshop.	Final reports produced. Results published in the Journal of Great Lakes Research.
Evaluation of sediment data for contribution to the contaminant problem; determine action plan.	2003-LaMP to hold Binational Sediment Workshop. Assess the nature & significance of sediment sources of critical pollutants to Lake Ontario. 2004- synthesis report will be prepared to integrate US and Canadian sediment reports.	Binational Sediment Workshop being planned for March 2004. Organization underway.
b. Cooperative monitoring	2003-LaMP to facilitate & coordinate intensive 4-Party cooperative monitoring projects in analytical comparability, lower food web surveys, atmospheric deposition and lakewide surveys. LaMP to produce fact sheet on monitoring programs. 2004- Participating agencies to begin data analyses & evaluation.	Cooperative monitoring projects are all either underway or planned for 2003 (see specifics below). Fact sheet was prepared in 2003.

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
Coordinate side-by-side analytical comparisons among 4-parties.	2003-4 Party participants to: Complete Phase I (Calibration of instruments) & prepare summary of data; Conduct Phase II (Comparison of lab methodology-preparation of extracts) and prepare summary of data; Review results from Phases I & II Conduct Phase III (Comparison of sample collection methods using standard reagents) Conduct Phase IV (Collect water samples at Niagara-On-The-Lake) 2004-4-Party participants to evaluate data; prepare summary of data & submit a report to the LaMP on the comparability of results among the 4 Parties.	Phase I completed. Review of results showed that all labs are measuring & reporting the contaminants of interest in a consistent & comparable manner; differences in end results cannot be attributed to differences in lab standards. Phase II completed. There were some differences between labs but not outside the range expected. Phase III is being conducted; data will be collated in Jan. 2004.
Coordinate lower food web study	2003-EC, EPA, DEC & OMOE to collaborate in sampling benthos, mysis & zooplankton in lake cruises in Spring, Summer & Fall. 2004-EC, EPA, DEC & OMOE to begin data analyses.	Sampling completed.
Coordinate atmospheric deposition study	2003-EPA/DEC to conduct air sampling from Lake Guardian during lake cruise & conduct land-based sampling; OMOE to conduct air sampling from ship during lake cruises; EC to conduct intensive sampling at IADN & Toronto buoy 2004- 4-Party participants to begin data analyses.	Air sampling, wet and dry deposition of contaminants from EPA Lake Guardian vessel, Sterling, and IADN took place July 6-16, 2003. EC Hg equipment was placed on the Lake Guardian & operated. OMOE did not do any air sampling on Lake Ontario because new vessel was still undergoing testing. Press events, TV and newspaper reports reached over ½ million people in the Lake Ontario basin.
Lake Ontario monitoring surveys	2003-OMOE, EC & EPA to conduct surveys at regular monitoring stations. 2004-OMOE, EC & EPA to begin data analyses.	MOE-regular nearshore monitoring work on Lake Ontario this year. -regular monitoring station data collection continues. EPA- Lake Survey 4/20-21; 8/11-12; air/water LOADS 7/7-16/03

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
3. Source identification		
a. Inventories		
Binational Sources & Loadings Strategy, to include updating of tables, maps, identification of air & water sources & prioritized listings of sources.	LaMP to update inventory and report in LaMP 2004 Biennial Report	Inventory tables and maps being updated.
US: Tributary Monitoring	2003-US LaMP partners to sample tributaries for critical pollutants, analyze samples & prepare report. 2004-US LaMP partners to develop plan to update loadings estimates.	Eighteen Mile Creek, Genessee River, Oswego River, Salmon River & Black River were monitored April & Sept.2002, and week of May 5th, July 7th & Oct. 6th 2003. Preliminary report for 2002 has been prepared (PCB analyses is delayed). Mercury loadings for 4 tribs with gaging stations were obtained. A final report will be issued when PCB data become available.
Canada: Report on Priority Watersheds to include status information; remedial measures; monitoring; recommendations for further action.	2003-Report by EC- "Sediment Quality in Canadian Lake Ontario Tributaries Part I- West of the Bay of Quinte". A screening level survey of tributaries as possible sources of PCBs, PAHs and 36 types of metals.	Work continues in 2003-2004 to complete sampling and analysis of tributaries east of Bay of Quinte. These reports represent the status information, with remediation, monitoring and recommendations for further action to be developed after the completion and evaluation of the reports (2005-06).
b. Source Trackdown		
US trackdown at Rochester Van Lare, Lockport, Carthage, Kelsey Creek and Wine Creek.	LaMP to incorporate results of trackdown activities & progress in remediating/controlling contaminant sources in LaMP 2004 Biennial Report.	Trackdown results in actions at various locations: In Rochester, investigating effluent treatment and GLI determinations for SPDES permit with further pretreatment controls. Consistent with GLNPO target. Carthage & Lockport plants to upgrade with grant awards. Kelsey Creek remediation including sediment removal and sampling show significant improvement. Wine Creek industrial site sources & remedial actions are under further evaluation. Remedial activities including treatment plant rehab and upgrades, pretreatment controls, discharge permit requirements, sediment removal, land based remediation and follow-up sampling indicate good results. Depending on the site, concerns have been addressed or further evaluation is underway. EPA Great Lakes grant to address 4 additional sites with trackdown sampling or data evaluation: Cayuga Creek, Two-Mile Creek, Gill Creek & Scajaquada Creek.

