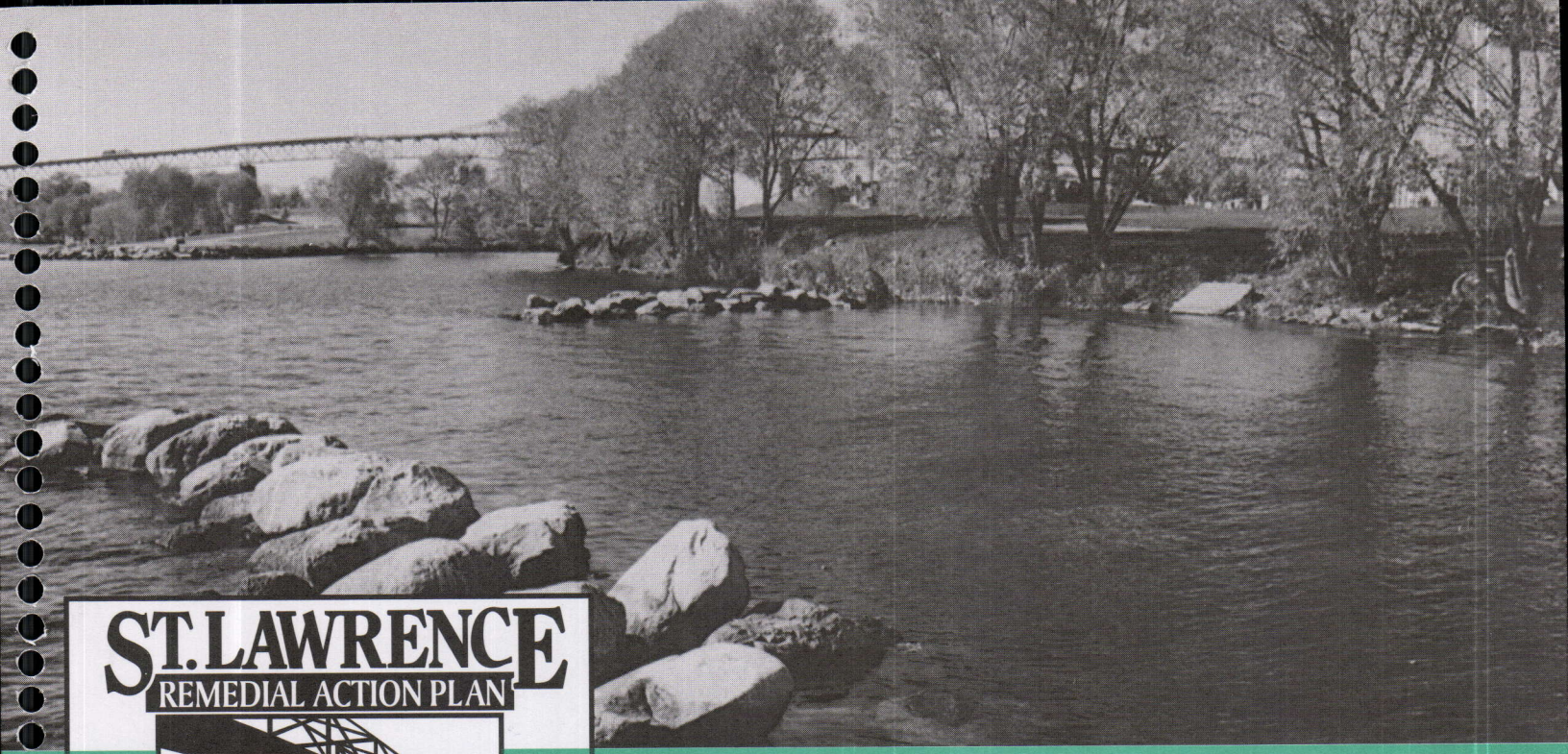

ST. LAWRENCE
REMEDIAL ACTION PLAN

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ST~LAURENT

Great Lakes, Great River

Remedial Action Plan for the St. Lawrence River (Cornwall) Area of Concern Stage 2 Report

November 1997

Great Lakes, Great River

Remedial Action Plan for
St. Lawrence River (Cornwall) Area of Concern
Stage 2 Report: The Recommended Plan

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The St. Lawrence River (Cornwall) Remedial Action Plan
Public Advisory Committee

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ST. LAWRENCE RIVER (CORNWALL) RAP STAGE 2 REPORT

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1. INTRODUCTION

This report is the Stage 2 submission of the St. Lawrence River (Cornwall-Lake St. Francis) Remedial Action Plan (RAP), in accordance with the Canada-Ontario commitment to the Great Lakes Water Quality Agreement.

Two RAPs, one Canadian and one American, are being developed for the Cornwall/Massena stretch of the St. Lawrence River, and this report concerns the activities of the Canadian RAP.

Sixty-four remedial actions for the St. Lawrence River AOC (the Canadian portion of the Cornwall-Lake St. Francis section of the St. Lawrence River shown in Figure 1) have been selected through a process of extensive consultation with the public. This Stage 2 Report discusses why the remedial measures were selected and how they will be implemented. It is a RAP Team and Public Advisory Committee document (discussed below) and does not necessarily reflect the opinion of government agencies.

Please note that, unless otherwise specified, in this report the terms St. Lawrence River RAP, St. Lawrence River AOC and the AOC refer to the Canadian portion of the stretch of the St. Lawrence River between the Moses-Saunders Power Dam and Valleyfield, Quebec.

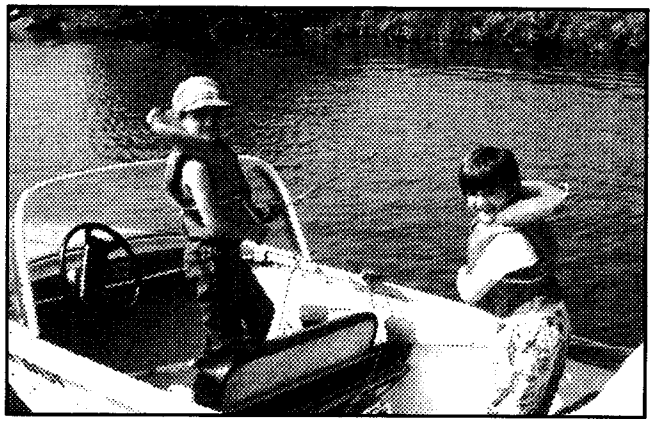
1.1 History of RAP Development

Boundary Waters Treaty

In 1909, Canada and the United States signed the *Boundary Waters Treaty*, recognizing a shared responsibility for water and related issues along their common borders. This established the International Joint Commission (IJC), an independent advisory body with equal representation from each country. The IJC continues to advise the governments of Canada and the US on matters pertaining to environmental quality in boundary waters including the Great Lakes.

Great Lakes Water Quality Agreement

Urged by the IJC for commitment and action to solve increasing water quality problems in the Great Lakes, in 1972 the governments of the two nations signed the first *Great Lakes Water Quality Agreement* (GLWQA) to protect and clean up the Great Lakes. The GLWQA was initially designed to address the problem of phosphorus pollution and associated eutrophication, which was of great concern in the 1960s and 70s. The Agreement was revised in 1978 to include management of toxic discharges to the Great Lakes and to formally adopt a holistic, ecosystem approach towards Great Lakes research, planning and management. In 1987, the GLWQA was amended to include a commitment by each nation to address problems in the most polluted areas around the Great Lakes through a number of programs, including Remedial Action Plans.



Fishing on the St. Lawrence River

In the 1970s, the IJC had identified 42 "areas of concern" (AOCs) in the Great Lakes at locations where the aquatic environment was most severely damaged. Seventeen AOCs are located in Canada, five of them on boundary rivers shared by the US and Canada. The remaining 25 AOCs are in the US. In 1985, the IJC's Great Lakes Water Quality Board recommended that a Remedial Action Plan (RAP) be developed and implemented for each area of concern. The approach to be used for

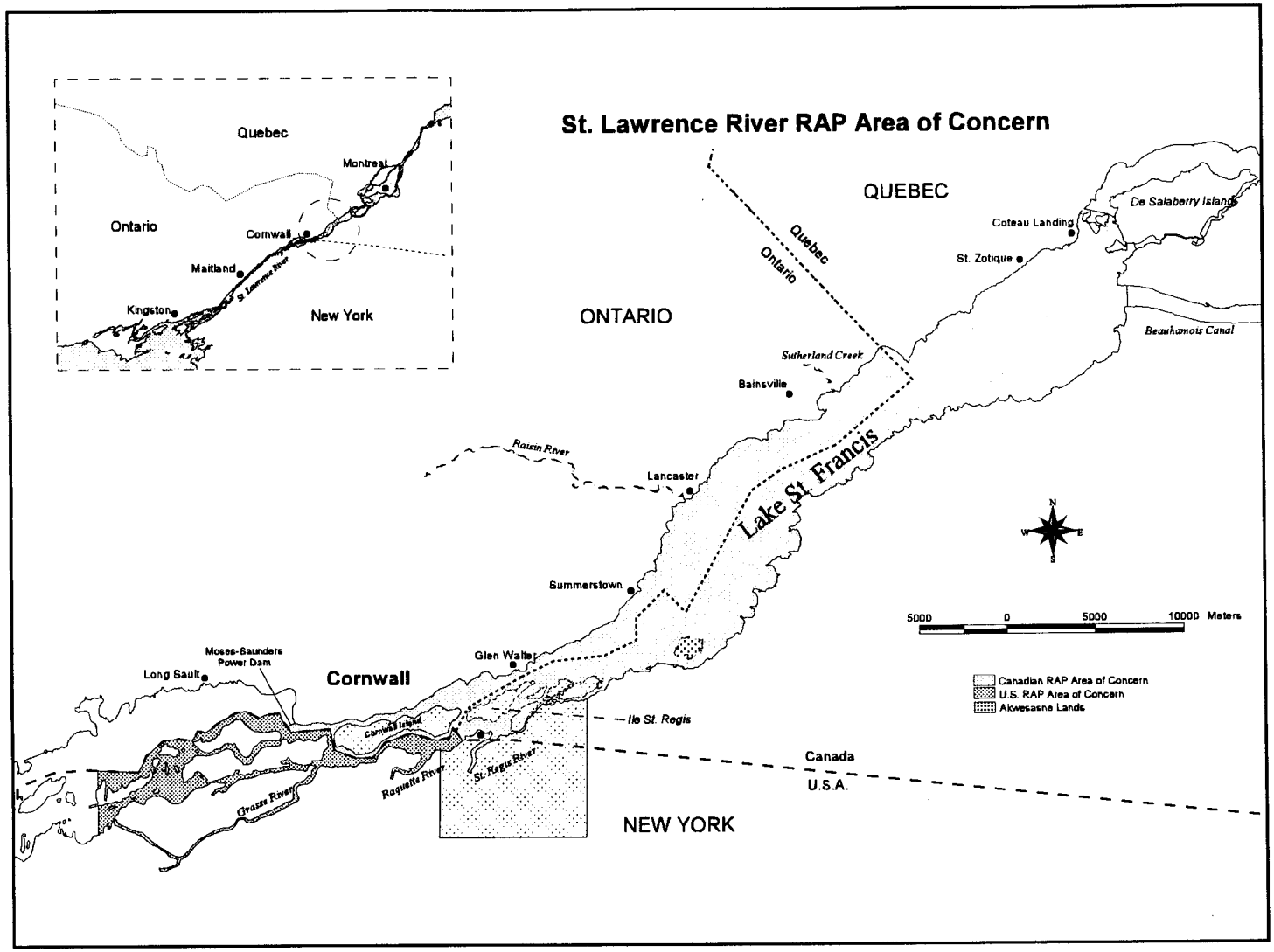


Figure 1: St. Lawrence River RAP Area of Concern.

carrying out a RAP–described below–was included as Annex 2 in the 1987 amended *Great Lakes Water Quality Agreement*. Since 1987 one AOC has been added and another (Collingwood, Ontario) taken off the list.

Canada-Ontario Agreement (COA) Respecting the Great Lakes Basin Ecosystem

Within Canada, Great Lakes water quality is a shared federal/provincial responsibility, and in 1971 Canada and Ontario signed the first *Canada-Ontario Agreement* (COA) *Respecting Great Lakes Water Quality*. This was done mainly to control discharges of phosphorus in municipal sewage as a way of implementing the first *Great Lakes Water Quality Agreement* then being negotiated by Canada and the US. COA has been renegotiated approximately every five years since 1971 and its focus has broadened to include toxic contaminants and urban and agricultural runoff. On July 6, 1994 a new *Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem* was signed (Canada and United States 1987). It provides a comprehensive set of specific environmental goals to be achieved in the Great Lakes-St. Lawrence Basin by the year 2000. Many of the goals apply to RAP Areas of Concern.

The following federal and provincial agencies are signatories to the 1994 Canada-Ontario Agreement:

Federal Agencies
- Environment Canada
- Department of Fisheries & Oceans
- Agriculture Canada
- Health Canada

Provincial Ministries
- Environment & Energy
- Natural Resources
- Agriculture, Food & Rural Affairs

Appendices II and III of this report highlight linkages of Cornwall RAP Recommendations with COA (1994) targets and Cornwall RAP/PAC Goals.

1.2 Basic Components of a RAP

Restoration of beneficial uses

RAPs are designed to restore the beneficial uses of aquatic ecosystems at each AOC. Annex 2 of the GLWQA lists the following fourteen "impairments of beneficial use" which could be caused by "a change in the chemical, physical or biological integrity of the Great Lakes System". (Boldface type indicates a use that has been identified as impaired in the St. Lawrence River AOC; italics indicate that more research is required to determine whether or not the beneficial use is impaired.)

- **restrictions on fish and wildlife consumption**
- tainting of fish and wildlife flavour
- **degradation of fish and wildlife populations**
- *fish tumours or other deformities*
- *bird or [other] animal deformities or reproduction problems*
- **degradation of benthos**
- **restrictions on dredging activities**
- **eutrophication or undesirable algae**
- restrictions on drinking water consumption, or taste and odour problems
- **beach closures**
- degradation of aesthetics
- added costs to agriculture and industry
- *degradation of phytoplankton and zooplankton populations*
- **loss of fish and wildlife habitat**

A RAP is considered "delisted" (no longer listed as an AOC) when there are no longer any impaired beneficial uses in the AOC. It is recognized that in reality it will not be possible to restore all beneficial uses completely in every AOC, because human settlement and industrialization have in some cases permanently altered the nature of the environment. In order to determine when an AOC can be delisted, each RAP develops a set of "delisting criteria". These are measurable environmental conditions that must be met for each beneficial use in order to conclude that the use has been restored. Delisting criteria for the St. Lawrence River AOC are discussed in Chapter 9.

Ecosystem approach

The GLWQA states that RAPs "shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in Areas of Concern" (Canada and United States 1987). This means approaching every decision about the environment in a manner that considers the potential direct and indirect effects of actions (or inaction) on all parts of the environment (land, water, air, plants and animals including humans). It is crucial to recognize that the ecosystem is a complex and dynamic network of interconnected components, living and non-living, and the state of one component always affects the condition of others. The Mohawk philosophy of everything being connected to everything else reflects this approach.

Great Blue Heron

Public involvement in environmental decision-making

A key part of every RAP is the involvement of citizens in decisions regarding their local environment. Humans are part of the ecosystem: they affect the ecosystem and changes to the ecosystem affect them. Decisions about the environment in a given AOC have a great impact on the local residents in terms of health, aesthetics and socioeconomic factors. Public Advisory Committees (PACs) were therefore formed in most AOCs (2 exceptions). A wide range of local "stakeholders" were represented on the PAC (*i.e.*, any interested local residents, including representatives from industry, academia, agriculture, tourism, hunting and fishing associations, local municipal governments and conservation authorities, teachers, members of environmental groups etc.). The local PAC works in conjunction with representatives from provincial and federal government agencies to complete the RAP, with ongoing efforts made to involve the wider public (non-PAC members). Chapter 3 describes public involvement in the St. Lawrence River RAP in detail.

Three stages of a RAP

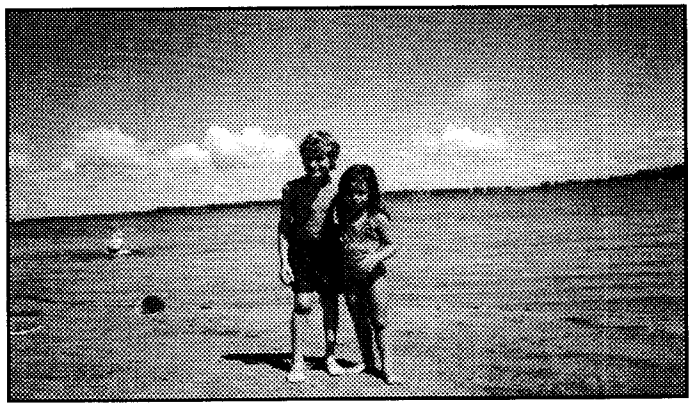
The GLWQA requires that, for each RAP, a formal report be submitted to the IJC for review and comment at three stages:
Stage 1: when a definition and description of the environmental problems and impaired beneficial uses in the AOC has been completed;
Stage 2: when remedial measures and implementation plans have been selected; and
Stage 3: when monitoring indicates that beneficial uses have been restored.

1.3 Contents and Purpose of This Report

This Stage 2 Report of the St. Lawrence River RAP discusses the remedial measures that were selected to restore the beneficial uses in the St. Lawrence River AOC and presents a detailed plan for implementing those measures.

1.4 Future Documentation

Prior to the Stage 3 Report it is anticipated that additional data will be made available in the form of data updates, monitoring reports and scientific papers. Opportunities are being explored for internet access to information about the progress of the St. Lawrence River RAP.



2. DESCRIPTION OF THE AREA OF CONCERN

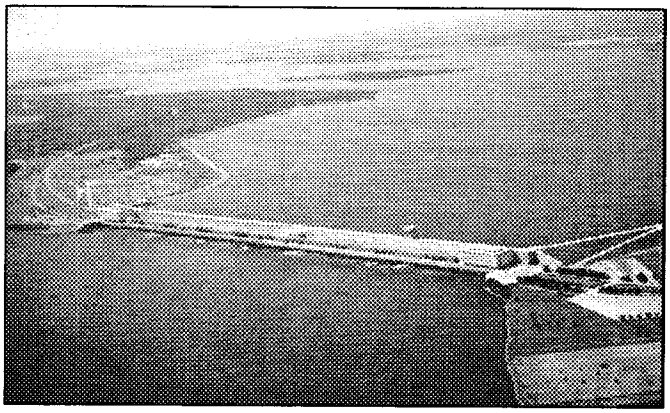
2.1 Physical Description

The St. Lawrence River RAP Area of Concern (AOC) (Figure 1) includes a stretch of the St. Lawrence River approximately eighty kilometres long, from the Moses-Saunders power dam (just upstream of Cornwall) downstream to the eastern outlet of Lake St. Francis in Quebec. The AOC includes waters shared by the United States, Canada and the Mohawks of Akwesasne.

The Moses-Saunders Dam, a binational facility at the western boundary of the AOC, is used to control water levels in Lake Ontario and to provide hydroelectricity. Construction and operation of the dam in 1954-1959 flooded the Long Sault Rapids, creating Lake St. Lawrence immediately upstream of the dam.

At Cornwall, below Lake St. Lawrence and the Moses-Saunders Dam, the St. Lawrence River divides into a north and south channel separated by Cornwall Island and Ile St. Regis–two large islands belonging to the Mohawks of Akwesasne. The north and south channels carry approximately one-third and two-thirds, respectively, of the total flow (7657.2 m^3/sec, ten year average 1985-1995) in this section of the river. Current speed ranges from 1.5 to 3.1 m/sec (St. Lawrence River Committee on Gauging 1985-1995).

In the eastern part of the AOC the St. Lawrence widens into an area that local residents refer to as Lake St. Francis. This large, shallow, slow-moving stretch of the river has water control structures including the Beauharnois Dam at its downstream end. In this document, the term "Lake St. Francis" refers to the entire stretch of the St. Lawrence River from the Moses-Saunders Power Dam to Valleyfield, Quebec. The eastern part of the AOC consists of a stretch approximately 57 km long and 1-7 km wide, with a mean depth of 5.5 m (maximum 22 m) and a turnover time of 2.3 days (M. Eckersley, MNR, unpublished data). By agreement, Quebec and Ontario authorities maintain water levels in the lake within strict limits (± 30 cm). The St. Lawrence Seaway Authority maintains a shipping channel in the central part of the lake by limited dredging at the Lancaster Bar. The current of the St. Lawrence River slows significantly in Lake St. Francis, especially outside of the shipping channel, where the lake is shallow and aquatic plants are abundant.



Moses-Saunders Power Dam

Most of the water in Lake St. Francis is from Lake Ontario; less than 5% of the flow is from tributaries to Lake St. Francis (St. Lawrence RAP Team 1992). The major tributaries to the Cornwall-Massena section of the St. Lawrence (the Grasse, Raquette and St. Regis Rivers) are located on the south side of the river in New York State. Tributaries on the Canadian side include the Raisin River, Fraser, Westley's, MacIntosh, Sutherland, Gunn and Wood Creeks as well as the Oliver-Magee Drain and Grays Creek.

The watershed of the Ontario tributaries in the AOC is referred to hereafter as the AOC watershed. The AOC watershed is defined as the area drained by all tributaries that flow directly into the Ontario portion of the AOC, as well as the Ontario portion of the drainage basins of the Delisle and Beaudette Rivers (which flow through Ontario then Quebec into Lake St. Francis).

The largest communities in the AOC are Cornwall, Ontario and Massena, New York, with populations of 47,137 (Diogo and Jeena 1995) and approximately 15,000 (NYSDEC 1990),

respectively. Municipalities within the AOC are listed in the next section of this chapter. Urban areas account for less than 5% of the area of concern; the remainder is either woodland (about one-third of the total area) or agricultural lands (57% of the total area). The area east of Cornwall is largely agricultural, supporting mainly dairy farming, corn, grain and hay production (St. Lawrence RAP Team 1992). For a socioeconomic profile of the AOC please see Diogo and Jeena (1995) and St. Lawrence RAP Team (1992).

2.2 Jurisdictions in the AOC

The AOC consists of land presided over by two federal governments (Canada and the US); Aboriginal governments (Mohawk Governments of the Akwesasne); two provincial governments (Ontario and Quebec); one state government (New York State); and, in the Ontario portion, four municipal governments border the St. Lawrence River (City of Cornwall, Township of Charlottenburgh, Township of Lancaster, Village of Lancaster). The Town of Alexandria and the Townships of Cornwall, Kenyon, Lochiel, Osnabruck and Roxborough are part of the AOC tributary watershed.

Although Canada and the US share the St. Lawrence River waters within the AOC, two separate RAPs are being developed: the St. Lawrence River (Cornwall) RAP in Ontario, Canada and the St. Lawrence River (Massena) RAP in New York State, USA. Mechanisms of cooperation between New York State and Canada are formally set out in a Memorandum of Understanding signed by both parties in 1988. A binational statement on goals and environmental problems for the Cornwall-Massena AOC was released by the governments of Canada, Ontario, US and New York State in 1996 (Environment Canada *et al.* 1994).

The Cornwall RAP is administered jointly by the federal and provincial governments of Canada and Ontario, under the *Canada/Ontario Agreement Respecting the Great Lakes Basin Ecosystem* (COA). The Massena RAP is administered by the New York State Department of Environmental Conservation (NYSDEC). In June 1993, the IJC approved the Stage 1 reports of both the Massena RAP and the Cornwall RAP. This report is the Stage 2 Report of the Cornwall RAP, to be submitted to the IJC. The Massena RAP Stage 2 Report was submitted to the IJC by NYSDEC in 1991 concurrently with their Stage 1 Report.

2.3 Impaired Uses

The International Joint Commission identified fourteen possible beneficial uses of water, as listed in the Great Lakes Water Quality Agreement. Many of these uses are impaired to some degree in the St. Lawrence River (Cornwall) AOC. Table 1 outlines the status of beneficial use impairments in the AOC.

2.4 Environmental Issues in the AOC

Seven major environmental issues of concern in the Cornwall/Massena section of the St. Lawrence River were identified in the Stage 1 Report of the Cornwall RAP:

- mercury contamination
- PCB contamination
- presence of other contaminants
- bacterial (fecal) contamination
- habitat destruction and degradation
- excessive growth of nuisance aquatic plants
- exotic species

Since the Stage 1 Report was released, fish and wildlife health problems related to contaminants have emerged as an eighth issue.

During Stage 2 of the RAP, the PAC and RAP Team examined over two hundred options for restoring the impaired beneficial uses associated with each of the seven environmental issues. Chapter 5 examines environmental problems and their causes for each of the seven major issues in the area of concern. Recommended remedial measures and remedial actions completed or in progress are discussed in Chapters 6 and 7. Options that were rejected during selection of the sixty-four recommended remedial measures are listed in Appendix I.

For more detailed information about environmental conditions in the AOC please refer to the Stage 1 Report of the Cornwall RAP (St. Lawrence RAP Team 1992), the Stage 1 Addendum (St. Lawrence RAP Team 1994) and other data reports referenced in this Stage 2 Report. For information about rejected remedial options please see Appendix I.

Table 1. Impairments of Beneficial Use in the St. Lawrence River (Cornwall) Area of Concern

IMPAIRMENT OF BENEFICIAL USE	STATUS IN AOC	REASON FOR IMPAIRMENT
Restrictions on fish & wildlife consumption	**Impaired**	. Mercury from Cornwall and other sources . PCBs from Massena and other sources
Tainting of fish & wildlife flavour	Not Impaired	
Degradation of fish & wildlife populations	**Impaired**	. Seaway & dam construction . Fishery exploitation . Loss of habitat due to development along shoreline & in wetlands . Possible contaminant impacts
Fish tumours or other deformities	* Possibly impaired	. Studies under way
Bird or [other] animal deformities or reproduction problems	* Possibly impaired	. Studies in Cornwall AOC under way; mudpupp deformities reported in Massena and Cornwall AOCs.
Degradation of benthos	**Impaired**	. Contaminant uptake possible (metals, organic compounds) . Loss of benthic habitat
Restrictions on dredging activities	**Impaired**	. Toxic contaminants (metals, oils & greases, PCBs)
Eutrophication or undesirable algae	**Impaired**	. Impaired in tributaries; unimpaired in St. Lawrence R. . Excess nutrients from municipal and rural sources
Restrictions on drinking water consumption, or taste & odour problems	Not impaired	
Beach closings / Water contact sports	**Impaired**	. Bacteria from municipal and rural sources
Degradation of aesthetics	Not impaired	. Originally listed as impaired because of odours from effluent (Domtar) in ambient water and odours from dead weed masses rotting in nearshore areas. . Weed mass problem is a seasonal phenomenon that occurs some years under certain wind conditions. Environmental impacts of large scale removal preclude use of this method to deal with the problem.
Added costs to agriculture or industry	Not impaired	
Degradation of phytoplankton and zooplankton populations	* Possibly impaired	. Undocumented . Zebra mussels could become a problem
Loss of fish & wildlife habitat	**Impaired**	. Seaway & dam construction . Development along shoreline and in wetlands . Habitat modification due to excessive weed growth

* *Possibly impaired*: Further research under way/planned to determine whether beneficial use is impaired in AOC.

2.5 Sources of Contaminants in the AOC

2.5.1 Point Sources

Figure 2 shows the location of major industrial and municipal water intakes and effluent outfalls in the AOC. The major point sources of contaminants in the area of concern are listed in Table 2.

Table 2. Major point sources of contaminants in the Cornwall AOC.

Jurisdiction	Type	Source	Comments
Canada	Industrial	Domtar Papers	• Kraft pulp mill & paper manufacturer • opened 1881
		ICI Canada Inc.	• inorganic & organic chemical manufacturer
		ICI Canada (Conpak)	• chemical packaging plant
		ICI Forest Products (formerly CIL)	• mercury cell process chlor-alkali plant • operated 1935-1995
		Cornwall Chemicals	• organic & inorganic chemical manufacturer • closed 1995
		Courtaulds Fibres	• rayon manufacturer • operated 1925-1992
	Municipal	Cornwall WPCP	• municipal sewage treatment plant
		Lancaster WPCP	• municipal sewage treatment plant
		Charlottenburgh WPCP (Glen Walter)	• municipal sewage treatment plant
United States	Industrial	ALCOA	• aluminum smelter and fabrication • opened 1903
		Reynolds Metals Co.	• aluminum smelter and fabrication • opened 1958
		GM Powertrain Division	• aluminum car parts manufacturer • opened 1959
	Municipal	Massena STP	• municipal sewage treatment plant
Mohawks of Akwesasne	Municipal	St. Regis STP	• municipal sewage treatment plant

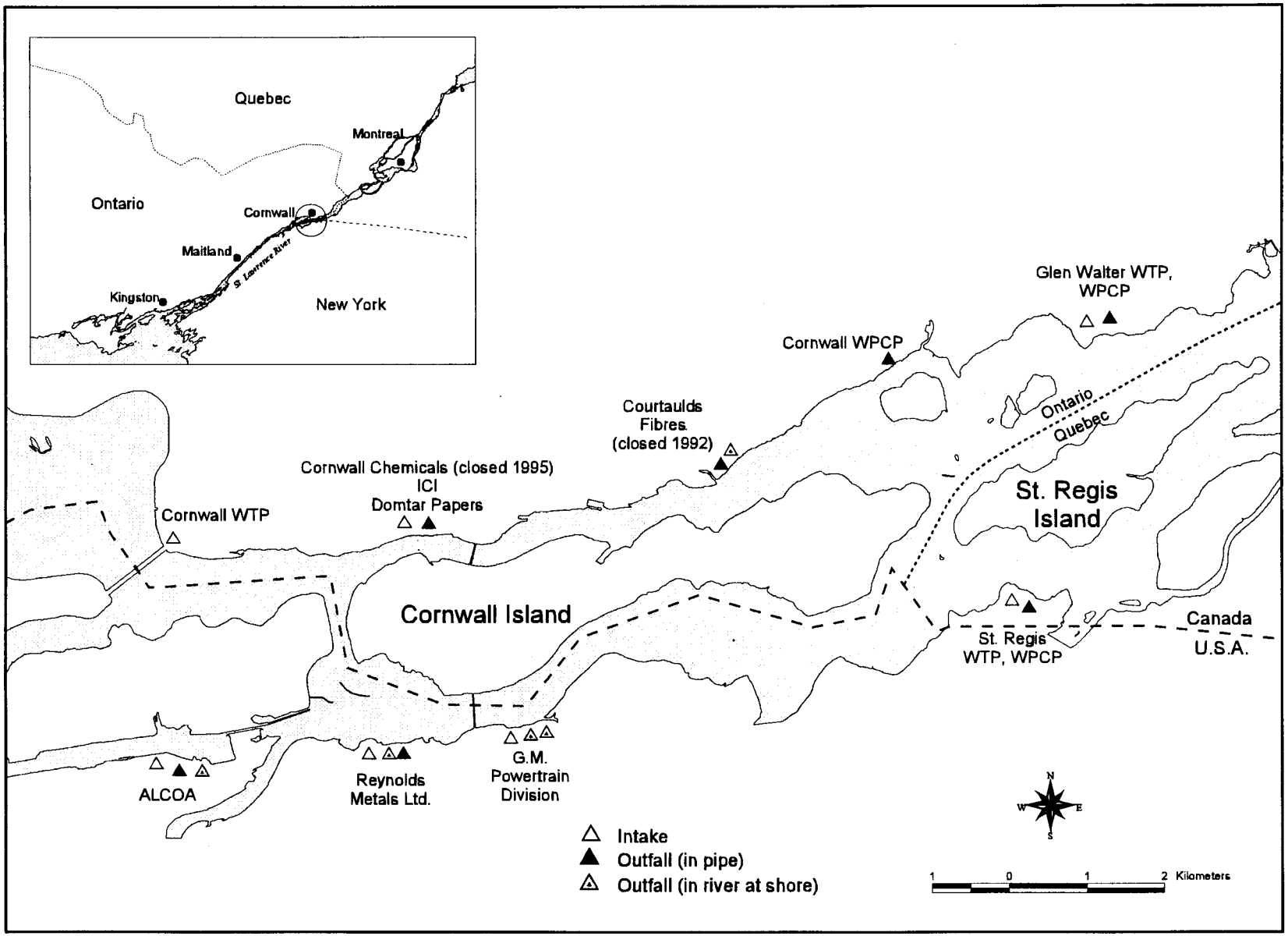


Figure 2: Location of major industrial and municipal intakes and outfalls in St. Lawrence River (Cornwall) RAP Area of Concern.

2.5.2 Non-point Sources

Contaminants also enter the AOC from the following non-point sources:

- upstream inputs from the Great Lakes basin and the upper St. Lawrence River
- agricultural and municipal inputs from the AOC watershed
- urban runoff from the City of Cornwall
- atmospheric emissions from Cornwall and Massena industries
- long range transport of airborne pollutants

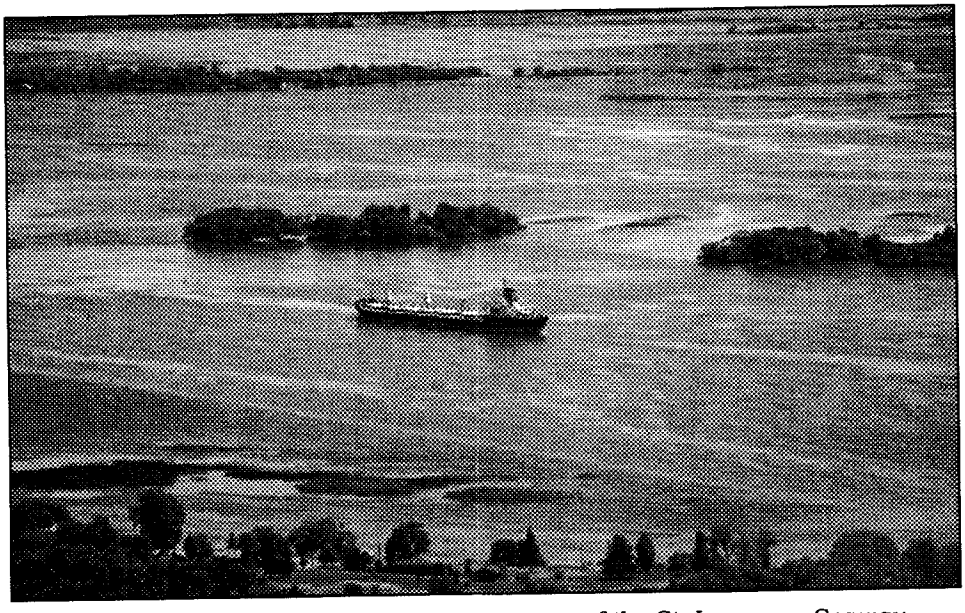
2.6 St. Lawrence Seaway Construction

In addition to present-day sources of contamination, historical events have severely affected the Cornwall-Lake St. Francis section of the St. Lawrence River. In particular, the development of the St. Lawrence Seaway (1954-1959) vastly altered the morphometry and hydrology of the river upstream of Cornwall. Construction of the Moses-Saunders power dam at Cornwall and the Long Sault and Iroquois control dams resulted in the formation of Lake St. Lawrence. This eliminated 40 km of rapids at Long Sault and inundated extensive areas of land as far upstream as Iroquois (Owen and Veal 1968). Major water control structures in the St. Lawrence River AOC are shown in Figure 3.

Downstream of Cornwall, the hydrology of Lake St. Francis has been considerably altered by human activities. The hydrological history of Lake St. Francis is complicated and has been summarized by Morin *et al.* (1994). In the late 1700s and the 1800s a series of canals and lock systems was constructed at Cornwall and at the eastern end of Lake St. Francis. However none of these impounded the St. Lawrence, they merely allowed shipping traffic to bypass large rapids.

The construction of the Beauharnois canal (1929-1932) still allowed the river to flow unimpeded through the channel north of Ile de Salaberry. It was not until 1942, with the completion of the fourth Coteau dam in this channel, that Lake St. Francis was finally impounded. The mean annual water levels and fluctuations considered to be natural (taken at Coteau Landing) show that before 1942, annual water levels were 46.03 m above sea level and annual fluctuations were 60 cm. After 1942 and before 1959, the mean annual water level increased by 32 cm to 46.35 m and the mean water level fluctuation was 50 cm.

With the construction of the dam at Cornwall and excavation of the Seaway, the mean annual water level remained at 46.35 m but the mean annual fluctuation was reduced to 15 cm at Coteau-Landing and approximately 30 cm in Lake St. Francis.



Ocean-going ship in the Lake St. Francis section of the St. Lawrence Seaway

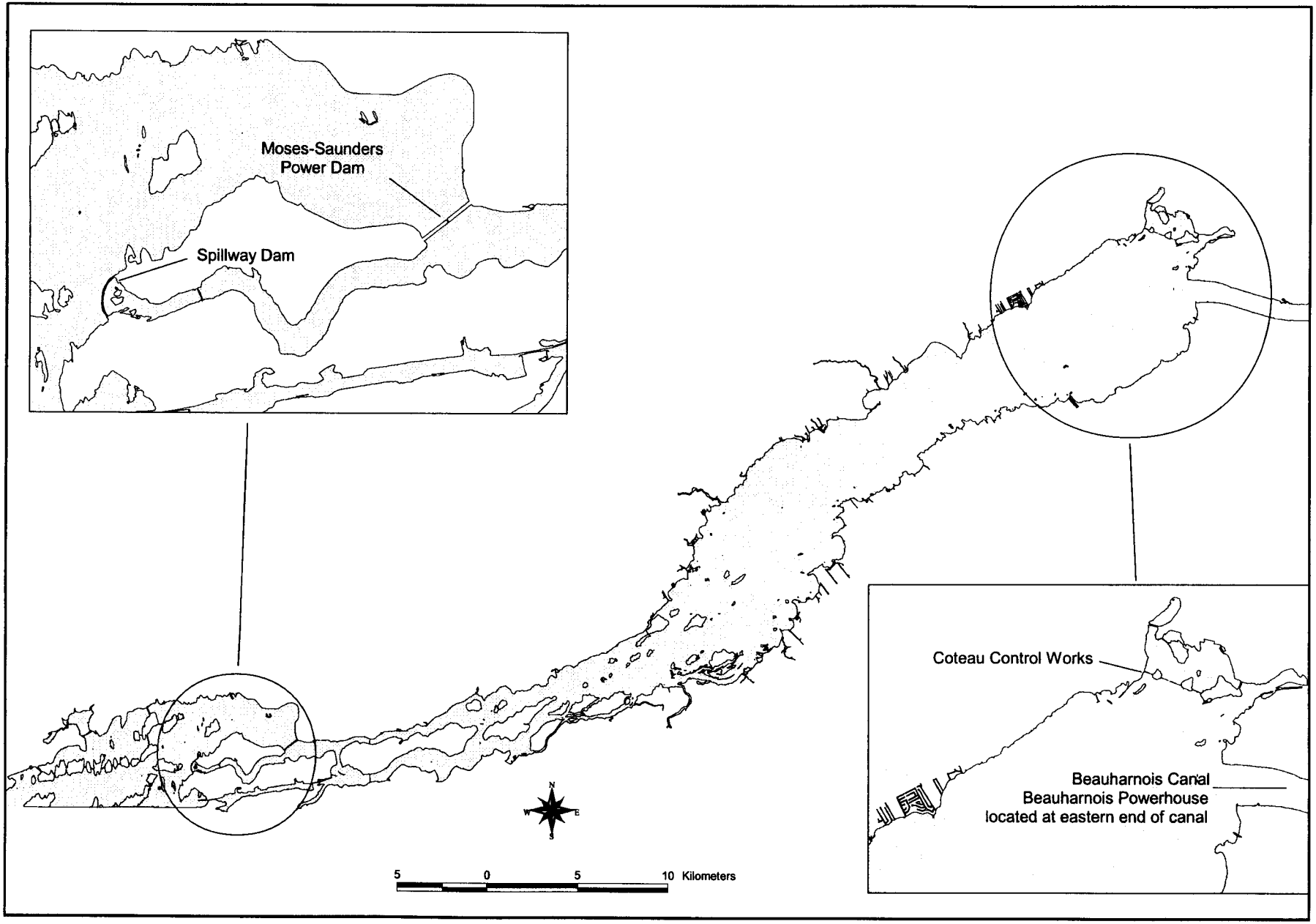
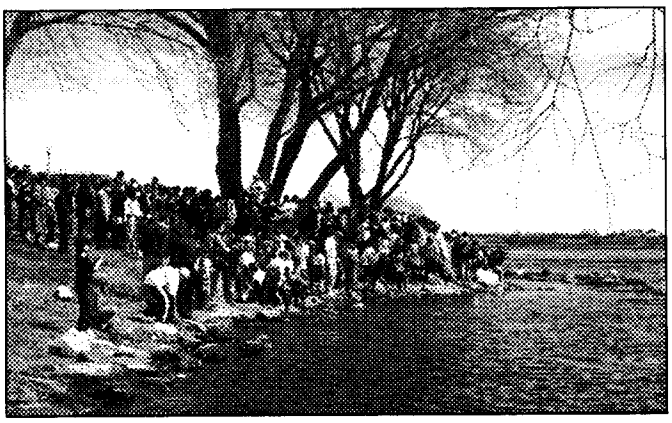


Figure 3: Major water control structures in the St. Lawrence River (Cornwall) RAP Area of Concern.

3. PUBLIC INVOLVEMENT IN DECISION MAKING



Pebble Drop - community support habitat projects

The St. Lawrence River (Cornwall) RAP was initiated in 1986 and has been developed by Environment Canada, the Ontario Ministry of Environment & Energy (MOEE), the Ontario Ministry of Natural Resources (MNR) and the Mohawk Governments of Akwesasne in conjunction with the St. Lawrence River Public Advisory Committee (PAC).

A RAP Team consisting of representatives from Environment Canada, MOEE, MNR and the Mohawk Governments of Akwesasne provides technical expertise and agency input. A Public Advisory Committee (PAC) provides ongoing public input to the RAP process. The RAP Team meets as required (approximately every two months) to work on various aspects of the RAP, with a PAC representative (either the PAC Facilitator or PAC Chair) participating in the meetings. A list of RAP Team members and their agency affiliations is provided at the end of this chapter.

The PAC meets monthly except during July, August and December. Its three subcommittees–the Technical Subcommittee, the Remedial Options Review Committee (RORC) and the Public Outreach Committee (POC)–meet as frequently as required. The structure of the public involvement program stayed essentially the same during Stage 1 and Stage 2 of the Cornwall RAP with individual committees meeting more or less frequently as the project progressed. PAC members who participated in PAC meetings from August 1992 to 1996 (*i.e.*, during Stage 2 of the RAP) are listed at the end of this chapter.

During Stage 2, the RORC undertook a detailed consideration of over two hundred potential remedial options. The RORC met often with RAP Team members in 1992-1993 to examine seven options tables option by option (one table of options for each of the seven environmental issues). After lengthy discussions sometimes lasting for several meetings, the RORC members voted for or against each option. The results of these votes were brought to the larger PAC at their monthly meetings, where the RORC explained which options they favoured and why. The PAC then voted as a whole to accept or reject each option.

After a set of preferred options for cleaning up the river had been agreed upon by the RAP team and the PAC, a document entitled *Choices for Cleanup: Deciding the Future of a Great River* was produced (August 1994) to explain the RAP process, the environmental problems in the St. Lawrence River AOC, and the preferred options for addressing these problems. Seven hundred and fifty English and two hundred and fifty French copies of this report were distributed to interested citizens in the AOC. The document has become an educational tool used by teachers of environmental courses at St. Lawrence Community College in Cornwall and by some highschool teachers in the area.

A meeting was hosted in September 1994 to introduce the preferred options in the *Choices for Cleanup* report to municipal officials within the AOC. A series of three open houses was also organized to introduce the document to the public outside of the PAC. A public meeting was then held to hear public reaction to the recommended options for cleaning up the river. The public was also invited to provide their input by mail or telephone.

The Remedial Options Review Committee (RORC) held four meetings to review all of the public input received. People who had made submissions, either at the public input meeting or by mail, were invited to the RORC meetings.

Submissions regarding the preferred options associated with wetlands were the most contentious received. The RORC met with and wrote to the Minister of Environment and Energy requesting a more flexible approach to the wetlands of the Bainsville Bay-Pointe Mouillee area. This approach was in line with a study undertaken in 1992 by a partnership of MNR, Environment Canada Great Lakes Cleanup Fund, the Raisin Region Conservation Authority (RRCA) and the municipality (Lancaster Township) before the provincial wetlands policy was adopted.

After discussing the public input that had been received, the RORC made recommendations to the PAC (which endorsed them) regarding associated revisions. The RAP preferred options were amended accordingly by the RAP team and approved by the PAC to provide the final set of RAP Recommendations presented in this Stage 2 Report. More detailed information about the remedial options and public involvement will be incorporated into a St. Lawrence River RAP Technical Report.

3.1 Public Input to the St. Lawrence River (Cornwall) RAP

This section offers the PAC's perspective on the process of public involvement in the St. Lawrence River RAP.

The St. Lawrence River Public Advisory Committee (PAC) was established in 1988 following the 1986 formation of a Remedial Action Plan Team of federal and provincial government representatives and representatives of the Mohawks of Akwesasne. The PAC consists of "stakeholders", that is, those with an interest in the Remedial Action Plan for the St. Lawrence River. Stakeholders include representatives from Akwesasne, area municipalities, various industries, Ontario Hydro, organizations such as the Eastern Ontario Health Unit and the Raisin Region Conservation Authority, cottage associations, fish and game associations, agricultural associations, educators, as well as citizens concerned about the river environment.

Some PAC members have been active since the PAC's inception; representation and participation by others has varied with the issues and circumstances. Unfortunately, participation from residents of Akwesasne has not been active recently. PAC members who participated in PAC meetings from November 1992 to 1997 are listed at the end of this chapter.

The entire Public Advisory Committee process has been an exercise in public involvement. PAC members have participated in numerous discussions about data collection and analysis, remedial options and selection of the final set of recommendations for cleaning up the St. Lawrence River AOC. PAC members have met monthly (excepting July, August and December) since the PAC's inception. During the consideration of remedial options there were weekly meetings of subcommittees such as the Remedial Options Review Committee and the Technical Committee. PAC members who have spent many volunteer hours have acquired considerable education in environmental issues as a result, and take seriously their responsibilities in contributing to the RAP for the St. Lawrence River AOC.

The Public Outreach Committee has attempted to inform other citizens within the AOC (who are not PAC members) about the progress of the RAP, by participating in the Cornwall Home & Trade Show and the Boat & Sportsman Show; writing newspaper articles discussing the various problems of pollution in the area; and participating in two videos made in cooperation with the local television station. The POC has developed a display and a slide show and has also produced a series of brochures explaining the various environmental problems of the AOC. The POC is currently producing a series of education kits to be used in AOC schools. Other PAC members have made numerous presentations to various groups and the PAC Chair has made a presentation to secondary school teachers as part of a Professional Development Day program.

The PAC has kept in touch with other groups concerned about the environment, such as the Green Team, the Cornwall Air Quality Association, the St. Lawrence River Institute of Environmental Sciences and the Resource Stewardship Stormont, Dundas & Glengarry (SD & G) Council. PAC and RAP team members participated in conferences held in Cornwall in 1995 and 1996 (Sharing Knowledge, Linking

Sciences: An International Conference on the St. Lawrence Ecosystem) by Ottawa University's Institute for Research on Environment and Economy and the St. Lawrence River Institute of Environmental Sciences. The PAC Chair also took part in an associated secondary school environmental event.

The St. Lawrence River (Cornwall) PAC has kept in touch with the St. Lawrence River (Massena) RAP in the US by having the PAC Chair or an alternate attend Massena RAP meetings. The Massena RAP Coordinator also attends PAC meetings in Cornwall. The PAC (Cornwall) participated in a conference organized by the Valleyfield, Quebec Zones d'Intervention Prioritaire (ZIP) in February 1995.

3.2 St. Lawrence River RAP/PAC Workshops

To date, the St. Lawrence River RAP/PAC has held four workshops:

- IJC Workshop on Remediation of Contaminated Sediments in Areas of Concern (held in cooperation with the Cornwall PAC). September 17-18, 1993. Cornwall, Ontario.
- St. Lawrence Joint Monitoring Workshop. April 28-29, 1992. Massena, New York.
- Technical Workshop on Remedial Options in the Cornwall AOC. March 5-6, 1991. Cornwall, Ontario.
- St. Lawrence RAP Technical Workshop. Gananoque. February 1988.

The PAC and the RAP Team contributed a number of papers and poster presentations at the 1995 and 1996 conferences Sharing Knowledge, Linking Sciences: International Conference on the St. Lawrence Ecosystem hosted in Cornwall by Ottawa University's Institute for Research on Economy and the Environment (IREE) and the St. Lawrence River Institute for Environmental Sciences (SLRIES). In 1997, the PAC and RAP Team participated in the 4th Annual International Symposium on the St. Lawrence Ecosystem held in Potsdam, NY.

3.3 St. Lawrence River RAP/PAC Publications

The St. Lawrence River RAP Team and PAC have been involved in the production of the following publications.

General Information

St. Lawrence RAP: Issues and Options. 1994. (Seven brochure set with cover folder.)

St. Lawrence RAP Team and St. Lawrence (Cornwall) Public Advisory Committee. 1994. *Choices for Cleanup: Deciding the Future of a Great River.* St. Lawrence River Remedial Action Plan Options Discussion Paper.

Technical Reports

Anderson, J. and J. Biberhofer. 1991. St. Lawrence RAP Technical Report No. 2. Water and Suspended Sediment Quality in the St. Lawrence River at Cornwall/Massena: 1988 Data Report.

Jardine, C.G. 1992. St. Lawrence RAP Technical Report No. 3. Fish Tainting Evaluation.

Metcalfe-Smith, J., L. Richman, R. Santiago, J. Biberhofer and J. Anderson. 1995. St. Lawrence RAP Technical Report No. 6. Chemical Characterization of St. Lawrence River Sediments in the Vicinity of the Oil Tank Storage Area, Cornwall, Ontario.

Mudroch, P. (in prep). St. Lawrence RAP Technical Report No. 5. Assessment of sediment quality at the Cornwall area of the St. Lawrence River, 1991. Environment Canada. March 1992.

McCorquodale, J.A., S.P. Zhou, Z. Ji. 1993. St. Lawrence RAP Technical Report No. 4. Pollutant Transport in the Cornwall Channel of the St. Lawrence River.

Richman, L.A. 1996. St. Lawrence River Sediment Assessment, 1994, Cornwall, Ontario. St. Lawrence RAP Technical Report No. 7.

Richman, L.A., G. Rupert and H. Young. 1997. Water Quality of Sutherland Creek, 1994, Cornwall, Ontario. St. Lawrence RAP Technical Report No. 8.

St. Lawrence RAP Team. 1995. Addendum to Stage 1 Report of St. Lawrence Remedial Action Plan (Cornwall/Lake St. Francis Area) (1988-1992).

St. Lawrence RAP Team. 1992. St. Lawrence River Area of Concern Remedial Action Plan for the Cornwall-Lake St. Francis Area Stage 1 Report: Environmental Conditions and Problem Definition.

St. Lawrence RAP Technical Report No. 1. 1992. Technical Workshop on Remedial Options in the Cornwall Area of Concern. March 1992.

Associated Documents

Comba, M.E., V.P. Palabrica and S.M. Backus. 1995. Polychlorinated biphenyl congeners in spottail shiners from the St. Lawrence River. AEH Research Report. RAP-100-92 No. 2.

Comba, M.E., K.L.E. Kaiser and S.M. Backus. 1993. Distribution of Polychlorinated Biphenyl Congeners in Spottail Shiners from the St. Lawrence River. NOI Research Report RAP-100-92, No.1 (Burlington: Environment Canada), pp.48.

Jordan-Simpson, D., P. Walsh and G. Sherman. 1994. Report on the Fish and Waterfowl Consumption Survey for the Cornwall Area. Laboratory Centre for Disease Control, Health Canada.

Kearney, J., D.C. Cole and D. Haines. 1995. Report on the Great Lakes Anglers Pilot Exposure Assessment Study. Great Lakes Health Effects Program, Health Canada (Ottawa: Health Canada). pp.99 & 9 Appendices.

Poulton, D.J. 1994. 1991 Cornwall Low-Level Metals Survey. Ontario Ministry of Environment and Energy. ISBN 0-7778-1317-3.

Richman, L.A. 1994. St. Lawrence River Sediment and Biological Assessment 1991. Ontario Ministry of Environment and Energy. ISBN 0-7778-2743-3.

Conference Presentations

Anderson, J. 1988. The St. Lawrence RAP, Overview and Approaches. First Nations Workshop on Great Lakes Remedial Action Plans, Cornwall.

Biberhofer, J. 1995. Development of a monitoring strategy for the Cornwall /Massena reach of the St. Lawrence River. (Abstract). Sharing Knowledge, Linking Sciences: An International Conference on the St. Lawrence Ecosystem. May 10-12, 1995, Cornwall. Conference Proceedings, Vol. I & II.

Biberhofer, J., J.L. Metcalfe-Smith and G.M. Pieczonka. 1996. Caged vs. resident mussels *(Elliptio complanata)* as biomonitors of metal pollution in the St. Lawrence River. Poster presentation at Sharing Knowledge, Linking Sciences: An International Conference on the St. Lawrence Ecosystem. May 13-16, 1996, Cornwall.

Code, A.E. 1995. Water quality retrofit of Fly Creek stormwater management system. In: (R. D. Needham and E.N. Novakowski, eds.) Sharing Knowledge, Linking Sciences: An International Conference on the St. Lawrence Ecosystem. May 10-12, 1995, Cornwall. Conference Proceedings, Vol. I & II.

Scientific survey on Lake St. Francis

Hickey, B.C. and M. Eckersley. 1997. Responses of the littoral zone fish community to habitat restoration efforts along the Cornwall waterfront. Abstracts, Thirty Second Central Canadian Symposium on Water Pollution Research. February 10-11, 1997, Canada Centre for Inland Waters, Burlington, Ontario.

Lorrain, S., C. Brochu, S. Moore and J. Biberhofer. 1996. Temporal trends of total PCBs in suspended solids in the Cornwall-Massena area. Abstract for Sharing Knowledge, Linking Sciences: An International Conference on the St. Lawrence Ecosystem. May 13-16, 1996, Cornwall.

Richman, L. , J. Metcalfe-Smith, R. Santiago, J. Biberhofer, J. Anderson. 1995. Chemical characterization of the St. Lawrence River sediments in the vicinity of the oil tank storage area, Cornwall, Ontario. (Abstract). Sharing Knowledge, Linking Sciences: An International Conference on the St. Lawrence Ecosystem. May 10-12, 1995, Cornwall. Conference Proceedings, Vol. I & II.

Richman, L.A., N.A. Rukavina and J. Biberhofer. 1996. Contaminated-sediment surveys at Cornwall, Ontario as a basis for dredge-site selection. 1996. Abstract for International Association for Great Lakes Research, 39th Conference. May 26-30, 1996, Erindale College, University of Toronto, Ontario.

Rukavina, N.A., J. Biberhofer and L. Richman. 1995. Application of new sediment data from Cornwall, Ontario to the planning of a RAP dredging project. Abstract for Sharing Knowledge, Linking Sciences: An International Conference on the St. Lawrence Ecosystem. May 13-16, 1996, Cornwall.

Stride, F.A. and S. I. Dreier. 1995. St. Lawrence (Cornwall) Remedial Action Plan: an overview of actions–1986-1995. *In:* (R. D. Needham and E.N. Novakowski, eds.) Sharing Knowledge, Linking Sciences: An International Conference on the St. Lawrence Ecosystem. May 10-12, 1995, Cornwall. Conference Proceedings, Vol. I & II.

Stride, F.A., J. Anderson, J. Biberhofer, S.I. Dreier, M. Eckersley, R. Helliar, B. Hickey and L.A. Richman. 1996. St. Lawrence Remedial Action Plan 1995 action and activities–an update on progress. Abstract for Sharing Knowledge, Linking Sciences: An International Conference on the St. Lawrence Ecosystem. May 13-16 , 1996, Cornwall.

3.4 St. Lawrence River (Cornwall) RAP Team Members during RAP Stage 2

RAP Team Members, 1997

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MOEE, Eastern Region

Rick Kirk, Coordinator
MOEE, Eastern Region

Conrad deBarros
MOEE, Eastern Region

Trevor Pawson
MOEE, Dorset

3.5 St. Lawrence River (Cornwall) PAC Participants (1992-1996)

PAC Chair: Elaine Kennedy

PAC Facilitator: Verna Ferguson (current)
Abby Curkeet
Jan Milnes

PAC Executive Assistant: Diane Seguin
(to June 1994)

PAC Members (1992-1996)

Guiseppe Belmonte, Cornwall Multicultural Committee
Della Berwanger, MacViro Consultants
Tim Blake, Courtaulds Fibres
Eric Cameron, St. Lawrence River Institute for Environmental Sciences (SLRIES)
Francis Chrétien, Ontario Federation of Agriculture
Andy Code, Raisin Region Conservation Authority
Nick Cox, Domtar Papers
Philippe Crabbé, Ottawa University Institute for Research on Env't & Economy (IREE)
Bruce Duncan, Ontario Hydro
Gerald Dupuis, Eastern Ontario Health Unit
Basil Earle, Courtaulds Fibres
Ann Gertler
Alain Godard, St. Lawrence Seaway Authority
Joanne Harper, Ontario Hydro
Garry Harris, Town of Alexandria
John Harwood, Courtaulds Fibres
Brian Hickey
Marcel Lapierre, Township of Charlottenburgh
Sandra Lawn, SLRIES
David Leech, SLRIES
Norm Levac, City of Cornwall
Neil MacLean, ICI Forest Products
Maryse Manseau, Societé pour Vaincre la Pollution (SVP)
Janet McDonald, Township of Lancaster
Don Munro
Roger Needham, Ottawa University IREE
Jack O'Dette, Ontario Federation of Anglers and Hunters
Jeff Ridal, SLRIES
Glen Runions
John St. Marseille
John Wood

PAC Guests (1992-1996)

Stephen Alexander, City of Cornwall
Jim Anderson, CH2MHill
Steve Anderson, SLRIES
Caroline Andrew, Ottawa University
M.L. Armstrong
Dave Arquette
M. Audet
Larry Becksteak, St. Lawrence College
Art Bedard
David Bell, MNR
Gerard Belley, Pilot, St. Lawrence Seaway
Manisha Bharti
Kevin Boehmer, CH2MHill
Daniel Bourdon, Lunker Club
V.H. Bush
Jim Cameron, MNR
J.M. Chaud
Philip Cheung, CH2MHill
Don Crites
Derek Drewry, Cornwall Std Freeholder
Ron Droste, Ottawa University
Clayton Duff, Courtaulds Fibres
Denis Dumas, Ottawa University
Eric Duguay
Ally Dusualt
Ron Eamer, Cornwall Electric
Rick Eamon
Cliff Evanitski, Environment Canada
David Fay, Environment Canada
Ian Ferguson, Parks Canada
David Fielding, City of Cornwall
Glen Fisher, Lunker Club
Todd Fisher, Lunker Club
Paul Fitzpatrick, City of Cornwall
Lynn Foley
Alison Fraser
Kim Fry
Melvin Gardner
Ann Gilbert, Ottawa University
Bill Girard, City of Cornwall
Lloyd Gorling
Murray Grant, Domtar Papers
Brian Gravely
Daniel Green, SVP
John Haines, Heritage Institute
Ken Hall, Hamilton BARC
Fern Hamelin, City of Cornwall
Jane Hamilton, Cornwall Std Freeholder
Brian Hein
Jackie Houde
Ernie Jackson, Cornwall Electric
Sultan Jessa, Cornwall Std Freeholder
John Johnson, ICI Canada Inc.

Stephen Judd
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Tom Kaneb, SLRIES
Elena Kapil, Green Team
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Colin Kirkman
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Harry Labreque
Michelle Lafleur-Box, Ottawa University
Jack Lalonde, Lunker Club
Diane Lalonde, St. Lawrence College
Kevin Lamoureux
Christine Laughlen, MacViro Consultants
Mathalie LaViolette, Ottawa University
Harvey Lemelin, IREE
Nathalie Lewis, Ottawa University
Bill Livingston
Michael Longland, MacViro Consultants
Shawn Loughrey, Ontario Hydro
John Lounsberry
Mr. and Mrs. H.F. Lynch
Ron MacDonell, Township of Lochiel
Tom Mahood, CH2MHill
Serge Malenfant
Ralston Maloney, ICI Forest Products
Chris Markell, Queen's University
Genevieve Martin
Robin McClellan, Massena RAC
Steve McDermid
Gerry McKenna, City of Cornwall
Craig McRae, Aquafor Beech Consultants
Ron McRae, Glengarry County Soil & Crop Improvement Association
Bert Mead, Massena RAP, NYSDEC
Frank Meng, Ottawa University
Allan Millward
John Milnes
Ian Morrison, ICI Forest Products
Raman Nayer, Domtar Papers
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Frank Nevin
Mrs. Charles Nevin
Nicholas Novakowski, Ottawa University
Jennifer O'Grady, MacViro Consultants
Carmen Penty
Jim Perkins, St. Lawrence Seaway
Dale Phippen
Richard Pinks, MacViro
Richard Puatis, MacViro
Subramanian Raman, Ottawa University
Jeff Ridal, SLRIES
Norm Robertson, Lunker Club
Phil Romeril
Bob Roth
Joe Rotheram
Mike Roy
Shelley Roy, Domtar Papers
Denis Sabourin
Charles Sangster, Township of Lancaster
Jim Sangster
Peter Sarch, Cornwall Envtl Resource Ctre
George Shoniker
Warren Sleeth, Ministry of Municipal Affairs
Dave Slessor, Totten Sims Hubicki
Ian Smith, MOEE
Joe Stevenson, CH2MHill
Etienne St. Aubain
Lise Arbic St. Louis
Jeff Taylor, MOEE
Denis Thibault
Daniel Trottier, Great Lakes Pilot
George Velema, Domtar Fine Papers
Ted Van den Oetelaar
Gail Wallace
Ken Warden
Craig Wardlaw, Wastewater Technol Intl
Claire Winchester, SLRIES
T. J. Woolfwood

4. GOALS AND OBJECTIVES OF THE ST. LAWRENCE RIVER (CORNWALL) RAP

The following goals and objectives were developed by the Goals Subcommittee of the PAC during Stage 1 of the RAP process.

Use Goals

Ecosystem Health

Restore the ecosystem in the area of concern such that populations of flora and fauna including humans be robust and self-sustaining in a balanced community, by:

- rehabilitating and protecting required habitats;
- ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects;
- preventing adverse impacts resulting from the introduction of non-native species.

Municipal Use of Water

Have an unlimited quantity of aesthetically pleasing water for municipal use, free from toxic or other potentially hazardous substances and effects.

Consumptive Use of Fish and Wildlife

Improve the quality of fish and wildlife for sustained human consumption, by:

- eliminating persistent toxic substances in fish and wildlife;
- reducing the level of naturally occurring metals to background (natural) levels; and
- ensuring that the odour and taste of fish and wildlife are not impaired by water quality.

Swimming

Ensure that swimming or other water contact sports are not impeded by water quality.

Boating

Improve recreational boating in current areas of use, principally by improving the usefulness of existing channels.

Recreational

Increase the enjoyment provided by other recreational uses such as wildlife viewing, hunting and sport fishing by:

- restoring the required flora and fauna;
- improving the aesthetics of the river and the shore; and
- maintaining access to these resources.

Industrial Use of Water

Ensure an adequate quantity and quality of water for industrial use.

Navigation

Maintain sufficient water depth for legitimate and safe seaway operation.

Power Generation

Maintain the use of St. Lawrence River water resources for the production of electricity in conjunction with environmental considerations.

Source Goals

Municipal Discharge

Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.

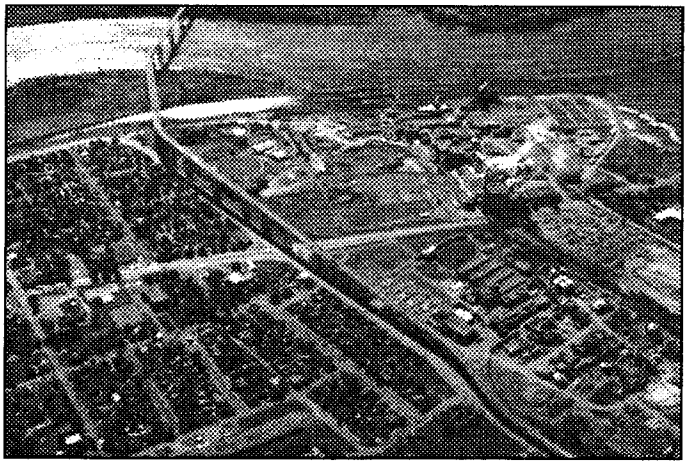
Industrial Discharge

Industries shall provide proper treatment for their effluent and, where necessary, modify their processes to ensure their effluents will be free from toxic and other potentially hazardous substances and effects.

Other Sources

Control the impacts from other sources by eliminating toxic and other potentially hazardous substances and effects.
Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging.
Activities for achieving this goal include:

- controlling erosion into tributaries and along shorelines;
- reducing nutrient inputs;
- preventing ground water contamination;
- eliminating atmospheric deposition of toxic and other potentially hazardous substances in the watershed;
- reducing bacterial inputs;
- controlling the impacts of sediment resuspension.



Cornwall

Cooper Marsh

5. ENVIRONMENTAL ISSUES IN THE AREA OF CONCERN

Seven major environmental issues of concern in the Cornwall Massena section of the St. Lawrence River were identified in the Stage 1 Report of the St. Lawrence River (Cornwall) RAP. These are discussed in Chapter 5, Sections 5.1 through 5.7. An additional environmental concern– fish and wildlife health impacts – is discussed in Chapter 5, Section 5.8.

5.1 ISSUE: Mercury Contamination

Mercury contamination in the St. Lawrence River between Cornwall, Ontario and Valleyfield, Quebec has been a concern since the late 1960s, contributing to the following impairments of beneficial use:

- restrictions on consumption of fish
- restrictions on dredging.

As well, mercury contamination may contribute to degradation of benthos, degradation of fish and wildlife populations and bird or animal deformities or reproductive problems.

Mercury occurs in a variety of chemical forms in the environment as a result of modifications brought about by biological and physical processes. The potential toxicity of environmental mercury is a function of its chemical form (Bunce 1994).

5.1.1 Water

Because of the high dilution capacity of the St. Lawrence River, mercury concentration in the water tends to be low except in the immediate vicinity of direct discharges. Total mercury concentrations in unfiltered river water were generally at or below the analytical detection limit of 0.01 µg/L in 1988 (Anderson and Biberhofer 1991) and 1991 (Richman 1994).

5.1.2 Suspended Solids

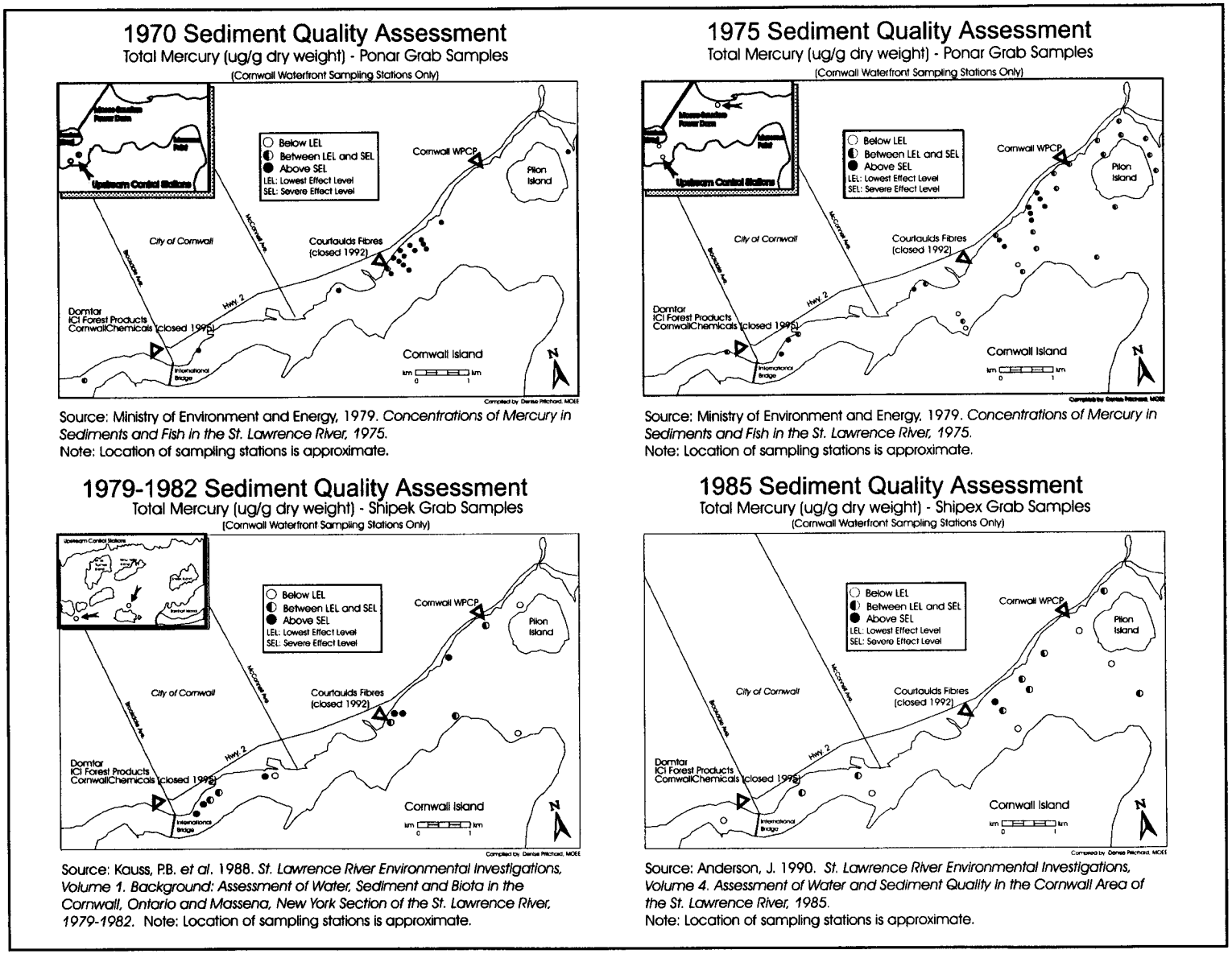
Total mercury in suspended solids in the water column ranged from 0.11 to 0.23 µg/g dry weight in a 1988 survey of the south channel of the St. Lawrence River (Anderson and Biberhofer 1991). In that study, the station with the highest concentration of mercury in suspended solids was located mid-way between Cornwall Island and Ile St. Regis. The Provincial Sediment Quality Guidelines lowest effect level for mercury in bottom sediment is 0.2 µg/g. No guideline exists for mercury concentration in suspended sediment.

The mercury content of suspended solids in Cornwall industrial effluent in the 1988 survey was highest in effluent from Courtaulds Fibres (closed 1992) and Courtaulds Films (closed 1989) (Anderson and Biberhofer 1991). These results correspond with observations from a 1979 survey in which mercury concentrations in suspended sediment from river water were highest (2.4 µg/g) at a station just offshore from Courtaulds' former shore-based discharge (Kauss *et al.* 1988).

In a 1991 survey of the north and south channels (Poulton 1994), mercury in suspended solids ranged from 0.09 to 0.54 µg/g dry weight, with the maximum concentration recorded at a station downstream of Pilon Island, between the mainland and Colquhoun Island.

5.1.3 Bottom Sediment

St. Lawrence River bottom sediment is contaminated with mercury at some locations in the area of concern. Concentrations of mercury above the severe effect level (2.0 µg/g) have been found along the Cornwall waterfront in surveys dating back to 1970, as shown in Figures 4, 5 and 6. Mercury concentrations were generally highest in samples collected from either of two areas: (1) approximately one kilometre downstream of the Domtar/ICI/Cornwall Chemicals discharge, and (2) immediately adjacent to and up to two kilometres downstream of the Courtaulds Fibres discharges. This pattern was observed in surveys carried out in 1970 and 1975 (MOE 1979), 1979-1982 (Kauss *et al.* 1988), 1985 (Anderson 1990), 1991



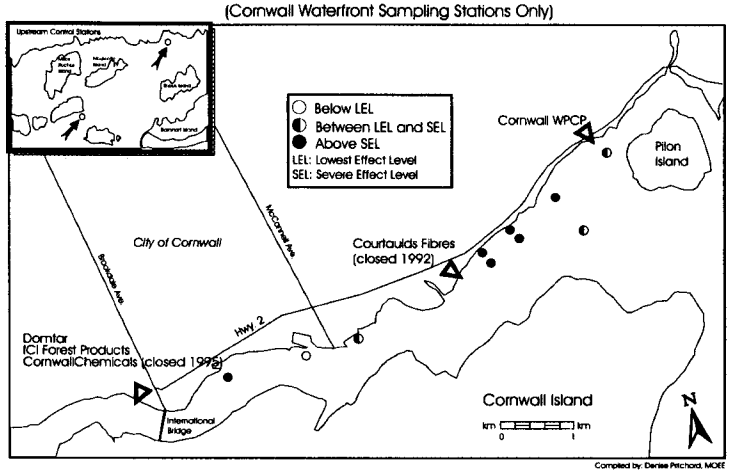
Source: Ministry of Environment and Energy, 1979. *Concentrations of Mercury in Sediments and Fish in the St. Lawrence River, 1975.*
Note: Location of sampling stations is approximate.

Source: Ministry of Environment and Energy, 1979. *Concentrations of Mercury in Sediments and Fish in the St. Lawrence River, 1975.*
Note: Location of sampling stations is approximate.

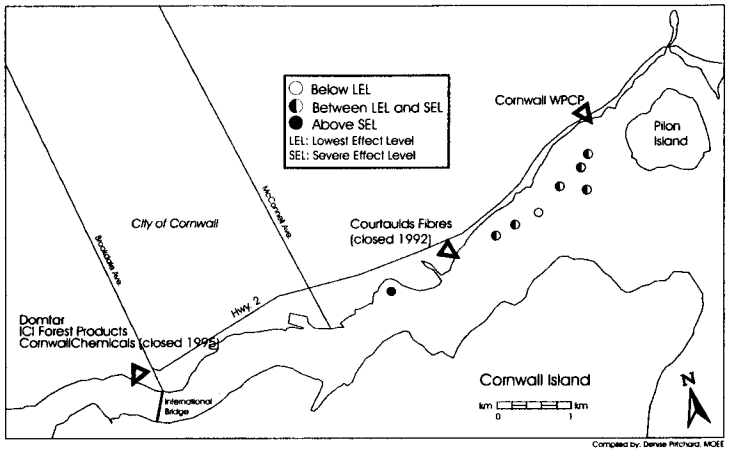
Source: Kauss, P.B. *et al.* 1988. *St. Lawrence River Environmental Investigations, Volume 1. Background: Assessment of Water, Sediment and Biota in the Cornwall, Ontario and Massena, New York Section of the St. Lawrence River, 1979-1982.* Note: Location of sampling stations is approximate.

Source: Anderson, J. 1990. *St. Lawrence River Environmental Investigations, Volume 4. Assessment of Water and Sediment Quality in the Cornwall Area of the St. Lawrence River, 1985.*
Note: Location of sampling stations is approximate.

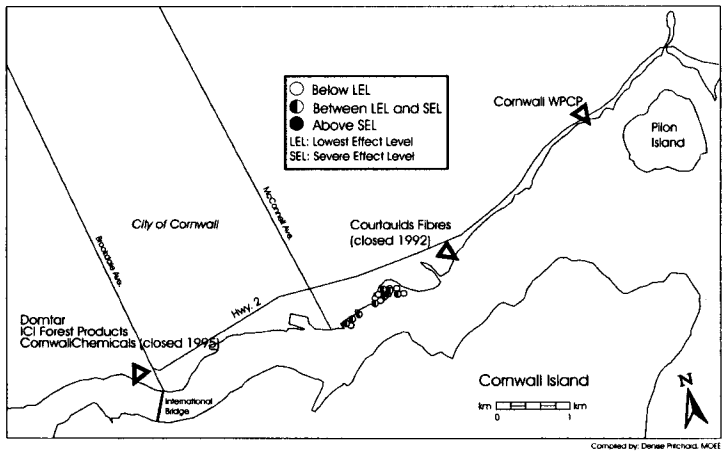
Figure 4: Total mercury in bottom sediment (1970, 1975, 1979-82, 1985 surveys), St. Lawrence River at Cornwall, Ontario.



Source: Richman, L. 1994. *St. Lawrence River Sediment and Biological Assessment, 1991.* Note: Location of sampling stations is approximate

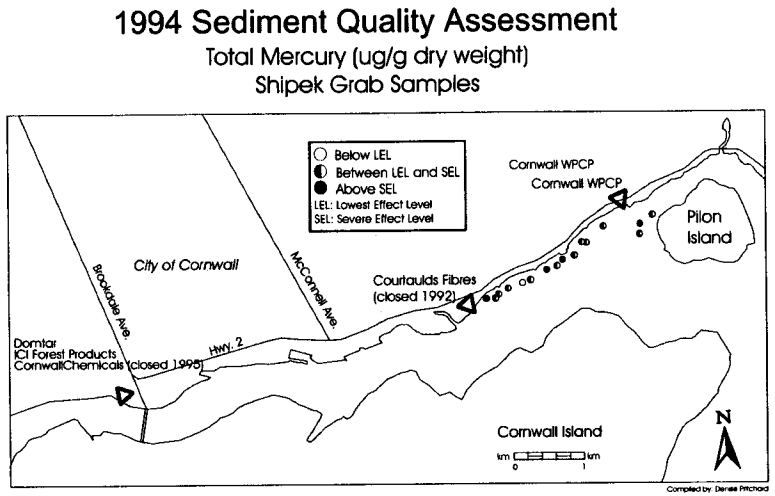


Source: Mudroch, P. 1992. *Assessment of Sediment Quality at the Cornwall Area of the St. Lawrence River, 1991.*

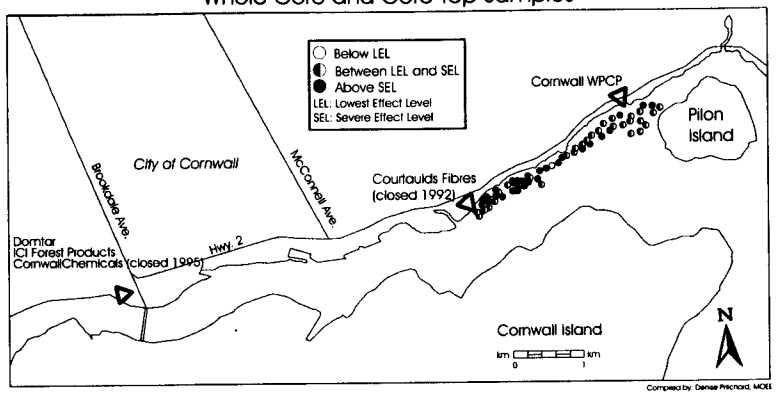


Source: Metcalfe-Smith, J. et al. 1995. "1992 Sediment Survey by the Ontario Ministry of Environment and Energy." in *St. Lawrence River Remedial Action Plan Technical Report No. 6. Chemical Characterization of St. Lawrence River Sediments in the Vicinity of the Oil Tank Storage Area.*

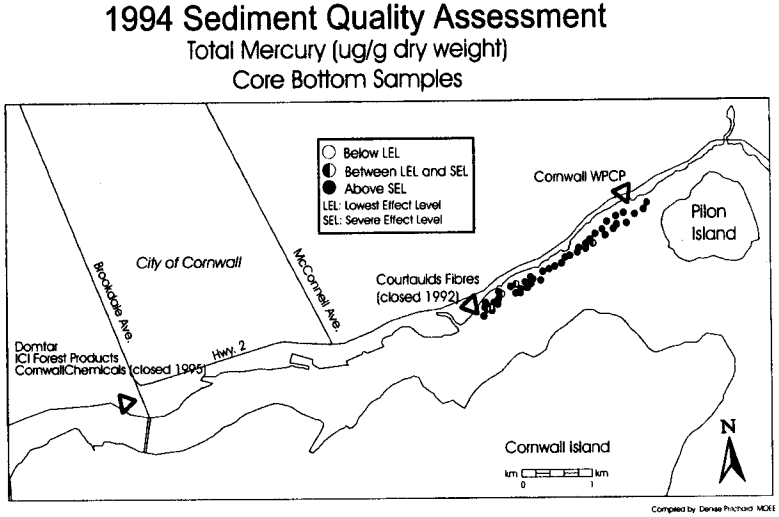
Figure 5: Total mercury in bottom sediment (1991 and 1992 surveys) St. Lawrence River at Cornwall, Ontario.



Source: Richman, L. 1996. *St. Lawrence River Sediment Assessment, 1994: Cornwall, Ontario.*



Source: Richman, L. 1996. *St. Lawrence River Sediment Assessment, 1994: Cornwall Ontario.*



Source: Richman, L. 1996. *St. Lawrence River Sediment Assessment, 1994: Cornwall, Ontario.*

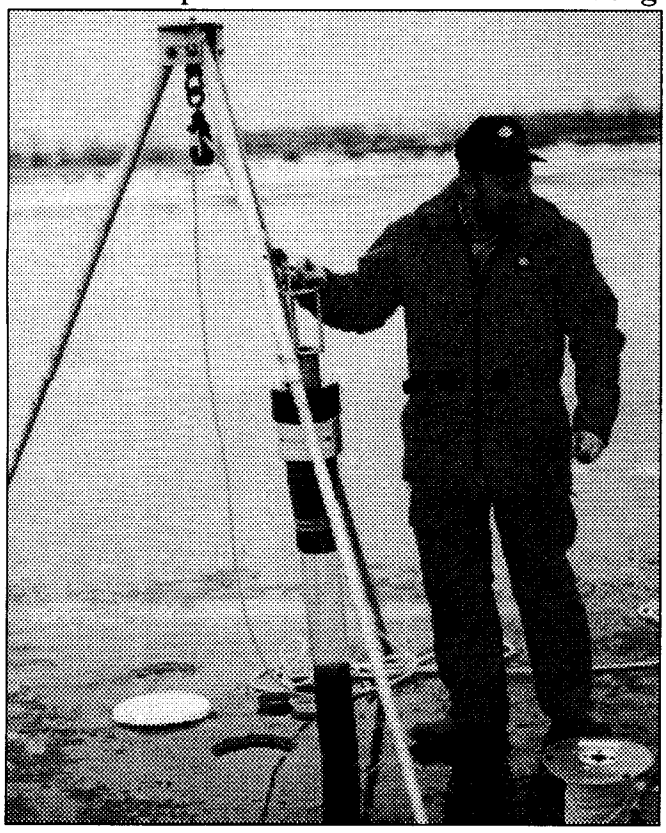
Figure 6: Total mercury in bottom sediment (1994 survey) St. Lawrence River at Cornwall, Ontario.

(Richman 1994) and 1994 (Richman 1996). Mercury concentrations in sediment from these areas decreased from the 1970s to the 1990s, likely in response to reductions in local mercury emissions and the replacement of shore-based dischargers with offshore diffusers. Diffusers were installed at Domtar/ICI in 1971 and at Courtaulds in 1977.

Mercury exceeded the severe effect level in bottom sediment at an embayment downstream of the Cornwall Harbour in 1970 and 1975 (MOEE 1979) and 1991 (Mudroch, unpublished data), but intensive study of the embayment by MOEE in 1992 and Environment Canada in 1993 (Metcalfe-Smith *et al.* 1995) did not find mercury above the severe effect level.

The closure of Courtaulds Fibres in November 1992 and ICI Forest Products' mercury cell process in March 1995 has eliminated local point sources of mercury, but mercury is still present above the severe effect level at some locations along the Cornwall waterfront.

A 1991 sidescan sonar study by Environment Canada (Mudroch, unpublished data) located two main depositional areas of sediment along the north shore of the river in the area of Cornwall. These were areas of fine-grained sediment, in which contaminants are most likely to accumulate. One depositional area was found in the embayment downstream of Cornwall Harbour; the other stretched along the Cornwall waterfront from the site of the Courtaulds outfall, downstream almost to Pilon Island. More recent surveys of bottom sediment type employed a sonar technology called RoxAnn to distinguish a range of sediment bottom types (Figure 7). Detailed RoxAnn mapping of the two depositional areas referred to above has been completed (Rukavina and Biberhofer 1993; Rukavina 1996) and mapping of additional areas of the Cornwall waterfront is planned.



Collecting sediment samples through the ice

Based on bottom-type information obtained from the RoxAnn mapping, an intensive survey of bottom sediment contaminants in 1994 extended up to 400 metres from shore and about two kilometres downstream from the Courtaulds diffuser to the west end of Pilon Island. Mercury concentration exceeded the severe effect level in 49% of the core top samples (*i.e.*, top 10 cm of the core, which is approximately the bioturbation zone) and 91% of the core bottom samples as shown in Figure 8 (see Richman (1996) for additional details). This confirmed the findings of a 1993 survey in which mercury was above the severe effect level in sediment from several nearshore stations adjacent to the former shore-based discharge at Courtaulds (BEAK, unpublished data).

Sediment further downstream in Lake St. Francis was sampled extensively by Environment Canada during 1979-1981 (Sloterdijk 1991) and again in 1989 (Lorrain *et al.* 1993). In 1979-1981, sediment mercury concentration exceeded the lowest effect level at 39% of 98 stations; in 1989, mercury was above the lowest effect level at 33% of the stations. Mercury concentrations did not exceed the severe effect level in 1979-1981 or 1989. Sediment along the north shore of the lake was more contaminated with mercury than sediment along the south shore, reflecting discharges of mercury from point sources located in the north channel at Cornwall.