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
Canadian PCB trackdown at 12 Mile Creek, Cataraqui & Etobicoke Creek.	2003-OMOE to identify local sources of PCBs in 12 Mile Creek; complete summary reports of mussel biomonitoring/water sampling; provide recommendations for further monitoring. OMOE to collect & analyze YOY fish from Lake Gibson; EC to analyze & report on sediment samples OMOE/EC to analyze/report on fish,mussel, water samples collected in 2001 in Etobicoke Creek; EC to analyze & report on sediment samples collected in 2001 & complete report. OMOE/EC to complete analysis of data collected in 2001/2002 in Cataraqui River. 2003/2004-OMOE & EC to prepare reports and make recommendations. LaMP to produce summaries of trackdown projects in LaMP 2004 Biennial Report.	12 Mile Creek:The analysis of 2002 sampling will be available in 2003/2004 (analysis of water sampling, caged mussels and sediment work). Further investigations in 2004 may include sampling in existing sewershed outfalls, and creeks to further trackdown potential PCB sources. Etobicoke Creek: The analysis of 2002 sampling will be available by the end of 2003 (results include large volume water sampling and sediment work). No major work has been identified for 2004 at this time. Cataraqui Creek: Groundwater and sediment samples were collected in 2003. Additional groundwater monitoring wells were established in 2003. Results from 2003 groundwater sampling and sediment work will be analyzed in early 2004. Assessment of 2002 biota data to determine the extent of biological impact is ongoing. Delineation of the area and extent of contaminated sediment will be completed in 2003/2004.
Canadian Project Trackdown Part II	2003-OMOE/EC to review previously identified tributaries to determine if trackdown is warranted. 2003-2004 OMOE/EC to identify funding sources, plan & initiate trackdown projects on identified tributaries. 2004-OMOE/EC to identify additional priority watersheds where trackdown is warranted.	Completed report, April 2003: "Interim Guidance Framework for PCB Source Track-Down Projects". This report outlines how tributaries that may be candidates for future trackdown projects, will be prioritized for selection in the future and provides guidance on conducting trackdown projects from initiation to completion.
Canadian Tributary Screening level survey of sediment quality.	2003/2004-EC to complete analyses of sediment samples in tributary mouths for chemicals of concern. Data will assist with identification of additional priority sites for follow-up work.	In 2002 - 130 tributary mouths were sampled from Niagara-on-the-Lake to the Bay of Quinte. Summary report produced April 2003. In 2003- 75 tributary mouths sampled (to date) in Lake Ontario. Approximately 30 tributary mouths left to be sampled in the St. Lawrence River.

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
4. Reduction Strategies		
a. Regulatory and voluntary actions		
Regulatory actions	LaMP to facilitate & coordinate transfer of information from 4 Parties to appropriate enforcement, regulatory & remedial action branches of EC, OMOE, EPA & DEC. LaMP to report actions & progress in LaMP 2004 Biennial Report.	US - Carthage: PCB requirement was added to the SPDES permit for the sewage treatment plant. Carthage plant and Climax Mfg. paper mill were sampled for PCBs by EPA as part of routine compliance inspection in Oct. 2002. Carthage & Lockport received grant money to upgrade treatment facilities. White Creek: Discharges into Wine Creek; is a source of: PCBs from 2 industrial hazardous waste sites; under further consideration. Involves EPA Superfund. Rochester: Waste water treatment plant effluent is in compliance with permit discharge requirements. PCB sample assessment method is being evaluated. Falls St. tunnel: Results of sampling provided to permit renewal process. Incorporation of GLI standards in all permits is desired.
Voluntary actions	LaMP to coordinate with Binational Toxics Strategy and EPA, EC, OMOE & DEC hazardous waste minimization & pollution prevention programs to encourage action on sources polluting Lake Ontario.	Attended GLBTS meeting in Toronto (Oct.2003). Working on developing joint projects which will be targeted to address Lake Ontario sources.
Promotion of pollution prevention programs	LaMP to identify existing grants & programs; develop a strategy for promotion of pollution prevention programs. LaMP to facilitate partnerships between stakeholder groups for promoting pollution prevention.	BTS Crosswalk of common priorities with LaMP activities (May 2003) - increased cooperation between BTS and LaMP in the area of pollution prevention.

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
b. Mass balance model		
Develop plan for independent peer review	2003-EPA to make hydrodynamic modifications to LOTOX2; develop charge for peer review; hold workshop for peer review panel; conduct peer review.	The Lotox2 peer review workshop was held at EPA's NYC R2 office July 16-17, 2003. The peer review panel in attendance consisted of 9 scientists/modelers representing academia, EPA, NYSDEC & EC. Additional comments were received from 2 reviewers who were not in attendance. Post-workshop written comments were received from all 11 peer reviewers and forwarded to the PI for response. These responses were received and revised model documentation. was received on Oct. 6th. The peer review comments/responses and the revised model documentation were distributed to the Agency's and peer reviewers for final review and sign-off. A training workshop for Lotox2 was held on 1/14/04.
Develop scenarios to assess management options	4 Parties to develop scenarios to assess management options	After final peer-review sign-off is received (see above), a conference call will be convened with the 4 Parties to discuss the application of the model and the development of management scenarios.
B. Physical/biological		
1. Goals, objectives and targets		
a. Update adopted ecosystem indicators and consider additional indicators and targets for physical and biological objectives as information becomes available.		
Mink and otter indicator	2003-LaMP to publish summary on mink/otter population assessment in LaMP Update 2003. 2004-LaMP to publish full report on mink/otter populations in LaMP 2004 Biennial Report.	Population assessment work is completed. Summary reported in Update 2003. Full report to be added to a future LaMP report.
Bald eagle indicator	LaMP will engage partners to develop an approach to evaluate existing habitat information with an aim of identifying important habitats to be considered for specific conservation or restoration activities. Specific activities may include an update of an earlier bald eagle nesting habitat assessment and the development of specific recommendations regarding these nesting habitats.	LaMP has initiated and obtained USEPA funding for a project on "Conserving Lake Ontario & Upper St. Lawrence River Bald Eagle Habitats". The primary objective of the study is to identify and prioritize remaining high quality bald eagle nesting and overwintering habitats. Canadian experts have been approached and funding requests for 2004/2005 are being made to conduct work for the project on the Canadian side of the Lake Ontario basin as well.

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
b. Evaluate information to complete assessment of beneficial use impairments.		
Benthos and phytoplankton	2003-LaMP to facilitate & coordinate monitoring of lower food web lakewide by 4 Parties and partners, and data analyses. 2004- LaMP to facilitate the writing of a synthesis report on findings.	Data collection completed.
2. Problem identification		
a. Habitat assessment		
Canadian habitat assessment and Watershed Management.	Cdn LaMP partners to identify & promote watershed management strategies in conjunction with Conservation Authorities, OMNR and other agencies; Cdn LaMP partners to liaise with OMNR to obtain information on COA funded activities related to habitat issues.	MOE is implementing a watershed management approach to water protection - with a major focus on source protection. MOE is working with L.Ont committee and MNR on COA funded activities related to fish and wildlife habitat issues in the AOCs and throughout the Lake Ontario basin.
US habitat assessment, strategy and actions.	US LaMP partners to develop a habitat inventory and build a framework for habitat strategy. US LaMP partners to liaise with Great Lakes Gap Analysis Project Group and assist in formulating products, strategies & actions to promote conservation of Great Lakes islands & coastal nearshore habitats. US LaMP partners to liaise with partners in establishing a community based regional network in order to develop & implement a program to protect & restore coastal wetlands.	Development of habitat inventory begun. Project began (10/03) to form partnerships with TNC, USF&WS and others to develop a Great Lakes islands assessment and identify a suite of island indicators. Project will target many of the GL basin's 30,000 islands, including those in the St. Lawrence River. Coastal Wetlands Consortium began pilot project of the coastal wetlands of Eastern Lake Ontario. Existing inventory (US & Cdn) of coastal wetlands was collected; field work on indicators was completed. Data will be analyzed to determine if methods can be used to compare indicator tests and develop a basinwide monitoring plan.
Establish value added linkages to International Joint Commission's water level study.	LaMP to maintain relationships with technical workgroups for information exchange and coordinated public outreach where warranted.	MOE met with Cnd. co-chair of ETWG (April3/03) MOE attended ETWG group meeting (Oct. 2003 and obtained information on the progress of the IJC Water Level Study. Letter to IJC Nov. 2003 promoting data sharing and to submit a request for mapping and studies associated with the IJC Water Level Study.

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
Work with Great Lakes Fishery Commission's Lake Ontario Committee to identify priority projects & investigations; develop common indicators.	2003 -LaMP to participate with the Lake Ontario Committee in their Lake Ontario Conference 2003/2004 -Participate in development of Lake Ontario Committee ecosystem objectives & revised Fish Community objectives for Lake Ontario	Joint meeting held in 2003; another joint meeting in 2004 is being discussed.
b. Human Health Issues	LaMP to maintain connection with the Binational Great Lakes Human Health Network. LaMP to work with Network to gather/exchange information pertaining to human health.	HHN Charter was finalized by network members. There are 31 members, including federal agencies (EPA, Health Canada, ATSDR, FDA), states and tribes. The US domestic network is in place with 6 Great Lakes states including NYS. Communication: Conference calls monthy - bimonthly; emails and web conferencing. EPA & EC participate in Network conference calls. Information exchange: EPA, ATSDR and IJC websites; meetings and conferences. HHN EPA & ATSDR members are preparing information on a number of health issues.
	Cdn LaMP partners to liaise with the Human Health Network, and/or Human Health agencies, to gather/exchange information on current & emerging human health issues of relevance to the LaMP. Cdn LaMP partners to identify actions & address current & emerging human health issues of relevance to the LaMP & make that information available to the public.	EC is participating on Human Health Network conference calls and is tracking progress in setting up the Canadian Network. Health Canada and the Ontario Ministry of Health sent a letter to 37 medical health officers around the province inviting them to participate in a meeting 12/03 aimed at establishing the Canada-Ontario Public Health Network, pursuant to COA 2002 commitments. The meeting took place as planned. EC and MOE were represented at the meeting. Collecting relevant health information as it becomes available. LaMP particpated in IJC Mercury Workshop (2/03) with a Lake Ontario LaMP display entitled "Understanding Mercury in Lake Ontariio".
c. Emerging Issues	LaMP to facilitate & promote collection of information on emerging issues. LaMP to assess available information & research and recommend appropriate management options & strategies where necessary.	Tracking Botulism E issue and obtaining information on the spread of the Round Goby and Asian Carp as emerging issues.

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
d. Invasive species	2003- LaMP to facilitate & coordinate collection of data on effects of zebra/quagga mussels on lower food web. 2003-2004 LaMP to assess available information & research on invasive species and recommend appropriate management options & strategies where necessary.	Completed collection of samples. Assessment of information & research is ongoing.
C. Public Outreach, Consultation, Reporting and Communicating		
1. Promote Partnerships	2003- LaMP to partner with Lake Ontario Committee for their Lake Ontario Conference; provide LaMP information, display; public outreach materials. Continue partnership with IJC water levels study.	LO LaMP participated in the LOC conference held March 2003. LO LaMP display was available and materials on the LaMP were distributed. LaMP representatives continue to work with IJC Study's Environmental Technical Work Group.
Information and data transfer	LaMP to submit data for inclusion into other databases, such as the IJC database. LaMP to promote information exchange and the availability of data for the public and stakeholders.	Letter to IJC 11/03 promoting data sharing and requesting the mapping and studies associated with the IJC Water Level Study.
2. Promote stewardship	LaMP to develop a strategy for more proactive promotion of stewardship; identify community-based actions & partnerships.	PIC will produce info packages for WG members on available outreach materials to take to meetings with stakeholders and the public. LaMP Stewardship poster completed 5/03 and released at events such as the NRTMP/LaMP Annual Meeting, Kingston Kid's Perch Derby. LaMP will continue to promote stewardship poster through various outreach events.
3. Maintain information connection	LaMP to work with binational committee to migrate the LaMP site to binational.net. LaMP to update & maintain Lake Ontario website. LaMP to review mailing list. LaMP to encourage other GL and non-governmental organizations to add links from their websites to Lake Ontario website.	Draft conversion of site complete. Ongoing.
4. Binational Lake Ontario Meetings	LaMP to convene binational meetings as necessary to meet specific objectives.	

Table 12.1 5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 through 2007) Status of Activities as of December 31, 2003 (Continued)

LaMP Activities	Products 2003/2004	Status of Activity
5. Annual Reports	LaMP to publish LaMP Update 2003 and LaMP Biennial Report 2004	LaMP Update 2003 published & mailed out to public. LaMP Binder and LaMP Biennial Report 2004 completed.
6. Annual meeting	LaMP to hold joint Lake Ontario/Niagara River Toxics Management Plan (NRTMP) public meetings in 2003 & 2004	LO/NRTMP public meeting held June 10, 2003.
7. SOLEC/IJC Meetings	LaMP to participate in IJC meeting in 2003 and SOLEC 2004	LaMP participated in IJC 2003. LaMP will participate in SOLEC 2004.
8. Public Outreach Strategy Review	LaMP to implement revised public involvement strategy.	Ongoing.

12.2 References

Coleates, R. 2003. Survey of Sediment Quality in Lake Ontario - A Summary of Sampling Results from September 1997.

Coleates, R. 2003. Field Sampling Report and Preliminary Data Presentation - Lake Ontario Tributaries Monitoring of Critical Pollutants April and September 2002.

Marvin, C. H., Charlton, M. N., Stern, G.A., Braekevelt, E., Reiner, E. J., and S. Painter. 2003. Spatial and Temporal Trends in Sediment Contamination in Lake Ontario. J. Great Lakes Res. 29(2):317-331.

CHAPTER 13 LAMP NEXT STEPS

13.1 Summary

The Four Parties will continue efforts to restore and protect Lake Ontario and its biological resources. The LaMP workplan is a fundamental component in maintaining progress for this goal. A new LaMP workplan became effective in January 2003 and is based on a 5-year schedule.