In the decade between 1979-1981 and 1989, mercury concentrations in bottom sediment from the north shore of Lake St. Francis decreased by an average of 34% (Lorrain *et al.* 1993). In the 1979-1981 surveys the maximum

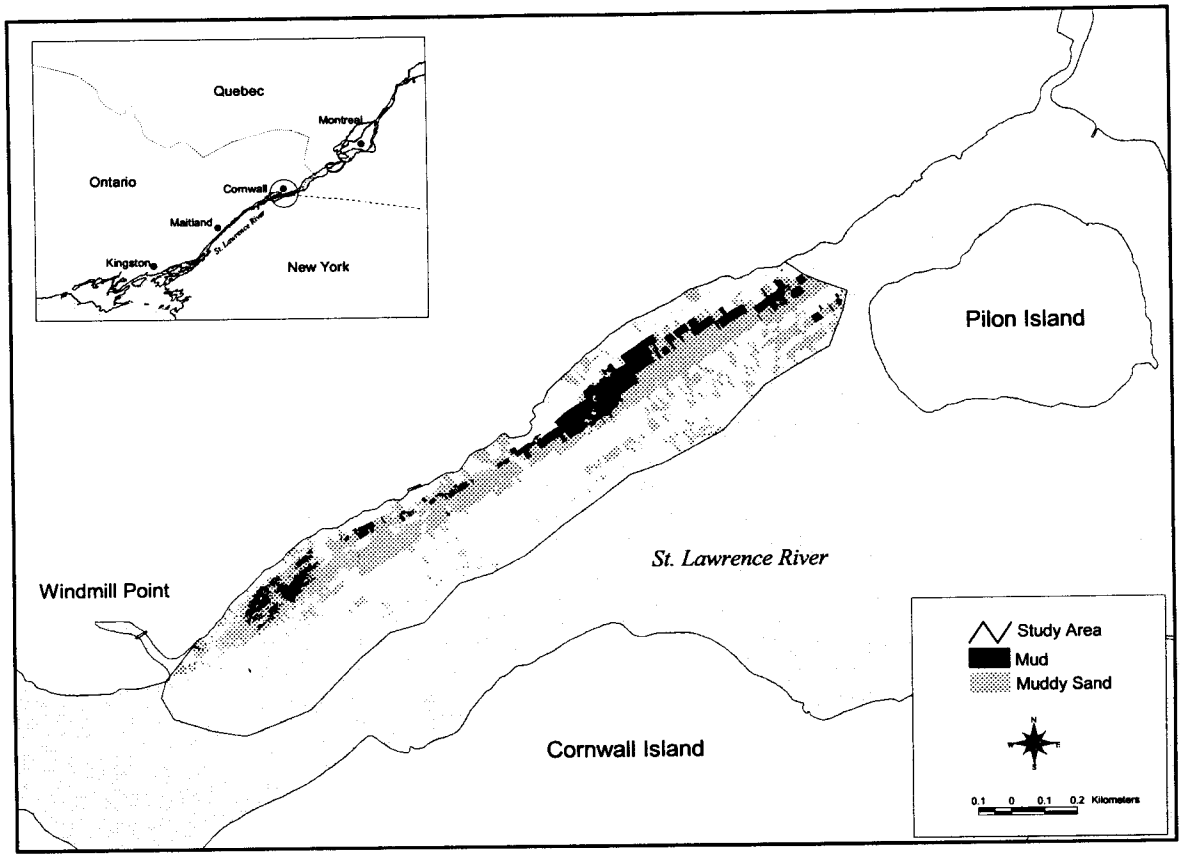


Figure 7: Soft sediment along the Cornwall waterfront: Windmill Point to Pilon Island.

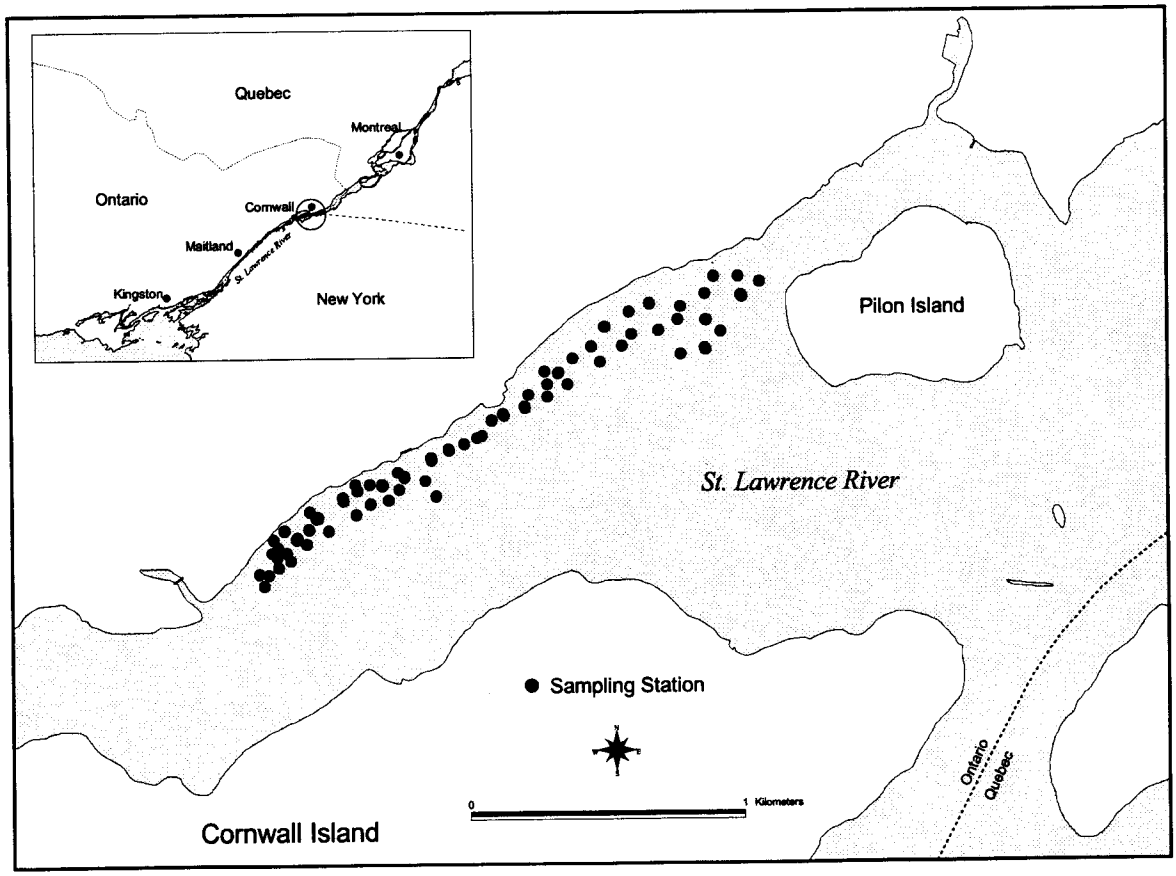


Figure 8: Sampling stations, 1994 MOEE survey (Richman 1996) St. Lawrence River at Cornwall, Ontario.

concentration observed was 1.47 µg/g and seven sites had mercury concentrations of 1.0-1.5 µg/g. In 1989 the highest mercury concentration was 0.67 µg/g (Sloterdijk 1991).

5.1.4 Benthos

In a 1991 MOEE survey, benthos from 13 stations in the AOC and 2 upstream control stations was analyzed for mercury (Figure 9) (Richman 1994). Concentrations of mercury in benthos were significantly higher at two stations adjacent to Courtaulds Fibres than at all other stations, as shown in Table 3. For all stations, there was a significant positive correlation between the mean mercury concentration in benthos and the ratio of total mercury concentration in sediment to total organic carbon ($r=0.80$, $p<0.003$). Organic matter binds mercury, rendering it less bioavailable. The ratio of total mercury in sediment to total organic carbon can be used to normalize sediment mercury data, effectively removing the influence of the organic material so that comparisons between stations can be made.

Table 3. Mercury concentrations (ng/g wet weight) in benthos collected from the St. Lawrence River, 1991 (Richman 1994).

Station number	Mean mercury concentration (ng/g wet weight) in benthos [std deviation]
82	26.5 [4.9]
83	11.9 [2.0]
365	31.8 [4.4]
366	12.2 [0.5]
368	55.8 [26.8]
368A	68.0 [26.3]
369	24.3 [9.4]
369A	24.4 [7.8]
370	7.7 [2.3]
370A	24 [1.6]
371	19.6 [3.0]
372	6.4 [0.8]
374	9.2 [1.0]
373	4.7 [0.9]
376	14.0 [1.5]

Bioassay results from the same survey showed that sediment collected from stations downstream of the point sources of contaminants resulted in high organism survival but exerted sublethal growth effects on the benthic invertebrates *Hexagenia limbata* (mayfly) and *Chironomus tentans* (midge) when compared with sediment collected from the reference stations 82 and 83. Bioassays reflect the cumulative effects of all contaminants in the sediment (i.e., not just mercury). Other contaminants are discussed in other sections of this report.

Sediment collected from station 368 and 368A (closest to Courtaulds' outfall) caused a significant growth reduction and lower body weight in exposed mayflies and midges when compared with growth in biota exposed to sediment from reference sites and all other sites sampled. Sediment from station 369 (downstream of station 368) also produced a significant reduction in growth and lower body weight for the midge exposures when compared with sediment from all other stations. For midge larvae, growth was reduced by 33% at station 368A, 36% at station 369 and 89% at station 368 when compared with growth on exposure to sediment from the reference stations (Richman 1994).

In addition, tissue concentrations of lead, copper, zinc and mercury were higher in minnows exposed to sediment from station 368 than in minnows exposed to sediment collected from the other stations. Sediment concentrations of these four metals were above the SEL at station 368. Sediment mercury concentrations were also greater than the SEL at station 368A and 369. This is strong evidence that sediment contamination has a potential to impair native species, particularly at station 368 and possibly at station 368A and 369.

The results of the sediment bioassays were consistent with the field survey. Sediment from the reference stations 82 and 83 consistently supported the highest growth in organisms; stations 368, 368A and 369 consistently supported the lowest growth; and station 370, 374 and 375 consistently supported intermediate growth (Richman 1994).

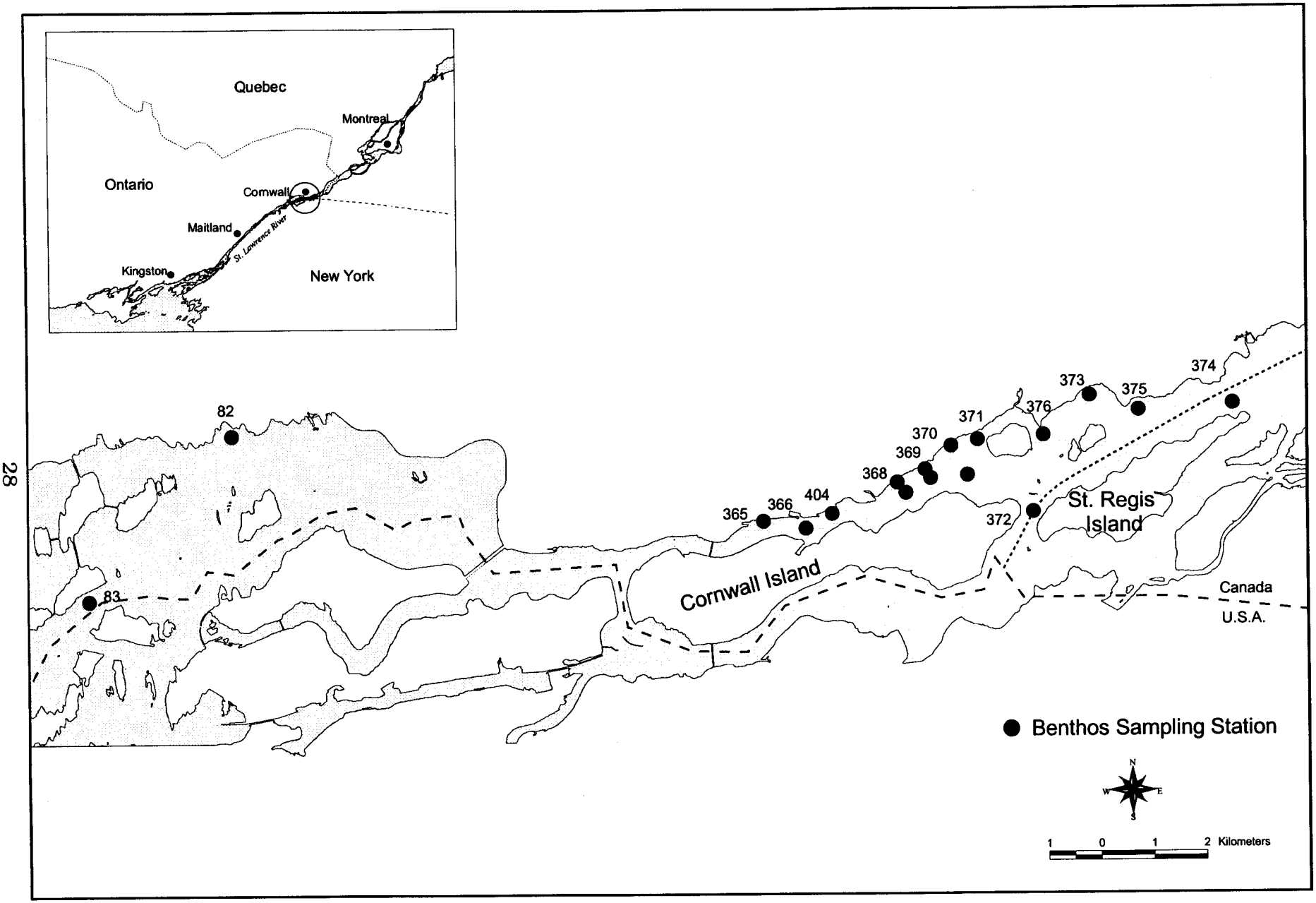


Figure 9: Benthos sampling stations, 1991 MOEE survey (Richman 1994), St. Lawrence River at Cornwall, Ontario.

5.1.5 Spottail Shiners

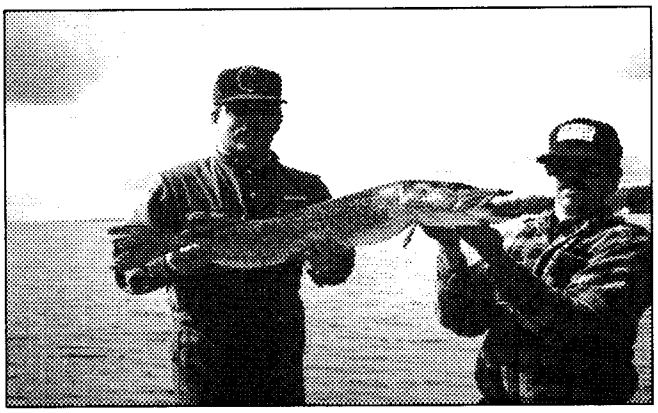
Spottail shiners *(Notropis hudsonius)* are effective biomonitors of bioaccumulative substances and have been extensively used as such throughout the Great Lakes basin. Young-of-the-year fish have been collected from several areas in the north and south channel of the St. Lawrence River at Cornwall annually since 1979 (Figure 10). Spottail shiners from more than 26 stations have been analyzed for PCBs, organochlorine pesticides and mercury as a indicator of water quality. An upstream station in Lake St. Lawrence (MacDonnell Island) is used as a reference station for comparison with fish collected downstream of known point sources.

As shown in Figure 11, total mercury concentration in spottail shiners collected from the upstream reference site in Lake St. Lawrence (MacDonnell Island) was lowest in 1989, at 11 ng/g wet weight (±8 ng/g) and highest in 1991, at 63 ng/g (±8 ng/g). Fish collected from the south channel of the river at Massena had concentrations of mercury similar to fish from the reference site for all years of sampling (MOEE unpublished data).

Concentrations of mercury in spottails collected in the north channel at Cornwall were generally similar to concentrations in those collected from the upstream reference site, except for 1988-1990 collections from the Cornwall marina (Civic Complex). In 1988, 1989 and 1990, mercury concentrations in spottail shiners from the Cornwall marina were higher than in fish from both upstream (Lake St. Lawrence) and downstream of Cornwall (downstream of the marina at Pilon Island). Mercury concentrations in fish collected from the Pilon Island site were similar to concentrations in fish from the Lake St. Lawrence reference site. In 1987, 1991 and 1993 concentrations of mercury in spottail shiners were similar throughout the study area.

5.1.6 Sportfish

Fish are the only biota for which a long-term data set on mercury concentrations is available. The MOEE and MNR Sportfish Contaminants Program has generated a data set for contaminants in walleye, northern pike and yellow perch from the early 1970s to 1995. Fish are collected annually or biannually from at least three sites in the St. Lawrence River (Thousand Islands, Lake St. Lawrence and Lake St. Francis).



Northern pike

These data were collected in order to compile the *Guide to Eating Ontario Sport Fish*. The program was not designed to compare mercury concentrations in fish from different parts of the river, but the data are now being reanalyzed to allow for these comparisons and will be the subject of a future report.

In order to allow comparison of tissue concentrations between years and between sampling sites, data on mean mercury concentrations have been adjusted to represent the mean concentration in a standard length fish (50 cm walleye; 55 cm northern pike; 25 cm yellow perch). Table 4 shows relative concentrations of mercury at the three St. Lawrence River sites for standard length walleye, northern pike and yellow perch in 1994. Preliminary comparisons for each species of fish are discussed below.

The reason for comparing fish from the AOC with those from areas considered to be at background levels (*e.g.*, the Thousand Islands) is to determine if the AOC fish are at or above the background concentrations. If they are above the background concentrations then the beneficial use (fish consumption) is considered to be impaired; if they are at or less than the background levels then the use is considered to be unimpaired.

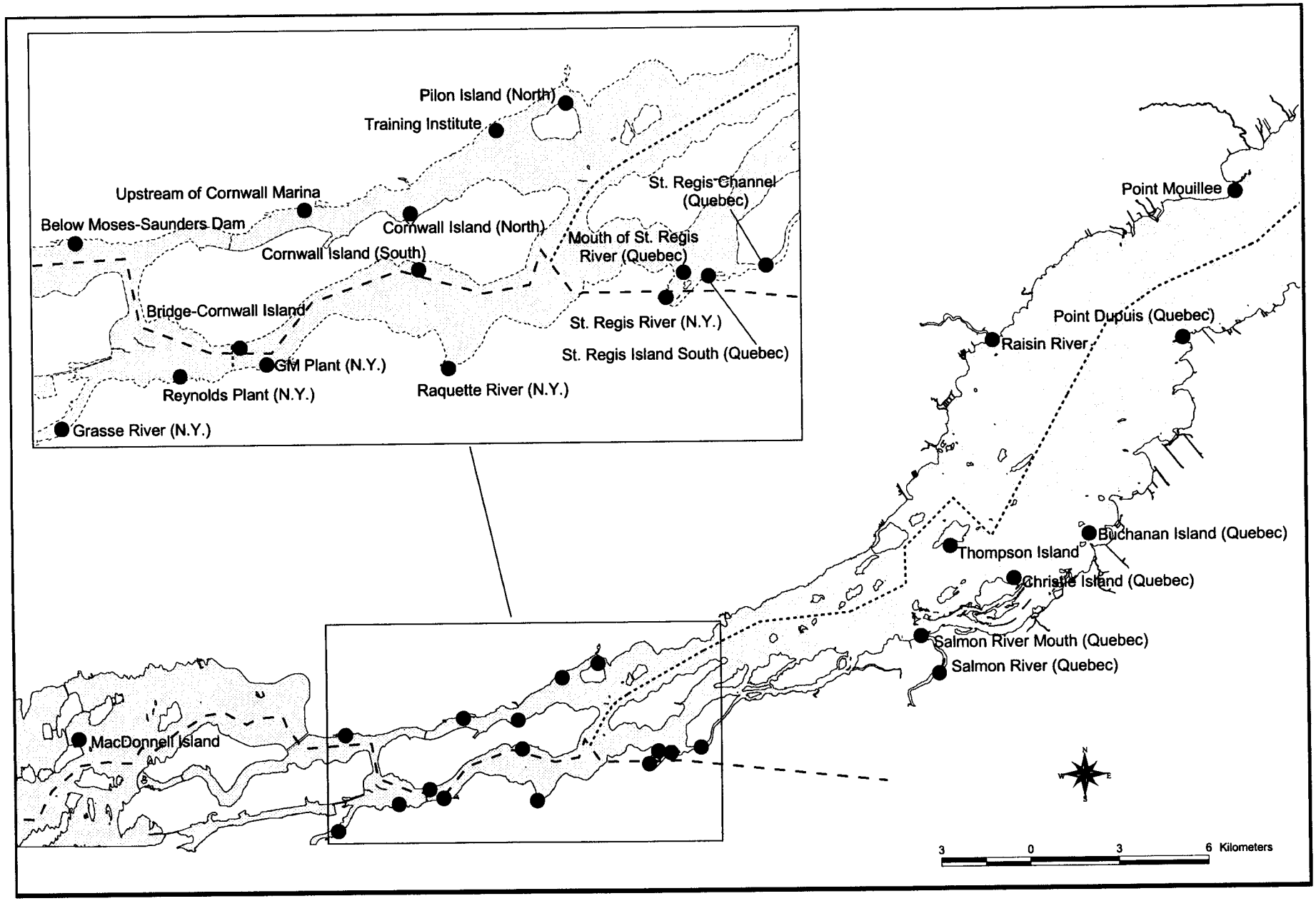


Figure 10: MOEE spottail shiner collection sites, St. Lawrence River.

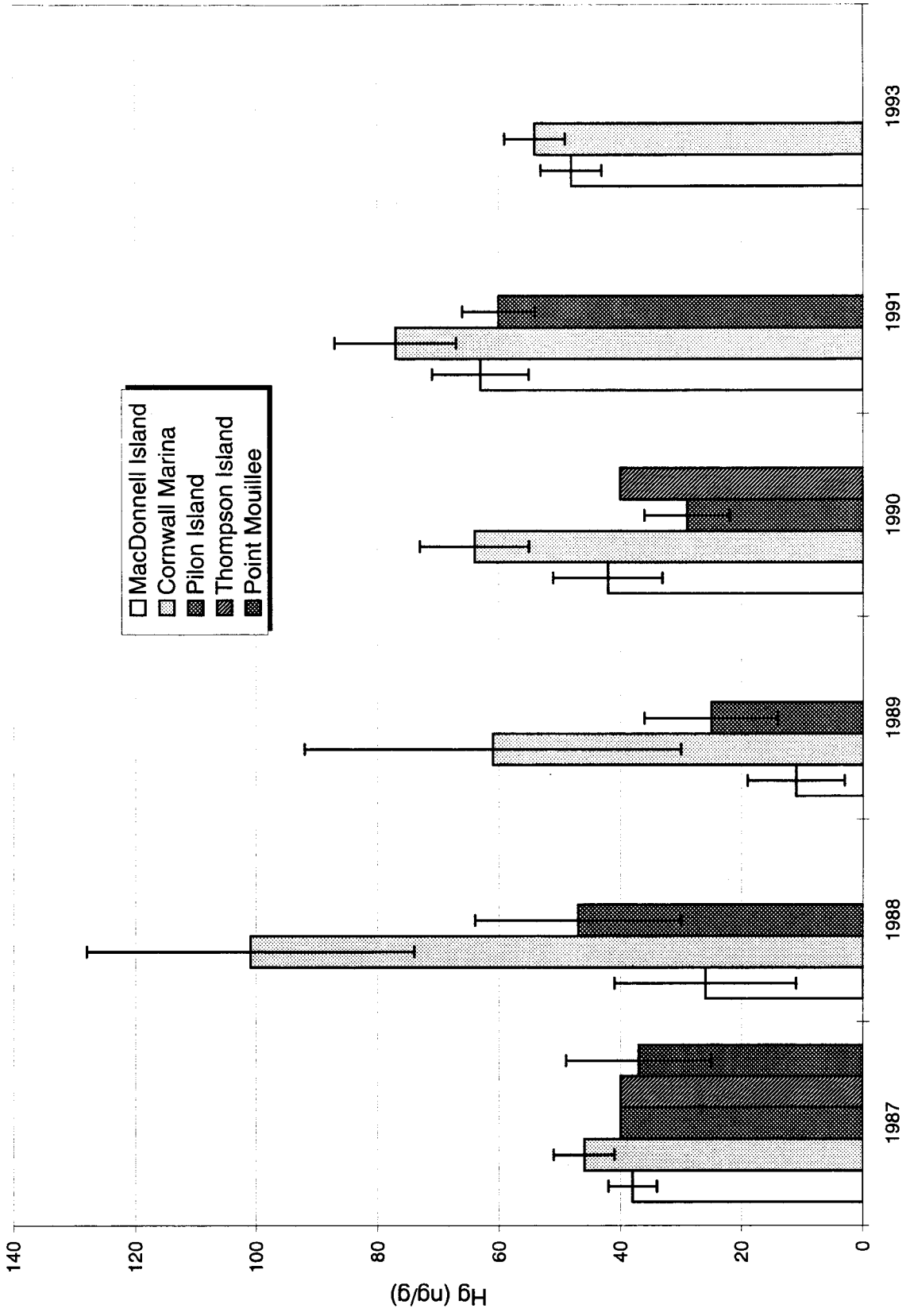


Figure 11: Total mercury (ng/g wet weight) in spottail shiners, St. Lawrence River.

5.1 Mercury

Body burdens of mercury have shown a gradual reduction in some sport fish species since 1970, likely in response to decreases in local emissions. However, there are still restrictions on consumption of some species (walleye, northern pike, smallmouth bass) due to mercury contamination (see Appendix V for 1997-1998 consumption guidelines for the St. Lawrence River near Cornwall). Mercury concentrations in larger, older walleye and northern pike still exceed 0.5 µg/g, Health Canada's guideline for restrictions on the consumption of fish.

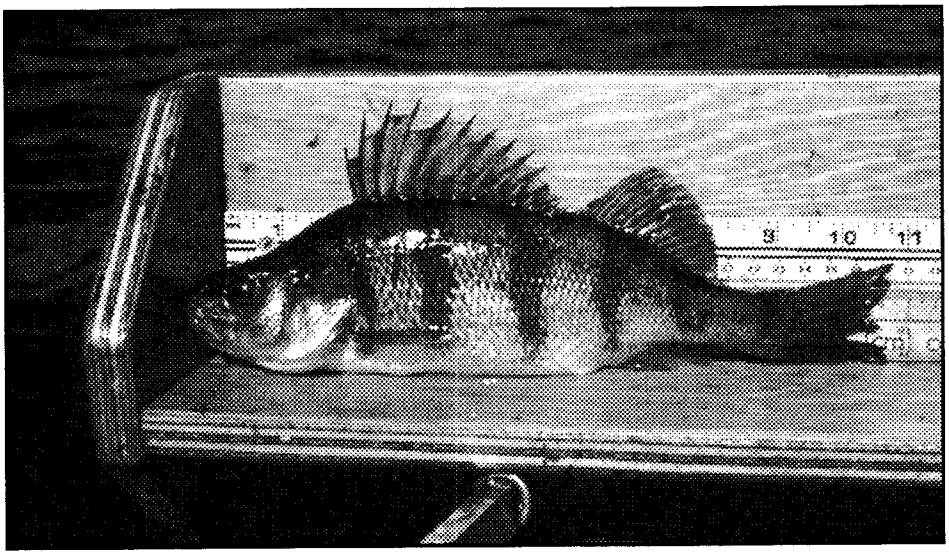
Table 4. Relative concentrations of mercury in sportfish (standardized length*) at three St. Lawrence River sites: Thousand Islands, Lake St. Lawrence, Lake St. Francis (i.e., the AOC), 1994 (MOEE/MNR Sportfish Contaminants Database).

	Thousand Islands	Lake St. Lawrence	Lake St. Francis (Cornwall AOC)
Walleye	++	++	+++
Northern pike	++	+	++
Yellow perch	+	+	+

* mean mercury concentration data were adjusted to represent the mean concentration in a standardized length fish (50 cm walleye; 55 cm northern pike; 25 cm yellow perch).

Notes to reader:

1) + lowest concentration ++ intermediate concentration +++ highest concentration.
   Symbols represent relative concentrations only and can be used for between-site comparisons only (not for comparison between-species).
2) Concentration data for individual species are presented in Figures 12 through 17.



Yellow perch

Age-length relationships for "standard size" fish

Analysis of area-specific age vs. length data shows the following relationships for "standard-size" yellow perch, walleye and northern pike (Cholmondeley 1989; Hendrick 1991; Liskauskas 1991; Bendig 1995).

Yellow perch (25 cm): In Lake St. Francis, a 25 cm yellow perch ranges from age 6-12 years, but most perch of this size would be ages 6, 7 and 8. In Lake St. Lawrence, a 25 cm yellow perch ranges in age from 7-10 years, with most aged 7 and 8. In the Thousand Islands yellow perch rarely reach a size of 25 cm, even at ages 8 or 9 years.

Walleye (50 cm): In Lake St. Francis, a 50 cm walleye is between 3 and 5 years old; most are 4. In Lake St. Lawrence, walleye of this length are 3-4 years old. Age-length relationships for walleye in the Thousand Islands are probably similar to Lake St. Francis, although data are too sporadic to be certain.

Northern pike (55 cm): In all parts of the St. Lawrence River upstream of Valleyfield, Quebec, northern pike 55 cm long are 2-3 years old, except in Lake St. Lawrence where they are 1-2 years old.

Walleye

Concentrations of mercury in walleye from Lake St. Francis (1970-1994) appear to have decreased from 1970 until 1982, thereafter remaining fairly stable until 1994. Figure 12 shows mean mercury concentrations in a 50 cm walleye in Lake St. Francis from 1976 to 1994. The closure of major point sources discharging mercury at Cornwall may lead to further reductions in the mercury concentrations in Lake St. Francis walleye.

Concentrations of mercury in walleye collected from Lake St. Francis appeared to be higher than concentrations in fish collected from the two upstream sites (Thousand Islands and Lake St. Lawrence), as shown in Figures 12 and 13. However, statistical analysis of the data is required to confirm this observation. Concentrations of mercury in walleye from the two upstream sites have shown little change over the sampling period (Thousand Islands, 1989-1993 and Lake St. Lawrence, 1981-1993) (MOEE and MNR Sportfish Contaminants Program data files).

Northern Pike

Mercury concentrations in northern pike of Lake St. Francis appeared to decrease slightly from 1977 and 1978 to 1984 and then remained stable until 1990, with the exception of a peak in 1989 (Figure 14). There may be some evidence of a decline in mercury concentrations in 1992-1994 relative to the early 1980s, but additional data (and detailed statistical analysis) for the next few years will be required to confirm this trend.

Mercury concentrations in northern pike were consistently higher in fish collected from Lake St. Francis than in fish from Lake St. Lawrence (Figure 14). Mercury concentrations in pike from Lake St. Francis were also higher than concentrations in Thousand Island fish (1984, 1986, 1989), although the difference in concentrations may not be statistically significant, with the possible exception of the 1989 data (Figure 15). From 1991 to 1994, the mercury concentrations in pike collected from Lake St. Francis were similar to those from the Thousand Islands; however, samples were not collected in the same years from both sites (MOEE and MNR Sport Fish Contaminant Program data files). This trend should be further investigated by collecting fish from both sites in 1997.

Based on this information, the delisting criterion for sportfish as it pertains to northern pike (see Chapter 9, Delisting Criterion I) has been met, since concentrations of mercury in fish from Lake St. Francis are similar to concentrations in fish collected upstream (Thousand Islands). Additional statistical analysis is required to confirm these trends.

Future sampling is required to determine why the data show that mercury concentrations are lower in Lake St. Lawrence pike than in pike from both Thousand Islands (farthest upstream site) and Lake St. Francis (farthest downstream site).

Yellow Perch

Yellow perch from Lake St. Francis have shown only small decreases in mercury concentrations since 1978. Mercury concentrations were highest in 1977, decreased in 1978, then remained stable until 1984 (Figure 16). Concentrations appear to have decreased again in 1986 (although this decrease may not be statistically significant) and remained stable until 1990 (with the exception of a peak in 1989 similar to the one observed for

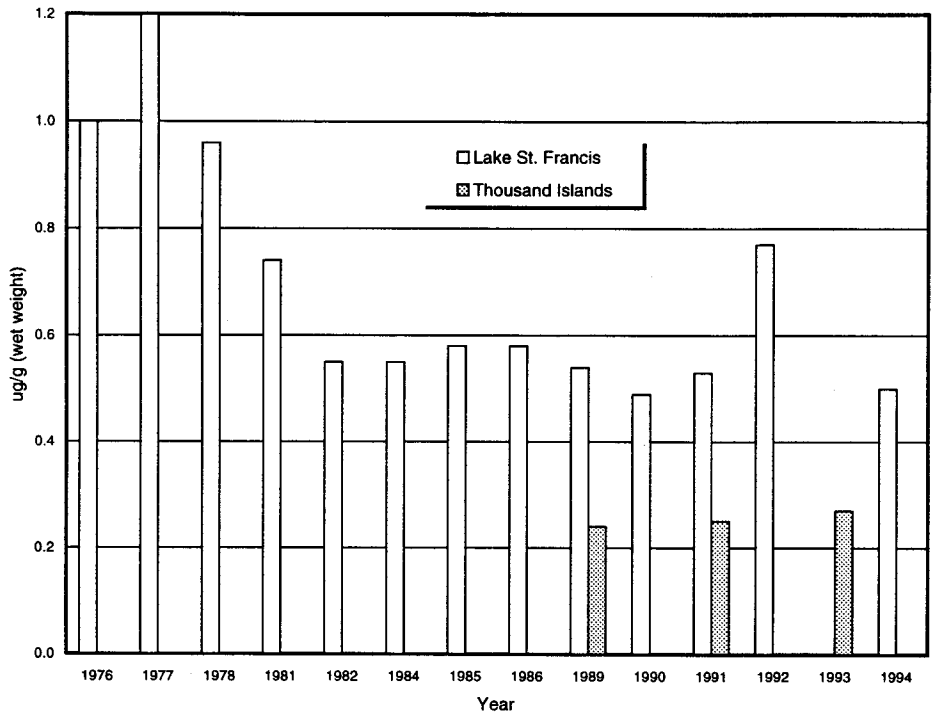


Figure 12: Mean mercury (ug/g wet weight) in 50 cm walleye, Lake St. Francis (1976-1994) and Thousand Islands (1989-1993).

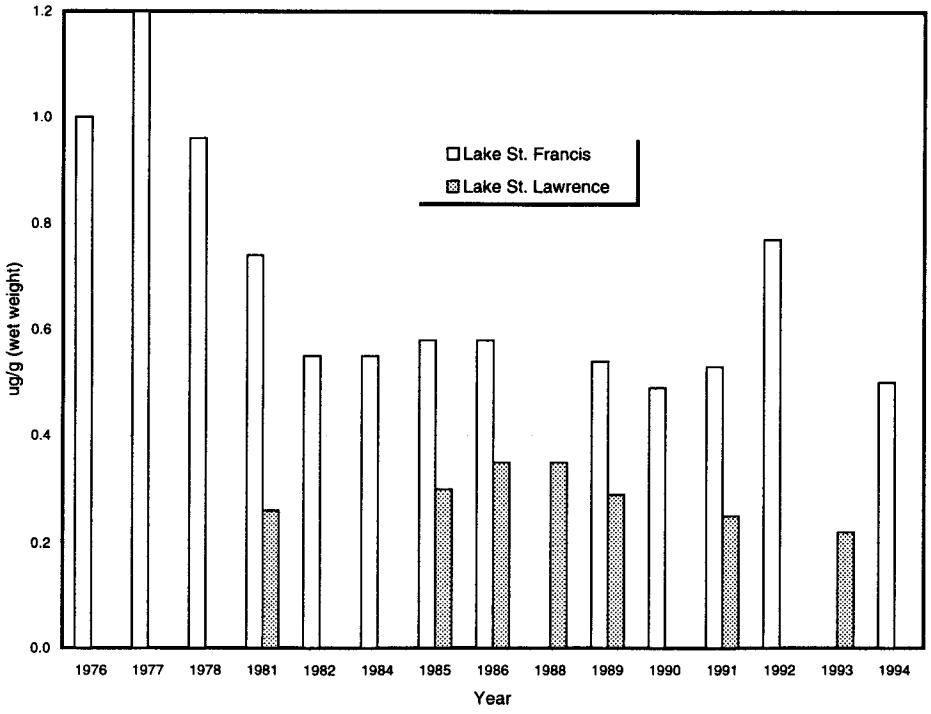


Figure 13: Mean mercury (ug/g wet weight) in 50 cm walleye, Lake St. Francis (1977-1994) and Lake St. Lawrence (1981-1993).

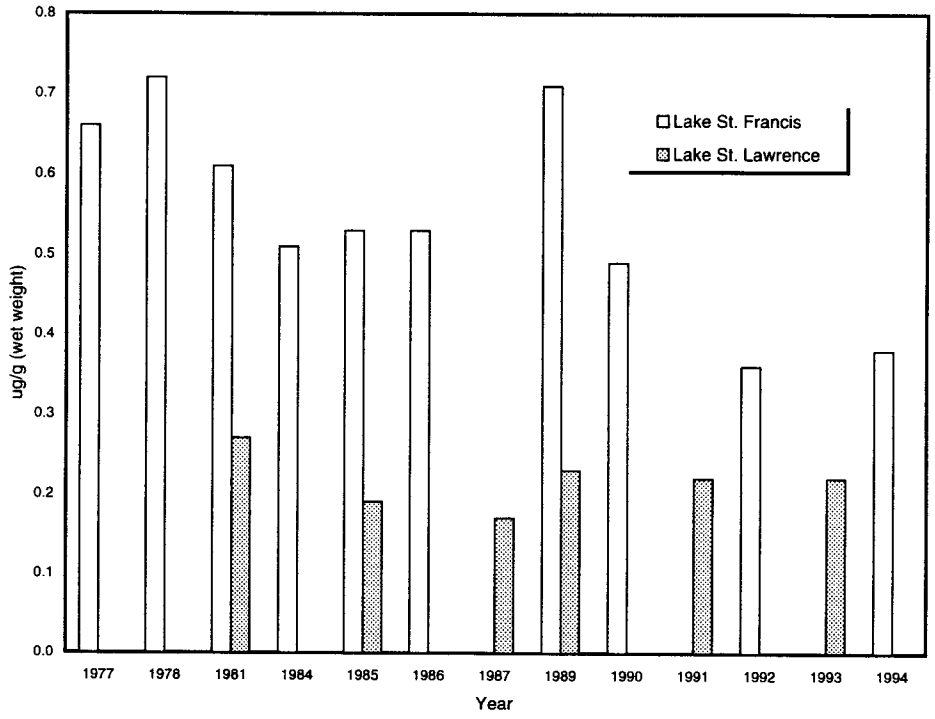


Figure 14: Mean mercury (ug/g wet weight) in 55cm northern pike, Lake St. Francis (1977-1994) and Lake St. Lawrence (1981-1993).

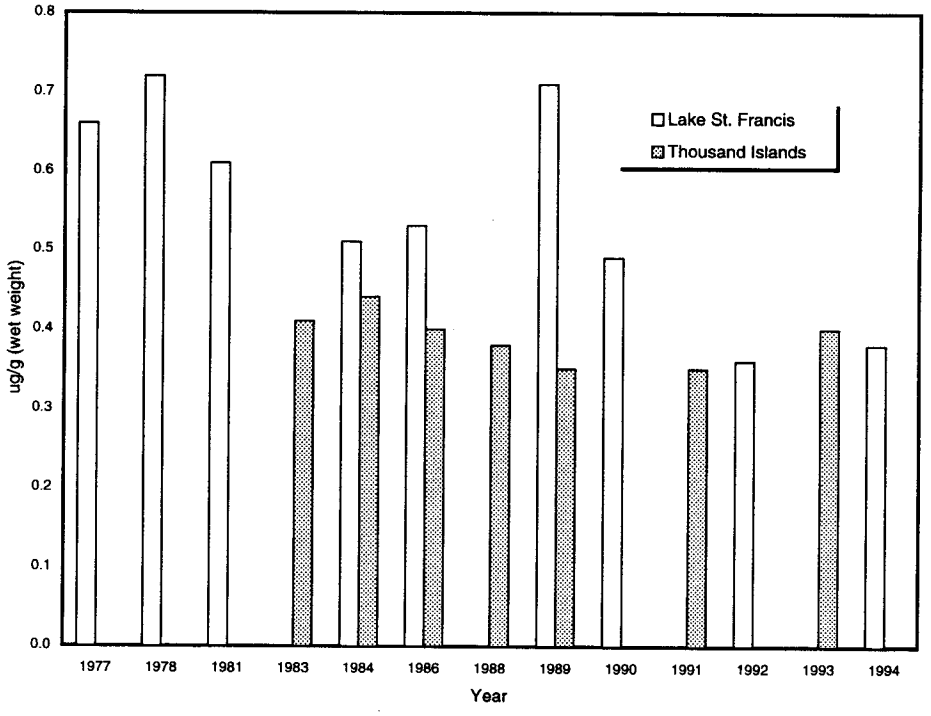


Figure 15: Mean mercury (ug/g wet weight) in 55cm northern pike, Lake St. Francis (1977-1994) and Thousand Islands (1983-1993).

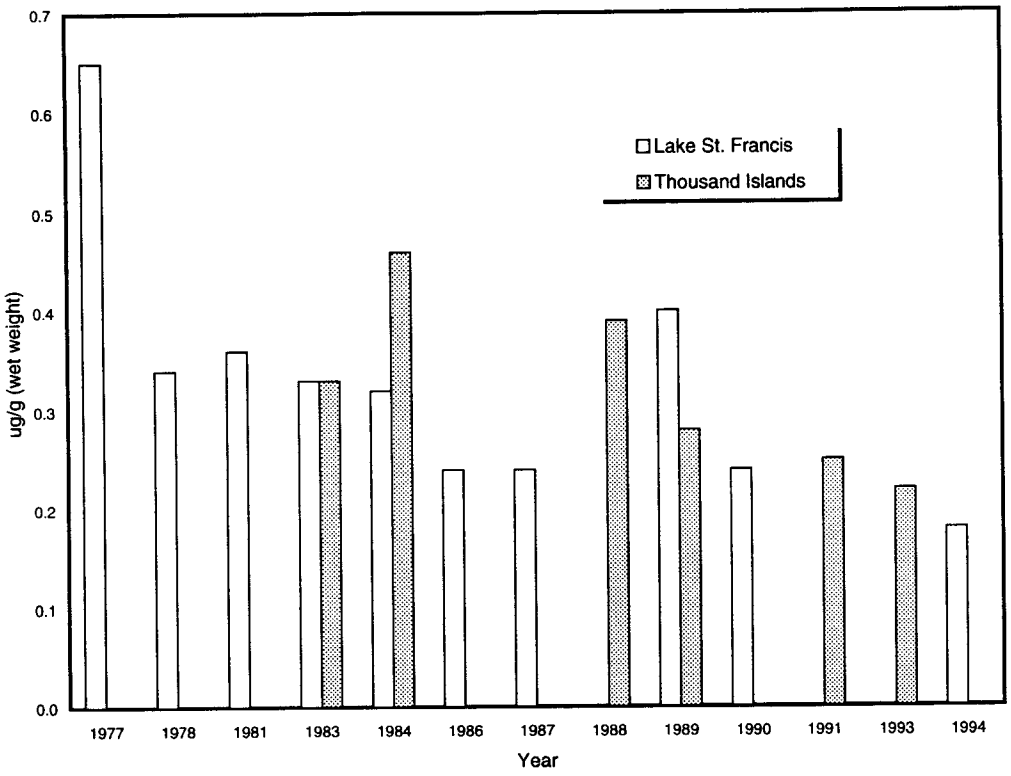


Figure 16: Mean mercury (ug/g wet weight) in 25 cm yellow perch, Lake St. Francis (1977-1994) and Thousand Islands (1983-1993).