In the upcoming years, special attention will be concentrated on the following activities:

- Coordination of binational monitoring efforts and programs to better assess the health of Lake Ontario and its ecosystem.
- Reducing critical pollutant loadings to the lake.
- Reporting on the status of adopted ecosystem indicators, habitat, source trackdown and invasive species.
- Broadening partnerships with other scientific groups to share data, conduct analyses, and assist with peer review.
- Conducting public outreach on pollution prevention, LaMP activities and partnering opportunities.

We are looking forward to this next phase of progress for Lake Ontario and its ecosystem. We invite you to view our new workplan and relevant documents on our Web site at www.binational.net.

13.2 Next Steps

The Four Parties will continue efforts to restore and protect Lake Ontario and its biological resources. The LaMP workplan is a fundamental component in maintaining progress for this goal. A new LaMP workplan became effective in January 2003 and is based on a 5 year schedule.

Coordination of binational monitoring efforts, particularly those related to the LaMP's ecosystem indicators, will be a special area of emphasis in future years. Planning is underway to evaluate the comparability of U.S. and Canadian surface water sampling methods used to measure levels of persistent toxic substances. LaMP staff are working to identify ways for U.S. and other Canadian program efforts to conduct another intensive binational cooperative monitoring year, such as the one that was successfully completed in 2003, in order to provide a more extensive and binational assessment of lakewide conditions. Along with developing a better understanding of the status of the Lake Ontario ecosystem, better coordination of monitoring efforts promises to provide real savings in terms of staff time and financial resources. The development of the LaMP Sources and Loadings Strategy provides an overall approach of how critical pollutant sources will be identified and addressed. The adoption of indicators to meet ecosystem goals and objectives lays out well-defined endpoints for the LaMP's restoration efforts, and a commitment to coordinated monitoring will build even stronger binational relationships necessary to achieve these ambitious goals.

Work will continue to restore beneficial use impairments through the LaMP's Sources and Loadings Reduction Strategy. Source information is being refined, allowing more specific abatement or remedial actions to be targeted. New and better approaches to pinpoint sources and deal with them are being used in trackdown activities in the tributaries to Lake Ontario, and as this activity becomes more common, it will become more efficient. The development of remedial and pollution prevention actions will continue to reduce critical pollutant loadings to the lake. Future LaMP reports will summarize the findings of these ongoing activities and highlight the status of critical pollutant control actions.

Now that the LaMP has adopted a suite of ecosystem indicators, future work will focus on the collection and synthesis information needed to report on the status of these indicators as part of future LaMP and SOLEC activities. The data collection and interpretation process will foster increased communication and coordination between U.S. and Canadian environmental programs. Environmental program staff will work to fine tune some of the less well-defined targets, such as those for prey fish populations. Partnerships with other scientific groups will be broadened to share data, conduct analyses, and assist with peer review.

In the area of habitat management, Canada will use its habitat assessment report and the U.S. will review its information base to identify priorities and follow up on recommendations. A binational habitat strategy for the LaMP will follow in future years.

Providing the public with a sound understanding of the complex problems facing the lake is the first step in gaining public support and participation in achieving the LaMP's goals. Ongoing activities include using opportunities to meet with existing groups, forming partnerships locally to assist in LaMP projects, and providing information when requested and regularly through the LaMP web site and mailings. We will continue to inform the public through reporting and public meetings, and will participate in other meetings such as SOLEC and International Joint Commission (IJC) biennial sessions.

The Lake Ontario ecosystem has seen many changes since the early beginnings of the Lake Ontario Toxics Management Plan through to the transition to the LaMP. Critical pollutant levels have declined dramatically since the mid 1970s and with our continued collective efforts, we will stay on the road to recovery.

We are looking forward to this next phase of progress for Lake Ontario and its ecosystem. We invite you to view our new workplan and relevant documents on our Web site at *www.binational.net*, and refer to Chapter 12 and Appendix D of this document.

Field Code Changed

13.3 Research Needs

This section will be completed as information becomes available.

13.4 Recommendations

This section will be completed during preparation of the 2006 Report.

13.5 References

Lake Ontario 5-Year Workplan, Lake Ontario Biennial 2004 Report, Appendix D
Lake Ontario 5-Year Workplan, Status of Activities, Lake Ontario Biennial 2004 Report, Chapter 12

Appendix A

Glossary

33/50 Program: A pollution prevention program sponsored by USEPA in voluntary partnerships with industry. The program's goals are to reduce targeted chemicals by 33 percent by 1992 and 50 percent by 1995.

Anthropogenic: Effects or processes that are derived from human activities, as opposed to natural effects or processes that occur in the environment without human influence.

Benthic: Pertaining to plants and animals that live on the bottom of aquatic environments.

Bioaccumulation: The accumulation by organisms of contaminants through ingestion or contact with skin or respiratory tissue.

Bioaccumulative Chemical of Concern (BCC) (Bioaccumulative Toxics): Any chemical that has the potential to cause adverse effects which upon entering the surface waters, by itself or as its toxic transformation products, accumulates in aquatic organisms by a human health bioaccumulation factor greater than 1000, after considering metabolism and other physiochemical properties that might enhance or inhibit bioaccumulation, in accordance with the methodology in Appendix B of Part 132 - Water Quality Guidance for the Great Lakes System. Source: Water Quality Guidance for the Great Lakes System.

Combined Sewer Overflow (CSO): A pipe that, during storms, discharges untreated wastewater from a sewer system that carries both sanitary wastewater and stormwater. The overflow occurs because the system does not have the capacity to transport and treat the increased flow caused by stormwater runoff.

Deforestation: The clearing of wooded areas.

Degradation: A term used in the indicators of beneficial use impairments defined by the Great Lakes Water Quality Agreement to indicate an environmental condition or state that is considered to be unacceptable or less than the condition that would exist in a healthy ecosystem. In the development of the LaMP the condition was determined after consideration of the Ecosystem Goals for Lake Ontario (Section 1.7) and the preliminary ecosystem objectives.

Diatoms: A class of planktonic one-celled algae with skeletons of silica.

Ecosystem: An ecological community and its environment functioning as a unit in nature.

Eutrophic: Relatively high amounts of nutrients (phosphorus and nitrogen) in the water column. Although eutrophic conditions occur naturally in the late stages of many lakes, rapid increases in nutrients due to human activities can destabilize aquatic food webs because plants and aquatic organisms cannot adjust to rapid changes in nutrient levels.

Final Effluent Limits: The amount of a pollutant allowed to be discharged by a U.S. industry or municipality.

Food Web: A network of interconnected food chains and feeding interactions among organisms.

Isothermal: Marked by equality of temperature.

Littoral: Relating to or existing on a shore.

Macroinvertebrates: Small organisms that do not have spinal columns; may filter bottom sediments and water for food.

Mesotrophic: Refers to a lake with relatively moderate amounts of nutrients (phosphorus and nitrogen) in its surface water.

Metric Tonne: Unit of weight used in Canada equal to 1,000 kilograms or 2,246 pounds. Equivalent to 1.102 U.S. tons.

Non-point Source: An indirect discharge, not from a pipe or other specific source.

Oligotrophic: Relatively low amounts of nutrients (phosphorus and nitrogen) in the water column. Lake Ontario's original nutrient levels can best be described as oligotrophic.

Pelagic: Related to or living in the open lake, rather than waters adjacent to the land.

Persistent Toxic Substance (Persistent Toxic Chemical): Any toxic substance with a half-life, i.e., the time required for the concentration of a substance to diminish to one-half of its original value, in any medium -- water, air, sediment, soil, or biota – of greater than eight weeks, as well as those toxic substances that bioaccumulate in the tissue of living organisms. Source: Great Lakes Water Quality Agreement of 1978, expanded by the IJC's Sixth Biennial Report of Great Lakes Water Quality.

Phytoplankton: Microscopic forms of aquatic plants.

Publicly-owned Treatment Works (POTW): A system that treats (which can include recycling and reclamation) municipal sewage or industrial wastes of a liquid nature. Large facilities are generally owned and operated by local governments.

Riparian: Habitat occurring along the bank of a waterway.

Salmonid species: Salmonid species are essentially trout species (eg. Lake trout, Brown, Brook,Chinook, Coho, Rainbow etc).

Sewage Treatment Plant (STP): A system that treats (which can include recycling and reclamation) municipal sewage or industrial wastes of a liquid nature. Large facilities are generally owned and operated by local governments.

Thermal Stratification (Thermocline): Differential rates of seasonal heating and cooling of shallow and deep waters result in the development of two horizontal layers of water having very different water temperatures. The depth where this abrupt temperature change occurs is known as the thermocline.

Toxic Substance: Any substance which can cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions, or physical deformities in any organism or its offspring, or which can become poisonous after concentration in the food chain or in combination with other substances. Source: 1978 Great Lakes Water Quality Agreement.

Volatilization: Evaporation.

Watershed: The land area that drains into a stream, river, estuary, or other water body; same as drainage area.

Water Quality Standards: In the U.S., a designated use of a water body (i.e., swimming, fishing, etc.) and the numerical or other criteria to protect that use.

Water Pollution Control Facility (WPCF): A system that treats (which can include recycling and reclamation) municipal sewage or industrial wastes of a liquid nature. Large facilities are generally owned and operated by local governments.

Water Pollution Control Plant (WPCP): A system that treats (which can include recycling and reclamation) municipal sewage or industrial wastes of a liquid nature. Large facilities are generally owned and operated by local governments.

Zooplankton: Microscopic animals that move passively in aquatic ecosystems.

List of Acronyms

ALCOA	Aluminum Corporation of America
AOC	Area of Concern
ATSDR	Agency for Toxic Substances and Disease Registry
AWWA	American Water Works Association
BAIT	Bay Area Implementation Team
BARC	Bay Area Restoration Council
BEAST	Benthic Assessment of Sediment
BEC	(Great Lakes) Binational Executive Committee
BQ RAP	Bay of Quinte RAP
BTMP	Binational Toxics Management Plan
BTS	(Canada-U.S. Great Lakes) Binational Toxics Strategy
BUIs	Beneficial Use Impairments
CDEC	Cornwall and District Environment Council
CDN	Canadian (for example, as in $24,000 (CDN))
CSOs	Combined Sewer Overflows
CWS	Canadian Wildlife Service
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DEC	(New York State) Department of Environmental Conservation (also NYSDEC)
DFO	(Canadian) Department of Fisheries and Oceans
DPW	(Canadian) Department of Public Works
EC	Environment Canada
EOWG	(Lake Ontario) Ecosystem Objectives Work Group
EPA	(U.S.) Environmental Protection Agency
ETWG	Environmental Technical Work Group
FBNR	Friends of the Buffalo/ Niagara Rivers
FDA	(U.S.) Food and Drug Administration
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
GL	Great Lakes
GLBTS	(Canada-U.S.) Great Lakes Binational Toxics Strategy

GLCUF	(EC's) Great Lakes Cleanup Fund (renamed Great Lakes Sustainability Fund)
GLFC	Great Lakes Fishery Commission
GLI	Great Lakes Initiative
GLNPO	Great Lakes National Program Office
GLRC	Great Lakes Research Consortium
GLSF	(Environment Canada's) Great Lakes Sustainability Fund
GLU	Great Lakes United
GLWCAP	(Canada's) Great Lakes Wetlands Conservation Action Plan
GLWQA	Great Lakes Water Quality Agreement
GLWQI	(U.S.) Great Lakes Water Quality Initiative
GRI	Great Rivers Institute
HCB	Hexachlorobenzene
HHN	Human Health Network
HSPF	(EPA) Hydrologic Simulation Program
IADN	Integrated Atmospheric Deposition Network
IAGLR	International Association of Great Lakes Research
IJC	International Joint Commission
LaMP	Lakewide Management Plan
LEL	Lowest Effects Level
LLRW	Low Level Radioactive Waste
LLRWMO	Low-Level Radioactive Waste Management Office
LO	Lake Ontario
LOADS	Lake Ontario Atmospheric Deposition Study
LOC	(Great Lakes Fishery Commission's) Lake Ontario Committee
LOTC	Lake Ontario Technical Committee
LOTMP	Lake Ontario Toxics Management Plan
LOTOX	Lake Ontario Toxics Modeling Project
LOTOX2	Second version of LOTOX model
M	Million (e.g., $3.2M)
MIB	Methylisoborneol
MNR	(Ontario) Ministry of Natural Resources
MOE	(Ontario) Ministry of the Environment
MOU	Memorandum of Understanding
NA	No data available
ND	Not detected
NOAA	(U.S.) National Oceanic and Atmospheric Administration
NPCA	Niagara Peninsula Conservation Authority
NRTMP	Niagara River Toxics Management Plan
NS	Not Sampled
NWF	National Wildlife Federation
NWRI	(Canadian) National Water Research Institute
NY	New York
NYC	New York City
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation (also DEC)
NYSDOH	New York State Department of Health
OCS	Octachlorostyrene
OMNR	Ontario Ministry of Natural Resources
OMOE	Ontario Ministry of the Environment
PAHs	Polycyclic Aromatic Hydrocarbons
PBDEs	Polybrominated diphenyl ethers