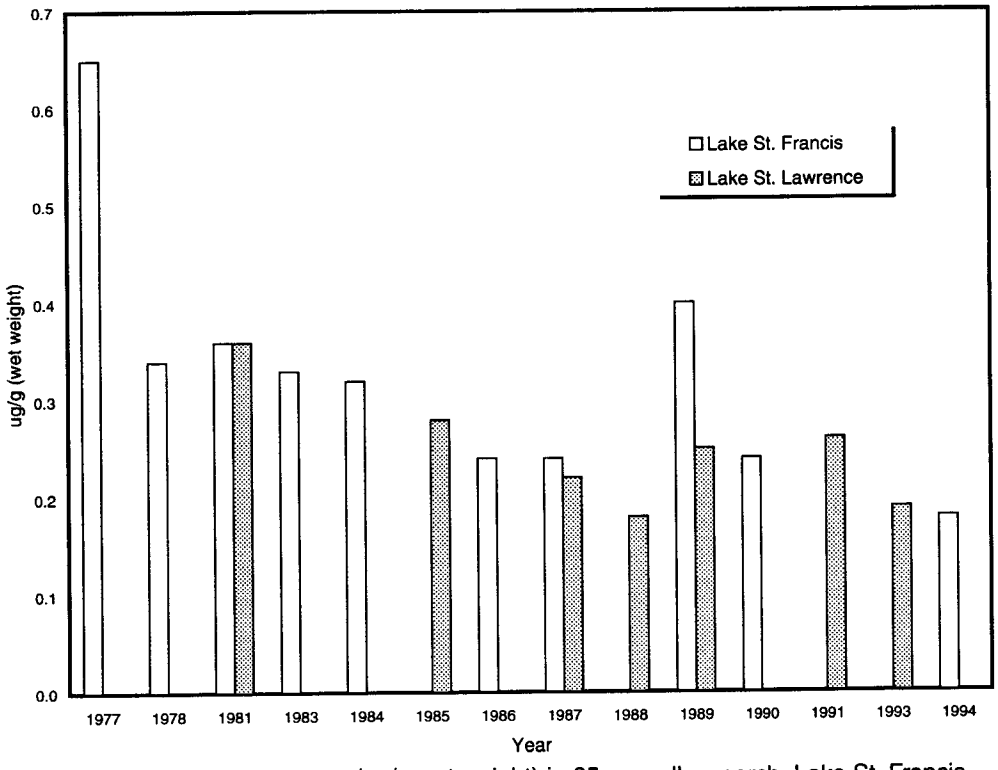


Figure 17: Mean mercury (ug/g wet weight) in 25 cm yellow perch, Lake St. Francis (1977-1994) and Lake St. Lawrence (1981-1993).

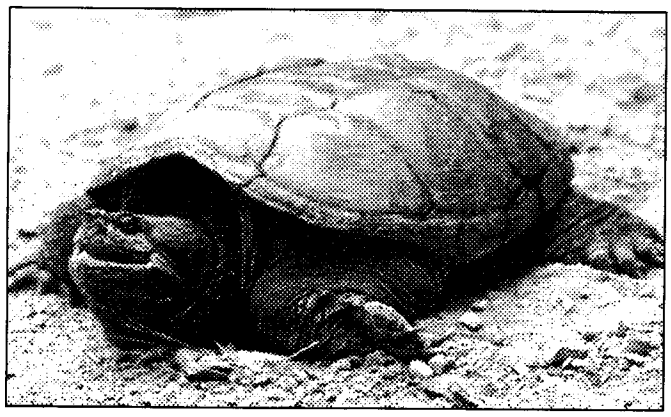
northern pike). The 1994 concentrations in perch appear lower than concentrations in the late 1980s. Additional future sampling is needed to confirm this downward trend.

Mercury concentrations in yellow perch collected from Lake St. Francis were similar to concentrations in fish from the Thousand Islands area and from Lake St. Lawrence (Figures 16 and 17). At times, Lake St. Francis concentrations were lower than fish from the Thousand Islands, with one exception in 1989. Mercury concentrations in yellow perch from Lake St. Lawrence show the same downward trend as seen in Lake St. Francis (MOEE and MNR Sportfish Contaminants Program data files).

Summary

Some sport fish species, such as pike and yellow perch, in the AOC are at or below mercury levels in fish from the upstream control site (Thousand Islands). However, there are still species (walleye) with mercury concentrations above those found in the Thousand islands and above the recommended consumption guidelines (i.e., the use is still impaired in the AOC). Large pike in Ontario generally tend to have high mercury levels (C. Cox, MOEE, pers. comm.) and it is possible that the levels seen in pike in the AOC may not decrease quickly in the future.

Further analyses of mercury concentrations in standard size fish from the AOC and the upstream part of the St. Lawrence River are being undertaken to refine the present information.



Snapping Turtle

5.1.7 Wildlife

A variety of recent studies of tree swallows, red-winged blackbirds, snapping turtle eggs and mudpuppies included tissue analysis for mercury. Samples were collected from areas in the Great Lakes-St. Lawrence River basin, including sites at Akwesasne and along the south shore of the St. Lawrence River near Massena, NY (Bonin *et al.* 1995; Bishop *et al.* 1995, 1996; Gendron *et al.* (in press). (See section 5.8 for more discussion).

5.1.8 Sources of Mercury

A number of Cornwall industries have released mercury for several decades directly to the river through discharge pipes or to the air through stacks. The largest point sources were Courtaulds Fibres (1925 to 1992) and ICI Forest Products, previously CIL (1934 to 1995). Cornwall Chemicals (closed March 31, 1995), Domtar Papers and the Cornwall Water Pollution Control Plant release(d) much smaller amounts of mercury. There are no significant US point sources of mercury in the area of Massena, NY.

ICI Forest Products (closed March 1995)

ICI Forest Products in Cornwall was the last chlor-alkali plant in Ontario to use a mercury cell process. ICI used a mercury cell electrolytic process to convert salt to sodium hydroxide (caustic soda) and chlorine. The plant discharged mercury in its wastewater stream and from ventilation air outlets in the mercury cell rooms. It is not known how much of the mercury that ICI released into the air was deposited in the AOC.

Historically, ICI discharged far more mercury to the river than it was discharging in 1995 when it shut down the chlor-alkali operation. The plant opened in 1934, but the earliest effluent monitoring done by the company and reported to the government was completed in 1970. Losses of about 410 g/day of mercury in liquid effluent were reported in 1970, when production capacity was 130 tons of chlorine per day. Losses of mercury were directly related to production capacity. When the plant started in 1934, the capacity was 24 tons/day; in 1942, 32 tons; 1954, 48 tons; 1956, 120 tons; 1968, 130 tons. Prior to 1960, Ontario's industrial plants and municipalities did little to control their liquid waste discharges to the environment.

Figure 18 shows mean annual discharges of mercury from ICI to air and water between 1970 and 1996. Federal regulations passed in 1972 set the maximum allowable amount of mercury to be discharged in chlor-alkali plant wastewater at 2.5 grams per tonne of chlorine production. For the ICI plant in Cornwall, this made the typical limit for ICI, Cornwall approximately 280 g/day. During the period from 1970 through 1994, the last complete operating year, the discharges to water went from 313 to 21 g/day, and the discharges to air in the period 1973-1996 went from 1435 to 156 g/day. Decreases in the discharges were due to improved pollution control and prevention measures.

Although the chlor-alkali plant was closed in March 1995, there will be discharges until decommissioning has been completed. In 1996 the discharges were an average of 9 g/day to water and 40 g/day to air. ICI is in the process of dismantling and decommissioning the site and will clean contaminated soil under the floor of the chlor-alkali plant to meet the MOEE Guideline for Contaminated Sites.

Cornwall Chemicals (closed 1995)

Until it closed at the end of March 1995, Cornwall Chemicals was one of three operations on site at ICI (ICI Forest Products, Cornwall Chemicals and Stanchem). Cornwall Chemicals manufactured organic and inorganic chemicals using chlorine and sodium hydroxide produced at ICI Forest Products. The plant produced carbon disulphide starting in 1942; sodium hydrosulphide starting in 1948; and carbon tetrachloride starting in 1956. It discharged approximately 3 g/day of mercury (1989-1990 annual average (Tuszynski 1992)), which came from mercury-contaminated caustic used to neutralize effluent and ICI brine used to regenerate water softener for the boilers.

ICI Conpak (Stanchem)

Effluent from ICI Conpak, a plant that packages inorganic chemicals for Stanchem, used to be released with effluent from Cornwall Chemicals. ICI Conpak discharged an average of 0.1 g/day of mercury in 1990. Since the chlor-alkali plant and Cornwall Chemicals have closed, the Conpak plant continues to package sodium hypochlorite, liquid chemicals (acids and bases) and compressed gases.

Courtaulds Fibres (closed November 1992)

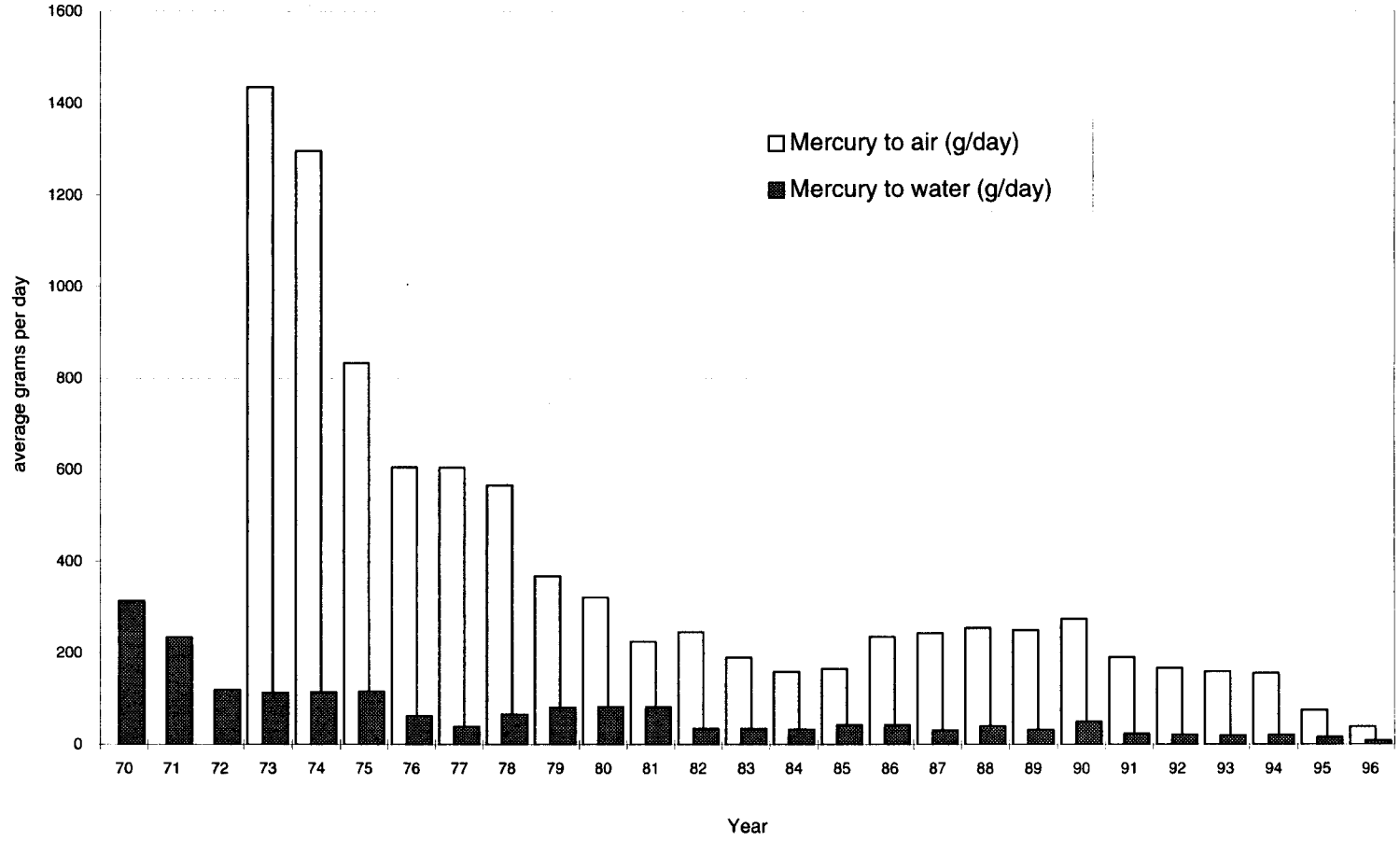
The Courtaulds Fibres rayon factory in Cornwall used large amounts of sodium hydroxide and sulphuric acid in its manufacturing process. Both these chemicals contained minute amounts of mercury. Almost all of the mercury in the sodium hydroxide and sulphuric acid eventually ended up in the plant discharge to the river, making Courtaulds a significant source of mercury to the river.

As a result of pressure by government environmental authorities, Courtaulds reduced its losses of sodium hydroxide and sulphuric acid by means of recycling and reusing, thereby reducing its discharges of mercury. These improvements started in the mid 1970s and continued until the plant was closed in 1992. Courtaulds reduced the amount of mercury discharged by purchasing caustic soda and sulphuric acid that contained less mercury. In 1990 Courtaulds discharged an average of 74 g/day of mercury to the river (Tuszynski 1992). Some of the mercury released at that time came from residual mercury in tanks and piping at the plant. The Ontario government was prepared to regulate the amount of mercury being discharged by the plant at the time of its closure.

Domtar Papers Ltd.

Because Domtar Papers' Cornwall pulp and paper mill releases its effluent in a common diffuser with effluent from Cornwall Chemicals and ICI Forest Products, mercury loadings to the river have often been described as coming from Domtar/ICI/ Cornwall Chemicals, even though the bulk of the mercury was from ICI, with a much smaller proportion from Cornwall Chemicals and Domtar.

In the past, pulp and paper mills used mercury as a slimicide to kill moulds growing on wood fibres. This practice was halted in 1970 at Domtar Papers in Cornwall, and the mill is now a minor discharger of mercury to the St. Lawrence River. The mercury it now discharges comes primarily from naturally occurring mercury in tree bark and from low level contamination of process chemicals. Average daily discharges were in the range of 2 g/day in 1990 (MISA Monitoring 1990) and 1997 (1997 MDL 0.06 µg/L). One value reported in 1997 indicated a load of approximately 30 g/day, but this is an anomalously high finding which



Year	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Mercury to air (g/day)				1435	1297	833	605	604	566	368	321	224	245	189	159	165	235	243	254	249	274	190	167	159	156	75	40
Mercury to water (g/day)	313	234	120	113	114	116	62	40	66	81	82	82	35	35	34	43	43	32	41	33	50	24	21	20	21	17	9

Figure 18: Discharges of mercury to water (1970-1996) and air (1973-1996) from ICI Canada, Cornwall, Ontario (average g/day)

may be an artefact of sampling or analysis (Nick Cox, Domtar Papers, pers. comm.).

City of Cornwall Municipal Sources

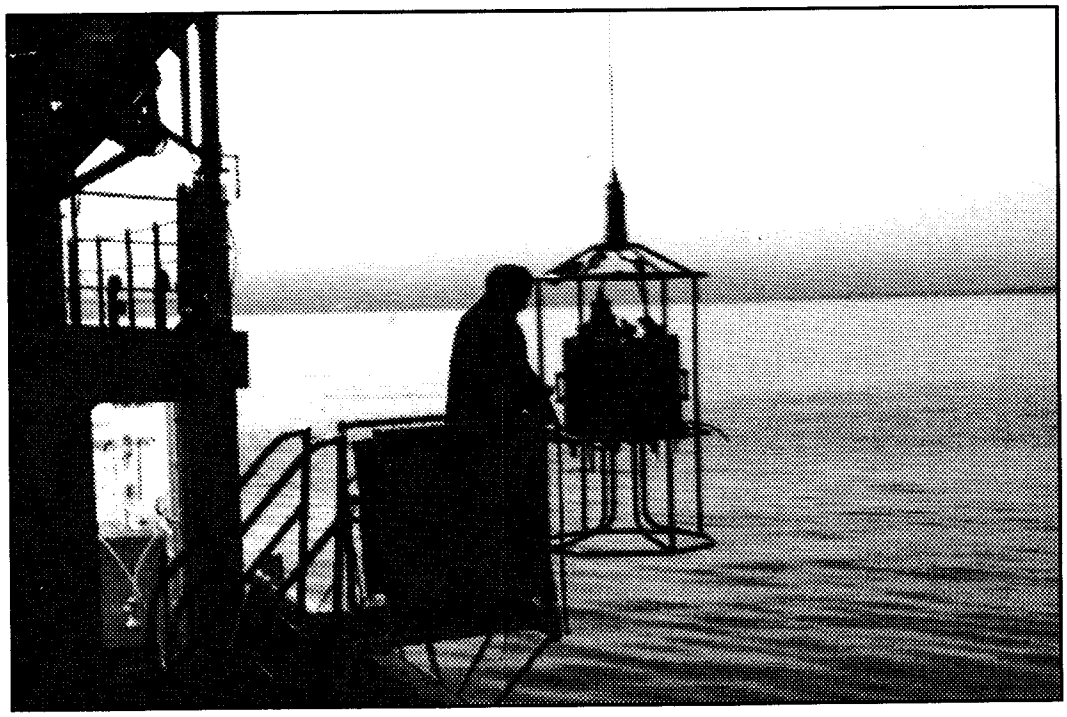
Schroeter & Associates (1993) used a transport-fate model to calculate mercury loadings from municipal sources in the City of Cornwall. The values derived from the model, with its inherent assumptions, were 1.3 g/day from surface runoff, 0.4 g/day from combined sewer overflows and 6.0 g/day from the Cornwall sewage treatment plant giving a total of 7.7 g/day (Schroeter & Associates 1993). It is important to note that these numbers are predicted rather than measured values. Wastewater from dental offices and surface runoff containing atmospheric mercury fallout are possible sources of the mercury in Cornwall WPCP effluent. Mercury loadings from surface runoff and combined sewer overflows should decrease with the shutdown of ICI's chlor-alkali operation and associated reduction in air emissions of mercury.

Contaminated Sediment

In addition to direct discharges of mercury, contaminated sediment in the Cornwall-Massena stretch of the St. Lawrence River may be continually releasing mercury to the food chain. As well, construction of the Beauharnois Dam and the flooding of Lake St. Francis probably resulted in a significant increase in levels of methyl mercury in the aquatic ecosystem of Lake St. Francis. The exact mechanism of mercury release associated with flooding is unknown but it may be related to increased bacterial methylation of naturally occurring mercury in the flooded soil.

Upstream Sources

The load of mercury entering the AOC from upstream sources has been estimated at 85.5 g/day based on calculations using flow and total mercury concentrations in water. This is a calculated estimate only and, as such, should be interpreted with caution (L. Richman, MOEE, pers. comm). Lake St. Lawrence may be a source of mercury due to flooding for creation of the St. Lawrence Seaway.



Water quality surveillance on the Great Lakes

5.2 ISSUE: PCB Contamination

The St. Lawrence River area of concern has been affected by historical releases of PCBs and PCB-contaminated material from three US Superfund sites located at Massena, New York. These releases entered the river either directly as part of the waste stream discharge or indirectly through surface run-off or landfill leachate. As a result, very high concentrations of PCBs have been measured in St. Lawrence River water, sediment and biota collected adjacent to these sites (St. Lawrence RAP Team 1992). The impact of these sites is not restricted to the Massena section of the St. Lawrence River, but continues further downstream in Canadian waters. The south shore of Lake St. Francis has elevated levels of PCBs when compared to levels along the north shore of Lake St. Francis and upstream of Massena.

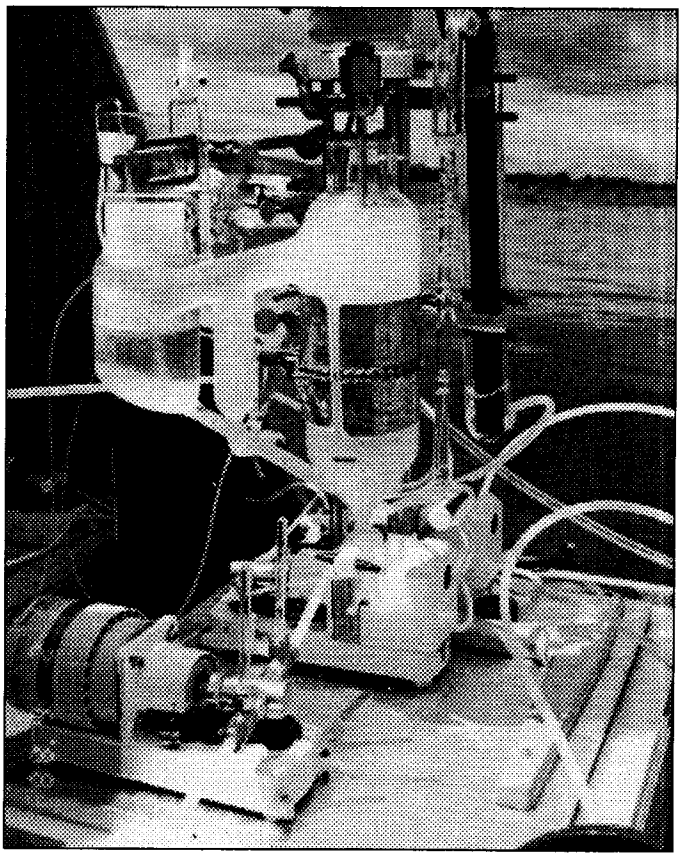
PCB contamination is a serious trans-border pollution issue, to the extent that the Massena RAP added trans-boundary pollution as a fifteenth impairment to the IJC's list of fourteen. While both of the St. Lawrence (Cornwall and Massena) RAPs recognize that PCB contamination crosses the international border, remedial activities can only be accomplished within the respective jurisdictions. Canadian agencies, through a federal/provincial review panel, provide comments and make recommendations to the US federal and state governments on activities related to the three Massena Superfund sites discussed in Section 5.2.8.

In the Canadian area of concern, PCB contamination has resulted in impairment or possible impairment of a number of beneficial uses. It has caused restrictions on consumption of fish and wildlife; transboundary movement of PCBs has the potential to contaminate drinking water obtained from private intakes in the St. Lawrence River; and elevated PCB concentrations may also degrade benthos and cause bird or animal deformities or reproduction problems.

PCB concentrations higher than anywhere in the St. Lawrence River upstream of Cornwall have been observed in river water, bottom sediment, forage fish and sport fish, waterfowl, snapping turtles and native mussels at various locations in the area of concern, predominately along the south shore (St. Lawrence RAP Team 1992; Metcalfe and Charlton 1990; Suns and Hitchin 1991; Suns *et al.* 1993).

5.2.1 Water

The concentration of PCBs entering the AOC in water from the Great Lakes generally meets or slightly exceeds the IJC guideline of 1 ng/L. There are local inputs of PCBs to the river, but the immense flow and dilution capacity of the St. Lawrence River makes significant inputs of PCBs difficult to detect in river water.



Sampling water for PCBs

A 1988 survey conducted by Environment Canada measured significant increases of PCBs, ten times higher than the background concentrations of 1 ng/L, that could be attributed to sources in the Massena area (Anderson and Biberhofer 1991). It is important to note that the high levels were not measured across the entire width of the river and therefore the ten-fold increase in concentration does not equate to a ten-fold increase in the loading of PCBs to the river. Water quality sampling in 1989 and 1990 did not detect the same magnitude of increases from upstream (background) levels to downstream. The analysis of PCB congener data indicates that there is still an input of PCBs attributable to the Massena region, although much less than has been discharged in the past. Continued implementation of the remedial activities at Massena is expected to further reduce these inputs.

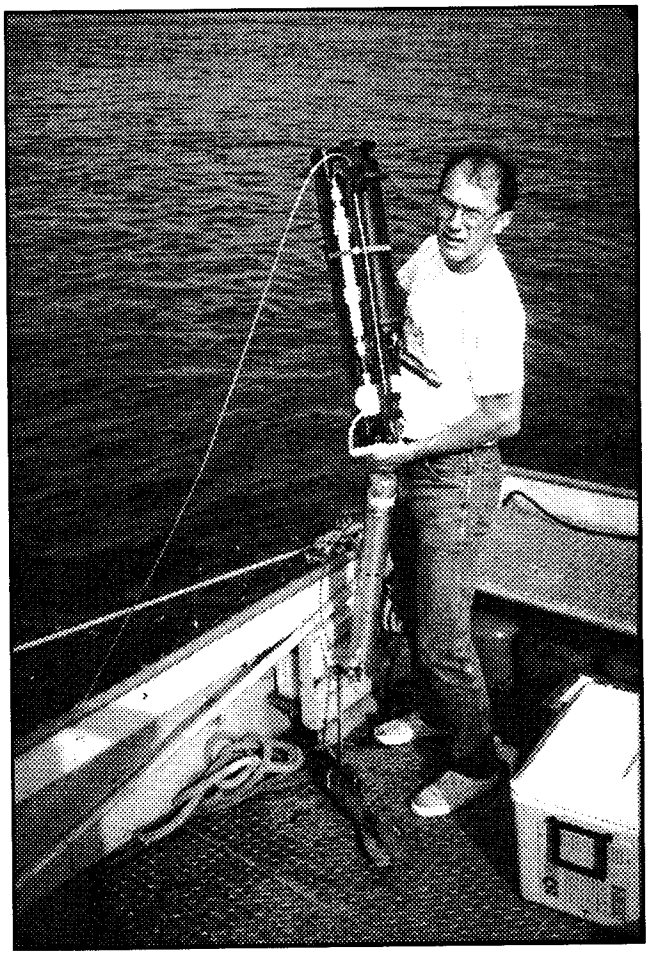
The water treatment plant in Glen Walter, Ontario, constructed in 1989, was designed with carbon filters after modelling of river flow patterns showed that PCBs from American sources could potentially reach the intake. This measure protects Glen Walter's public drinking water supply from PCB contamination, but shoreline residents who obtain their drinking water directly from the river through private intake pipes with home treatment systems risk exposure to PCBs.

The City of Cornwall Water Treatment Plant (WTP) intake is located upstream of the Moses-Saunders Dam and Cornwall/Massena industries and is therefore not susceptible to PCB contamination from those sources.

5.2.2 Suspended Solids

PCBs tend to attach to particulate material suspended in the water column. These suspended solids settle and contribute a major portion of the sediment on the bottom of the river. Local inputs to the river of contaminants such as PCBs are therefore reflected in the measured concentrations of contaminants in the bottom sediment. Enrichment of PCBs in suspended solids has been documented in studies conducted by Environment Canada in 1990 and 1991 which measured elevated levels of PCBs in suspended particulate material collected in the south channel (Comba *et al.* 1995b).

To document the river's response to remedial activities occurring within the AOC, Environment Canada has established a network of Long Term Sensing Sites (LTSS). A component of these stations is a series of suspended sediment traps that sample suspended material moving in the river. Preliminary data indicate that PCB concentrations in suspended solids are still higher along the south shore than in mid-Lake St. Francis or the north shore. A portion of this enrichment can likely be attributed to historical deposits downstream of Massena which are mobilized during high flow periods or other disturbances. As remedial activities at Massena continue, it is anticipated that these PCB concentrations will be further reduced.



Water and suspended solids sampling

5.2.3 Bottom Sediment

Bottom sediment has accumulated PCBs to high concentrations (in excess of 10,000 ng/g) in depositional areas downstream of local sources in the St. Lawrence River along the south shore of Lake St. Francis. Sediment at sites adjacent to the industrial facilities (see Section 5.2.8) continues to be elevated along the south shore. PCB-contaminated bottom sediment acts as an ongoing source of PCBs, which can be transported by erosion and resuspension or can move into the food chain through uptake by organisms living in or near the sediment.

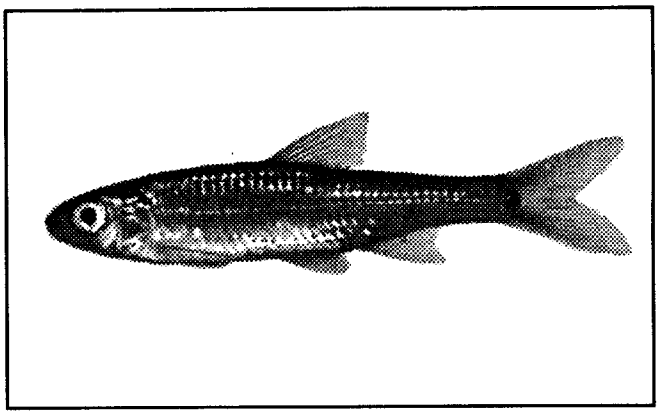
In 1985, Environment Ontario surveyed bottom sediment in the St. Lawrence River area of concern (Anderson 1990). PCB concentrations were highest at stations in the south channel of the St. Lawrence River and at one station in the north channel. The maximum PCB concentration observed on the US side of the river was over ten times higher than the maximum on the Canadian side (13,750 ng/g near the GM plant compared with 1010 ng/g near the Courtaulds outfall).

Similar results were found in a 1992 MOEE survey. The highest concentrations of PCBs were found in sediment collected from the south channel, particularly in front of GM (maximum concentration 23,600 ng/g), downstream of Reynolds (median concentration 570 ng/g) and at the mouth of the Grasse River (median concentration 240 ng/g). High PCB concentrations were also found in Lake St. Francis along the south shore at Ile Christatie (median concentration 700 ng/g). Generally, concentrations were lower than values reported in 1985. The 1992 survey, which included eight stations from the north channel and north shore of Lake St. Francis as far as Point Mouillée, found that concentrations of PCBs were below the MOEE detection limit of 20 ng/g at all stations. Previously unpublished data tables from the 1992 MOEE survey are included as Appendix VI in this report.

Comprehensive studies of Lake St. Francis sediment conducted by Environment Canada in 1979 and 1989 showed that PCB concentrations decreased significantly throughout Lake St. Francis over that decade (Lorrain *et al.* 1993). This is consistent with eastern Lake St. Francis core data reported by Carignan *et al.* (1994), which shows a decline in sediment PCB concentrations in the northern portion of Lake St. Francis since the 1960s, at a sampling site that reflects sediment contamination related to north shore point sources. Flow patterns in Lake St. Francis separate contamination along the north and south shores, with south shore sediment contamination considered to reflect Massena point sources and contaminants from north shore sources tending to accumulate in sediment along the north shore (Carignan et al. 1994).

5.2.4 Spottail Shiners

The limited home range (~ 1 km^2) of young-of-the-year spottail shiners *(Notropis hudsonius)* makes these fish valuable biological indicators for investigating point sources of specific contaminants. Young-of-the-year spottail shiners collected between 1979 and 1996 near Massena on the south shore contained more PCBs than fish from the north shore (Suns and Hitchin 1991; Suns *et al.* 1993; Comba *et al.* 1993; Comba *et al.* 1995a). Spottails collected from the mouths of the Grasse and Raquette Rivers and from sites near the GM and Reynolds Metals Co. plants contained higher concentrations of PCBs than spottails from anywhere else in the Great Lakes basin.



Spottail shiner

Although concentrations are still high in spottails collected from the south channel (up to more than 4700 ng/g in the Grasse River and 2500 ng/g in front of Reynolds Metals), more recent data from 1990-1994 indicate that concentrations of PCBs have decreased. Mean

concentrations in spottails collected from the Raquette River were 1837±455 ng/g in 1988 and 1203±402 ng/g in 1989. Mean PCB concentrations in spottails from the Raquette River had decreased to 261±31 ng/g in 1991 and 259±21 ng/g in 1994 (Suns *et al.* 1993; Comba *et al.* 1995a). The Great Lakes Water Quality Agreement total PCBs guideline for the protection of birds and other wildlife which consume fish is 100 ng/g wet weight (Canada and United States 1987).

Spottail shiners collected from as far downstream as Point Dupuis (see Figure 10) were contaminated with PCBs showing the same congener-specific patterns as spottails collected in the south channel. The congener patterns link the contamination to the major sources in the Massena area. This congener-specific pattern is different for fish collected from the north channel and fish collected upstream of Massena at the reference site in Lake St. Lawrence (MacDonnell Island).

Spottail shiners collected from some locations in the north channel have shown elevated concentrations of PCBs relative to the upstream reference station (MacDonnell Island). These results have been inconsistent over time, however, and in some cases there is high variability in the results. For example, concentrations of PCBs in spottails from the Cornwall marina site near the Civic Complex have been variable since 1979, with concentrations ranging from relatively high values of 367±100 ng/g in 1980 to low levels in 1987 (37±26 ng/g). From 1991 to 1994 PCB concentrations ranged from 251±143 ng/g to 140±8 ng/g. Samples have been collected from this site annually for 11 years. Throughout this period concentrations of PCBs in spottails collected from the marina were, at times, greater than those found in fish from the reference station and, at other times, similar to those found in spottails from the reference station.

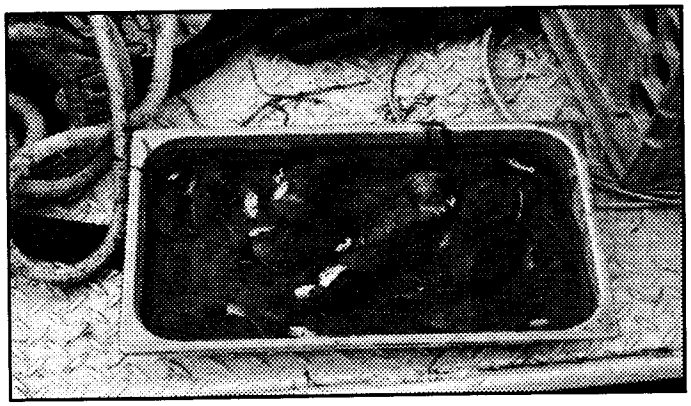
Since 1990, concentrations of PCBs in spottails collected from Pilon Island and Thompson Island have been variable (Suns and Hitchin 1991; Suns et al. 1993; Comba et al. 1993; Comba et al. 1995a; MOEE unpublished data). Total PCB concentration in spottails collected from Pilon Island was 62±21 ng/g in 1990; 115±16 ng/g in 1994; 202 ng/g in 1995 (only one composite sample was analyzed in 1995); and 48±18 ng/g in 1996. At Thompson Island, total PCB concentration in spottail shiners was 38±22 ng/g in 1990; 180±40 ng/g in 1992; undetectable in 1993; 150±12 ng/g in 1994; and 34±13 ng/g in 1996.

Fish collected further downstream near Point Mouillée in Lake St. Francis have relatively low concentrations of PCBs .

5.2.5 Indigenous Mussels

Indigenous freshwater mussels (Elliptio complanata) are unable to break down PCBs and this results in a net accumulation of PCBs–measured as body burden–in the animal. Moreover, the congener-specific PCB profile within a mussel tends to resemble the profile of PCBs to which it has been exposed. These factors make E. complanata a useful biomonitor of PCBs in the St. Lawrence River.

In 1985, two species of native mussel *(Elliptio complanata* and *Lampsilis radiata)* were collected from 17 stations in the St. Lawrence River between Lake Ontario and Trois Rivières and from 3 stations in the Ottawa River (Metcalfe and Charlton 1990). Mussels were analyzed individually for a variety of chemical contaminants including 63 PCB congeners. PCBs were highest in mussels from New York waters and undetectable in mussels from Canadian waters. Mussels from the mouth of the Grasse River had the highest concentration of PCBs (492 ng/g) and contained additional PCB congeners not present in mussels collected further upstream, indicating a local source of PCBs in the Cornwall-Massena area.



Collection of freshwater mussels

As part of a 1992 MOEE sediment survey, indigenous mussels were collected from 17 stations in the north and south channels of the St. Lawrence River and from Lake St. Francis. Results of the survey are included in this report as Appendix VI (PCB Data Tables, MOEE 1992 Survey). Sampling locations are shown in Figure 19.

In the 1992 survey, high PCB concentrations were detected in mussels collected from the mouth of the Grasse River (median concentration 260 ng/g), downstream of Reynolds (median concentration 470 ng/g) and in front of GM (median concentration 2670 ng/g), consistent with high concentrations of PCBs in sediment from these sites. Lower concentrations were detected in mussels from the south side of St. Regis Island (median concentration 60 ng/g) and Ile Christatie (median concentration 100 ng/g). Mussels collected from stations further downstream (Point Dupuis, Point Génier, Ile Grenadier and Baie des Brises) did not have detectable concentrations of PCBs (MOEE detection limit 20 ng/g). Mussels collected from the north channel and from the north shore further downstream in Lake St. Francis as far as Point Mouillée all had PCB concentrations below the detection limit, with the exception of two mussels collected downstream of Domtar (60 ng/g and 80 ng/g) (see Appendix VI).

Since 1990, Environment Canada has maintained a network of 14 mussel monitoring sites within the Cornwall/Massena reach of the St. Lawrence River (Figure 20). Sites were selected to provide information on the impacts of any PCB releases from Cornwall or Massena. Mussels of a specific size range (*i.e.*, age) have been collected annually in mid- to late-fall. Patterns of PCB body burdens and congener profiles in the mussels confirm that the mussels are affected by local sources of PCBs and the impact can be seen at considerable distances downstream. Congener profiles in the mussels show enrichment with lower chlorinated PCBs, which indicates a local PCB source since background PCB congener profiles ("weathered PCBs") tend to be dominated by the more highly chlorinated and environmentally stable PCBs.

5.2.6 Sportfish

Contamination with PCBs and mercury has caused restrictions on consumption of a number of sportfish species in the area of concern. The federal department of Health & Welfare advises against consuming fish containing more than 2 µg PCBs/g muscle tissue (wet weight). Due to PCB concentrations exceeding this guideline, consumption restrictions have been advised for sturgeon and channel catfish in the St. Lawrence River (Cornwall) area of concern. As well, the commercial eel fishery is restricted to eels below 680 grams in weight and the carp fishery has been closed for several years (1979, 1980, 1982 and 1986-present).

The Akwesasne fishery has been severely affected by consumption advisories based on mercury and PCB content. Since 1978 the Mohawk Governments of Akwesasne have advised women of child bearing age and children under the age of 15 not to consume any fish species taken from the St. Lawrence River.

Appendix V shows consumption restrictions on sport fish within the area of concern as indicated in the 1997-1998 *Guide to Eating Ontario Sport Fish*. While there are other contaminants in fish, these advisories are the result of mercury and PCB contamination.

5.2.7 Wildlife

PCB contamination of wildlife has not been extensively studied. Three snapping turtles collected on Cornwall Island in 1988 by the Ontario Ministry of Natural Resources (MNR) contained PCBs at concentrations above federal fish consumption guidelines (Hebert *et al.* 1993). As a consequence, both MNR and the Mohawk Governments of Akwesasne have advised against eating snapping turtles from the area of concern.

Snapping turtle eggs have also been collected from areas upstream and downstream of the Cornwall area from Hoople Creek; Long Sault; Grays Creek above the Dam and Raquette River; St. Regis River; and marshes in Akwesasne along Lake St. Francis (Struger *et al*, 1994; Bonin *et al*, 1995; Bishop *et al*, 1996).

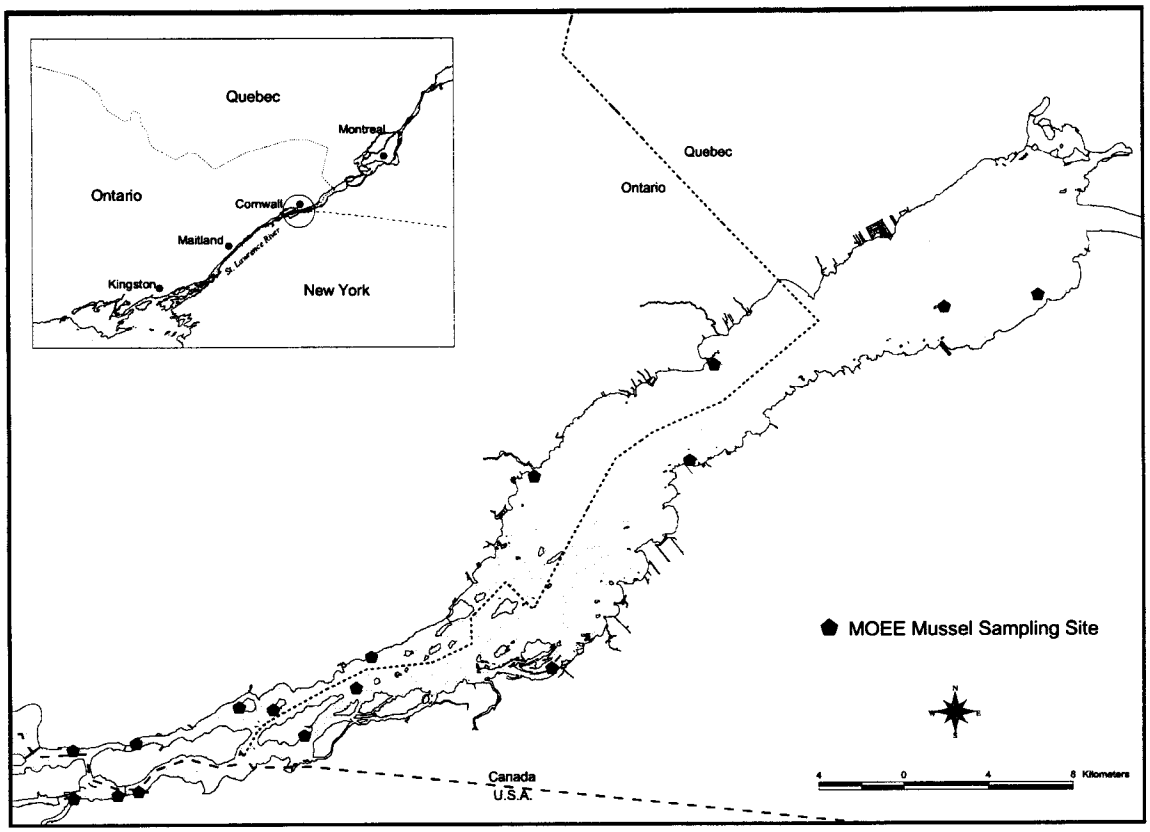


Figure 19: Sampling stations, 1992 MOEE survey of indigenous mussels and sediment, St. Lawrence River at Cornwall (previously unpublished, see data tables in Appendix VI).

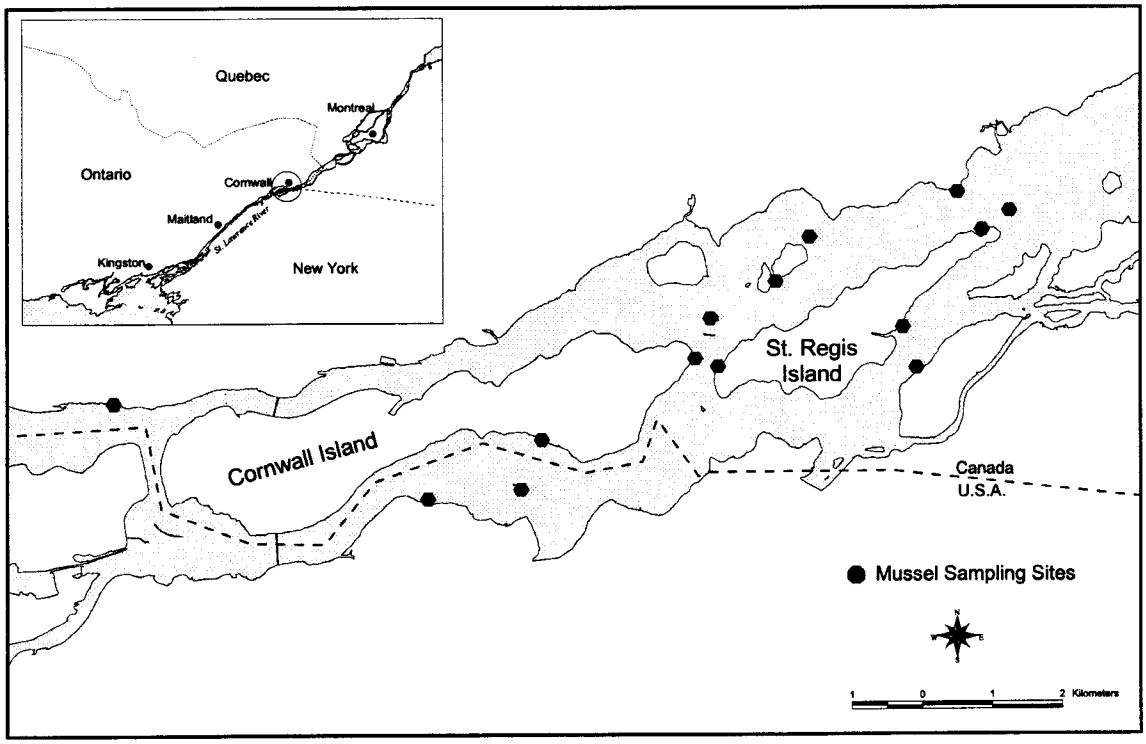


Figure 20: Environment Canada mussel monitoring sites, St. Lawrence River, Cornwall/Massena reach.