PCBs	Polychlorinated biphenyls
PI	Principal Investigator
PIC	Public Involvement Committee
PISCES	Passive In-Situ Chemical Extraction Sampler
ppb	parts per billion
PPCP	Pollution Prevention and Control Plan
ppm	parts per million
ppt	parts per trillion
PWL	Priority Waterbody Listing
R2	(EPA's) Region 2
RAP	Remedial Action Plan
RAC	Remedial Advisory Committee
RRCA	Raisin Region Conservation Authority
SEL	Severe Effects Level
SLAEC	St. Lawrence Aquarium and Ecological Center
SLRIES	St. Lawrence River Institute of Environmental Sciences
SOLEC	State of the Lakes Ecosystem Conference
SPDES	(New York) State Pollutant Discharge Elimination System
STP	Sewage treatment plant
SUNY	State University of New York
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TRCA	Toronto and Region Conservation Authority
USACE	United States Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USF&WS	U.S. Fish and Wildlife Service (also USFWS)
WG	(Lake Ontario LaMP) Work Group
WPCF	Water pollution control facility
WPCP	Water pollution control plant
WQCC	Water Quality Coordinating Committee
WQMAC	Water Quality Management Advisory Committee
WQS	Water Quality Standards
WRAPS	Watershed Restoration and Protection Strategies
WRT	Waterfront Regeneration Trust
WTP	Water Treatment Plant
WWFMMP	(Toronto's) Wet Weather Flow Management Master Plan
YoY	Young of the Year (fish)

Appendix B
Lake Ontario Letter of Intent

Lake Ontario MAY 22 1996

Progression of Toxics Management Plan to Lakewide Management Plan
Letter of Intent

In 1987, the Niagara River Declaration of Intent (DOI) committed the Four Parties (Environment Canada, U.S. Environmental Protection Agency, Ontario Ministry of the Environment, and New York State Department of Environmental Conservation) to develop Toxics Management Plans for the Niagara River and Lake Ontario. The Lake Ontario Toxics Management Plan (LOTMP) was developed in 1989 and was updated in 1991 and 1993.

The goal of the LOTMP is a lake that provides drinking water and fish that are safe for unlimited consumption and allows natural reproduction of the most sensitive native species. The LOTMP reduces toxic inputs to the Lake through the implementation of new and existing programs and the development of basin-wide pollution prevention strategies. The LOTMP has been the primary toxic substances reduction planning effort for Lake Ontario.

The 1987 amendments to the Great Lakes Water Quality Agreement committed the federal governments of the United States and Canada to develop Lakewide Management Plans (LaMP) for each of the five Great Lakes. The LaMP will provide a comprehensive ecosystem approach to restore beneficial uses by reducing levels of critical pollutants that cause lakewide problems. Critical pollutants are substances that singly or in combination pose a threat to human health or aquatic life due to their toxicity, persistence in the environment and/or their ability to accumulate in organisms.

The Four Parties agree that one program (the LaMP) should be developed which provides an overall framework for our efforts. The LOTMP has been the primary toxic substances reduction planning effort for Lake Ontario. As such, it serves as a foundation for the development of the Lake Ontario LaMP. In order to assure that the LaMP documents reflect the intent of the LOTMP, the Four Parties have agreed to review and incorporate all relevant commitments from the LOTMP. Documentation of the progress that has been achieved towards these goals will be provided in the first LaMP document.

The LaMP process provides a mechanism to continue to deliver the LOTMP committed to in the 1987 DOI. The attached Lake Ontario LaMP Workplan establishes commitments and milestones for the development of the LaMP, within the constraints of available resources.

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Appendix C

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New York State Department of Environmental Conservation Regional Offices

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University Libraries

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Atlantic States Legal Foundation
658 West Onondaga Street
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Canadian Repositories

Environment Canada
Library Services Section
Canada Centre for Inland Waters
867 Lakeshore Road
Burlington, Ontario L7R 4A6
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Ontario Ministry of the Environment Offices

Ontario Ministry of the Environment
Public Affairs and Communications Branch
135 St. Clair Avenue West
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Intergovernmental Relations Office
135 St. Clair Avenue West
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MOE Regional Office
Central Region
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Toronto, Ontario M4H 1A8

MOE Regional Office
Eastern Region
133 Dalton Avenue
Kingston, Ontario K7L 4X6

MOE Regional Office
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119 King Street West
Hamilton, Ontario L8N 3Z9

International Joint Commission Offices

International Joint Commission
100 Ouellette Avenue
Windsor, Ontario N9A 6T3

International Joint Commission
100 Metcalfe Street
Ottawa, Ontario K1P 5M1

Municipal Government

Regional Municipality of Niagara
P.O. Box 1042
Thorold, Ontario L2V 4T7

University Libraries

Queen's University
Kingston, Ontario K7L 3N6

University of Toronto
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Toronto and Region RAP
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Appendix D

5-Year Binational Workplan for the Lake Ontario Lakewide Management Plan (2003 Through 2007)

LaMP Activities	Products 2003/2004	Products 2005-2007
A. Chemical. Reduce inputs of LaMP's six critical pollutants		
1. Goals, objectives and targets		
a. Update adopted ecosystem indicators and make progress on additional indicators and target levels for critical pollutants.	LaMP to report update on adopted indicators in LaMP 2004 Biennial Report.	LaMP to identify & assemble information on additional indicators as information becomes available.
2. Problem identification		
a. Update current total lake contaminant problem.		
Update estimates of Lake Ontario critical pollutant loadings	LaMP to refine loadings estimates with new data in LaMP 2004 Biennial Report	LaMP to update loadings as information becomes available
US Sediment monitoring	2003-EPA to produce final report. Data to be used in Binational Sediment Workshop.	
Canadian Sediment quality	2003-EC to produce final reports. Data to be used in Binational Sediment Workshop.	
Evaluation of sediment data for contribution to the contaminant problem; determine action plan.	2003-LaMP to hold Binational Sediment Workshop. Assess the nature & significance of sediment sources of critical pollutants to Lake Ontario. 2004- Develop action plan.	LaMP to facilitate the identification of priority areas for remedial action.
b. Cooperative monitoring	2003-LaMP to facilitate & coordinate intensive 4-Party cooperative monitoring projects in analytical comparability, lower food web surveys, atmospheric deposition and lakewide surveys. LaMP to produce fact sheet on monitoring programs. 2004- Participating agencies to begin data analyses & evaluation.	4 parties to continue data analyses; LaMP to publish synthesis reports; LaMP to facilitate long term approach to binational monitoring strategy.