PCB concentrations upstream of the dam were elevated compared to sites in Lake Erie and some sites in Lake Ontario other than Hamilton and Lynde Creek. However, turtle eggs from upstream of the dam were much less contaminated than the eggs from Massena. Turtle eggs from Massena showed total rates of developmental problems (deformed young plus unhatched eggs) that were twice those of the control area, Algonquin Park. However, probably due to variability in the success among clutches at Massena the rates were not significantly higher than at Algonquin Park.

Lake St. Francis waterfowl contain significant levels of PCBs. The highest levels found in the Great Lakes basin were observed in mallards (29.4 ng/g wet weight) in 1988 and greater scaup (558.6 ng/g wet weight) in the fall of 1989 (Braune, in prep.). There are no consumption guidelines for waterfowl with respect to PCB content and Health Canada advises against the use of poultry guidelines as an alternative.

Several recent studies have examined PCB contamination in wildlife from sites around the Great Lakes-St. Lawrence River basin, including sites at Akwesasne and along the south shore of the St. Lawrence River near Massena, NY. Tissues analyzed were from tree swallows, red-winged blackbirds and snapping turtle eggs (Struger *et al.* 1993; Bonin *et al.* 1995; Bishop *et al.* 1995; Bishop *et al.*, in prep.*a*, in prep.*b*; Gendron *et al.*, in prep.; Gendron *et al.*, in press). (See section 5.8 for more discussion).

5.2.8 Sources of PCBs

The main sources of PCBs in the area of concern are three large industrial facilities near Massena, New York: Aluminum Company of America (ALCOA), General Motors Powertrain Division (GM) and Reynolds Metals Co.. These industries and the rivers adjacent to their properties have been designated as Superfund sites by either the US Environmental Protection Agency (USEPA) or New York State Department of Environmental Conservation (NYSDEC). This designation legally requires the industries to design and implement remedial measures that will reduce the environmental risk posed by the sites to levels acceptable by federal, state and St. Regis tribal jurisdictions (with public and Canadian government input).

All three sites are currently engaged in land-based remedial activities, and in late 1995 General Motors removed close to 25,000 cubic metres of PCB-contaminated sediment from the St. Lawrence River. Reynolds Metals is preparing plans to remove the contaminated sediment in the St. Lawrence River adjacent to the plant site and ALCOA has completed a limited dredging operation near its outfall in the Grasse River and is preparing plans to address downstream contamination in the Grasse River.

Loading from the daily operations of these sites is also under review, with non-detectable as the targeted permissible discharge of PCBs (using a detection limit of 65 ng/L for each PCB congener). ALCOA and General Motors are implementing water management programs that will significantly reduce the amount of water used in their industrial processes, thereby reducing the amount of water that has to be treated.

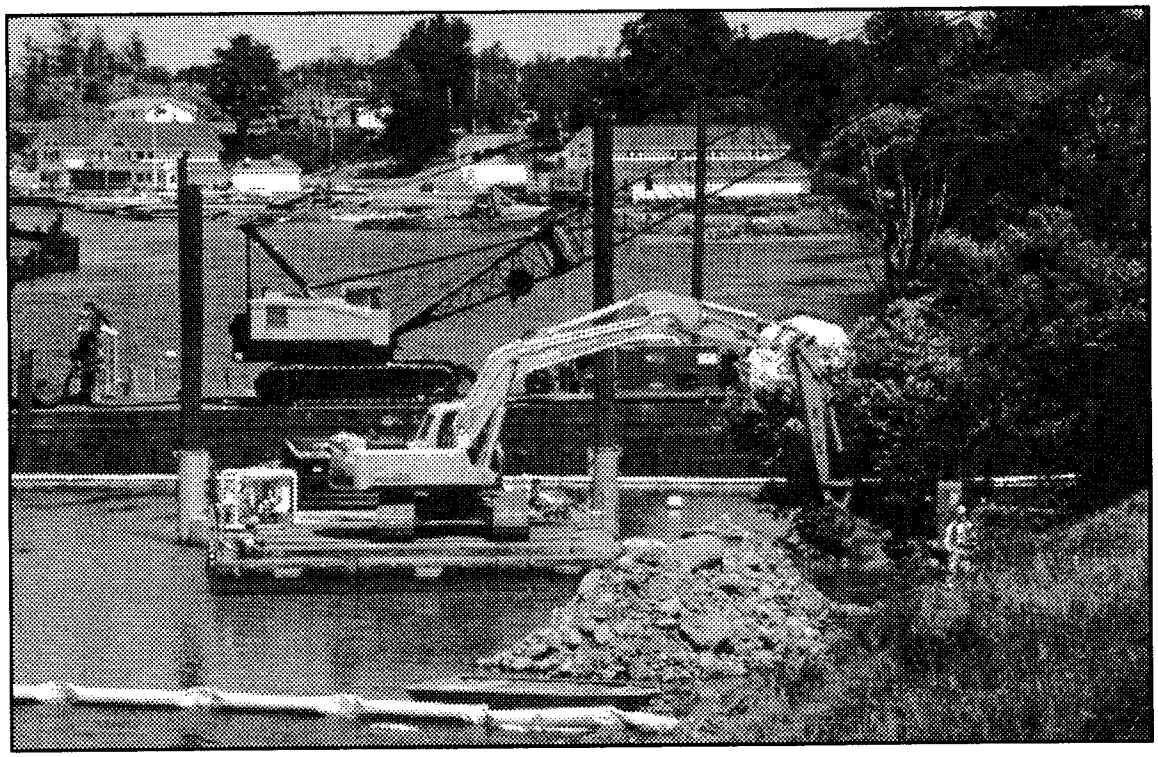
Data on historical PCB loadings from these US sources are limited. SPDES (State Pollutant Discharge Elimination System) did not include PCBs in their permits until recently. New York State's Department of Environmental Conservation estimated 1989 total annual PCB discharges from the three industries as 12.45 kg/year from ALCOA, 1.16 kg/year from Reynolds Metals Co. and 0.02 kg/year from General Motors. These estimates reflect permitted PCB discharges from the industrial outfalls after controls were put in place (NYSDEC 1990). PCB loadings to the St. Lawrence River from the industrial sites through surface runoff and groundwater cannot be measured and are not reflected in the 1989 loading estimates.

Upstream sources within the Great Lakes basin also contribute to the PCBs found in the St. Lawrence River. In Canada, the manufacture and use of PCBs was banned in 1978. There are no known discharges of PCBs on the Canadian side of the river, although in the past there were industrial and municipal discharges of these compounds.

5.2 PCB Contamination

The amount of data on PCBs in Cornwall effluent (summarized in Table 5) is very limited. These data indicate that there could be areas of sediment in the north channel that are contaminated with PCBs from historical discharges. This should be investigated further in light of elevated PCB concentrations that have been observed at times in spottail shiners collected from the north channel as described in Section 5.2.4.

Since the PCB ban, most PCB-containing equipment in the Cornwall area has been removed from service and placed in storage facilities which are regulated by law and regularly inspected by Ontario Ministry of Environment and Energy staff. All known PCB-contaminated materials have been removed from the ICI-Cornwall Chemicals and Domtar sites. At one time there were 10 PCB storage facilities in Cornwall. In the last few years, several sites have been closed as the material stored in them has been decontaminated. There are now 5 active storage sites in Cornwall.



Removing contaminated sediment

Table 5. Total PCBs in Cornwall effluent (g/day) in 1979 and 1980 (Kauss *et al.* 1988), 1988 (Anderson and Biberhofer 1991), 1990 (Ryan and Edmonds 1992), 1994-1996 (MOEE Data Files) and 1997 (N. Cox, Domtar Papers, pers. comm.).

Year (Month)	Sample Site (g/day)	Total PCBs
1979	Domtar CIL Cornwall Chem Courtaulds Cornwall WPCP	58 (N=4) 1.7 (N=4) 0.1 (N=4) 1.3 (N=4) 0.9 (N=4)
1980	Domtar CIL/Cornwall Chem Courtaulds Cornwall WPCP	16.3 (N=9) 0.3 (N=9) no data 0.4 (N=3)
1988 * (Jun & Sep)	Domtar/CIL Courtaulds Cornwall WPCP	ND ND ND
1990	ICI Forest Products ICI Conpak	0.3 0.002
1994 (Nov)	ICI Forest Products ICI Conpak	ND ND
1995 (Oct)	ICI Forest Products ICI Conpak Cornwall Chem	ND ND ND
1996 (Jun)	ICI Forest Products ICI Conpak Cornwall Chem	ND ND ND
1997 (Jan)	Domtar	tentatively detected **

* June and Sept 1988 data are from 24-hour composite sample (N=1)
** further investigation required
N number of samples
ND not detected

Note to Reader: This table has been compiled using data from a variety of monitoring programs. Each program had different sampling and analytical capabilities and requirements and the data should be interpreted accordingly.

5.3 ISSUE: Presence of Other Contaminants

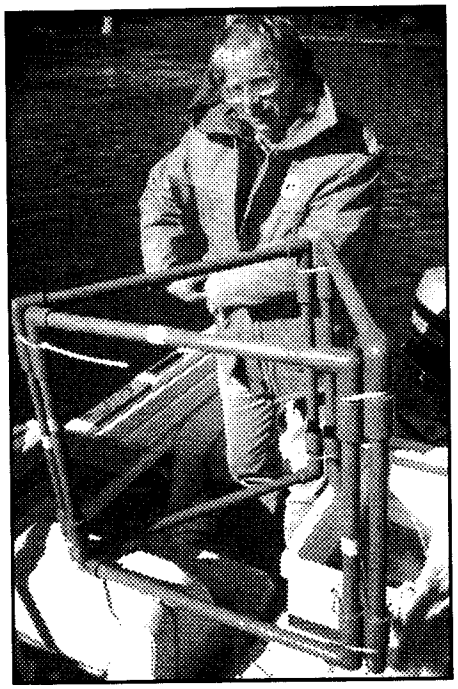
The Cornwall-Massena section of the St. Lawrence River contains many other contaminants in addition to mercury and PCBs. Some are discharged by local industries and others enter the St. Lawrence River in water from Lake Ontario. Contaminants other than mercury and PCBs that have been found in the area of concern at concentrations higher than recommended guidelines include: phenolics, oils and greases, polynuclear aromatic hydrocarbons (PAHs), dioxins and furans, and various metals.

5.3.1 Phenolics and Fish Tainting

The Cornwall section of the St. Lawrence River was identified as an area of concern partly because a study in 1964 indicated that water from this part of the river caused tainting in several types of fish, including perch and walleye (Swabey 1964). Tainting occurred over a distance of at least 20 km downstream of Cornwall. Because the tainted flavour was similar to the odour of Domtar effluent, it was inferred that Domtar's discharges were responsible for the problem.

The subsequent installation of an effluent diffuser by Domtar in 1971, followed by shutdown of the sulphite mill and construction of a clarifier in 1972, helped reduce the size of the zone affected by tainting substances. Findlay and Naish (1979) determined that certain phenols, resin acids and sulphur compounds were potential tainting agents in Domtar effluent, and in 1983 Domtar carried out a study which showed that its effluent could cause tainting at concentrations of 0.25-0.40% (Findlay *et al.* 1983).

It is not clear whether tainting is still a problem. A 1988 survey of 800 anglers on Lake St. Francis failed to find a significant number who thought fish flavour was tainted (MNR 1989). Controlled taste tests of fish caught upstream and downstream of the Domtar diffuser in 1990 provided inconclusive results (Jardine 1992).



Fish tainting experiment

In 1994 Domtar spent $61 million on the construction of a facility to provide secondary treatment of its wastewater. The facility began operating in February 1995 and it was expected that secondary treatment would reduce or eliminate phenolics that have the potential to cause tainting. A 1997 study of rainbow trout indicated no significant difference ($p>0.05$) in taste between control fish exposed to laboratory dilution water and fish exposed to Domtar final effluent diluted to 0.5 or 5.0% (V. Naish, Domtar Research, Technical memorandum: September 15, 1997). An effluent concentration of 0.5% is above the maximum concentration in the St. Lawrence River at the point of discharge and 5% concentration is ten-fold higher than the concentration of effluent in the receiving water (Ecological Services for Planning 1996).

5.3.2 Oils and Greases

In 1985, oils and greases exceeded Ontario's guideline for open water disposal of dredged material (1500 µg/g) in 74% of bottom sediment samples collected from the north shore and 33% of samples from the south shore of the St. Lawrence River in the area of Cornwall and Massena (Anderson 1990). Concentrations were especially high at three areas along the north shore: (1) an area extending from the Domtar/ICI/Cornwall Chemicals diffuser to St. Regis Island; (2) just downstream of Courtaulds/BCL; and (3) in front of Universal Terminals at Cornwall Harbour.

In the 1985 survey, the highest concentration of oils and greases (16,748 µg/g) was found in an area just downstream of Courtaulds where metal concentrations were also very high and where the benthic community was degraded (Anderson 1990). More recent data from a sediment survey in 1994 confirm high concentrations of oil and grease along the waterfront downstream of Courtaulds Fibres. Concentrations in 1994 ranged from 930-15,307 µg/g in surface sediment and core samples. The median value for the data set was 2849 µg/g (Richman 1996).

Sediment samples collected immediately downstream of Universal Terminals at the Cornwall waterfront in 1985 contained up to 2940 µg/g oils and greases. Species richness was poor in the sediment at this site and only pollution-tolerant species were common. The sediment was soaked with oil and tar, which would likely restrict benthos to the upper layers of sediment where some oxygen would be available to them (Anderson 1990).

More recent samples collected in 1993 from the area immediately downstream of Universal Terminals contained oils and greases at concentrations ranging from 180-6000 µg/g (Metcalfe-Smith *et al.* 1995). However, bioassays showed toxicity in sediment samples from only a few stations, and these were only slightly toxic to laboratory test organisms in sublethal tests. As well, the composition of the resident benthic community was found to be minimally impacted by sediment contamination, based on abundance of organisms and number of taxa (Metcalfe-Smith *et al.* 1995).

Thick, black deposits of heavy oil and grease that have been noted along the Cornwall waterfront may consist of the heavy fuel oil, Bunker 'C'. In contrast, the kinds of oils and greases that are present at low concentrations in effluent from local industries and the Cornwall sewage treatment plant are light enough to remain afloat and would in time be broken down by bacteria. The source of the heavy oil and grease deposits is therefore unknown; they may have come from historical spills. Heavy oils and greases have been stored, used or transferred between land and water vessels (loaded/unloaded) at several sites along the Cornwall waterfront: Domtar/ICI/Cornwall Chemicals, Courtaulds Fibres Ltd. and the Cornwall Public Port facility at Harbour Road.

MOEE files document past spills to the river at Domtar and Courtaulds. In the early 1980s, there was a spill of several hundred gallons of Bunker 'C' into the Cornwall Canal. Heavy oil coated rocks and collected in small embayments along the Cornwall waterfront. Domtar hired a contractor to do a clean-up. At Courtaulds, an unknown quantity of Bunker 'C' was spilled in 1969. Ontario Water Resources Commission conducted an investigation after receiving complaints from the public. Another spill of 200-300 gallons (900-1500 L) occurred at Courtaulds in 1971.

A Phase I audit of Cornwall's Public Port facility on Harbour Road was conducted in 1993 by the owner of the property (Transport Canada). The port facility has wharves on the St. Lawrence River which can accommodate Seaway draught vessels, although the port is not actually situated in the St. Lawrence Seaway. The site is leased to the following companies: Universal Terminals Ltd., Valley Terminals and Warehousing Inc., Cornwall Storage and Warehousing Ltd., and Cornwall Street Light and Power Co. Ltd. (Canadian Coast Guard 1993).

Fuel oil and gasoline have been stored at Universal Terminals since the St. Lawrence Seaway opened in 1958. During construction of the Seaway (1954-1958) Bunker 'C' was loaded onto dredges from the Universal Terminals land site. Universal Terminals currently stores diesel fuel on-site and has done so since the late 1950s. Diesel fuel

Table 6. Average daily discharges of oils & greases (kg/day) measured from Cornwall point sources during MISA Twelve-Month Monitoring, 1989-1991.

Industry	Average loading (kg O&G/day)	Time period of averaging	Reference
Courtaulds Fibres	727.3	Oct 1/89 -Sep 30/90	Tuszynski (1992) (MISA Monitoring)
Domtar Papers	oils & greases not measured		
Cornwall WPCP	oils & greases not measured	Oct 1/89 -Sep 30/90	
Cornwall Chemicals	3.2	Dec 1/89 -Nov 30/90 Feb 1/90 -Jan 31/91	Tuszynski (1992) (MISA Monitoring)
ICI Forest Products	6.8	Dec 1/89 -Nov 30/90 Feb 1/90 -Jan 31/91	Ryan and Edmonds (1992) (MISA Monitoring)
ICI Conpak	0.1		Ryan and Edmonds (1992) (MISA Monitoring)

Note to Reader: This table has been compiled using data from a variety of monitoring programs. Each program had different sampling and analytical capabilities and requirements and the data should be interpreted accordingly.

contains a range of hydrocarbons similar to those detected in samples of sediment collected by MOEE in 1992 from the St. Lawrence River in the area of Universal Terminals (Canadian Coast Guard 1993).

The Phase I audit of the Cornwall Public Port consisted of site investigations, interviews with lessees and a review of environmental records. No samples of any kind were collected during the Phase I investigations. A Phase II study showed areas of the land site contaminated with total petroleum hydrocarbons. Supplemental investigations have been completed and a remedial plan is being developed for the site.

5.3.3 PAHs (polynuclear aromatic hydrocarbons)

PAHs were detected in 1988 in the effluent of Domtar/ICI/Cornwall Chemicals, Courtaulds Fibres (closed 1992), Courtaulds Films (closed 1989) and the Cornwall sewage treatment plant, although total PAH concentrations were not elevated in suspended solids collected downstream of these discharges (Anderson and Biberhofer 1991).

MISA Monitoring in 1990 (OMOE 1991a, 1991b) revealed that the effluent from Domtar's Cornwall plant contained higher levels of PAHs than any other pulp and paper mill in Ontario. Domtar frequently reports small oil spills and leaks, and these likely contain PAHs. A special study is

Table 7. Concentration of PAHs (µg/L) in Domtar effluent, January 1997 (N. Cox, Domtar Papers, pers. comm.).

PAH	After primary treatment	After secondary treatment	MDL
benzo(a)anthracene	1.9	0.30	0.2
chrysene	2.3	0.40	0.3
fluoranthene	9.9	2.6	0.2
phenanthrene	21.0	6.4	0.3
pyrene	4.6	1.3	0.3

MDL=method detection limit

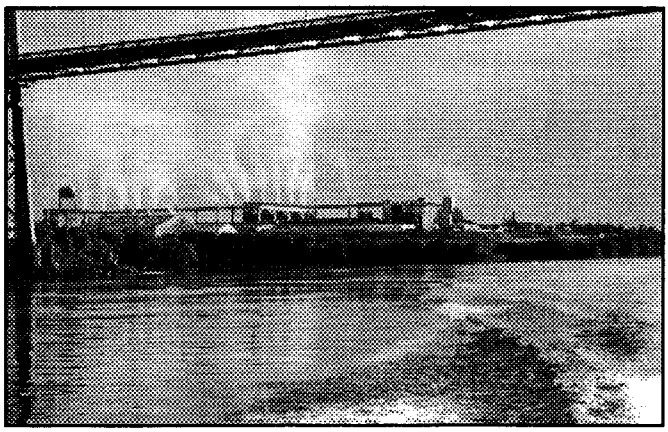
Note to reader: Current regulations and objectives for PAHs are based on concentrations. Regulatory agencies are in the process of developing objectives based on toxicity of PAHs in order to accurately reflect the cumulative toxicity of multiple PAHs in a medium (e.g., sediment, effluent, soil).

being planned to address this issue (see St. Lawrence River RAP Recommendation #10 in Chapter 6). Table 7 shows concentrations of PAHs measured in Domtar effluent in January 1997.

The most significant point sources of PAHs in the Cornwall/Massena section of the St. Lawrence River are Reynolds Metals Co. and ALCOA near Massena, NY. High concentrations of PAHs are common in effluent from aluminum smelting plants (Environment Canada and Health Canada 1994).

In 1994, a total of 63 sediment core samples and 16 surface grab samples were collected from the area downstream of Courtaulds (Richman 1996). For PAHs, although there was evidence of a local source, concentrations were generally similar to values typically found in industrialized areas in the Great Lakes basin. Total PAH concentrations were below the lowest effect level (LEL) of 4 µg/g in fifty-one percent of core tops (*i.e.*, samples for which the top 10 cm of sediment was analyzed). In the remainder of the core tops, concentrations were above the LEL and mostly ranged from 4-10 µg/g, with a few stations having core top sediment concentrations ranging from 10-14 µg/g. Two stations had concentrations as high as 18-20 µg/g, which is considerably below the severe effect level (SEL) for total PAHs (calculated as 123 and 360 µg/g, respectively at those two stations).

The highest proportion of total PAHs throughout the 1994 study area was attributable to fluoranthene, phenanthrene and pyrene. At most stations there were also higher concentrations of chrysene and benzo(a)anthracene compared with the other PAHs analyzed. Figure 21 shows the distribution profile of the PAHs in sediment from a selected station (station 14) in the 1994 survey (Richman 1996).



Reynolds Metals, Massena, New York

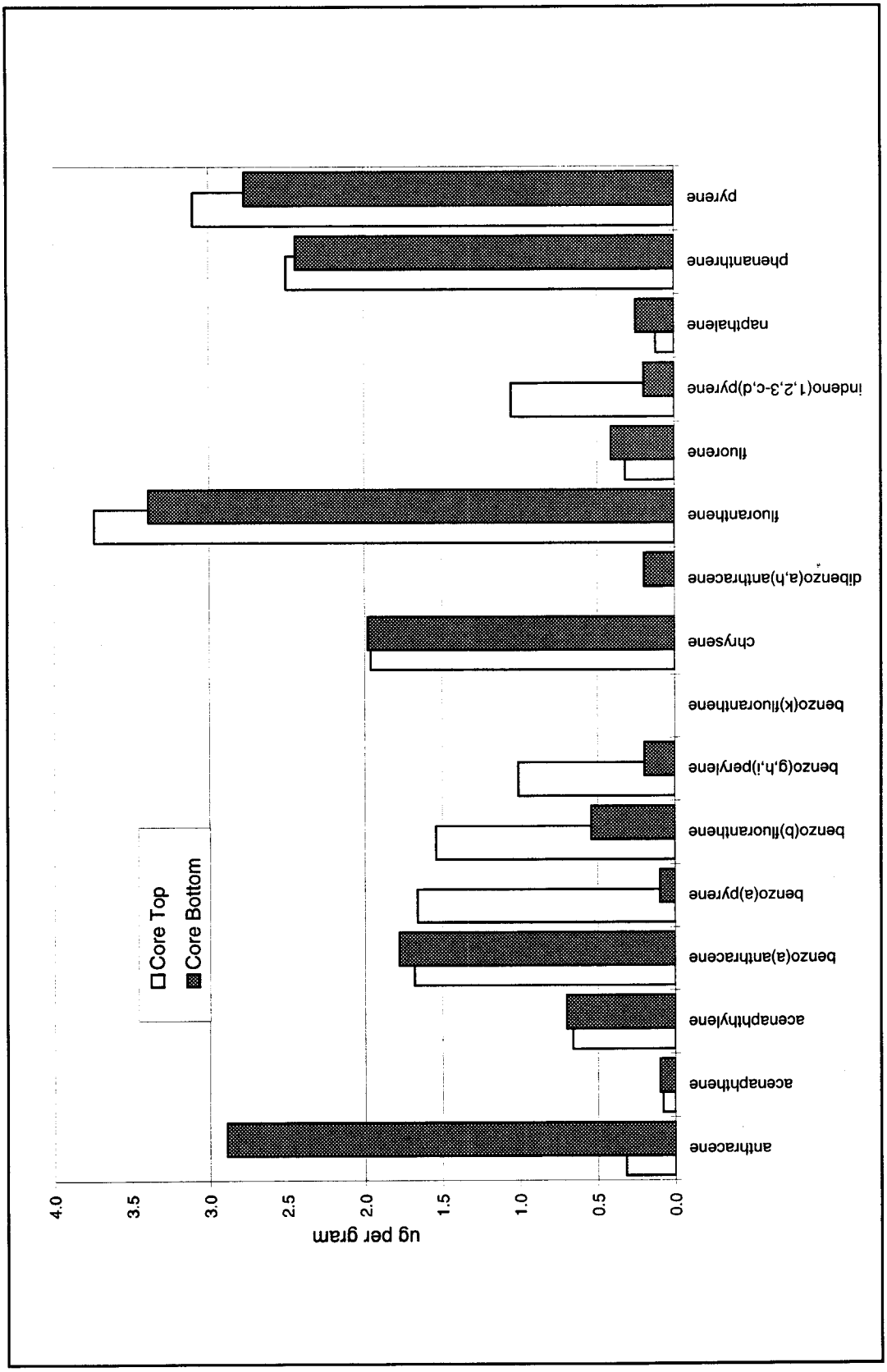


Figure 21: Typical distribution profile of PAHs in sediment collected from a site between Windmill Point and Pilon Island, 1994 (Richman, 1996)

5.3.4 Dioxins and Furans

In 1989 Environment Canada conducted a survey of dioxins and furans in the bottom sediment of receiving waters adjacent to Canadian pulp and paper mills. Dioxins and furans were detected in sediment downstream of Domtar's Cornwall operation, but values for the control site upstream of Domtar were unreliable and could not be used for comparison. The report of the 1989 study describes the degree of sediment contamination with dioxins and furans as "high" at Domtar, Cornwall in relation to the other sites in the Canada-wide survey (Trudel 1991). Since there are no guidelines or criteria available for dioxins and furans in sediment, it is difficult to judge the significance of the observed concentrations. Details of data from this study can be found in Addendum to the Stage 1 Report (St. Lawrence RAP Team 1994).

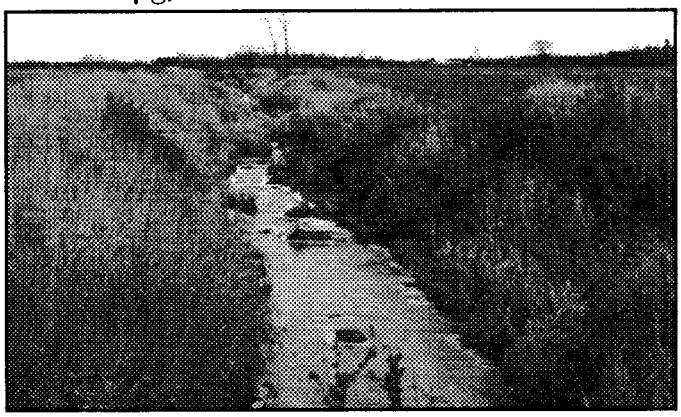
Monitoring has detected minor amounts of dioxins and furans in effluent from Cornwall industries, but sampling of fish shows that these compounds are not a concern with respect to fish consumption. Levels of dioxins and furans in fish do not exceed Health Canada consumption guidelines (St. Lawrence RAP Team 1994). This was confirmed by Domtar in its first cycle Environmental Effects Monitoring (EEM) study, in which the dioxin and furan concentrations in white sucker and yellow perch were two orders of magnitude lower than the standard set by Health Canada (N. Cox, Domtar Papers, pers. comm.).

Dioxins and furans have been detected in soil samples taken from Reynolds Metals Co. property, which borders the St. Lawrence River (south shore), but the amount reaching the river is unknown (NYSDEC 1990). There are no known or permitted discharges of dioxin on the Reynolds site.

5.3.5 Pesticides

In studies carried out between 1979 and 1989, pesticide concentrations throughout the Cornwall-Massena section of the river and downstream into Lake St. Francis generally represented background St. Lawrence River levels (Kauss *et al.* 1988; Anderson and Biberhofer 1991). No major local source of pesticides is indicated in the area of concern.

A certain amount of pesticides does come from agricultural activities in watersheds draining into the St. Lawrence River. For example, p,p'-DDD was found at a concentration of 0.02 µg/L in water from the lower channel of the Raisin River in 1979 (Kauss *et al.* 1988). This exceeds the Provincial Water Quality Objective of 0.003 µg/L for DDT and its metabolites.



Agricultural drain

In 1979-1981, the total DDT concentration (DDT plus its metabolites) in sediment throughout Lake St. Francis was lower than total DDT concentrations reported for sediment in Lake Erie and Lake Ontario. Organochlorine pesticides other than DDT were below the detection limit in Lake St. Francis sediment or in trace amounts. Levels were similar to or less than those observed in Lake Erie and Lake Ontario (Sloterdijk 1991). DDT in sediment is above the lowest effect level but below the severe effect level in places in Lake Erie and Lake Ontario.

Recent data (1993/94) collected by Environment Canada at Wolfe Island (headwaters of the St. Lawrence River), estimates total DDT loadings to be 1.8 kilograms per year. Similar loadings were estimated for dieldrin,-BHC and lindane (Biberhofer 1995).

5.3.6 Chloroform and Carbon Tetrachloride

Carbon tetrachloride and chloroform concentrations were low or undetectable in St. Lawrence River water collected from the AOC in 1985 and 1988 (Anderson 1990; Anderson and Biberhofer 1991). Ontario's Drinking Water Objectives specify a maximum acceptable concentration of carbon tetrachloride (0.005 mg/L) in treated drinking water; otherwise, there are no firm guidelines for acceptable concentrations of carbon tetrachloride or chloroform in surface waters.

From 1942 until March 1995, Cornwall Chemicals (50% owned by ICI Canada Inc.) manufactured a variety of chemicals using chlorine and sodium hydroxide produced at ICI Forest Products. Between October 1989 and September 1990, they discharged an average of 11.361 kg/day of carbon tetrachloride and 0.056 kg/day of chloroform (Tuszynski 1992). Decommissioning of the plant is expected to continue for approximately three years and will include detailed subsurface investigations (in progress) and excavation and remediation of contaminated soil at the former carbon tetrachloride site.

Facilities that use chlorine for disinfection, zebra mussel control, or as a process chemical are also often sources of chloroform. These would include Domtar Papers, the Cornwall sewage treatment plant and Ontario Hydro.

5.3.7 Metals (other than mercury)

Sediment is contaminated with metals at various locations in the area of concern and, with the exception of iron, metal concentrations are higher in the north channel than in the south channel. Core data reported by Carignan *et al.* (1994) for a site at the eastern end of the northern portion of Lake St. Francis shows a decline in sediment metal concentrations since the 1960s. At the beginning of the sedimentary record (1943±7 yr), all trace metal concentrations (Cd, Cr, Cu, Ni, Pb, Zn) were above expected values for unpolluted pre-industrial sediments. This is not surprising since major upstream industrial point sources in Cornwall had already been operating for one to six decades (see Table 2). Sediment metal concentrations increased rapidly from the 1940s to reach a maximum in 1960 (±4 yr) for Cr, Cu, Ni and Zn and 1970 (±3 yr) for Cd and Pb, thereafter decreasing until the early 1980s. During the following decade (to 1992, when this core data was collected) metal concentrations had not significantly decreased, except for Pb. The study did not include analysis for mercury (Carignan *et al.* 1994).

A 1985 survey revealed that concentrations of zinc, lead, copper, chromium, nickel, arsenic and cadmium were higher than the Provincial Sediment Quality Guidelines lowest effect level at a number of sites around the area of concern. Only one site had sediment metal concentrations higher than the severe effect level. This was at the Courtaulds Fibres/Courtaulds Films discharger, where zinc, lead and copper were all present in the sediment at concentrations higher than the SEL (Anderson 1990).

These data were confirmed by studies done in 1991 (Richman 1994) and 1994 (Richman 1996). A comparison of 1991 sediment quality data with upstream reference sites in Lake St. Lawrence suggests local sources of copper, mercury, lead and zinc, since median concentrations of these metals were higher in the Cornwall area downstream of Courtaulds Fibres than at the reference stations. In 1994, sites with sediment concentrations greater than the SEL for zinc, lead and copper were limited to the area near the shore close to and immediately downstream of Courtaulds' former shore based outfalls which historically discharged these metals.

Effluent monitoring showed that concentrations of zinc and lead were higher in Courtaulds Fibres' effluent than in their intake water (Anderson 1990; Tuszynski 1992), and the Provincial Water Quality Objective for zinc (20 µg/L) was exceeded in 32% of water samples taken near the discharge (Anderson 1990). In 1988, suspended solids in Courtaulds' plant effluents contained high concentrations of zinc, lead and copper (Anderson and Biberhofer 1991). It was concluded that Courtaulds Fibres/Courtaulds Films (now closed) was likely a significant source of metal contamination observed in the sediment near its discharges. In the case of

zinc, at the time it closed (1992) Courtaulds was the main source of zinc in the AOC and one of the highest dischargers of zinc in the Great Lakes basin, as described in Section 5.3.7.1.

The oil tank storage area or "tank farm" is located in an area of industrial development at the Cornwall Harbour, near the foot of McConnell Avenue. The site is owned by Transport Canada and operated by Universal Terminals. Sediment surveys were carried out in this area in 1992 (MOEE) and 1993 (Environment Canada) to determine the type, degree and extent of sediment contamination in a small embayment immediately downstream of the tank farm. In comparison with other areas in the north channel of the AOC at Cornwall, concentrations of cadmium, mercury, lead, zinc and nickel in sediment at the tank farm were low. Concentrations of arsenic, chromium and copper were similar to those elsewhere in the north channel, although the highest concentrations of all three elements in the entire reach were found at one station in the tank farm study area. A narrow band of sediment within 20 m of shore was the most contaminated. Chemical characterization of sediment in the tank farm study area showed that the degree of sediment contamination was not severe, and that the area affected was very localized (Metcalfe-Smith *et al.* 1995).

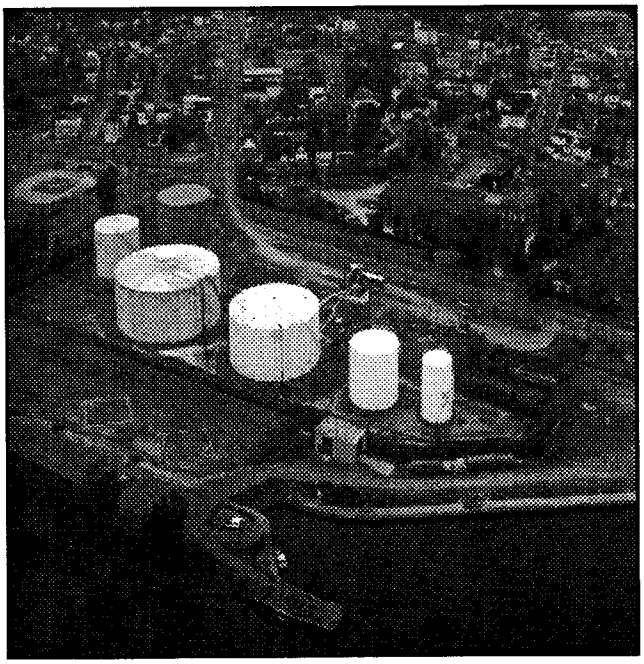
5.3.7.1 Zinc

In 1994, a sediment survey of the area extending about 200 km downstream of Courtaulds Fibres and about 400 metres from shore, found high concentrations of zinc in sediment collected close to the Courtaulds Fibres former shore based outfalls. Zinc concentrations exceeded the LEL in 86% of core top samples (top 10 cm of the core was analyzed) and 98% of core bottom samples (about 10 cm of sediment from the bottom of the core was analyzed) (N=47). Eleven percent of the core tops and 23% of the core bottoms exceeded the SEL (Richman 1996). Ontario's Provincial Sediment Quality Guidelines for zinc specify an LEL of 120 µg/g and an SEL of 820 µg/g.

Concentrations of zinc above the SEL ranged from 857-2045 µg/g in core tops and were as high as 3729 µg/g in sediment from core bottoms. The stations that exceeded the SEL were located within 20-30 metres from shore, adjacent to the Courtaulds property and within about 80 metres downstream of their former outfalls (Richman 1996).

Although there were exceptions at some stations, in general, contamination of sediment continued downstream with concentrations of zinc decreasing with increasing distance from the outfalls both in the downstream direction and perpendicularly from shore. A band of contaminated sediment was present along the shoreline almost as far as Pilon Island, the most westerly point in the study area (Richman 1996).

Before closing in November 1992, Courtaulds Fibres was the main source of zinc in the AOC and one of the highest dischargers of zinc in the Great Lakes basin. Zinc is an integral component of the rayon-making process, used to improve the quality of rayon fibres, and was a principal constituent of Courtaulds' liquid waste. From October 1989 to September 1990, Courtaulds Fibres discharged an average of 345.39 kg Zn/day into the St. Lawrence River (Tuszynski 1992). Other Cornwall industries and the Cornwall WPCP discharged measurable amounts of zinc but at loadings two to five orders of magnitude smaller, as shown in Table 8.



Universal Terminals, Cornwall, Ontario

Table 8. Average discharges of zinc (kg/day) from Cornwall Cornwall point sources.

Industry	Average loading (kg Zn/day)	Time period of averaging	Reference
Courtaulds Fibres	345.39	Oct 1/89 - Sep 30/90	Tuszynski (1992) (MISA Monitoring)
Domtar Papers	5.8 4.0 (in 1996)	Jan 1/90 - Dec 31/90	OMOE 1991a, 1991b (MISA Monitoring) N. Cox, Domtar Papers, pers. comm.
Cornwall WPCP	1.6	April-May 1987	MISA Monitoring (1988)
Cornwall Chemicals	0.08	Oct 1/89 - Sep 30/90	Tuszynski (1992) (MISA Monitoring)
ICI Forest Products	0.42	Dec 1/89 - Nov 30/90 Feb 1/90 - Jan 31/91	Ryan and Edmonds (1992) (MISA Monitoring)
ICI Conpak	0.007	Dec 1/89 - Nov 30/90 Feb 1/90 - Jan 31/91	Ryan and Edmonds (1992) (MISA Monitoring)

Note to Reader: This table has been compiled using data from a variety of monitoring programs. Each program had different sampling and analytical capabilities and requirements and the data should be interpreted accordingly.

5.3.7.2 Lead

Courtaulds Fibres (closed 1992) was also the main source of lead in the area of concern. Because it is acid-resistant, lead was extensively used in the plant for lining tanks and pipes that handled the large quantities of sulphuric acid required to manufacture rayon. Corrosion caused some lead to be discharged in the effluent (an average of 2.139 kg/day in 1990 (Tuszynski 1992)). Before it closed in November 1992, Courtaulds Fibres had replaced most of its lead piping and tank linings with plastic products.

MISA monitoring data for 1990 showed that lead discharges averaged 0.178 kg/day from ICI Forest Products and 0.028 kg/day from ICI Conpak. Other industrial or municipal facilities in Cornwall were insignificant sources of lead.

In a 1994 MOEE survey of sediment downstream of Courtaulds Fibres, sediment lead concentrations were above the SEL (250 µg/g) in core tops from three stations and core bottoms from seven stations. Core tops from three stations in the vicinity of Courtaulds' former shore-based discharges contained lead at concentrations of 385 µg/g, 421 µg/g and 655 µg/g respectively. The highest lead concentrations were found in sediment from core bottoms, with concentrations at seven stations ranging from 287-859 µg/g. These same stations were also contaminated with zinc, copper and mercury at concentrations greater than the SEL. As in the pattern observed for zinc, contamination of sediment continued downstream, with concentrations of lead decreasing with increasing distance from Courtaulds' former shore-based outfalls.

Almost all of the stations sampled contained lead at concentrations greater than the LEL (31 µg/g) (Richman 1996).

Lake St. Francis is part of the Atlantic Flyway for migratory ducks and geese

A non-industrial source of lead that is a growing environmental concern is the deposition of lead shotgun pellets in areas used for waterfowl hunting. Waterfowl in various parts of the Great Lakes basin and elsewhere die from lead poisoning when they eat spent lead shotgun pellets discharged into marshes. Predatory birds such as eagles can also receive fatal doses of lead from eating waterfowl that contain lead shot. Statistics on the number of birds dying from ingestion of lead shot are limited. Reliable estimates are difficult to obtain because birds containing lead may fly to another area before the onset of poisoning, and birds dying from lead poisoning become secretive and difficult to find (Belrose 1976).

Lake St. Francis is a major staging area for migrating waterfowl and a popular waterfowl hunting area. A survey by the Canadian Wildlife Service in the early 1980s found lead shot in the gizzard of 2% of 233 dabbling ducks and 12% of 41 diving ducks collected from hunters at Lake St. Francis (Dennis 1990). In 1988 and 1989, wing bones of immature dabbling ducks (mallard ducks, American black ducks, ring-necked ducks and mallard-American black duck hybrids) that had been shot by hunters were analyzed for lead. Areas of Canada showing both high hunting pressure and elevated lead levels in wing bones (*i.e.*, ≥10% of the samples contained ≥10 mg/kg of lead in bone) were identified as areas prone to problems with lead contamination of waterfowl, that could be considered for non-toxic shot zoning. The area around Cornwall was one of ten such zones identified in Ontario (Dickson and Scheuhammer 1993).

Several countries, including the US, have banned the use of lead shot for waterfowl hunting. In the US, poisoning of bald eagles that prey on waterfowl containing lead pellets was one of the main incentives for the nation-wide ban that came into effect September 1991 (United States Fish and Wildlife Service 1986). Canada is phasing in new hunting regulations that prohibit possession or use of lead shot for the purpose of hunting migratory birds anywhere in Canada beginning in 1997.

5.3.7.3 Copper

Sediment from several nearshore stations adjacent to the former shore based discharge at Courtaulds was found to contain copper above the severe effect level in a 1993 survey (BEAK, unpublished data report). A 1994 sediment survey confirmed the data from the BEAK study. The SEL for copper (110 µg/g) was exceeded or approached in sediment collected from three stations in the vicinity of the shore based discharges, which is consistent with the data for mercury, lead and zinc. Concentrations at the most contaminated stations ranged from 107-138 µg/g in core tops and from 100-181 µg/g in the bottom of the cores (Richman 1996).

As observed for zinc and lead, concentrations of copper decreased with increasing distance from the former shore based discharges. Only six of the 63 core samples collected had concentrations of copper below the LEL (16 µg/g) (Richman 1996). These data confirm an earlier MOEE survey in 1985 in which sediment at the Courtaulds discharger was found to contain copper at concentrations above the severe effect level (Anderson 1990).

5.3.7.4 Cadmium, chromium, nickel

Concentrations of cadmium, chromium and nickel were highest in sediment near or downstream of the Courtaulds outfall in 1985. However, the spatial distribution of these metals within the area of concern indicated no major local sources. It was concluded that these particular metals probably came from sources upstream in the Great Lakes (Anderson 1990).

This was supported by the results of a 1994 sediment survey. Although bottom sediment concentrations of cadmium, chromium and nickel exceeded the LEL (0.6 µg Cd/g; 26 µg Cr/g; 16 µg Ni/g) throughout the 1994 study area, a comparison with upstream reference sites suggests that these metals were only slightly elevated above background concentrations, with the possible exception of chromium (Richman 1996). Local point sources have discharged these metals at low concentrations but additional sources upstream of Cornwall, including Lake Ontario, have probably also contributed to the slight enrichment of these metals in sediment throughout the river.

In the case of chromium, the median concentration in the study area was only 4 µg/g higher than at the upstream reference stations. Nevertheless, the range of concentrations above the median value suggests that there may be some additional enrichment of chromium in the study area (Richman 1996).

Concentrations of cadmium, chromium and nickel were above the LEL in 81%, 60% and 67% of the core tops respectively (top 10 cm section of the core samples). Sediment from core bottoms exceeded the LEL for cadmium, chromium and nickel in 79%, 66% and 80% of the samples respectively. The similarity between core tops and bottoms in the percentage of samples exceeding the LEL suggests that the degree of contamination in the area has not changed over time (Richman 1996).

A closer look at the concentrations at each station confirms this conclusion for nickel and chromium. For cadmium, however, although the number of stations exceeding the LEL has not changed, concentrations increased from core bottom to core top samples by more than 100% at many stations. Although there appears to be an increase in cadmium contamination over time, concentrations still do not approach the SEL (10 µg/g). They remain close to the LEL (0.6 µg/g) and are similar to concentrations of cadmium in Lake St. Lawrence sediment (Richman 1996).

Stainless steel tanks and piping used in many industrial applications contain 15-20% chromium. Corrosion of this equipment can result in discharges of chromium by industrial or municipal facilities. MISA monitoring in 1987 and 1990 showed that Cornwall industries and the Cornwall sewage treatment plant did not have significant concentrations of chromium in their effluent (MISA Monitoring 1988; OMOE 1991a, 1991b; Ryan and Edmonds 1992; Tuszynski 1992) as shown in Table 10.

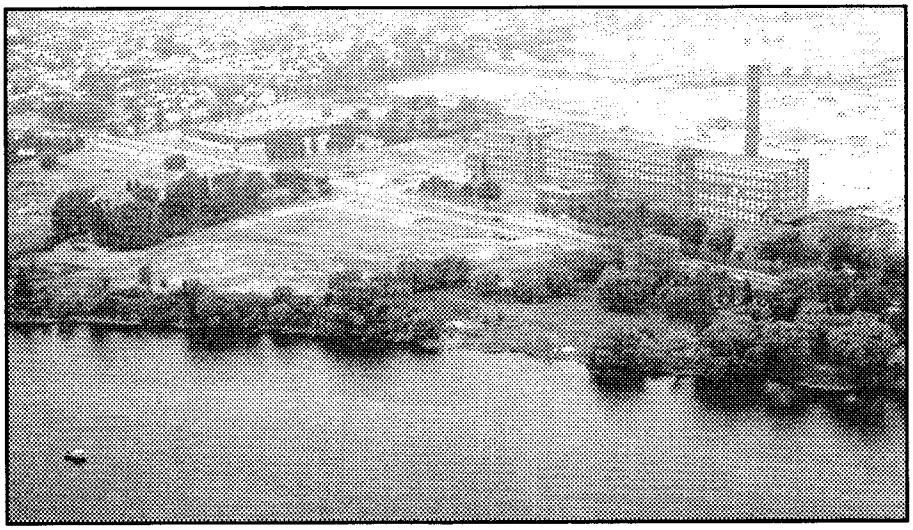
5.3.8 Wildlife

Several recent studies of tree swallows, red-winged blackbirds, snapping turtle eggs and mudpuppies included tissue analysis for a variety of contaminants. Samples were collected from areas in the Great Lakes-St. Lawrence River basin, including sites at Akwesasne and along the south shore of the St. Lawrence River near Massena, NY (Bonin *et al.* 1995; Bishop *et al.*, in prep.a, in prep.b; Gendron *et al.*, in prep.; Gendron *et al.*, in press). (See section 5.8 for more discussion).

Table 9. Average discharges of copper (kg/day) from Cornwall point sources.

Industry	Average loading (kg Cu/day)	Time period of averaging	Reference
Courtaulds Fibres	1.403	Oct 1/89 - Sep 30/90	Tuszynski (1992) (MISA Monitoring)
Domtar Papers	1.075	Jan 1/90 - Dec 31/90	OMOE 1991a, 1991b (MISA Monitoring)
Cornwall WPCP	0.5	April-May 1987	MISA Monitoring (1988)
Cornwall Chemicals	0.010	Oct 1/89 - Sep 30/90	Tuszynski (1992) (MISA Monitoring)
ICI Forest Products	0.082	Dec 1/89 - Nov 30/90 Feb 1/90 - Jan 31/91	Ryan and Edmonds (1992) (MISA Monitoring)
ICI Conpak	0.007	Dec 1/89 - Nov 30/90 Feb 1/90 - Jan 31/91	Ryan and Edmonds (1992) (MISA Monitoring)

Note to Reader: This table has been compiled using data from a variety of monitoring programs. Each program had different sampling and analytical capabilities and requirements and the data should be interpreted accordingly.

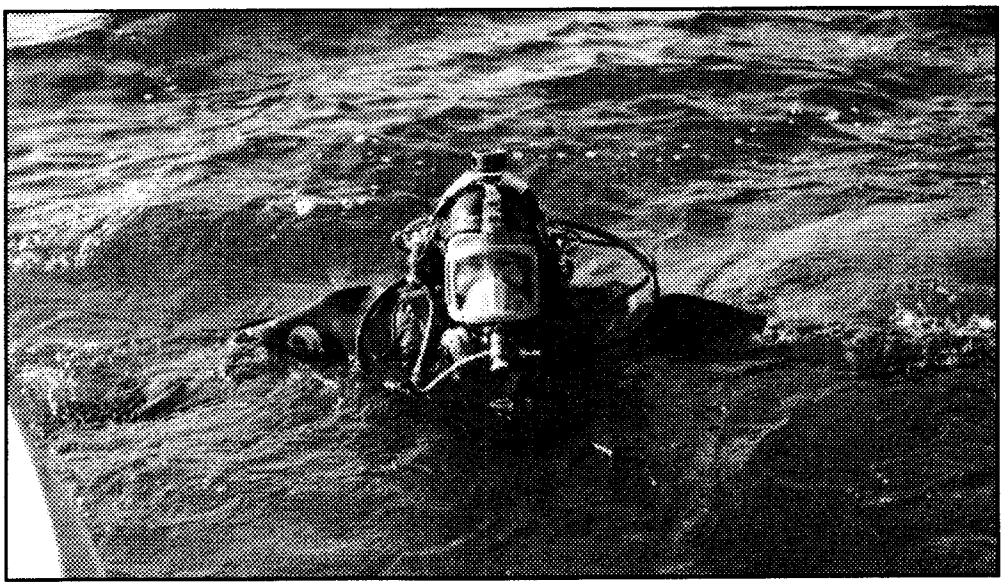


Decommissioning in progress at the Courtaulds site

Table 10. Average discharges of chromium, cadmium and nickel (kg/day) from Cornwall point sources.

Industry	Average loading (kg/day)	Time period of averaging	Reference
Courtaulds Fibres	Cd 0.090 Cr 1.124 Ni 0.624	Oct 1/89 - Sep 30/90	Tuszynski (1992) (MISA Monitoring)
Domtar Papers	Cd 0.086 Cr 1.291 Ni not detected	Jan 1/90 - Dec 31/90	OMOE 1991a, 1991b (MISA Monitoring)
Cornwall WPCP	Cd 0.001 Cr 0.003 (hexavalent Cr) Ni 0.88	April-May 1987	MISA Monitoring (1988)
Cornwall Chemicals	Cd 0.001 Cr 0.003 Ni 0.088	Oct 1/89 - Sep 30/90	Tuszynski (1992) (MISA Monitoring)
ICI Forest Products	Cd 0.068 Cr 0.160 Ni 0.095	Jan 1/90 - Dec 31/90	Ryan and Edmonds (1992) (MISA Monitoring)
ICI Conpak	Cd 0.001 Cr 0.004 Ni 0.009	Jan 1/90 - Dec 31/90	Ryan and Edmonds (1992) (MISA Monitoring)

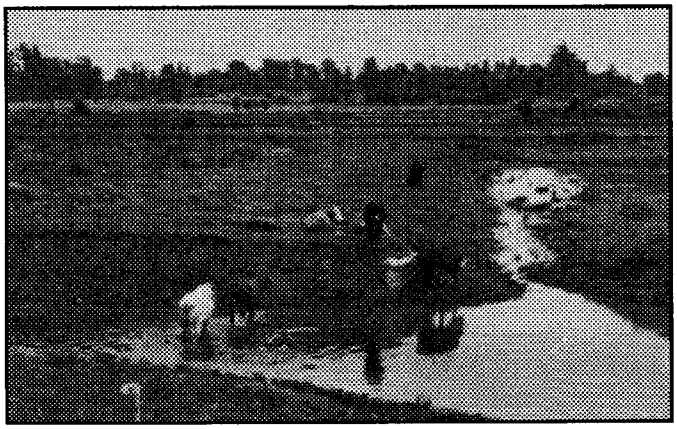
Note to Reader: This table has been compiled using data from a variety of monitoring programs. Each program had different sampling and analytical capabilities and requirements and the data should be interpreted accordingly.



5.4 ISSUE: Bacterial (Fecal) Contamination

Mainstream St. Lawrence River water typically has fecal coliform densities of fewer than 10 organisms/100 ml. Localized areas with densities above the Provincial Water Quality Objective for recreational use* are due to bacteria from a variety of sources including industrial effluent, sewage treatment plant discharges, combined sewer overflows from urban areas, private septic systems and agricultural runoff. Bacterial contamination of St. Lawrence River water in the AOC has resulted in periodic beach closures and has the potential to affect untreated drinking water obtained from private intake pipes along the St. Lawrence River.

**(The previous Provincial Water Quality Objective for recreational use was: no more than 100 fecal coliform bacteria / 100 mL water. It has been replaced by: 100 Escherichia coli / 100 mL water.)*



Cattle in stream

Monitoring data from as early as 1913 indicated that the St. Lawrence River was contaminated by bacteria in places from the Thousand Islands to Cornwall. This was ascribed to sewage discharges from vessels and by communities along the river (IJC 1914). Water quality data for the river were collected following development of the St. Lawrence Seaway, including surveys carried out by Health and Welfare Canada from 1965 to 1967 to assess the status of municipal pollution control programs. These indicated localized inputs of coliform bacteria in the Cornwall area and in the areas of the Grasse and St. Regis Rivers (IJC 1969).

A 1975 Environment Ontario study of the effects of major Cornwall municipal and industrial discharges on surface water, found high fecal coliform densities in the St. Lawrence River downstream of the Courtaulds outfalls (Experience 1975). The sources of contamination were not identified at that time. Elevated total and fecal coliform densities were also found in the same area of the river in 1977 and 1985 (Environment Canada 1978; Environment Canada 1985).

Fecal coliform densities observed in a 1980 Environment Ontario survey exceeded the Provincial Water Quality Objective for recreational use. River water samples from stations as far as 8 km downstream of the Domtar/ICI/Cornwall Chemicals diffuser exceeded the Objective during the July, September and October surveys. Water samples collected immediately downstream of Courtaulds exceeded the Objective in November. High bacterial densities were also observed at the mouth of the Raisin River near South Lancaster (Kauss *et al.* 1988).

A 1982 survey confirmed the 1980 results, with the highest fecal coliform densities observed downstream of the Domtar/ICI/Cornwall Chemicals diffuser. Fecal coliform densities in Domtar's effluent suggested that it was the major contributor of fecal coliform bacteria to the St. Lawrence River at Cornwall during the two studies (Kauss *et al.* 1988). Further study by MOEE led to the conclusion that the main type of coliform bacteria in the effluent was *Klebsiella*, a type of bacterium that has been detected near other pulp and paper mill discharges. Questions about the significance of *Klebsiella* with respect to human health led to a review of the problem and the conclusion that *Klebsiella* in the environment is not a human health concern (St. Lawrence RAP Team 1992). Non-pathogenic coliform bacteria have since been eliminated from the Provincial Water Quality Objective for recreational use, which now measures only *E. coli* rather than total numbers of coliform organisms.

High fecal coliform densities were also evident near the Courtaulds Fibres (closed 1992) and Courtaulds Films (closed 1989) complex during the 1982 Environment Ontario study. These levels correlated well with rainfall events, suggesting storm water or combined sewer overflows as the sources of bacterial contamination (Kauss *et al.* 1988).

Domtar Papers has continued to monitor the concentration of bacteria in its effluent. Levels have dropped off because of the addition of secondary treatment and the removal of human sewage from the mill's sewer system. Monitoring in 1995 showed *E. coli* concentrations of fewer than 400 organisms/100 ml of effluent, which means that concentrations are below the Provincial Water Quality Objective where the diffuser discharges into the St. Lawrence River.

Stormwater runoff and sewage overflows and bypasses are potential sources of fecal contaminants from the City of Cornwall. The capacity of the Cornwall WPCP (which provides primary treatment with chlorination) was increased in 1988 and the number and volume of combined sewer overflows at Pitt Street, Amelia Street and Brookdale Avenue were minimized. The City of Cornwall, Ontario Ministry of Environment & Energy, and Environment Canada have developed a comprehensive Pollution Control Plan for the City of Cornwall, to address problems associated with sewage and stormwater in the city (City of Cornwall 1995).

The Eastern Ontario Health Unit monitors water quality at four beaches along the St. Lawrence River from Cornwall to the eastern border of Ontario. Charlottenburgh Park (now closed for economic reasons), Camerons Point, Lancaster Park and Lancaster Wharf are sampled weekly during the summer. Charlottenburgh Park was closed due to bacterial contamination in 1986 and from June 30 to August 2 in 1989. No beaches have been closed in the AOC since 1990. In the Quebec portion of Lake St. Francis, no public beach closures have been reported since the Quebec environment ministry (MENVIQ) began monitoring beaches in 1984 (St. Lawrence RAP Team 1992).

In 1990 and 1991, the Raisin Region Conservation Authority studied the problem of surface water quality in the vicinity of shoreline beaches in the Raisin Region. Background levels of fecal coliform in the St. Lawrence River were typically less than 10 organisms/100 mL of water, well below the Provincial Water Quality Objective for recreational use (100 organisms/100 mL) (Pilon and Karl 1992).

High fecal coliform densities were found at a number of locations in the Raisin River watershed. Fecal contamination in the nearshore area between Summerstown and Pilon Point and further downstream at South Lancaster near Lancaster wharf was attributed to faulty residential septic systems. Fecal contamination observed at the mouths of the Raisin River and Finney Creek near South Lancaster is the result of agricultural runoff from lands drained by these tributaries.

Pilon and Karl (1992) recommended that a program be implemented to reduce bacterial and phosphorus loadings into Finney Creek and the Raisin River, and that sewage disposal systems in Lancaster and Glengarry Parks be studied in order to determine their impact, if any, on beach water quality. Some of the recommendations were carried out and funded through MOEE's Clean Up Rural Beaches (CURB) program until 1995, with an emphasis on improving agricultural land management practices that adversely affect water quality. From 1992-1995 many projects were carried out in cooperation with individual landowners along AOC tributaries to the St. Lawrence River as described in Chapter 7, Remedial Actions Completed or In Progress. The CURB program was cancelled in 1995, but tributary restoration projects are continuing in the AOC with funding from Environment Canada's Great Lakes Cleanup Fund.

In Sutherland Creek, *E. coli* and fecal streptococci concentrations exceeded the Provincial Objective for recreational water quality at almost all stations surveyed along the creek in 1994, with the exception of the stations at the mouth of the creek and in Bainsville Bay. This indicates the presence of animal waste: cattle access to the creek at these stations and the spreading of manure up to the banks are the likely causes of the high bacterial concentrations observed (Richman *et al.* 1997).

5.5 ISSUE: Excessive Growth of Nuisance Aquatic Plants

Two sorts of aquatic plant–algae and aquatic macrophytes–have caused problems in the area of concern. Algal blooms cause taste and odour problems in drinking water in the AOC. This impairment is related to excessive nutrient input, particularly phosphorus. Aquatic macrophytes in Lake St. Francis have become a nuisance because they hinder boating, fishing, swimming and other river recreation in late summer.

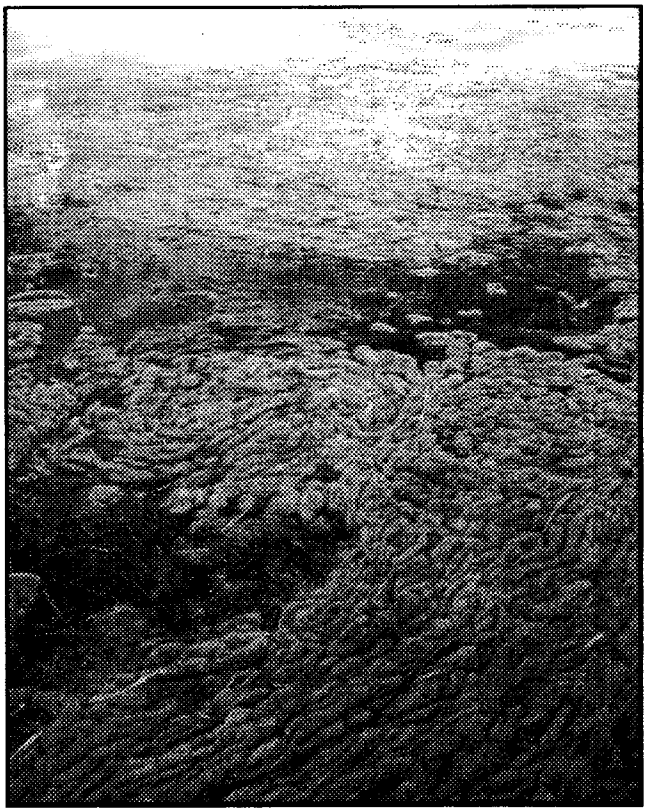
Plant masses occasionally break off and form thick, floating mats that accumulate in nearshore areas and aesthetically degrade the area. This is a natural occurrence which cannot be corrected without harmful environmental consequences and is therefore not considered an impairment of beneficial use as defined in Section 2.3 and Table 1.

5.5.1 Algal Blooms

In the 1960s and 70s, the Canadian and US governments adopted phosphorus control as the primary method of reversing or preventing eutrophication which was most evident in Lake Erie. Phosphorus removal from municipal and industrial discharges and the introduction of low-phosphate detergents have significantly reduced inputs of phosphorus to all of the Great Lakes since the early 1970s. In response, phosphorus concentrations in Lake Ontario water entering the St. Lawrence River at Wolfe Island, Kingston have gradually declined since the mid-1970s as shown in Figure 22.

In the fall of 1989 and almost every fall since then, algae have been tainting the drinking water at Cornwall's Water Treatment Plant. This problem has been remedied by the installation of a carbon filtration system at the Cornwall WTP in 1997. Taste and odour problems could still occur, however, at municipal and private water intakes downstream in Lake St. Francis during periods of prolific algal growth. The suspected cause of the taste problem is a seasonal alteration in the type and amount of algae present in the raw water intake.

Nutrients enter the St. Lawrence River from upstream sources and from point and non-point sources in the AOC. Point sources include sewage treatment plants at Cornwall, Glen Walter, Massena and St. Regis, and industrial wastewater discharges in Cornwall and Massena. Non-point sources of nutrients include urban runoff, erosion and rural surface runoff. The nutrients in rural runoff come from fertilizers, improperly handled manure and milkhouse wash water, waste from livestock that wade in rivers and streams, and faulty shoreline septic systems.



Algae bloom

The Great Lakes Water Quality Agreement calls for all sewage treatment plants in the Great Lakes basin with a daily capacity of 4500 m^3 (1 million gallons) or more to limit the phosphorus content of their discharge to a maximum of 1 mg/L. Ontario interprets this phosphorus removal requirement as applying

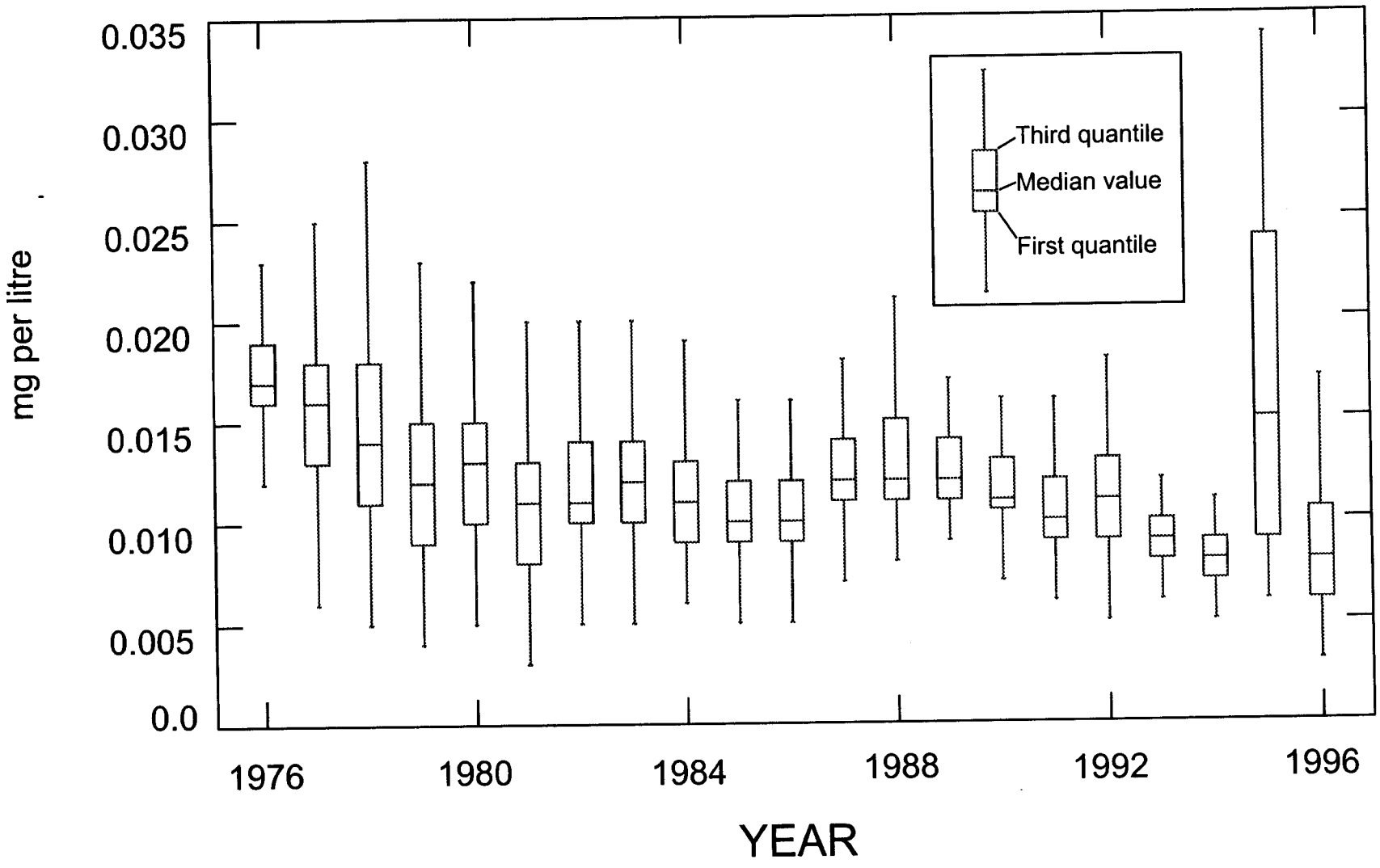


Figure 22: Phosphorus concentration in Lake Ontario water entering the St. Lawrence River at Wolfe Island, 1976-1996.

to sewage treatment plants in the St. Lawrence River as well as the Great Lakes. New York State interprets it as applying only to sewage treatment plants in the Great Lakes themselves and not to any plants downstream of Lake Ontario. Hence, New York State sets no guideline for phosphorus discharges from its sewage treatment plants discharging to the St. Lawrence River and does not monitor phosphorus in effluent from those plants.

The Cornwall WPCP removes some of the phosphorus from its effluent, which meets the current total phosphorus requirement of 1 mg/L . The Glen Walter sewage treatment plant treats much less than 4500 m^3 daily and is therefore not required to meet the 1 mg/L phosphorus limit.

Nutrient concentrations are generally higher at the mouth of tributaries draining agricultural lands, due to nutrients present in agricultural runoff. Although tributary flows are low compared to the main river and therefore contribute a relatively small amount of nutrients to the St. Lawrence River as a whole, localized impacts (increased growth of algae and aquatic macrophytes) can be observed at tributary mouths. The impacts of increased nutrient levels where tributaries such as Finney Creek, Gunn Woods Creek, Sutherland Creek and the Raisin River discharge into the St. Lawrence River can be decreased by reducing phosphorus inputs to these waterways.

Although Lake St. Francis is part of the St. Lawrence River it has many of the same characteristics as a lake, yet its phosphorus content exceeds the guidelines for lakes. Studies in 1988 showed concentrations were rarely below 0.01 mg/L (Anderson and Biberhofer 1991). Reducing the input of phosphorus to Lake St. Francis will help to reduce algal growth but will have no effect on the growth of rooted aquatic plants, as discussed below.

5.5.2 Macrophytes

Thick growths of aquatic macrophytes and algae occupy much of Lake St. Francis during the summer. Macrophytes such as Eurasian milfoil (*Myriophyllum* sp.) make boat access to marinas and shoreline residences increasingly difficult as the season progresses; dense plant beds and excessive growth of algae make swimming unpleasant or impossible in some areas.

Plant masses occasionally break off and form thick floating mats that accumulate in nearshore areas. These have at times filled all or part of a bay with a weed mass over a hectare in area and up to a metre thick. Accumulations of decaying plants restrict water flow and the water around them becomes warm and stagnant. These conditions encourage bacteria to multiply thus aggravating the problem of bacteria and other fecal contaminants entering Lake St. Francis from agricultural sources and faulty septic systems.

Excessive plant growth in Lake St. Francis is mainly due to the drastic changes in river flow imposed by construction of the Beauharnois Dam and the St. Lawrence Seaway. This included construction of the Beauharnois Dam (1929-1932), completion of dams (Coteau 1,2,3 and 4) between 1934 and 1942 (which finally completed the impoundment of Lake St. Francis) and the construction of the St. Lawrence Seaway in the late 1950s (Morin *et al.* 1994).

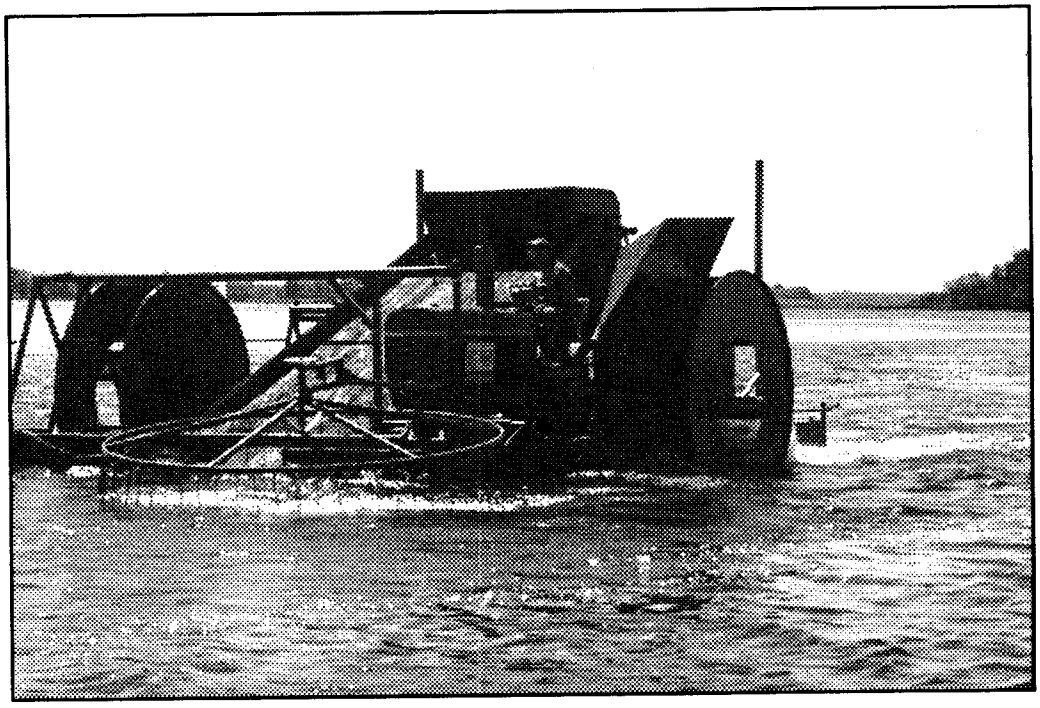
The natural (1919-1929) mean annual water level of 46.03 m and the mean annual variation in water level of 60 cm (measured at Coteau Landing) remained virtually unchanged until 1942, when completion of the Coteau dams resulted in a 0.32 m increase in the mean annual water level to 46.35 m and a decrease in the mean annual variation to 50 cm. This situation persisted until 1958, when the construction of the Seaway resulted in no change in the mean annual water level but drastically decreased the mean annual variation to 15 cm (Morin *et al.* 1994).

Overall, between 1929 and 1990 at Coteau Landing, the mean annual water level increased by 32 cm (from 46.03 to 46.35) and the mean annual variation in water levels decreased by 45 cm (from 60 cm to 15 cm). With the construction of dams downstream of Lake St. Francis, lands upstream were flooded, velocities in the nearshore areas decreased and sediment deposition increased. Construction of

the Seaway further changed flow patterns in Lake St. Francis by directing water down a deep, central navigation channel and reducing flow in nearshore areas. Water level fluctuations also became less pronounced.

These changes created conditions that promote plant growth. Areas of shallow water expanded, with associated increases in light penetration and temperature, and deposition of nutrient-rich sediment (released from the flooded lands) increased. Eurasian milfoil, which was invading many southern Ontario waterbodies during the 1960s, became established in Lake St. Francis. By 1973, it had become a dominant part of the ecosystem and was one of the two most abundant plant species in Lake St. Francis, along with tape grass.

Reducing phosphorus inputs to Lake St. Francis will have no effect on the growth of aquatic macrophytes. These plants are rooted in sediment which already contains excess phosphorus due to Seaway construction, so macrophyte growth is limited only by available space. There are no effective control measures for Eurasian milfoil and floating mats, and blocked access for boats should be dealt with on a case by case basis.



Mechanical weed harvester

5.6 ISSUE: Habitat Destruction and Degradation

Destruction and degradation of fish and wildlife habitat in the St. Lawrence River (Cornwall) area of concern occur in three main ways:

- wetland degradation or loss
- physical alteration, disruption and destruction of aquatic habitat
- shoreline erosion along the St. Lawrence River and its tributaries.

In many cases habitat destruction or degradation is the main reason for the degradation of the fish and wildlife populations in the AOC.

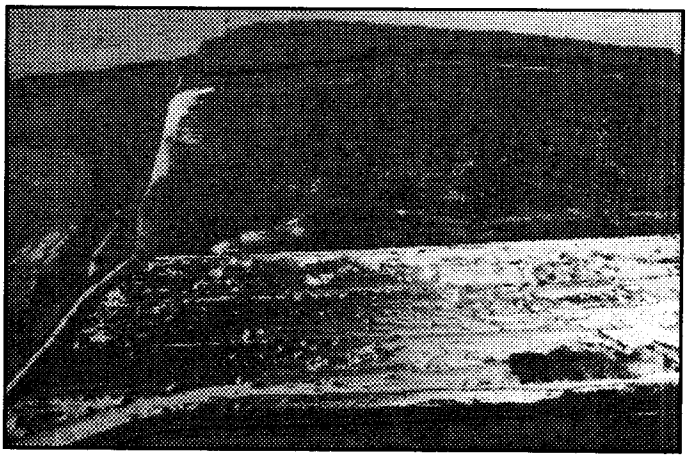
5.6.1 Wetlands

Over three-quarters of the wetlands in southern Ontario south of the Canadian Shield have been lost since European settlement began. Only in the last decade, however, have resource management agencies and naturalist groups begun to focus on protecting wetlands. Present-day management of Ontario wetlands consists of three main elements: evaluation, protection and restoration.

Ontario's 1996 Natural Heritage Policy recognizes the importance of wetland protection and directs planning agencies and municipalities to "have regard for" wetlands in land use planning decisions. It directs that this Policy be applied to provincially significant wetlands (formerly termed Class 1, 2 and 3 wetlands). The classification of wetlands is based on the Provincial Wetland Evaluation System (Versions 2 and 3). The Natural Heritage Policy is now implemented with the Ministry of Municipal Affairs and Housing acting as the main provincial contact.

5.6.1.1 Location of wetlands in the area of concern

Only two major wetland complexes remain in Ontario waters of the St. Lawrence AOC: Bainsville Bay and Charlottenburgh marshes. Both are provincially significant wetlands threatened by a variety of development pressures. There is one more provincially significant wetland at Westley's Point and at least two other small, unevaluated coastal wetlands. The total area of all of these wetlands is approximately 1300 hectares.



Point Mouillee, Lake St. Francis

Additional wetland habitats in the Ontario portion of the AOC include aquatic plant beds, such as those located along the Lancaster Bar, which provide significant staging habitat for a variety of migrating waterfowl. Lake St. Francis is located in a major eastern North America migration flyway. The largest of the Lake St. Francis wetlands lie along the south shore, in and adjacent to lands of the Mohawks of Akwesasne. They have not been formally evaluated but are important waterfowl habitats.

There is also a variety of inland wetlands in watersheds draining into the AOC and these have been evaluated. They number 57, ranging in size from 3 to 1484 hectares. Of these, seven are provincially significant (covering 6112 ha) and the remaining 50 wetlands cover 3641 hectares.

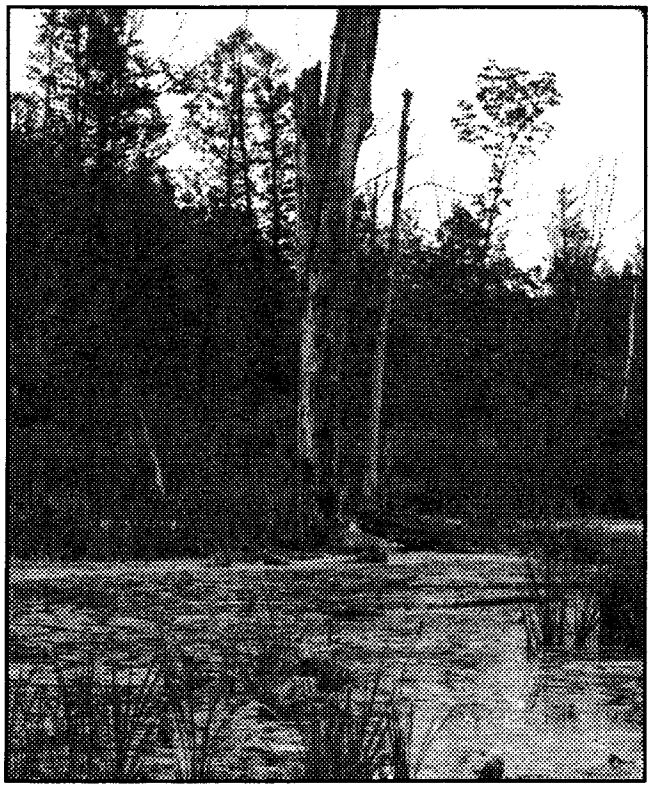
Based only on evaluated wetlands, which would include all of the provincially significant ones, total wetland area in the Ontario portion of the AOC is 11,096 hectares or approximately 5.3% of the watershed area. An additional approximately 120 small wetlands in the AOC

watershed (defined in Section 5.6.4) have not been evaluated and probably average 5-10 ha in size, for a total of 900 hectares.

Overall watershed wetland coverage, including unevaluated wetlands, is therefore in the order of 12,000 hectares or 5.8% of the watershed area. This is close to but below the target of 10% overall wetland coverage in Great Lakes AOCs, and the distribution of the wetlands is such that some sub-watersheds have considerably less than the target of 6% for sub-watersheds (Environment Canada *et al.* 1996). To meet the overall wetland area target, an additional 8800 ha of wetland would need to be restored or created in the St. Lawrence River AOC.

5.6.1.2 Causes of wetland destruction

Wetland destruction occurs in two ways: direct loss and degradation. The former results from development that eliminates wetland habitat; the latter is due to changes that reduce the wetland values of an area even though the area may still meet the definition of a wetland.



Inland Marsh

Direct loss of wetlands occurs when they are filled in or dredged for residential, industrial, recreational or agricultural purposes. The major threat to the coastal wetlands at Bainsville Bay and Charlottenburgh marshes is development for recreational and residential development. Inland wetlands are under pressure from agricultural drainage and development interests, housing developments and, in some cases, industrial development.

Wetlands can be degraded without a direct loss of overall area, and are considered degraded if any loss of ecological form or function occurs. Construction and maintenance of roads, pipelines and hydro transmission corridors has fragmented wetland habitats, increased human disturbances and altered vegetation communities, water levels and water movement in wetlands. Agricultural development, land use and drainage have substantially reduced the size, number and function of most inland wetlands in the AOC tributary watershed. For example, construction and maintenance of agricultural drains has substantially altered the natural hydrology of inland wetlands by reducing seasonal water levels, which reduces wetland size, habitat and species diversity, flood retention and water quality benefits. The presence of carp can also contribute to wetland degradation: in wetland restoration efforts in other areas of the Great Lakes basin, carp have in some instances hindered the reestablishment of aquatic vegetation, due to increases in turbidity in areas in which carp are concentrated and uprooting of vegetation by carp.

The wetlands in Lake St. Francis have been most severely damaged by alterations in the natural hydraulic cycle of the St. Lawrence River. These changes were brought about by construction of the Beauharnois Dam (1929-1932), the completion of the dams (Coteau 1,2,3 and 4) between 1934 and 1942 (which finally completed the impoundment of Lake St. Francis) and the construction of the St. Lawrence Seaway in the late 1950s. As described in Chapter 5.5, the mean annual water level at Coteau Landing increased from 46.03 m to 46.35 m and mean annual variation in water level decreased from 60 cm to 15 cm (Morin *et al.* 1994).

Lake St. Francis was changed from a flowing river habitat with seasonally fluctuating water levels into a slow-moving reservoir with much more stable water levels. Water control structures at the downstream end increased mean water levels and reduced the magnitude and frequency of water level fluctuations. The St. Lawrence Seaway further dampened natural water level fluctuations by diverting water away from nearshore areas and forcing more flow down the shipping channel in the middle of the river. A water levels reference study has been initiated for Lake Ontario-St. Lawrence River by the IJC Water Levels Reference Board. This study could result in alterations to the existing water level management regime, although it will not result in a return to natural water level fluctuations.

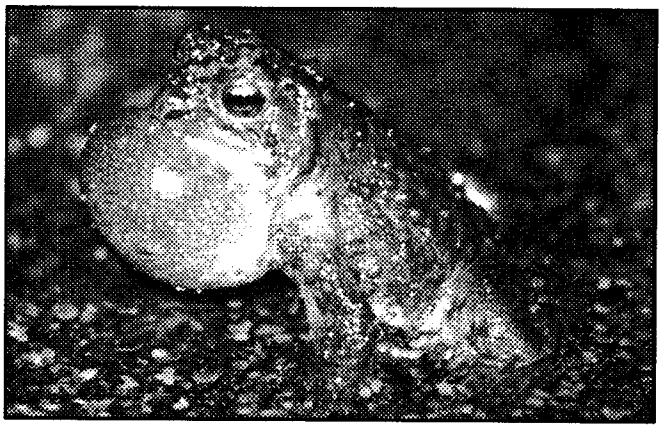
In its natural state, the St. Lawrence River would have flooded substantially during late spring, water levels would have receded over the summer, increased slightly during the fall, and decreased substantially over the winter. This regime recharged and refreshed wetlands, maintaining habitat diversity. In the absence of changing water levels, the wetlands of Lake St. Francis have become extensive cattail monocultures with very little open water. The reduction in plant and habitat diversity has severely reduced wetland values, particularly for fish and wildlife species.

Increased flow in the navigation channel and reduced flow in nearshore areas have contributed to the establishment of dense beds of submerged macrophytes in much of Lake St. Francis. It has been suggested by local fishermen that the extent of offshore bulrush beds, which provide valuable habitat for yellow perch and waterfowl, may have been reduced as a result of increased competition from submerged plants and wave wash effects from Seaway traffic, although this has not been documented.

In summary, there has been a great reduction in the extent and quality of wetlands in the area of concern, especially following construction of the Beauharnois Dam and the St. Lawrence Seaway. Residential, commercial and industrial development continue to degrade and destroy the few wetland areas that remain, pushing waterfowl, fish and other animals out of the area in the process.

5.6.1.3 Status of marsh birds and amphibians in the area of concern

This section is based on a recent Long Point Bird Observatory assessment of marsh bird and amphibian monitoring program results for the St. Lawrence River area of concern. Coastal marshes (Bainsville, Charlottenburgh) and inland marshes (Loch Garry Marsh, Glengarry Bridges Marsh) within the AOC were surveyed, as well as Hoasic Creek Swamp which is outside of the AOC. The assessment was based on abundance and diversity of amphibian and bird indicator species as well as overall marshbird and amphibian abundance and diversity (Chabot and McCracken 1997 (draft)).



American Toad

Based on initial analyses surveying 8 marshes, overall, the St. Lawrence River AOC is marginally not impaired, although several of the marshes are in poor shape. Major habitat rehabilitation projects have been done within Bainsville and Charlottenburgh marshes, and Loch Garry and Glengarry Bridges marshes are large, extremely diverse wetlands. The conclusion underscores the innate value of these particular wetlands and reflects the value of the rehabilitation projects completed within them.

5.6.2 Physical Alteration, Destruction or Disruption of Aquatic Habitats

Although fish and wildlife habitat is affected by a wide range of factors, this section focuses only on physical aspects such as shelter, substrates (bottom surfaces), depths and currents. The effects of contaminated water and sediment on fish and wildlife are extensively discussed elsewhere in this report. Very little quantitative data is available to determine the exact amount of habitat lost and the degradation that has occurred. The development of GIS tools will allow for a more detailed examination of recent and future loss. Qualitatively, the extent of historical development and the severity of responses in the fish community which have been observed (*i.e.*, decline in the sturgeon population) are good evidence that habitat destruction has been and remains an issue in the AOC.

Physical alteration of aquatic habitats in the St. Lawrence River area of concern has occurred in two main ways: (1) by Seaway and dam construction, and (2) by a variety of smaller scale development pressures.

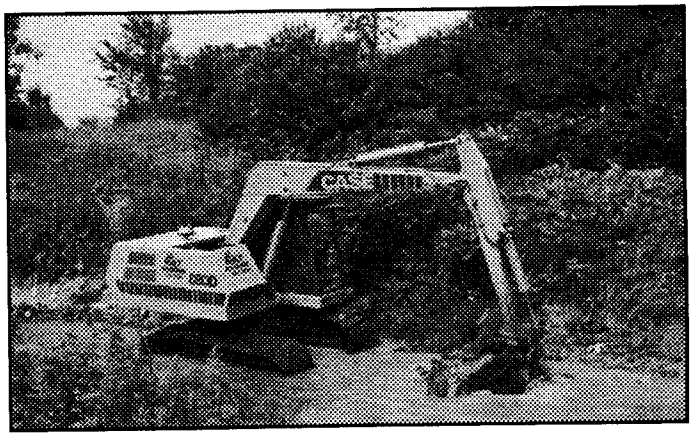
5.6.2.1 Seaway and dam construction

Extensive channel modification during Seaway construction altered the natural locations of substrates. Excavation of the navigation channel eliminated many in-river reefs and shoals that had provided good fish habitat and it directed more of the flow to the centre of the river thereby reducing velocities in the nearshore areas. Sediment deposition in nearshore areas increased as a result, which led to the growth of submerged aquatic plant beds that further reduced flow in nearshore areas. River habitats are, by nature, more diverse and productive (Edwards *et al.* 1989) than lake environments, and habitat diversity was reduced when Lake St. Francis was impounded, mainly at the expense of shallow-water riffle areas and wetlands.

While the full impact of large-scale modifications to the river may not be realized for a century, it is apparent that the system is moving towards some degree of stability 30 years after the last major project. From an ecosystem point of view, most of the major disruption and adjustment associated with Seaway and dam construction has occurred, although dredging activities continue (at the Lancaster Bar in Lake St. Francis every 20-25 years) in order to maintain the navigation channel.