LaMP Activities	Products 2003/2004	Products 2005-2007
Coordinate side-by-side analytical comparisons among 4-parties.	2003-4 Party participants to: Complete Phase I (Calibration of instruments) & prepare summary of data; Conduct Phase II (Comparison of lab methodology-preparation of extracts) and prepare summary of data; Review results from Phases I & II Conduct Phase III (Comparison of sample collection methods using standard reagents) Conduct Phase IV (Collect water samples at Niagara-On-The-Lake) 2004-4-Party participants to evaluate data; prepare summary of data & submit a report to the LaMP on the comparability of results among the 4 Parties.	LaMP to facilitate coordination amongst the 4-Parties concerning the practical application of the comparability evaluation.
Coordinate lower food web study	2003-EC, EPA, DEC & OMOE to collaborate in sampling benthos, mysis & zooplankton in lake cruises in Spring, Summer & Fall. 2004-EC, EPA, DEC & OMOE to begin data analyses.	EC, EPA, DEC & OMOE to complete data analyses. LaMP to prepare synthesis report with recommendations for future actions. LaMP to determine need for, and feasibility of, developing additional Lake Ontario lower food web indicators.
Coordinate atmospheric deposition study	2003-EPA/DEC to conduct air sampling from Lake Guardian during lake cruise & conduct land-based sampling; OMOE to conduct air sampling from ship during lake cruises; EC to conduct intensive sampling at IADN & Toronto buoy 2004-4-Party participants to begin data analyses.	4 Parties to continue data analyses. LaMP to prepare synthesis report.
Lake Ontario monitoring surveys	2003-OMOE, EC & EPA to conduct surveys at regular monitoring stations. 2004-OMOE, EC & EPA to begin data analyses.	OMOE, EC & EPA to continue data analyses. LaMP to prepare synthesis report.
3. Source identification		
a. Inventories		
Binational Sources & Loadings Strategy, to include updating of tables, maps, identification of air & water sources & prioritized listings of sources.	LaMP to update inventory and report in LaMP 2004 Biennial Report.	LaMP to update inventory and report in LaMP 2006 Biennial Report.

LaMP Activities	Products 2003/2004	Products 2005-2007
US: Tributary Monitoring	2003-US LaMP partners to sample tributaries for critical pollutants, analyze samples & prepare report. 2004-US LaMP partners to develop plan to update loadings estimates.	LaMP to integrate tributary loading results into LaMP 2006 Biennial Report.
Canada: Report on priority watersheds to include status information; remedial measures; monitoring; recommendations for further action.		LaMP to report in LaMP 2006 Biennial Report.
b. Source Trackdown		
US trackdown at Rochester Van Lare, Lockport, Carthage, Kelsey Creek and Wine Creek.	LaMP to incorporate results of trackdown activities & progress in remediating/controlling contaminant sources in LaMP 2004 Biennial Report.	NYSDEC to follow-up on additional monitoring & remedial actions where indicated.
Canadian PCB trackdown at 12 Mile Creek, Cataraqui & Etobicoke Creek.	2003- OMOE to identify local sources of PCBs in 12 Mile Creek; complete summary reports of mussel biomonitoring/water sampling; provide recommendations for further monitoring. OMOE to collect & analyze YOY fish from Lake Gibson; EC to analyze & report on sediment samples OMOE/EC to analyze/report on fish,mussel, water samples collected in 2001 in Etobicoke Creek; EC to analyze & report on sediment samples collected in 2001 & complete report. OMOE/EC to complete analysis of data collected in 2001/2002 in Cataraqui River. 2003/2004 -OMOE & EC to prepare reports and make recommendations. LaMP to produce summaries of trackdown projects in LaMP 2004 Biennial Report.	OMOE to complete report on 12 Mile Creek; determine & implement remedial action plans for 12 Mile Creek, Etobicoke Creek and Cataraqui River if and where required.

LaMP Activities	Products 2003/2004	Products 2005-2007
Canadian Project Trackdown Part II	2003 - OMOE/EC to review previously identified tributaries to determine if trackdown is warranted. 2003-2004 OMOE/EC to identify funding sources, plan & initiate trackdown projects on identified tributaries. 2004 - OMOE/EC to identify additional priority watersheds where trackdown is warranted.	2005- OMOE/EC to proceed with identified tributary trackdown projects & report on findings. OMOE/EC to plan additional trackdown work within identified priority watershed areas.
Canadian Tributary Screening level survey of sediment quality.	2003/2004 - EC to complete analyses of sediment samples in tributary mouths for chemicals of concern. Data will assist with identification of additional priority sites for follow-up work.	EC to report results of screening and begin trackdown work, if indicated. EC to begin work on additional identified priority watersheds. LaMP to synthesize results & report in LaMP 2006 Biennial Report.
4. Reduction Strategies		
a. Regulatory and voluntary actions		
Regulatory actions	LaMP to facilitate & coordinate transfer of information from 4 Parties to appropriate enforcement, regulatory & remedial action branches of EC, OMOE, EPA & DEC. LaMP to report actions & progress in LaMP 2004 Biennial Report.	LaMP to liaise with enforcement & regulatory actions in the Lake Ontario basin.
Voluntary actions	LaMP to coordinate with Binational Toxics Strategy and EPA, EC, OMOE & DEC hazardous waste minimization & pollution prevention programs to encourage action on sources polluting Lake Ontario.	LaMP to encourage appropriate partners to determine a strategy to reduce the sources & assist partners to implement the strategy.
Promotion of pollution prevention programs	LaMP to identify existing grants & programs; develop a strategy for promotion of pollution prevention programs. LaMP to facilitate partnerships between stakeholder groups for promoting pollution prevention.	LaMP to continue to promote pollution prevention strategies and programs through partnerships.