5.6.2.2 Residential, commercial and industrial development

Another type of physical habitat alteration is more insidious, more incremental and still occurring. Small scale dredging, filling and other habitat modifications are driven by a variety of development pressures. Landowners along the St. Lawrence River waterfront and on inland streams put constant pressure on the littoral zone by straightening shorelines, removing rocks and logs, removing aquatic plants, deepening the area next to shore or filling it in, removing shoreline terrestrial vegetation, channelizing small streams, and placing new developments on undeveloped shoreline.



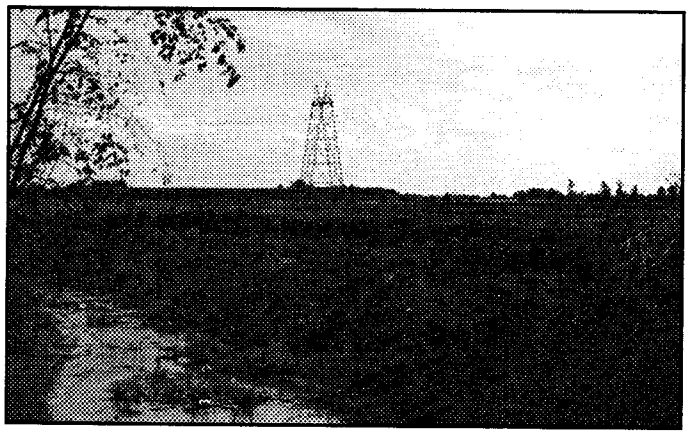
Habitat being lost to development

Inland streams, which provide important fish and wildlife habitat, have been physically altered by various human activities. Agricultural land use practices and channel modifications for flood control have increased erosion and sedimentation and destroyed or degraded river bank (riparian) habitats. The natural channel characteristics of most of the inland waters in the AOC have been changed as a result.

5.6.3 Shoreline Erosion

Natural uncontrolled rivers erode during peak discharge periods and the river slowly carves a natural channel for itself. Over geological periods of time, this generally results in the upper reaches of a river containing little sediment and the lower reaches or deltas being rich in sediment deposits. The St. Lawrence River no longer has a natural erosion-deposition cycle because peak flows and water levels have been attenuated by means of control structures. Because it has been impounded, the river now has a series of sediment traps such as Lake St. Francis along its length. None of the substantial changes in erosion patterns that were associated with Seaway construction were adequately documented.

Present-day erosion problems are confined to four main areas in the AOC: inland tributaries, shorelines adjacent to shipping channels, the shoreline of Pointe Mouillee adjacent to Bainsville Bay and shorelines in the Cornwall Island-St. Regis section of the north channel.



Erosion of shoreline

Erosion in inland tributaries results from channel modifications associated with drainage projects; the loss of floodplain storage (including wetlands); removal of vegetation along the banks and in the floodplain due to development or agricultural practices; and hardening of shorelines, which increases the downstream energy of the river or stream. Erosion affects aquatic habitats in tributaries by increasing silt levels in the water, increasing siltation on fish spawning beds and reducing water velocities particularly during low flow periods. All of the tributaries to Lake St. Francis share this problem and an overall impact on the fish community in the St. Lawrence River is felt because the tributaries are key spawning and nursery habitats for many of the fish species in Lake St. Francis.

The second main area of erosion in the AOC is on shorelines adjacent to the shipping channel, which are being eroded by increased wave action associated with freighter traffic. Erosion problems have been identified on Hamilton, Stanley, Clark, Renshaw and Jacobs Islands to date. This issue is being addressed by Transport Canada, which has implemented a multi-year shoreline protection program that involves placing continuous stone barriers along the affected areas.

The third area affected by erosion is the Bainsville Bay-Pointe Mouillee area, a provincially significant wetland complex and key fish production area covering approximately 4 km of shoreline on Lake St. Francis just west of the Ontario-Quebec border. Pointe Mouillee extends about one km into the lake, creating a shallow, protected and relatively productive bay to the east. Pointe Mouillee is eroding along its face at a rate of 3 m/yr. The cause of the erosion has been identified as normal wave wash from wind- and storm-generated waves, possibly accelerated by the present low mean annual water level fluctuations (Loftus *et al.* 1992).

Erosion of Pointe Mouillee threatens a privately held wetland that provides habitat for waterfowl, and the eroded material is being deposited as an underwater sandbar across the mouth of Bainsville Bay. As the sandbar grows, it increasingly restricts flow in the Bay and the resulting excess of submerged macrophytes is reducing the quality of yellow perch habitat in Bainsville Bay.

The fourth affected area is the Cornwall Island-St. Regis Island section of the north channel. Shorelines here are not adjacent to the shipping channel, yet they show signs of continuing erosion. The erosion may be related to the channel modifications associated with Seaway construction but this has not been confirmed. Some remedial work is planned by

the federal Department of Public Works in partnership with the Mohawks of Akwesasne in 1997.

In addition, many small areas of the shoreline have erosion problems associated with recreational and residential developments. Erosion occurs when landowners destabilize the shoreline by removing vegetation or by changing the micro-flow patterns along the shoreline through construction of docks or boathouses. Shoreline protection works (using vegetative and structural remedies such as plantings and rip-rap placement) have been undertaken in many of these areas and the magnitude of the problem is gradually being reduced.

The St. Lawrence River is one of the great rivers of the world, yet it is often taken for granted, even though millions of people, birds, fish and other aquatic animals depend upon it. The ecosystem in the St. Lawrence River area of concern is as severely affected by habitat destruction and degradation as it is by discharges of toxic contaminants to the river. Every portion of habitat that disappears takes with it numerous plants and animals and disrupts the balance of life in the ecosystem.

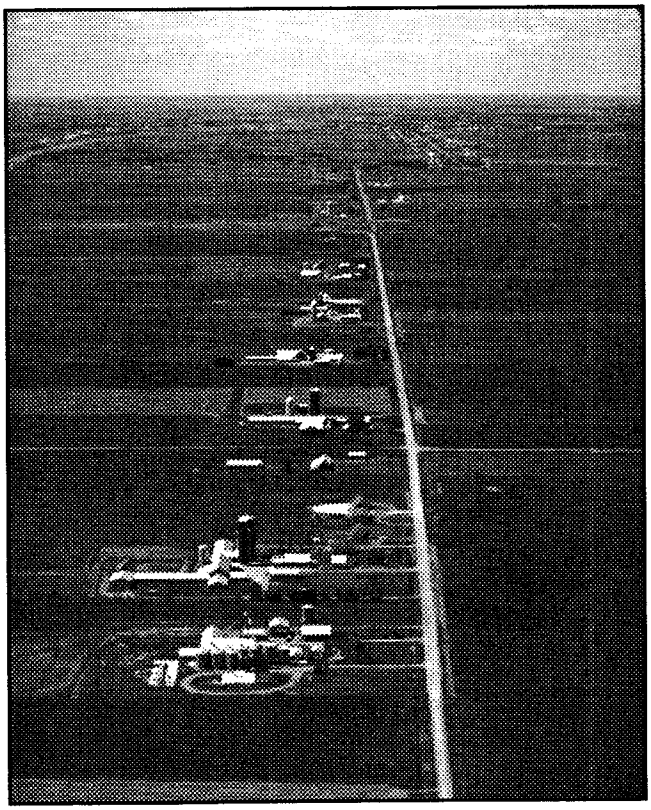
5.6.4 Terrestrial Habitat (Upland and Riparian Habitats)

The *AOC watershed* is defined as the area draining all tributaries that flow directly into the Ontario portion of the AOC, as well as the Ontario portion of the drainage basin of the Delisle and Beaudette Rivers (which flow through Ontario and Quebec into Lake St. Francis).

The upland habitats in the AOC watershed consist of a mosaic of forested, riparian, agricultural and reverting lands as well as developed areas. This mosaic has been created during the past 200 years by agricultural and other development as well as forest harvest operations. The major features of the landscape which are lacking include mature and over-mature forested areas, riparian vegetated areas (forested and non-forested), large blocks of contiguous forest, and forested corridors to link these various areas together. The original landscape would have been substantially forested with different forest succession stages created by wildfire.

A goal of having 10% of the forested area as mature to overmature forest translates to approximately 7400 ha of mature to overmature forest in the St. Lawrence River AOC. It is estimated, however, that there are probably less than 500 ha of such forest in the AOC watershed–a substantial lack (J. Wilson, MNR, pers. comm.). Mature forests of sufficient size provide a distinct habitat type used by a variety of species, many of which have become rare as this habitat type has disappeared across most of southern Ontario. Restoration of this habitat type will take a long time, given that it may take another 50-100 years for parts of the existing forest cover to reach maturity.

The present estimate for total forest cover in the AOC watershed is 74,288 ha of a total land area of 208,273 ha (based on entire townships), which is 35.7% of the total watershed area. Overall, this is satisfactory (the Great Lakes AOCs target is a minimum of



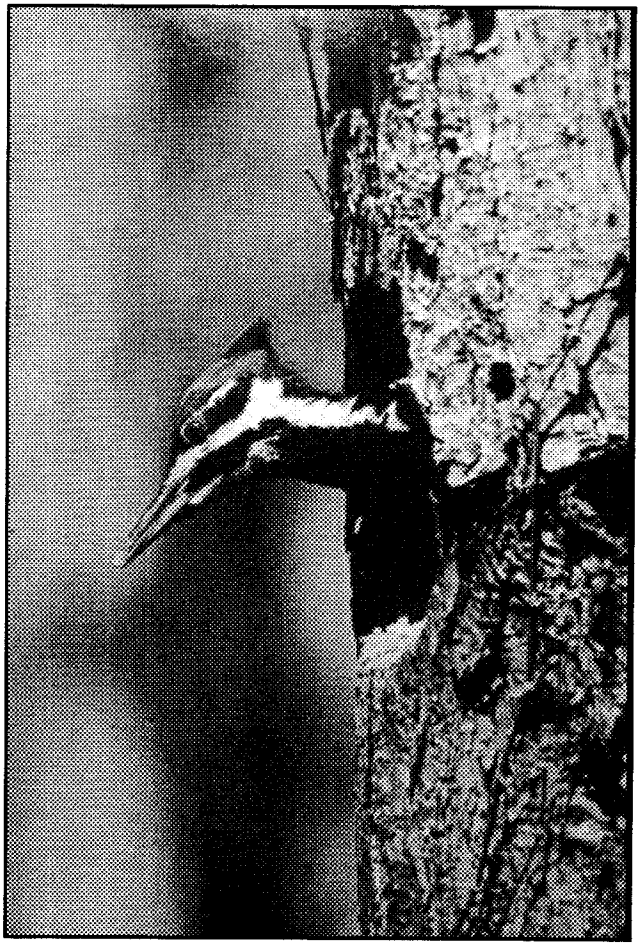
Agricultural development can lead to loss of habitat diversity

30%) (Environment Canada *et al.* 1996). However, the distribution of the forest cover by sub-watersheds is uneven and consequently there are some sub-watersheds which have less than the 30% forest cover overall objective for watersheds. It is the distribution and diversity of forest cover which is impaired, not the overall percentage of forest cover in the watershed.

Riparian habitats (forested and non-forested) are vegetated areas along watercourses. Lacking a full GIS analysis it is not possible to estimate the distribution and amount of riparian habitat in the AOC watershed, but the Great Lakes AOCs objective of 75% minimum coverage in each sub-watershed is not close to being achieved (M. Eckersley, MNR, unpublished data). The creation of more riparian habitat is important for the wildlife species which rely on it. In a broader context, vegetated riparian areas act to reduce the erosion and runoff of agricultural and urban products directly into the watercourse. Runoff from these sources has substantially impaired the water quality, increased water temperatures and impaired fish habitat in the tributaries. Reestablishment of riparian vegetated areas can be accomplished quickly because this type of vegetation becomes established quickly (within one year for non-forested areas). Reestablishment of forested riparian habitat will of course take much longer.

Large, forested areas with an interior forest surrounded by a 100 m or 200 m wide forested buffer are also desirable habitat types, as are forested areas more than 1000 ha in size. The presence of these large landscape features automatically provides habitat diversity in mainly agricultural landscapes and is therefore an objective for all RAP Areas of Concern. At this time, without a full GIS-based habitat supply analysis, it is not possible to determine if the AOC watershed has sufficient forest cover of this type. The same is true for forested corridors that connect areas of forest cover. Given the large extent of forest cover in the watershed (35.7%) it is likely that many of these features are now present on the landscape.

Overall, for terrestrial habitats in the AOC and its tributary watersheds the assumption, based on recent publications (Riley and Mohr 1994; Environment Canada *et al.* 1996), is that if the features described above are provided at the levels indicated in the previous paragraphs then fish and wildlife habitat in the watershed will be sufficient in size, diversity and quality to support and sustain the fish and wildlife species that should occur (because of historical presence or present-day use) in the AOC.



Pileated Woodpecker

5.7 ISSUE: Exotic Species

A number of exotic (non-native) species live in the Cornwall-Massena section of the St. Lawrence River. These include zebra and quagga mussels, purple loosestrife and Eurasian milfoil. Pacific salmon were intentionally introduced into Lake Ontario for sport fishing and have now moved downstream into parts of the St. Lawrence River. The common carp was intentionally introduced in North America in the 1800s. The river ruffe, an accidentally introduced European fish, now inhabits Lake Superior and may spread through the Great Lakes basin into the St. Lawrence River. Sea lamprey do occur in the AOC but at numbers that do not have an impact on fish populations.

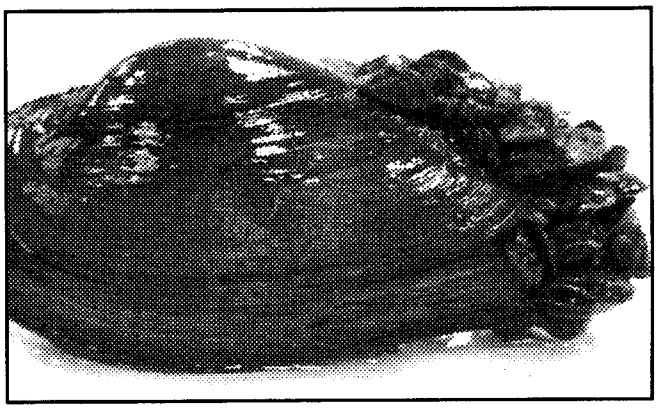
The exotic species of most concern to the St. Lawrence River RAP are the zebra mussel (*Dreissena polymorpha*), the quagga mussel (*Dreissena* sp.) and purple loosestrife (*Lythrum salicaria*). Other species such as Eurasian milfoil and carp are firmly established and have become a part of the AOC's aquatic ecosystem. Pacific salmon do not threaten the river ecosystem in the Cornwall-Lake St. Francis area, although they could pose a threat to Atlantic salmon stocks on the East coast.

5.7.1 Zebra mussels

There is evidence that zebra mussels (*Dreissena polymorpha*) were initially introduced to the Great Lakes in late 1986, through the discharge of ballast water into Lake St. Clair from an ocean-crossing ship (Griffiths *et al.* 1991). These non-native mussels were first discovered in the Great Lakes basin in 1988 (Hebert *et al.* 1989).

The first check point for ballast water of ships entering the Great Lakes is at Massena, NY. Zebra mussels were first reported in the Cornwall-Massena section of the St. Lawrence River in 1989 and were believed to have come from ballast water discharged in the area. In 1990 they were found only at Cornwall and Prescott but by 1991 they had spread throughout the St. Lawrence River AOC.

A related species, the quagga mussel (*Dreissena* sp.), has also been recently collected from the area of concern, probably introduced in the same manner as the zebra mussels. Both species are unique freshwater bivalves in that their life cycle does not require fish as an intermediate host. This contributes to their ability to invade, colonize and proliferate in new areas. Quagga mussels can colonize depths greater than the zebra and their contribution to the issue may be that they effectively (by living at greater depths) allow these two mussel species to invade and inhabit a greater amount of habitat.



Zebra mussels attached to native mussel

Zebra mussel densities as high as 200,000-700,000/m² have been recorded for Lake Erie and the St. Clair River. Densities throughout the length of the St. Lawrence River range from 4,000-20,000/m² (Ricciardi *et al.* 1995). Zebra mussels may also be present in parts of the Raisin River and perhaps other tributaries to the St. Lawrence (F. Pick, Ottawa University, pers. comm.).

The full impact zebra mussels will have on the St. Lawrence River ecosystem has yet to be determined, but a number of significant changes have already been observed, which could be related to the presence of zebra mussels. Water clarity has increased dramatically, which may be due in part to filter feeding by zebra mussels in the upstream waters. Filtering removes plankton from the

water column, interrupting the food chain, which may result in a decrease in the abundance of certain species of fish or other aquatic life in the Great Lakes-St. Lawrence River ecosystem.

Analysis of long-term historical data on phosphorus inputs and phytoplankton (green algae) densities for western Lake Erie indicates that phytoplankton densities and increases in water clarity in that water body are more likely due to phosphorus reductions over the past 40 years than to the presence of zebra mussels (Nicholls 1996). Data on phytoplankton and water clarity in the St. Lawrence River AOC have not been collected over such a long period and are much more recent, so it is not possible to do a similar analysis for the AOC with respect to relative contributions of phosphorus reductions and zebra mussels to recently observed changes in local water clarity.

A more immediate impact of zebra mussel colonization and proliferation has been the demise of native mussel populations. During their life cycle, free swimming larvae (veligers) of *Dreissena* sp. attach to hard substrates then begin to develop shells. In silty or sandy areas of the river bottom, the only available hard substrate may be the shells of native mussels. Once zebra mussels attach to a native mussel (sometimes as many as 100 per individual) it becomes impossible for the native mussel to maintain normal activities such as feeding, locomotion and respiration. Ricciardi *et al.* (1995) propose that this interference places such an energy burden on native mussels that they are unable to survive the winter. Collection attempts made by Environment Canada in 1996 confirm that, for the most part, native mussel populations are now absent from the Cornwall/Massena region of the St. Lawrence River.

5.7.2 Purple loosestrife

Purple loosestrife (*Lythrum salicaria*) has been invading wetlands in North America since the 1800s, when it was introduced from Europe as a garden flower. Since then it has spread across the continent from the Atlantic regions to British Columbia, Washington and Oregon, and from southern Manitoba to the northern reaches of the Mississippi basin (Raloff 1992).

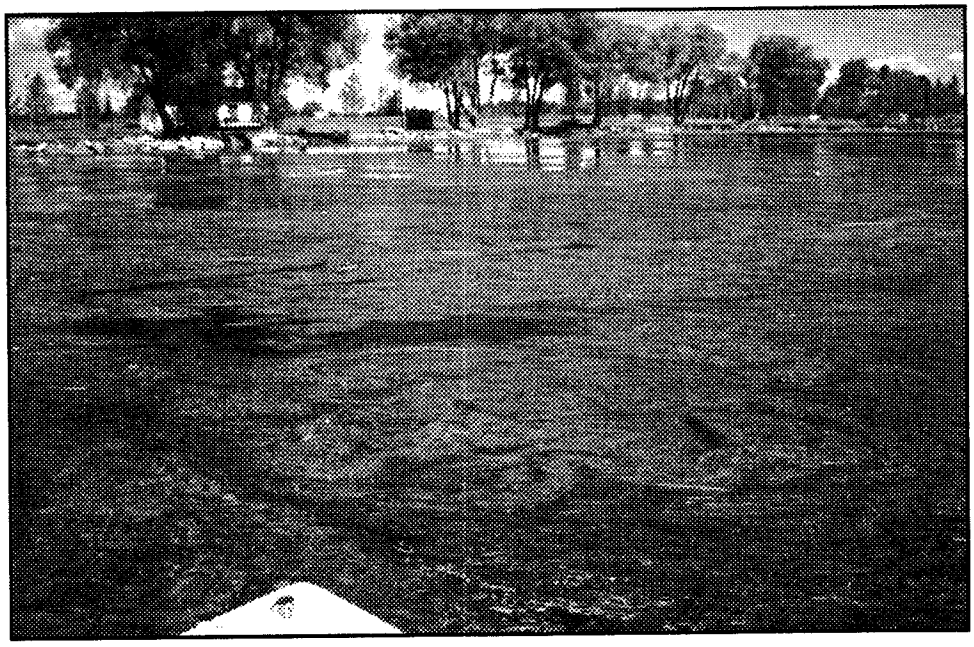
Although the distribution of purple loosestrife in the St. Lawrence River area of concern has not been surveyed, the plant has been noted in all of the wetlands along the north shore of Lake St. Francis. It is not a dominant component of these areas now, and there are no data on how quickly it is spreading, but it is expected to become more abundant and methods of controlling its spread are being examined.

Purple loosestrife

One method of controlling an exotic plant is to introduce a natural insect predator from the plant's area of origin. This reestablishes the herbivore:plant relationship that exists in the native range of the plant. Thus, European beetles (*Galerucella calmariensis, G. pusilla* and *Hylobius transversovittatus*) that feed exclusively on leaf tips of purple loosestrife have been shown to be an effective biological control agent for this plant (University of Guelph, Biological Control Laboratory, 1996 Fact Sheet). Extreme care is required in deciding whether to proceed with a wide-spread program to control an exotic plant by introducing an exotic insect predator. This type of introduction could solve one problem but create others within the ecosystem. The strategy is still under investigation to determine if a province-wide program should be endorsed.

5.7.3 Other exotic species

Other exotic species have either become a part of the aquatic system (milfoil, carp), have not yet arrived (river ruffe) or do not present a problem (Pacific salmon) in the area of concern. Eurasian milfoil is a problem in Lake St. Francis; excessive growth of milfoil and other nuisance aquatic plants is discussed in Chapter 5.5. To this point, carp have not been an issue in wetland or aquatic habitat restoration in the AOC.



Dense growth of Eurasian milfoil

5.8 ISSUE: Fish and Wildlife Health Effects

A variety of contaminants have been documented in fish and wildlife in the Great Lakes and elsewhere (*e.g.*, White et al. 1988; Frank *et al.* 1983; Smith *et al.* 1985; Weseloh *et al.* 1989; Bishop *et al.* 1991, 1994, 1995; Heath *et al.* 1993; Russell *et al.* 1995; Struger *et al.* 1993; Weseloh et al. 1995). Some data linking contaminants to specific health effects exists for fish (Heath *et al.* 1993), water birds (Frank *et al.* 1983; White *et al.* 1988), amphibians (Russell *et al.* 1995) and a few top-order predators.

Contaminants that have been detected in wildlife include heavy metals; organic compounds such as DDT, PCBs, PAHs, dioxins and furans; alkyl phenols; and compounds that have been linked to the disruption of hormonal activities in birds and mammals, egg shell thinning and hatching success in birds, and neurological and developmental abnormalities in amphibians, birds and mammals (White *et al.* 1988; Frank *et al.* 1983). The effects of synergistic and antagonistic interactions of toxic contaminants in relation to fish and wildlife health are poorly understood for the Great Lakes ecosystem, and no such effects have been identified specific to the St. Lawrence River AOC.

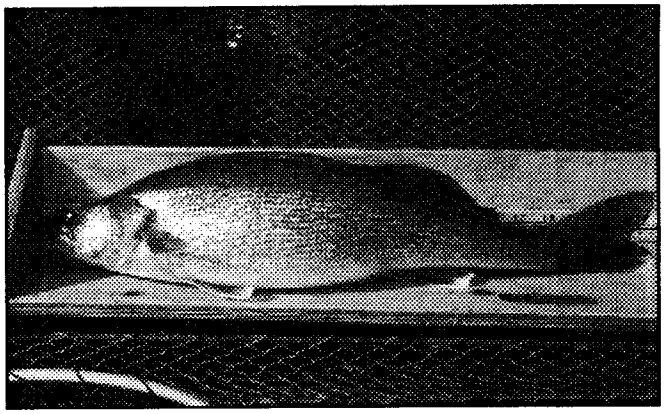
Health effects are very difficult to identify in wild species and when found it is often impossible, because of the variety of chemical and non-chemical stresses the species face, to directly link any health effects specifically to chemical contaminants. The science of identifying and determining the causes of health impairments is new and lacks resolution as a result. It is important to note that there could be existing but unidentified health impairments in fish and wildlife species in the St. Lawrence River (Cornwall) AOC.

There is evidence that the health of fish and wildlife in the St. Lawrence River (Cornwall) AOC is being impaired, most likely due to chemical contamination. Two studies are in progress and are discussed below (walleye liver tumours and mudpuppy deformities).

Research has been more extensive for sites at Akwesasne and along the south shore of the St. Lawrence River near areas of PCB-contaminated sediment (Struger *et al.* 1993; Bonin *et al.* 1995; Bishop *et al.* 1995; Bishop *et al.*, in prep.a, in prep.*b*; Gendron *et al.*, in prep.). Gendron *et al.* (in press) reported a significant correlation between the occurrence of limb defects in mudpuppy populations and the concentration, in corresponding egg samples, of contaminants such as organochlorine pesticides and PCBs. Biochemical changes associated with developmental and reproductive processes were observed in mudpuppies (Gendron *et al.*, in press) and tree swallows (Bishop *et al.*, in prep.*b*).

5.8.1 Fish Tumour Studies

In 1990, a Great Lakes basin-wide study of liver tumour frequencies in walleye and white suckers showed that Lake St. Francis (Raisin River) walleye had a very high frequency of 18%, compared to 0-0.5% frequencies in all other sampled areas (Baumann *et al.* 1996). This suggested that chemical contaminants in the AOC could be responsible for the tumours, although the tumours themselves have not been definitively shown to impair walleye health. Tumour frequencies for white suckers in Lake St. Francis were similar to values from other AOCs and at a level thought to be non-problematic.



Walleye

Five years later, walleye were collected from Lake St. Francis (Raisin River) as well as from reference sites in Hoople Creek at Lake St. Lawrence (1995) and the Salmon River at the Bay of Quinte (1996), to determine whether: (1) 1990 Lake St. Francis tumour frequencies were an anomaly in time, and (2) liver tumour frequencies in walleye from other non-AOC (Lake St. Lawrence) and AOC (Bay of Quinte) areas were similar to 1990 Lake St. Francis values.

The choice of 1995 and 1996 reference sites was based on information indicating that the walleye stocks in Lake St. Francis, Lake St. Lawrence and the Bay of Quinte are different and isolated. Moreover, these are the only sites in the upper St. Lawrence and eastern Lake Ontario with walleye spawning stocks large enough to allow for sufficient sample collections. Analysis of the data was gender- and age-specific for each location.

In the 1995 and 1996 studies, liver tumour frequencies in walleye from the AOC (Lake St. Francis), Lake. St. Lawrence and Bay of Quinte were similar to each other and to the 1990 Lake St. Francis values (Hayes and Portt 1996; Hayes and Portt, draft). With respect to item (1), above, it can therefore be concluded that the high liver tumour frequencies observed in 1990 Lake St. Francis fish were not a one-time anomaly, since five years later they were again found in Lake St. Francis walleye of a similar age range.

With respect to item (2), above, the 1995 data from Lake St. Lawrence and the 1996 data from Bay of Quinte show that liver tumour rates in walleye of similar age and gender were similar to those observed in Lake St. Francis (1990 and 1995). This indicates that either walleye in all three areas are affected by tumour-causing chemical contamination or tumours are a natural phenomenon of older walleye. The data are insufficient either to eliminate the possibility of a health impairment or to demonstrate one.

A study is being proposed to expand the investigation to uncontaminated sites outside the Great Lakes basin, in order to determine if chemical induction is a factor in tumour development or if these tumour rates are typical (but not chemically induced) of walleye populations in eastern North America.

5.8.2 Mudpuppy Studies

Mudpuppies in the AOC have elevated rates of deformities compared to control populations outside the AOC. These deformities may be caused by environmental contamination and further study is need to confirm this.

Bonin *et al.* (1995) found significant geographical differences in contamination patterns of aquatic salamanders (mudpuppies) collected in 1988-1992 from sites in the Ottawa and St. Lawrence Rivers. The mudpuppies were analyzed for PCBs, organochlorines and mercury, and the study results indicated that this species (*Necturus maculosus*) might be a useful bioindicator for such contaminants.

In 1993, Environment Canada surveyed mudpuppies from the Ottawa River and four locations in the St. Lawrence River between Cornwall and Quebec City, to investigate physiological responses of the mudpuppy to toxic environmental contaminants. Unusually high limb deformity rates were found in mudpuppies from a site on the south shore of the St. Lawrence River near Massena, immediately west of the mouth of the Raquette River where there are areas of severe PCB and PAH contamination in sediment. The prevalence of deformities was significantly higher ($P<0.0001$) at the Massena site than at the reference site (Batiscan River). Fifty-eight percent (28/48) of animals sampled at the Massena site had deformities, compared with 9% (6/69) at the reference site (Gendron *et al.* 1994).

To determine if a similar situation existed in the St. Lawrence River AOC on the Canadian side of the river, mudpuppies were collected along the Cornwall waterfront in 1996. Limb deformities were present in 47% (7/15) of animals collected at five locations along the Cornwall waterfront, from about one kilometre upstream of Domtar to about one kilometre downstream of the former Courtaulds Fibres site. Reference sites, both in the Ottawa River and elsewhere in the St. Lawrence, had a deformity rate of less than 10%. The reason for the high prevalence of deformities is unknown at this time. The sampling station with the highest frequency of deformities was approximately one kilometre upstream of present-day and historical Cornwall point sources of contaminants (Environment Canada, unpublished data).

5.8.3 Other Studies

Another contaminants health effects study has been conducted in Lake St. Louis and Lake St. Francis, by Quebec provincial agencies. Lower fecundity rates for yellow perch were found in fish from the more heavily contaminated sections of Lake St. Louis, whereas a similar effect was absent in Lake St. Francis perch (Dumont 1996).

Environment Canada has not sampled Lake St. Francis in any of its bird health monitoring programs, due to the absence of breeding sites of the monitored species (osprey, bald eagle, cormorants, herring and ring-billed gulls). Contaminant levels in Herring Gull eggs from Strachan Island have been monitored since 1986. Strachan Island is located approximately 400 m above the Cornwall Dam and, although it is technically outside the AOC, gulls typically forage up to 30-40 km in all directions from their colony site. Gulls from Strachan island would certainly feed within the boundaries of the AOC.

In 1996, concentrations (ug/g. wet weight) of selected contaminants in gull eggs at Strachan Island were as follows: PCBs (16.9), DDE (2.44), mirex (0.54), p-mirex (0.21). Nine other routinely monitored OC compounds (dieldrin, heptachlor epoxide, HCB, two tetrachlorobenzenes, pentachlorobenzene, oxychlordane and a- and b-HCH) were all less than 0.1 ug/g (see Bishop *et al.* 1992 and Pettit *et al,* 1994 for additional compounds and analytical details). None of the chemical concentrations found in gull eggs from Strachan island are high enough to pose a health hazard to the gulls at the site.

Temporal trends in concentrations of DDE and PCBs in gull eggs from Strachan island were calculated. Although levels of both compounds have fluctuated during the monitoring period (1986 to present), as of 1996, DDE and PCB levels had declined 32.0 and 17.2%, respectively since 1986.

The Great Lakes-wide database for the Herring Gull allows the comparison among many AOC and non-AOC sites. For DDE, samples from Strachan island are greater than those from the Niagara River but less than those from Kingston (Snake Is.), Toronto and Hamilton Harbours. For PCBs, concentration in gull eggs from Strachan Island were greater than those at Kingston and Niagara but less than at Toronto and Hamilton Harbours. Contaminant levels in gull eggs from Strachan Island represent a very vivid, easy to understand portrayal of spatial and temporal trends in a wildlife species.

Collections of black-crowned night heron eggs from Lake St. Francis are planned for 1998, to compare contaminant levels in the eggs with samples collected in other parts of the Great Lakes basin (C. Weseloh, Environment Canada, pers. comm.). The collection of 10 eggs (1 from each of 10 nests) is unlikely to have a detrimental impact on the breeding population at this site, since generally only 2 of the 3 eggs laid (on average) will produce fledged young (Mousseau 1996).

Recently, Domtar Papers Ltd. completed the first cycle of the federally-required Environmental Effects Monitoring (EEM) Program, which is designed to detect impacts of pulp and paper effluent on fish and benthos in receiving waters. Results for the Cornwall waterfront indicate that the benthic community near the Domtar outfall may be affected more by habitat factors than by effluent. The presence or absence of effluent impacts on fish was not clearly established in the EEM report, although no dioxins were found in the fish sampled (Ecological Services for Planning 1996).

For the benthic community, habitat variation confounded interpretation of the data. Habitat variables accounted for 70% of the benthic community difference. However, habitat types varied in relation to exposure to Domtar effluent. This makes the data difficult to analyze and lends uncertainty to any conclusions drawn.

The site exposed to Domtar effluent had significantly lower benthic abundance and richness than either the upstream (reference) site or the downstream sites (farfield). Much of the difference was attributed to variations in habitat. There are no specific comments on the impact of the effluent on the benthic community, but it was concluded that 70% of the between-site variation in benthic community parameters was due to between-site differences in habitat. Of the 12 sites sampled, oils and greases were detected on the vegetation, water or sediment only at sites 5 and 6 (downstream of

Domtar at the canal exit) and sites 8 and 11 (downstream of the former Courtaulds diffuser). All of the sites sampled were reported to have "healthy levels of richness and abundance of benthic organisms" (Ecological Services for Planning 1996).

Fish sampling was conducted using two sentinel species (yellow perch and white sucker) to examine growth, fecundity, age, size, egg size, sexual maturity, liver weights and contaminant parameters (dioxins and furans). While there were various between-site differences in these parameters for the reference and exposure sites, the number of samples taken was small, resulting in high variability which makes interpretation of the results problematic. The document states that "no mill-related effects could be inferred from the [fish] data". This could reflect the low number of samples, inherent variability in the parameters analyzed or the possibility that the yellow perch and white sucker move to varying degrees between the three areas sampled. The report provides very little written comparison of the data for exposed and reference areas with respect to these parameters and is inconclusive in terms of effluent impacts.

Fish contaminants analyses detected furans in both yellow perch and white suckers. Concentrations of the furan 2,3,7,8-T4CDF ranged from 200-900 pg/g at the reference sites and 500-2400 ng/g at the exposed site. Total T4CDF ranged from 200-900 pg/g at the reference site and 500-2700 pg/g in sampled fillets. The report states that "the elevated furan concentrations in white sucker from the exposure area suggest this species is exposed to mill effluent" but that for yellow perch "the presence of furan contamination at the reference areas suggests that upstream sources may be responsible for the levels observed in fish [perch] tissue". It is possible that movement of fish among areas is a confounding factor in this situation as well (Ecological Services for Planning 1996).

With respect to dioxins, the report states that "levels of all dioxin congeners were below the detection limit (800 pg/g) in both species from both the reference and exposure areas".

Toxicity testing showed no effect, for any of the bioassays performed, at the assumed river effluent concentration of less than 1% within 15 m of the diffuser.

Overall, the report provides some useful information regarding environmental effects of Domtar discharges, but the major purpose of the study was to determine the appropriate sampling regime for further monitoring. More complete environmental effects information should be forthcoming in future phases of the EEM cycle (Ecological Services for Planning 1996).

6. RECOMMENDED REMEDIAL ACTIONS

Through a process of technical investigation and public consultation described elsewhere in this report, a total of sixty-four Recommended Remedial Actions have been selected by the St. Lawrence River (Cornwall) RAP Team and PAC. They are discussed in this chapter, grouped into the following categories:

6.1 Implement Basin-Wide Actions in the Great Lakes-St. Lawrence River Ecosystem
6.2 Reduce Industrial Pollution
6.3 Remediate Contaminated Sediment
6.4 Reduce Pollution from Municipal Sources
6.5 Reduce Pollution from Rural Sources
6.6 Control the Growth of Nuisance Aquatic Plants
6.7 Control or Reverse Habitat Degradation and Destruction
6.8 Control Erosion
6.9 Control Exotic Species

Table 11 lists the complete set of St. Lawrence River RAP Recommendations; the sections that follow discuss estimated cost, potential partners, regulatory responsibility, implementation schedule and the brief background for each recommendation. Please note that the list of potential partners for a given recommendation may not be all inclusive.

In addition to the sixty-four Recommendations in Table 11, the St. Lawrence River RAP Team and PAC recommend that an Education Strategy be implemented in the AOC to increase awareness and knowledge of environmental issues specifically applied to the local area. The RAP Education Strategy includes thirteen education recommendations outlined in Section 6.10 of this chapter. Recommendations regarding future research activities in the AOC are included at the end of Chapter 10 (Section 10.8).

Cornwall waterfront in winter time

Table 11. St. Lawrence River (Cornwall) RAP Recommendations.

St. Lawrence River (Cornwall) RAP Recommendations	
I. GREAT LAKES-ST. LAWRENCE RIVER BASIN-WIDE ACTIONS	
# 1	Ask the federal and provincial governments to show more tangible evidence of their commitment to the goal of virtual elimination of persistent toxic contaminants by using their legislative authorities to ban the use of mercury and production of persistent toxic compounds like dioxins and dibenzofurans.
# 2	Recommend that lead shot be banned from the Great Lakes-St. Lawrence Basin and replaced by a non-toxic, non-bioaccumulating type of shot. Encourage anglers to switch to non-toxic sinkers and jigs through voluntary exchange programs such as Bay of Quinte RAP's "Take A Little Lead Out!" program.
# 3	Recommend that parties to the Great Lakes Water Quality Agreement negotiate an agreement regarding long-range transport of airborne mercury and PCBs into the area of concern.
# 4	Recommend that the governments of New York State, Ontario, the United States and Canada develop and implement the Niagara River Toxics Management Plan and the Lakewide Management Plans, and recommend that these plans call for elimination of the production, use and release of mercury and other persistent toxic substances like dioxins and dibenzofurans.
# 5	Establish federal and provincial regulations banning the manufacture and sale of all detergents containing phosphates.
# 6	Recommend that OMAFRA vigorously pursue its pesticides reduction goal in the Great Lakes-St. Lawrence River Basin by encouraging improved chemical herbicide/pesticide application practices, integrated pest management and other alternative farming practices that reduce the environmental impact of pest and weed control.
# 7	Recommend that all authorities involved in managing public lands, transportation routes and transmission corridors in the Great Lakes-St. Lawrence River Basin do the following: (1) provide an inventory of their herbicide and pesticide use, and (2) develop and implement strategies that will reduce their use of these chemicals in the Basin by 50% by the year 2002.

II.	INDUSTRIAL POLLUTION SOURCES
# 8	Ensure enforcement of legal limits set by MISA and Federal Pulp and Paper Regulations.
# 9	Install state-of-the-art technologies that reduce or concentrate Domtar effluent.
# 10	Identify sources of PAHs in Domtar effluent and take steps to control or eliminate them.
# 11	Track decommissioning of Courtaulds Fibres, ICI Forest Products (mercury cell process), Cornwall Chemicals and other closed plants via participation of RAP Team through MOEE and public consultation with PAC.
# 12	Recommend that current and all future industries that are direct dischargers in the area of concern operate plants to achieve a compliance limit of 1 mg/L (monthly average) total phosphorus and an objective of 0.5 mg/L.
# 13	Although air quality issues not affecting water quality are outside the RAP mandate, they are integral to ecosystem health. It is therefore recommended that the activity of the existing MOEE air monitoring working group for the City of Cornwall and surrounding area should be continued and expanded to include identification of remedial actions. This MOEE working group should be extended to include a public participation component.

St. Lawrence River (Cornwall) RAP Recommendations	
III. CONTAMINATED SEDIMENT	
# 14	Implement a Canada/US monitoring program to track site-specific and AOC-wide impacts of American site remediation efforts in Massena.
# 15	Develop appropriate federal/provincial positions on remediation of the Reynolds Metals, ALCOA and GM sites by means of the Canadian Review Panel, which reviews the various cleanup plans for PCBs, PAHs, dioxins and dibenzofurans.
# 16	In areas where contaminant levels in sediment are below the severe effect level but above the lowest effect level, implement source control measures to prevent further contamination of sediment and allow remediation of contaminated sediment to occur by means of burial by the natural sedimentation process.
# 17	In areas where contaminant levels in sediment exceed the severe effect level for mercury, PCBs or other persistent toxic contaminants or where the sediment is found to be acutely toxic (i.e., the "hot spots"), prevent further contamination by implementing source control measures and remediate sediment by the most appropriate state-of-the-art technology (e.g., dredging, capping, in situ treatment).
# 18	Participate in additional studies at Cornwall Harbour to determine if the land-based contamination is affecting the River. If there is an impact, ensure that the appropriate corrective actions are implemented to protect the River.

St. Lawrence River (Cornwall) RAP Recommendations	
IV. MUNICIPAL POLLUTION SOURCES	
# 19	Upgrade Cornwall sewage treatment plant to secondary treatment or equivalent treatment consistent with the MOEE Municipal MISA program.
# 20	Recommend that the City of Cornwall provide carbon filtration treatment (or equivalent) for its drinking water to eliminate taste and odour problems.
# 21	Find and eliminate the source of PCBs in spottail shiners collected from the Cornwall waterfront.
# 22	Monitor progress in implementing recommendations of the City of Cornwall's Pollution Control Plan (PCP) to ensure that pollution problems associated with the City's sewer systems are corrected as recommended in the Plan.
# 23	Encourage careful use of water by implementing a volume-based water pricing system.
# 24	Require new dwellings to use water-saving devices such as low volume toilets and shower heads and institute a program of retrofitting old houses for water conservation.
# 25	Recommend that the City of Cornwall review and update its sewer use by-laws by incorporating the latest version of MOEE's Model Sewer Use By-Law.
# 26	Recommend that the City of Cornwall modify the snow dump site to contain surface runoff, and that they undertake a feasibility study to find a more acceptable long term solution to the problem.
# 27	Request that in its Official Plan, the City of Cornwall delineate zones of coal tar contamination and define development constraints for those zones and that a Notice on Title be registered for all of the affected properties.
# 28	Upgrade Glen Walter sewage treatment plant to achieve a compliance limit of 1 mg/L total phosphorus and an objective of 0.5 mg/L.
# 29	Recommend phosphorus removal to a compliance limit of 1 mg/L, with an objective of 0.5 mg/L, at all wastewater treatment systems along the St. Lawrence River upstream of Cornwall.
# 30	Recommend that New York State install treatment facilities for phosphorus removal at its sewage treatment plants discharging into the St. Lawrence River and its tributaries.

St. Lawrence River (Cornwall) RAP Recommendations	
V. RURAL POLLUTION SOURCES	
# 31	Control stormwater discharges from municipalities other than Cornwall, particularly roads and communities along the Raisin and St. Lawrence Rivers, by collecting and treating stormwater.
# 32	Install proper septic systems on private shoreline properties where land is sufficient and can meet existing regulations; carry out inspections to ensure compliance.
# 33	Where land is not sufficient, install holding tanks and institute municipal or other regulatory agency collection to the sewage treatment plant, with costs included in annual property tax assessments.
# 34	As a long-term plan, install sewage treatment plants for river communities, including Summerstown, South Lancaster, Pilon Island, Cornwall Island and Bainsville.
# 35	Inspect park and campground sewage disposal systems and correct deficient systems.
# 36	Where feasible, collect and treat stormwater and discharge at downstream end of beach.
# 37	Eliminate livestock access to surface waters by providing education and financial incentives to farmers and by enforcing existing regulations.
# 38	Inspect manure piles and milkhouse waste disposal systems which have the potential to be sources of surface water contamination, and correct by: (1) providing education to farmers on how to correct the problem; (2) providing financial incentives to farmers; (3) enforcing existing regulations; (4) incorporating into municipal zoning by-laws, the Agricultural Code of Practice regarding manure/milkhouse wastes; (5) establishing a bioconversion facility for production of fertilizer from manure and other organic sludges pending feasibility study (to determine available manure supply, interest in participation etc.).
# 39	Endorse the Farm Environmental Plan program described in *Our Farm Environmental Agenda* as part of the development of an agricultural land stewardship program.
# 40	Regulate discharges of grey water from new boats.
# 41	Increase enforcement of existing regulation for discharge of black water.