LaMP Activities	Products 2003/2004	Products 2005-2007
b. Mass balance model		
Develop plan for independent peer review	2003- EPA to make hydrodynamic modifications to LOTOX2; develop charge for peer review; hold workshop for peer review panel; conduct peer review.	
Develop scenarios to assess management options	4 Parties to develop scenarios to assess management options	
Develop plan for Binational management oversight		LaMP to evaluate results and determine how the model can be used as a predictive tool in various management scenarios.
Evaluate application of the model for PCB load reduction activities.		Both US & Canada to review & evaluate applying the model for PCB load reduction activities, consistent with regulations/framework of each country.
Integrate new data into model		EPA to integrate new data from cooperative monitoring into the mass balance model.
B. Physical/biological		
1. Goals, objectives and targets		
a. Update adopted ecosystem indicators and consider additional indicators and targets for physical and biological objectives as information becomes available.		
Mink and otter indicator	2003- LaMP to publish summary on mink/otter population assessment in LaMP Update 2003. 2004- LaMP to publish full report on mink/otter populations in LaMP 2004 Biennial Report.	LaMP to continue the collection & analysis of harvest statistics on mink/otter as required.
Bald eagle indicator	LaMP will engage partners to develop an approach to evaluate existing habitat information with an aim of identifying important habitats to be considered for specific conservation or restoration activities. Specific activities may include an update of an earlier bald eagle nesting habitat assessment and the development of specific recommendations regarding these nesting habitats.	LaMP to encourage partnerships to conserve & restore identified bald eagle habitat areas & to develop new nesting sites.

LaMP Activities	Products 2003/2004	Products 2005-2007
b. Evaluate information to complete assessment of beneficial use impairments.		
Benthos and phytoplankton	2003- LaMP to facilitate & coordinate monitoring of lower food web lakewide by 4 Parties and partners, and data analyses. 2004- LaMP to facilitate the writing of a synthesis report on findings.	LaMP to re-assess status of beneficial use impairments & take action on results of assessment. LaMP to obtain additional input from stakeholders & public, as necessary.
2. Problem identification		
a. Habitat assessment		
Canadian habitat assessment and Watershed Management.	Cdn LaMP partners to identify & promote watershed management strategies in conjunction with Conservation Authorities, OMNR and other agencies; Cdn LaMP partners to liaise with OMNR to obtain information on COA funded activities related to habitat issues.	Cdn LaMP partners to establish partnerships between stakeholders to assist municipalities with the implementation of watershed management strategies.
US habitat assessment, strategy and actions.	US LaMP partners to develop a habitat inventory and build a framework for habitat strategy. US LaMP partners to liaise with Great Lakes Gap Analysis Project Group and assist in formulating products, strategies & actions to promote conservation of Great Lakes islands & coastal nearshore habitats. US LaMP partners to liaise with partners in establishing a community based regional network in order to develop & implement a program to protect & restore coastal wetlands.	US LaMP partners to develop habitat gap analysis and targeted future actions.
Establish value added linkages to International Joint Commission's water level study.	LaMP to maintain relationships with technical workgroups for information exchange and coordinated public outreach where warranted.	LaMP to integrate new technical data & information into LaMP reports, where applicable.
Work with Great Lakes Fishery Commission's Lake Ontario Committee to identify priority projects & investigations; develop common indicators.	2003 -LaMP to participate with the Lake Ontario Committee in their Lake Ontario Conference 2003/2004 -Participate in development of Lake Ontario Committee ecosystem objectives & revised Fish Community objectives for Lake Ontario	Continue to partner, share information with Great Lakes Fishery Commission and the Lake Ontario Committee.

LaMP Activities	Products 2003/2004	Products 2005-2007
b. Human Health Issues	LaMP to maintain connection with the Binational Great Lakes Human Health Network. LaMP to work with Network to gather/exchange information pertaining to human health.	LaMP to continue awareness of human health concerns in the basin and connection with Binational Human Health Network.
	Cdn LaMP partners to liaise with the Human Health Network, and/or Human Health agencies, to gather/exchange information on current & emerging human health issues of relevance to the LaMP. Cdn LaMP partners to identify actions & address current & emerging human health issues of relevance to the LaMP & make that information available to the public.	Cdn LaMP partners, in association with human health organizations, will continue to promote human & ecosystem health within the Lake Ontario basin & will disseminate information on the human health impacts of environmental contaminants.
c. Emerging Issues	LaMP to facilitate & promote collection of information on emerging issues. LaMP to assess available information & research and recommend appropriate management options & strategies where necessary.	LaMP to continue awareness of emerging issues in the basin.
d. Invasive species	2003- LaMP to facilitate & coordinate collection of data on effects of zebra/quagga mussels on lower food web. 2003-2004 LaMP to assess available information & research on invasive species and recommend appropriate management options & strategies where necessary.	LaMP to work with appropriate agencies to promote the prevention of future introductions of exotic species by raising awareness of the problems and the need to take action.
C. Public Outreach, Consultation, Reporting and Communicating		
1. Promote Partnerships	2003- LaMP to partner with Lake Ontario Committee for their Lake Ontario Conference; provide LaMP information, display; public outreach materials. Continue partnership with the IJC water levels study.	LaMP to work with other agencies as appropriate
2. Promote stewardship	LaMP to develop a strategy for more proactive promotion of stewardship; identify community-based actions & partnerships.	LaMP to continue implementation.

LaMP Activities	Products 2003/2004	Products 2005-2007
3. Maintain information connection	LaMP to work with binational committee to migrate the LaMP site to binational.net. LaMP to update & maintain Lake Ontario website. LaMP to review mailing list. LaMP to encourage other GL and non-governmental organizations to add links from their websites to Lake Ontario website.	LaMP to continue to update websites and the network of interested groups.
Information and data transfer	LaMP to submit data for inclusion into other databases, such as the IJC database. LaMP to promote information exchange and the availability of data for the public and stakeholders.	LaMP to continue to promote information & data transfer.
4. Binational Lake Ontario Meetings	LaMP to convene binational meetings as necessary to meet specific objectives.	LaMP to convene binational meetings as necessary.
5. Annual Reports	LaMP to publish LaMP Update 2003 and LaMP Biennial Report 2004	LaMP to publish Updates 2005 & 2007 and LaMP Biennial Report 2006
6. Annual meeting	LaMP to hold joint Lake Ontario/Niagara River Toxics Management Plan (NRTMP) public meetings in 2003 & 2004	LaMP to hold joint Lake Ontario/Niagara River Toxics Management Plan (NRTMP) public meetings in 2005, 2006 & 2007
7. SOLEC/IJC Meetings	LaMP to participate in IJC meeting in 2003 and SOLEC 2004	LaMP to participate in IJC meetings in 2005 and 2007 and SOLEC 2006
8. Public Outreach Strategy Review	LaMP to implement revised public involvement strategy.	LaMP to assess results of strategy implementation & revise accordingly.