St. Lawrence River (Cornwall) RAP Recommendations	
VI. NUISANCE AQUATIC PLANTS	
# 42	Support managed mechanical harvesting as a continued option for controlling nuisance aquatic macrophytes in selected areas of Lake St. Francis.
# 43	Prohibit the use of chemical herbicides by individuals to provide access lanes for boating adjacent to shoreline. The only exceptions to be considered will be in artificial canals with no flow.
# 44	Continue to allow individuals to physically remove (under permit) a pre-determined and limited amount of aquatic vegetation from the water in front of their property.
# 45	Mechanically harvest plants over several hectares of Bainsville Bay to improve water circulation and flow in the Bay and increase dissolved oxygen levels.

St. Lawrence River (Cornwall) RAP Recommendations	
VII. HABITAT DEGRADATION AND DESTRUCTION	
# 46	As a first priority, acquire all wetlands on Lake St. Francis now privately owned.
# 47	As a second priority, secure all additional provincially significant wetlands in the watershed.
# 48	Encourage municipalities to continue to implement the Provincial Natural Heritage Policy (1996) which requires all planning agencies to have regard for provincially significant wetlands in their planning decisions. The Policy calls for no development in provincially significant wetlands and no development on adjacent lands if the wetland will be affected. This policy is to be interpreted as part of all the new Planning Act policies by municipalities and agencies.
# 49	Encourage municipalities to protect wetlands that are not designated provincially significant by requesting that they include development constraints and buffer zones around these areas.
# 50	Establish a joint Quebec/Ontario/Mohawks of Akwesasne committee to coordinate the protection and management of wetlands in Lake St. Francis.
# 51	Continue to use existing legislation (including the federal Fisheries Act, Public Lands Act, Lakes and Rivers Improvement Act, Conservation Authorities Act and Environmental Protection Act) to protect aquatic habitats (including fish habitat and wetlands) where this legislation applies. Continue to require a minimum compensation of 1:1 (new habitat created : habitat altered) for fish habitat harmfully altered by development activities. Minimum compensation should be 1:1 for like habitat on site; 1:2 for like habitat off site or replacement habitat on site; and 1:4 for replacement habitat off site.
# 52	Change the existing provincial work permit system, to prevent any dredging or filling in any shoreline wetland unless that activity would directly enhance the function or value of the wetland.
# 53	Develop and implement a program to identify the causes of wetland and aquatic habitat degradation in the area of concern, identify appropriate remedies and ensure their implementation.

St. Lawrence River (Cornwall) RAP Recommendations	
# 54	Restore and enhance wetlands by using, where appropriate and pending the EA and CEAA processes, techniques such as controlled water level impoundments, construction of open water habitats (level ditching) and shoreline reconstruction.
# 55	Develop an integrated planning approach for shoreline development based on resource management information which would be collected and managed in a collective GIS-based database. This would include information on fish & wildlife species in the affected area, habitat type and degree of expected alteration, impacts on nearshore water currents and potential erosion impacts, and potential impacts on water quality.
# 56	Restore shallow-water reef habitat by constructing artificial reefs at various locations including Bainsville Bay-Pointe Mouillée and the Cornwall waterfront, giving priority to areas closer to the power dam.
# 57	Work with the Mohawks of Akwesasne to protect fish habitat and prevent shoreline degradation.
# 58	Encourage the enhancement of the protection, number, size, quality and distribution (i.e., reduce fragmentation) of certain terrestrial habitats (i.e., mature and overmature forests, riparian habitats) and their dependent species.
# 59	Using the present regulatory system, continue to permit small, privately-owned shoreline properties to be stabilized on a site-by-site basis (includes shorelines of Lake St. Francis and tributaries) using erosion control techniques such as rip-rapping, revegetation, natural revetments and construction of offshore wave barriers and reefs.
# 60	For specific problem areas, design the appropriate stabilization technique and implement the work as a government initiative either with public funding only or on a cost-shared basis with the landowner.
# 61	Design a shoreline stabilization project for Pointe Mouillée, based on the completed feasibility study, which incorporates the appropriate wetland and fish habitat protection and enhancement measures.

St. Lawrence River (Cornwall) RAP Recommendations	
VIII. EXOTIC SPECIES	
# 62	Recommend that all regulatory agencies ensure that no accidental introductions of exotic species occur in the area of concern and that any planned introductions are subject to the appropriate level of provincial and federal environmental assessment.
# 63	Recommend mandatory regulation requiring treatment or exchange (or some other technique) to ensure that ballast water cannot be a carrier for the introduction of exotic species into the area of concern.
# 64	Discontinue chlorination as a control measure for exotic mussels as soon as a more environmentally sound method becomes available.

Note: The Recommendation numbers in this document do not directly correspond to the numbering of the seventy-nine options discussed in Choices for Cleanup: Deciding the Future of a Great River *(August 1994). Numbering has been altered through addition or deletion of several remedial options, based on a thorough RAP team and PAC review of the input received during public consultation in Stage 2 of the Cornwall RAP.*

6.1 Implement Basin-Wide Actions in the Great Lakes-St. Lawrence River Ecosystem

Some of the issues affecting the St. Lawrence River area of concern are broad-based environmental concerns that can only be addressed by taking action to correct the problem throughout the Great Lakes-St. Lawrence Basin. For example, many persistent toxic contaminants enter the St. Lawrence River from sources outside the Cornwall-Massena area and measures need to be taken to control or eliminate these inputs at their source. Therefore, the following general actions are recommended for addressing Great Lakes basin-wide issues.

 # 1 ***Ask the federal and provincial governments to show more tangible evidence of their commitment to the goal of virtual elimination of persistent toxic contaminants by using their legislative authorities to ban the use of mercury and production of persistent toxic compounds like dioxins and dibenzofurans.***

ESTIMATED COST:
COST CURRENTLY UNKNOWN.

POTENTIAL PARTNERS:
ENVIRONMENT CANADA / MOEE / HEALTH CANADA / PAC / OPAC

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA / MOEE

IMPLEMENTATION SCHEDULE:
IMMEDIATE

The *Great Lakes Water Quality Agreement* commits the governments of Canada and the United States to a policy of virtual elimination of inputs of persistent toxic substances to the environment. The Agreement states that "the philosophy adopted for control of inputs of persistent toxic substances shall be zero discharge". Canada and the US are currently working towards establishing a binational strategy for virtual elimination of toxic contaminants. Public consultation regarding the strategy is ongoing.

The provincial government of Ontario has established a Municipal-Industrial Strategy for Abatement (MISA) program, to regulate discharges of persistent toxic substances and conventional pollutants in effluent to the point where they are virtually eliminated from the environment.

The two levels of government should implement concrete actions in the form of a ban on the use of mercury and production of persistent, toxic compounds like dioxins and dibenzofurans. Such a ban would show evidence of their commitment to the goal of virtual elimination and zero discharge.

 # 2 ***Recommend that lead shot be banned from the Great Lakes-St. Lawrence Basin and replaced by a non-toxic, non-bioaccumulating type of shot. Encourage anglers to switch to non-toxic sinkers and jigs through voluntary exchange programs such as Bay of Quinte RAP's "Take A Little Lead Out!" program.***

ESTIMATED COST:
NON-TOXIC TACKLE: $35,000-$50,000 TO IMPLEMENT A SINKER AND JIG EXCHANGE PROGRAM SUCH AS TAKE A LITTLE LEAD OUT! IN THE AOC.

POTENTIAL PARTNERS:
PAC / LOCAL FISHING ASSOCIATION (LUNKER CLUB) AND COMMUNITY CLUBS (LION'S CLUB, ROTARY CLUB)/ SLRIES / MOEE / MNR / ENVIRONMENT CANADA / RRCA / MANUFACTURERS OF NON-TOXIC FISHING TACKLE

REGULATORY RESPONSIBILITY:
NONE FOR NON-TOXIC FISHING TACKLE.
ENVIRONMENT CANADA FOR NON-TOXIC SHOT.

IMPLEMENTATION SCHEDULE:
NON-TOXIC SHOT: 1997

SINKER EXCHANGE PROGRAM:
1998

Canada is phasing in new hunting regulations that prohibit possession or use of lead shot for the purpose of hunting migratory birds anywhere in Canada beginning in 1997. The Cornwall RAP supports an outright ban on lead shot. In addition, we recommend that anglers be encouraged to switch from lead sinkers and jigs to non-toxic alternatives such as bismuth and tin, which are now available commercially.

This can be done by implementing public education and awareness programs within the AOC such as *Take A Little Lead Out!*, a very successful Bay of Quinte RAP program in which anglers participating in fishing derbies were encouraged to exchange their lead sinkers and jigs for non-toxic bismuth and tin.

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3 *Recommend that parties to the Great Lakes Water Quality Agreement negotiate an agreement regarding long-range transport of airborne mercury and PCBs into the area of concern.*

ESTIMATED COST:
INTERNAL AGENCY PROGRAM COSTS.

POTENTIAL PARTNERS:
ENVIRONMENT CANADA / US EPA / PAC / OPAC

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA / MOEE

IMPLEMENTATION SCHEDULE:
THE RECOMMENDATION CAN BE REGISTERED IMMEDIATELY THROUGH THE FORMAL AGENCY ENDORSEMENT OF THIS STAGE 2 RAP RECOMMENDATION. IMPLEMENTATION OF CONTROL AND REDUCTION PROGRAMS REQUIRES NEGOTIATION THROUGH PROCESSES UNDER THE CANADA-UNITED STATES AIR QUALITY AGREEMENT.

Mercury and PCBs enter the St. Lawrence River AOC in atmospheric depositions from worldwide sources, as well as in local industrial and municipal discharges. The primary source of airborne mercury to the area of concern—ICI Forest Products in Cornwall—is no longer an active atmospheric source due to closure of its mercury cell chlor-alkali facility in 1995. The issue of long-range transport of airborne pollutants (LRTAP) into the St. Lawrence AOC must be dealt with at the level of international negotiations, with a focus on the entire Great Lakes-St. Lawrence basin.

In *First Progress Report Under the 1994 COA* the governments of Canada and Ontario clearly recognize that "the atmosphere is now an increasingly significant pathway for loadings of...pollutants into the [Great Lakes-St. Lawrence] basin". Thus, Recommendation # 3 corresponds with the stated intention of both levels of government to reduce depositions of airborne pollutants into the Great Lakes-St. Lawrence ecosystem.

In Canada, the implementation of programs to control emissions and to address broader issues such as regional air quality problems is a responsibility shared by the federal and provincial governments. Coordination among the provinces and the federal government is done through the Canadian Council of Ministers of the Environment and the Council of Energy Ministers.

In 1991, the *Canada-United States Air Quality Agreement* was signed and a bilateral Air Quality Committee was established to address the issue of transboundary air pollution. Progress reports in 1992 and 1994 highlight activities that have achieved significant reductions in emissions of sulphur dioxide and nitrogen oxides in both countries. Many of the strategies to reduce these acid rain related emissions utilize energy efficiency techniques and renewable energy programs which contribute to the reduction of other air and water contaminants like mercury and PCBs. However, specific targets for the reduction of persistent toxic contaminants are not identified in the Air Quality Agreement.

Satellite image of the Great Lakes

 # 4 *Recommend that the governments of New York State, Ontario, the United States and Canada develop and implement the Niagara River Toxics Management Plan and the Lakewide Management Plans, and recommend that these plans call for elimination of the production, use and release of mercury and other persistent toxic substances like dioxins and dibenzofurans.*

ESTIMATED COST:
INTERNAL AGENCY PROGRAM COSTS.

POTENTIAL PARTNERS:
ENVIRONMENT CANADA / MOEE / PAC / OPAC

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA / MOEE

IMPLEMENTATION SCHEDULE:
THE RECOMMENDATION CAN BE REGISTERED IMMEDIATELY THROUGH THE FORMAL AGENCY ENDORSEMENT OF THIS STAGE 2 RAP RECOMMENDATION. IMPLEMENTATION OF BINATIONAL CONTROL AND REDUCTION PROGRAMS REQUIRES RECOMMENDATIONS UNDER THE NIAGARA RIVER TOXICS MANAGEMENT PLAN, THE LAKE ONTARIO LAKEWIDE MANAGEMENT PLAN AND NEGOTIATION BY AGENCIES, AND INDUSTRIAL AND MUNICIPAL DISCHARGERS.

The *1994 Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem* (COA) seeks to decommission 90% of high-level (>1%) PCBs in Ontario, to destroy 50% of the high-level PCBs now in storage, and sets the target of a 90% reduction by the year 2000 in the use, generation or release of the remaining "Tier I" substances—benzo(a)pyrene, hexachlorobenzene, alkyl lead, mercury, octachlorostyrene, PCDD (dioxins) and PCDF (dibenzofurans). Development and implementation of the Lake Ontario Lakewide Management (LaMP) Plan and the Niagara River Toxics Management Plan as set out in formal agreements and declarations signed by the governments of Canada and the United States will be the primary mechanism to achieve this COA target. This will reduce or eliminate inputs of contaminants to the AOC from upstream sources. An estimated 85.5 grams of mercury, for example, now enters the St. Lawrence River daily from upstream sources.

The *Niagara River Declaration of Intent* (1987), signed by the governments of Canada, USA, Ontario and New York State, includes a commitment to develop Toxics Management Plans for the Niagara River and Lake Ontario. Under the terms of the GLWQA (1987), Canada and the United States are obliged to develop and implement a Lakewide Management Plan for each of the Great Lakes. The Lake Ontario Toxics Management Plan (LOTMP) was developed in 1989 and updated in 1991 and 1993. LOTMP commitments will continue to be met through the development and implementation of the LaMP for Lake Ontario. The LaMP will provide specific load reduction targets, with the long-term goal of restoring all beneficial uses.

 # 5 *Establish federal and provincial regulations banning the manufacture and sale of all detergents containing phosphates.*

ESTIMATED COST:
INTERNAL COSTS

POTENTIAL PARTNERS:
ENVIRONMENT CANADA / MOEE / PAC / OPAC

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA / MOEE

IMPLEMENTATION SCHEDULE:
THE RECOMMENDATION CAN BE REGISTERED IMMEDIATELY THROUGH THE FORMAL AGENCY ENDORSEMENT OF THIS STAGE 2 RAP RECOMMENDATION.

This recommendation has also been endorsed by the Ontario Public Advisory Council (OPAC), representing all the Canadian areas of concern.

Since the mid-1970s there has been a significant decrease in phosphorus concentrations in water leaving the Great Lakes at Kingston, Ontario where Lake Ontario empties into the St. Lawrence River (Figure 22). This reflects the effectiveness of phosphorus control measures taken by the Canadian and US governments during the 1960s and 70s to address the problem of eutrophication. Low phosphate detergents were introduced and phosphorus discharges from industries and sewage treatment plants were reduced.

Water clarity in Lakes Ontario and Erie has increased greatly since the 1970s and this has been particularly noticeable in the past several years. The recent increase in clarity was initially thought to be primarily due to colonization by large numbers of phytoplankton-filtering zebra mussels, but a look at the trend over the longer term indicates that phosphorus reductions over the two decades since the mid-1970s are likely the main factor (MOEE 1996). It is a reversal of the earlier tendency of these lakes to produce excessive amounts of algae and aquatic macrophytes (eutrophication).

The long term effect of zebra mussels on the Great Lakes ecosystem is unknown, but the fact remains that human activities still contribute excess phosphorus to the Great Lakes. Detergents that do not contain phosphorus are readily available as an alternative, which would facilitate a ban on the manufacture and sale of phosphate-containing detergents. Such a ban would help to provide long-term protection against excess phosphorus inputs from rural residences on private septic systems and help sewage treatment plants to more easily reach their phosphorus discharge limits.

 # 6 ***Recommend that OMAFRA vigorously pursue its pesticides reduction goal in the Great Lakes-St. Lawrence River Basin by encouraging improved chemical herbicide/pesticide application practices, integrated pest management and other alternative farming practices that reduce the environmental impact of pest and weed control.***

ESTIMATED COST:
NO NEW COSTS IDENTIFIED

POTENTIAL PARTNERS:
OMAFRA / FARMERS / AGRICULTURE CANADA / PAC / OPAC

REGULATORY RESPONSIBILITY:
OMAFRA

IMPLEMENTATION SCHEDULE:
IMMEDIATE

"Improved chemical herbicide/pesticide application practices" refers to application methods (frequency, timing, equipment) that reduce environmental impact. OMAFRA's "Food Systems 2002" program aims to reduce the agricultural use of herbicides and pesticides by 50% by the year 2002. To meet this goal it will be necessary to develop, promote and implement a specific strategy for the St. Lawrence River (Cornwall) AOC. This should include promotion of organic farming and integrated pest management as an alternative to farming practices that employ only chemicals for pest control.

 # 7 ***Recommend that all authorities involved in managing public lands, transportation routes and transmission corridors in the Great Lakes-St. Lawrence River Basin do the following:***
(1) provide an inventory of their herbicide and pesticide use, and
(2) develop and implement strategies that will reduce their use of these chemicals in the Basin by 50% by the year 2002.

ESTIMATED COST:
INTERNAL COSTS

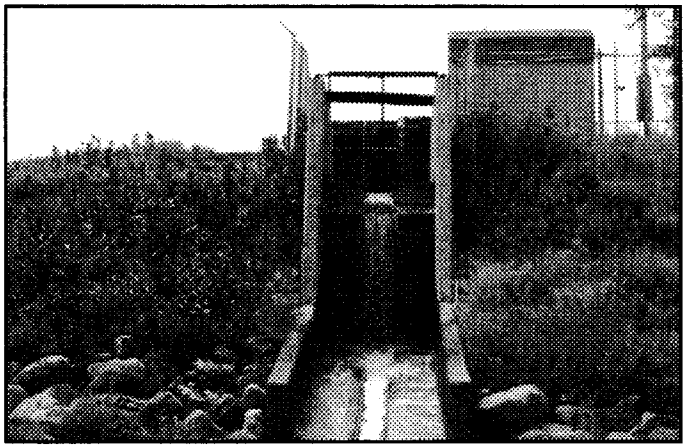
POTENTIAL PARTNERS:
MOEE / MUNICIPALITIES / ONTARIO HYDRO / PIPELINE COMPANIES / MTO / RRCA / ENVIRONMENT CANADA / MNR
REGULATORY RESPONSIBILITY: MOEE / ENVIRONMENT CANADA

IMPLEMENTATION SCHEDULE:
IMMEDIATE

Recommendation # 7 extends the goal of OMAFRA's "Food Systems 2002" program (described with Recommendation # 6) to non-agricultural sectors that are involved in pest and weed control.

6.2 Reduce Industrial Pollution

Pollutants from industrial sources in the area of concern include mercury, PCBs, other contaminants, bacteria, and nutrients such as phosphorus. The main industrial dischargers in the Cornwall area are Domtar Papers, ICI Forest Products and Conpak. Courtaulds Fibres in Cornwall has been closed since 1992. The major industries in Massena, NY are ALCOA, General Motors Powertrain Division and Reynolds Metals Co.



Shore-based discharge

8 *Ensure enforcement of legal limits set by MISA and Federal Pulp and Paper Regulations.*

ESTIMATED COST:
$61,000,000

POTENTIAL PARTNERS:
100% DOMTAR PAPERS

REGULATORY RESPONSIBILITY:
MOEE / ENVIRONMENT CANADA

IMPLEMENTATION SCHEDULE:
IMPLEMENTED FEBRUARY 1995

Construction of the secondary treatment plant at Domtar in Cornwall was completed well ahead of schedule. Operation began in February 1995 and it has been meeting the requirements of both the MISA and federal regulations consistently since then. The plant's design allows it to cope with in-plant spills and problems with little or no impact on the final effluent quality.

9 *Install state-of-the-art technologies that reduce or concentrate Domtar effluent.*

ESTIMATED COST:
$200,000,000

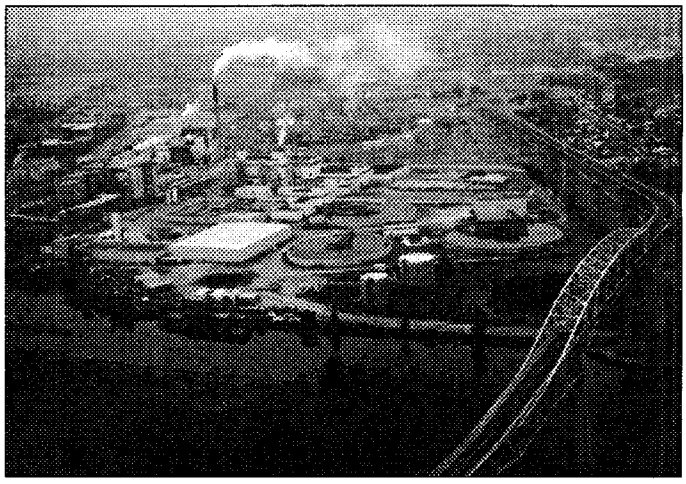
POTENTIAL PARTNERS:
90% DOMTAR PAPERS / 10%
GOVERNMENT TO ENCOURAGE COMPLIANCE WITH MOEE MISA

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA

IMPLEMENTATION SCHEDULE:
2002

The goal of zero discharge of toxic contaminants can be achieved by implementing Recommendation # 9 over the next ten years. Chlorine dioxide is still being used as a bleaching chemical but chlorine gas has been eliminated from the process by extended delignification with oxygen-bleaching.

Eventually, the application of emerging state-of-the-art technologies such as ozone/peroxide/ hydrosulphite bleaching could eliminate chlorine, reduce non-persistent contaminants by 95% and persistent contaminants by 98%. At the moment, application of this technology is difficult and very expensive.



Secondary treatment facility at Domtar Papers

10 *Identify sources of PAHs in Domtar effluent and take steps to control or eliminate them.*

ESTIMATED COST:
UNDETERMINED.

POTENTIAL PARTNERS:
WORK WITH COMPANY TO DETERMINE SOURCES AND CORRECT ACTIVITY OR FAULTY EQUIPMENT THAT CONTRIBUTES TO SOURCE.
ASSISTANCE FROM THE MOEE POLLUTION PREVENTION OFFICE POSSIBLE.

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
2 YEARS BEGINNING IN 1997

MISA monitoring in 1990 (OMOE 1991a; OMOE 1991b) revealed that the effluent from Domtar's Cornwall plant contained higher levels of PAHs than any other pulp and paper mill in Ontario. Although Domtar has since installed a secondary treatment facility, recent effluent monitoring indicates the presence of PAHs in their effluent. Domtar frequently reports small oil spills and leaks; these likely contain PAHs. It should be possible to reduce PAH discharges by instituting better housekeeping practices in the Domtar plant once the sources of PAHs have been identified.

11 *Track decommissioning of Courtaulds Fibres, ICI Forest Products (mercury cell process), Cornwall Chemicals and other closed plants via participation of RAP Team through MOEE and public consultation with PAC.*

ESTIMATED COST:
NONE

POTENTIAL PARTNERS:
100% INDUSTRY

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
COURTAULDS FIBRES - ONGOING TO 1997
CORNWALL CHEMICALS - ONGOING TO 1999
ICI FOREST PRODUCTS - ONGOING TO 2000

Courtaulds has nearly completed the decommissioning of its property. MOEE has approved its Phase 2 studies and is awaiting confirmation that problem areas such as the closed landfill site have been remediated. Courtaulds has regraded the landfill site to improve drainage and a toe-drain has been installed to collect any leachate and direct it to the City of Cornwall sewage system for treatment.

At Cornwall Chemicals, most of the production equipment and buildings at the site have been removed. Investigations to determine the extent of the soil and groundwater contamination are under way.

ICI Forest Products is dismantling their mercury cell room. Because the cell room equipment is contaminated with mercury, care is being taken to minimize mercury emissions to the atmosphere during this operation. MOEE and the company are discussing a plan describing how it intends to determine the extent and environmental impact of soil and groundwater contamination.

12 *Recommend that current and all future industries that are direct dischargers in the area of concern operate plants to achieve a compliance limit of 1 mg/L (monthly average) total phosphorus and an objective of 0.5 mg/L.*

ESTIMATED COST:
UNKNOWN

POTENTIAL PARTNERS:
100% INDUSTRY

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
INDUSTRIES ARE CURRENTLY MEETING THE PROPOSED COMPLIANCE LIMIT.

In order to reduce the growth of algae in Lake St. Francis, the RAP recommends a consistent maximum phosphorus concentration for all point sources in the AOC. All municipal and industrial dischargers in the AOC should limit the phosphorus content of their effluent to a maximum of 1 mg/L with an objective of 0.5 mg/L.

 # 13 Although air quality issues not affecting water quality are outside the RAP mandate, they are integral to ecosystem health. It is therefore recommended that the activity of the existing MOEE air monitoring working group for the City of Cornwall and surrounding area should be continued and expanded to include identification of remedial actions. This MOEE working group should be extended to include a public participation component.

ESTIMATED COST:
NONE (PART OF ONGOING MOEE PROGRAM).

POTENTIAL PARTNERS:
RESIDENTS' AIR QUALITY COMMITTEE / MOEE

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
ONGOING.

In December 1995, the Cornwall Air Quality Committee met with an MOEE Air Monitoring Working Group and provided public input on air quality issues and MOEE activities dealing with these issues. This MOEE group is still active and currently focussing on emissions from the Domtar Kraft Mill. Discussions are continuing with the company about certain compounds that are emitted and why discharges of these and other odorous compounds persist. The Cornwall Air Quality Committee is inactive, but a new sub-committee started by the local Chamber of Commerce has been very active and MOEE has participated in its discussions.

6.3 Remediate Contaminated Sediment

Areas of contaminated sediment in the US and Canadian portions of the St. Lawrence River can act as ongoing sources of pollution, releasing contaminants into the aquatic food chain or directly into the water itself. Plans are under way to remediate some of the most severely contaminated US sediment and some projects have been completed.

 # 14 Implement a Canada/US monitoring program to track site-specific and AOC-wide impacts of American site remediation efforts in Massena.

ESTIMATED COST:
$200,000 IN 1995 (INCLUDES $100,000 START UP COSTS); $50,000-100,000 ANNUALLY THEREAFTER WHILE DREDGING OPERATIONS ARE UNDER WAY.

POTENTIAL PARTNERS:
ENVIRONMENT CANADA / MOEE / MNR / QUEBEC MINISTRY OF ENVIRONMENT AND WILDLIFE / RAP

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA / MOEE / QUEBEC MINISTRY OF ENVIRONMENT AND WILDLIFE.

IMPLEMENTATION SCHEDULE:
MAY-NOV 1995 AND ONGOING FOR 3-5 YEARS.

A number of activities are being conducted by Canadian agencies to monitor St. Lawrence River environmental quality and assess the impact of the US sediment remediation efforts. These include: short term (during dredging) water quality testing, drinking water intake sampling (if required), long-term water and sediment quality sampling, and biomonitoring programs involving fish and mussels.

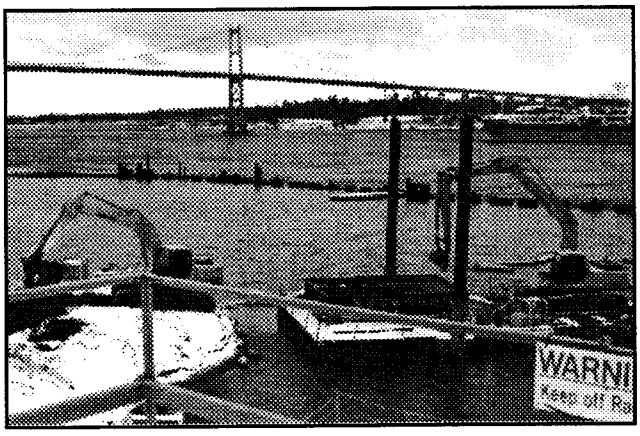
Turbidity and PCB monitoring at the site:
River water quality monitoring immediately adjacent to the dredge sites is ongoing during the sediment removal activities. The intent of the program is to corroborate and complement the monitoring required of the US companies by US EPA.

Time-integrated water quality monitoring:
An upstream/downstream program was developed to provide a comparison of PCB concentrations in water over a 2-4 week period for the duration of the sediment removal activities. This was designed to determine whether there are increases in PCBs in water downstream of Massena industrial facilities. The types and ratio of PCB congeners downstream versus upstream are being used to indicate whether the PCBs originated from regional or upstream sources.

Biological monitoring:
Young-of-the-year fish (spottail shiners) are collected from several sites annually in the vicinity of Cornwall, Massena and Lake St. Francis. Due to the limited range (1-2 km) of these fish in their first year, they provide a good indication of the presence and bioavailability of contaminants close to the source as well as the availability of contaminants to fish-eating wildlife.

The MOEE and MNR Sport Fish Contaminants Monitoring Program involves the collection and analysis of sport fish from lakes and rivers throughout Ontario. The fish are analyzed for a variety of substances including mercury, PCBs, mirex, DDT and dioxins. The results are used to develop tables published everysecond year in the Guide to Eating Ontario Sport Fish. Fish in the AOC are collected annually from Lake St. Francis and usually less frequently from various upstream stations in Lake St. Lawrence and the Thousand Islands. By testing the same species at the same location over a period of years the effectiveness of pollution control actions can be determined.

Long-term monitoring:
The long-term effectiveness of remedial work in the region as a whole is being assessed using a network of Long Term Sensing Sites (LTSS). The objective of the program is to study the quality of the sediments and suspended solids at six fixed permanent sites, five of which are downstream from Cornwall and Massena.



Contaminated Sediment Removal Project

#15 *Develop appropriate federal/provincial positions on remediation of the Reynolds Metals, ALCOA and GM sites by means of the Canadian Review Panel, which reviews the various cleanup plans for PCBs, PAHs, dioxins and dibenzofurans.*

ESTIMATED COST:
$15,000 PER YEAR FOR 3-5 YEARS

POTENTIAL PARTNERS:
ENVIRONMENT CANADA AS LEAD WITH PARTICIPATION BY HEALTH CANADA, MOEE AND THE QUEBEC MINISTRY OF ENVIRONMENT AND WILDLIFE.

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA

IMPLEMENTATION SCHEDULE:
DEPENDENT ON US REMEDIATION SCHEDULES. ONE FORMAL REVIEW IN 1995 (AMENDMENT TO GM RECORD OF DECISION). ONGOING INFORMAL COMMUNICATION.

Industrial site cleanup and river sediment remediation are being implemented at ALCOA, Reynolds Metals and General Motors Powertrain Division under the requirements and guidance of US federal and state authorities. Environment Canada provides the lead for Canadian agencies, through the Canadian Review Panel, to review and comment on all cleanup activities at the Massena Superfund sites. Membership of the Review Panel consists of representatives from Environment Canada (Ontario and Quebec Region), Health Canada, and the Ontario and Quebec environment ministries. Comments are submitted either directly to USEPA or New York State or formally through the Canadian Department of Foreign Affairs.

Comments submitted to the US federal or state authorities are dependent upon the issue, and the strength of agreement or disagreement with a proposed course of action varies accordingly. Legal processes under federal and state Superfund legislation require the governments to consider all comments received. If this process does not achieve satisfactory results, all avenues of agency and diplomatic negotiation should be pursued. As a last resort, legal action could be taken in US courts regarding specific issues of contention.

 # 16 *In areas where contaminant levels in sediment are below the severe effect level but above the lowest effect level, implement source control measures to prevent further contamination of sediment and allow remediation of contaminated sediment to occur by means of burial by the natural sedimentation process.*

ESTIMATED COST:
SEE RECOMMENDATIONS PERTAINING TO SOURCE CONTROL (RECOMMENDATIONS # 8, 9, 10, 12).

POTENTIAL PARTNERS:
SEE RECOMMENDATIONS PERTAINING TO SOURCE CONTROL (RECOMMENDATIONS # 8, 9, 10, 12).

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA / MOEE

IMPLEMENTATION SCHEDULE:
ONGOING, SEE RECOMMENDATIONS PERTAINING TO SOURCE CONTROL (RECOMMENDATIONS # 8, 9, 10, 12).

Sediment investigatons using an underwater video camera

Removal or treatment of moderately contaminated sediment is not justifiable in terms of cost. There is a high potential for contaminated particles of sediment to be resuspended and transported downstream while sediment is being removed. Low level contaminated sediment should be left in place so that it can gradually be buried by new, uncontaminated sediment once the source of contamination has been controlled.

 # 17 *In areas where contaminant levels in sediment exceed the severe effect level for mercury, PCBs or other persistent toxic contaminants or where the sediment is found to be acutely toxic (i.e., the "hot spots"), prevent further contamination by implementing source control measures and remediate sediment by the most appropriate state-of-the-art technology (e.g., dredging, capping, in situ treatment).*

ESTIMATED COST:
TO BE DETERMINED.

POTENTIAL PARTNERS:
TO BE DETERMINED.

REGULATORY RESPONSIBILITY:
MOEE / ENVIRONMENT CANADA
FISHERIES ACT RESPONSIBILITIES: DFO / MNR

IMPLEMENTATION SCHEDULE:
TO BE DETERMINED.

Detailed information on sediment contaminants exists for the area along the Cornwall waterfront from Windmill Point to Pilon Island but data are sparse for the area from Windmill Point to the western extent of the AOC. Environment Canada and MOEE have made commitments to develop a sediment management strategy for the Cornwall waterfront. The strategy will consist of a series of steps to evaluate, select and implement the most appropriate actions for sediment management, congruent with Recommendations # 16 and # 17. Evaluation will include acquisition and review of historical and new chemical and physical data.

18 *Participate in additional studies at Cornwall Harbour to determine if the land-based contamination is affecting the River. If there is an impact, ensure that the appropriate corrective actions are implemented to protect the River.*

ESTIMATED COST:
TRANSPORT CANADA $50K

POTENTIAL PARTNERS:
TRANSPORT CANADA / ENVIRONMENT CANADA / MOEE

REGULATORY RESPONSIBILITY:
TRANSPORT CANADA / ENVIRONMENT CANADA / MOEE

IMPLEMENTATION SCHEDULE:
BEGIN SUMMER 1996, COMPLETE WINTER 1997

Transport Canada completed a non-intrusive (*i.e.*, no sampling) Phase 1 assessment of the site in 1993, which led to a Phase 2 site characterization study. Chemical and physical data were collected from boreholes and monitoring wells and an initial site assessment was prepared. A supplemental study was undertaken in 1996 to acquire additional information necessary to fully characterize the site. A remedial action plan is now being prepared for the site based on these assessments.

6.4 Reduce Pollution from Municipal Sources

Municipal areas contribute contaminants to the St. Lawrence River in sewage treatment plant effluent, combined sewer overflows and stormwater runoff. These inputs may be contaminated with bacteria, phosphorus and persistent toxic substances such as mercury. There are two sewage treatment plants in the area of concern: Cornwall and Glen Walter. New York State has a number of sewage treatment plants discharging to the St. Lawrence River or its tributaries. The St. Regis Village Sewage Treatment Plant is located on lands of the Mohawks of Akwesasne.

19 *Upgrade Cornwall sewage treatment plant to secondary treatment or equivalent treatment consistent with the MOEE Municipal MISA program.*

ESTIMATED COST:
$30,000,000 FOR UPGRADE TO SECONDARY TREATMENT.

POTENTIAL PARTNERS:
CITY OF CORNWALL / MOEE / ENVIRONMENT CANADA / OCWA

REGULATORY RESPONSIBILITY:
CITY OF CORNWALL / MOEE / ENVIRONMENT CANADA

IMPLEMENTATION SCHEDULE:
UNDER DISCUSSION

COA (1994) specifies a target of upgrading fifteen primary sewage treatment plants to secondary treatment by the year 2000. As well, under MOEE's Municipal MISA program, the 22 sewage treatment plants in Ontario that still have primary treatment and are on major receiving streams will be upgraded to secondary treatment over a twenty year period. The upgrades will be carried out in order of priority based on existing effluent quality at each plant.

The Cornwall WPCP will likely be assigned a low priority because its effluent already meets secondary treatment requirements for BOD, suspended solids and total phosphorus. In addition to reducing these three parameters, however, secondary treatment removes almost all dissolved organic compounds and increases the efficiency of removal of mercury and other metals. The Cornwall WPCP should therefore be upgraded to secondary treatment on a timetable consistent with the Municipal MISA program.

20 *Recommend that the City of Cornwall provide carbon filtration treatment (or equivalent) for its drinking water to eliminate taste and odour problems.*

ESTIMATED COST:
$200,000 EVERY FOUR YEARS

POTENTIAL PARTNERS:
CITY OF CORNWALL / SLRIES

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE::
JUNE 1998

In recent years, a taste and odour problem has developed every fall in the drinking water in the City of Cornwall. This is due to the proliferation of certain algae, bacteria or fungi. The problem is experienced in all municipalities taking water from Lake Ontario or the St. Lawrence River. An activated carbon filtration system installed at the Cornwall Water Treatment Plant in 1997 will eliminate the problem.

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21 *Find and eliminate the local source of PCBs in spottail shiners collected from the Cornwall waterfront.*

ESTIMATED COST:
SPOTTAIL SURVEYS: $3,000 PER YEAR FOR COLLECTIONS + $9,000 PER YEAR FOR ANALYSIS.

EFFLUENT MONITORING:
COST BORNE BY INDUSTRY.

STORMWATER MONITORING:
$80,000-$116,000 DEPENDING ON NUMBER OF SAMPLING STATIONS.

REMEDIATION:
COST TO BE DETERMINED.

POTENTIAL PARTNERS:
MOEE / ENVIRONMENT CANADA / INDUSTRY / WPCP

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
EFFLUENT MONITORING: 1997

STORMWATER MONITORING:
1997

SPOTTAIL SHINERS:
ANNUAL COLLECTIONS ONGOING.

There are no known PCB sources on the north shore of the St. Lawrence River in the AOC. PCBs have seldom been detected in Cornwall industrial and municipal effluent. However, spottail shiners collected from the Cornwall waterfront have, with only a few exceptions, higher concentrations of PCBs than fish collected upstream in Lake St. Lawrence. PCBs were detected in suspended solids from Cornwall industrial effluents in the late 1980s (Anderson and Biberhofer 1991).

To determine the source of PCBs, suspended solids in effluent from the Domtar diffuser and the Cornwall WPCP should be monitored. In addition, water and suspended solids from storm sewers should be monitored for PCBs during wet weather events and spring runoff, using flow weighted samples. A monitoring program should be implemented for storm sewers in industrial catchment areas where stormwater is suspected to contain PCBs. Sampling should be done during wet weather events at a selected number of outfalls. Spottail shiner collections are currently made on a yearly basis as part of the MOEE spottail shiner monitoring program.

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22 *Monitor progress in implementing recommendations of the City of Cornwall's Pollution Control Plan (PCP) to ensure that pollution problems associated with the City's sewer systems are corrected as recommended in the Plan.*

ESTIMATED COST:
MINOR

POTENTIAL PARTNERS:
RAP TEAM / PAC

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
1995 AND SUCCESSIVE YEARS AT INTERVALS OF 5 YEARS MAXIMUM LENGTH

The actions listed in Table 12 were recommended by the Cornwall PCP (City of Cornwall 1995) to address pollution problems associated with the City's sewer systems. The RAP Team and PAC have endorsed the PCP and will therefore carry out Recommendation # 22 to review activities related to the actions recommended in the PCP and seek options to ensure that these actions are implemented.

Table 12. Status (1997) of remedial actions recommended by City of Cornwall Pollution Control Plan

Action recommended in City of Cornwall Pollution Control Plan 1995 (City of Cornwall 1995)	Related City of Cornwall actions as of 1997
Install storage facility to store 17,500 cubic metres of combined sewer overflow at Brookdale (first priority).	Preliminary study was done to investigate proposed location of holding tank. No further work has been done.
Continue real time control with the Brookdale gate.	Ongoing
Complete sewer separation projects planned for Pitt St and part of Central Western and Brookdale subcatchments.	Ongoing: some separations have been completed; remainder scheduled for completion in 1997 subject to Municipal Council approval and Provincial funding approval.
Review PCP findings prior to initiation of any further sewer separation projects.	The only sewer separation projects planned are those which would discharge to the newly constructed Fly Creek Flood Reduction System. The Fly Creek Flood Reduction System discharges to the Fly Creek Pond which will be modified to treat the storm water.
Continue existing stormwater BMPs including street sweeping program and catchbasin cleaning.	*Stormwater quantity control:* There are 3 stormwater quantity control structures in the City: dry pond at Wellington St & Northwoods Crescent; wet pond for Fly Creek at Tenth St and Virginia Dr; dry pond for Cornwall Motor Sales on Brookdale Ave. *Street sweeping and flushing:* Commercial and industrial areas of the city are cleaned approximately every second day. These priority areas roughly cover the combined sewer parts of the city. The core east and west areas are cleaned about every 2 weeks. The remainder of the road network is cleaned about 7 or 8 times per year. In 1993 the City flushed and swept 2,750 km of curb. The PCP recommends that a similar level of maintenance be continued. (City of Cornwall 1995). *Catchbasin cleaning*: All catchbasins along the main city arteries are cleaned annually. In addition, alternating halves of the remaining catchbasins are cleaned each year. Thus during a two year period, the main arteries are cleaned twice and the remainder of the city once. The PCP recommends that a similar level of maintenance be continued. (City of Cornwall 1995).

Action recommended in City of Cornwall Pollution Control Plan 1995 (City of Cornwall 1995)	Related City of Cornwall actions as of 1997
Continue ongoing program of implementing on-lot (overland) flow reduction program.	Since the 1970s it has been the City's policy not to construct combined sewers unless there is absolutely no reasonable alternative. The City has therefore been separating stormwater out of the combined sewer system for some time now by constructing both a sanitary and a storm sewer when a reconstruction project is undertaken. Where feasible in this process, all house laterals are reconnected to the appropriate sewer (i.e., sump pumps, weeping tiles, down spouts are connected to storm sewer; sanitary lateral to the sanitary sewer). Unfortunately, lateral reconnection is not always possible because storm and sanitary laterals are often combined and cannot be separated without doing significant work on private property and inside the house. The City's sewer separation program has therefore effectively removed overland storm flow from the combined sewer but less effectively removed flow from sump pumps, weeping tiles and downspouts. In particularly high extraneous flow areas, the City has undertaken a down spout disconnection program. Most recently, approximately 90% of homeowners contacted in the Riverdale area voluntarily disconnected their down spouts. In newly developed areas, the City of Cornwall requires separated sewers. Therefore, in all subdivisions since 1970 houses have a separate storm lateral and sanitary lateral connected to the appropriate sewers. (N. Levac, City of Cornwall Engineering Department, pers. comm).
Continue City's water conservation program.	See Recommendations # 23 & 24
Enhance vegetation and flow distribution in the Fly Creek pond to optimize ability of pond to improve water quality.	A Steering Committee with representation from the RAP Team, PAC, RRCA and City of Cornwall is overseeing the redesign of the Fly Creek Stormwater pond to provide stormwater treatment while maintaining current capacity, as well as providing safe habitat for fish and wildlife and opportunities for recreation. The project is being carried out through a partnership of Environment Canada (Great Lakes 2000), MNR, City of Cornwall, RRCA , MOEE and PAC.
Complete detailed feasibility study on use of stormwater quality control wet ponds in existing developed areas; if outcome positive, construct stormwater ponds in existing developed areas.	This review is being initiated through the Fly Creek Stormwater Pond Retrofit Study. Results from that study may assist in future work. Partners are the Raisin Region Conservation Authority, Environment Canada's Cleanup Fund, Ministry of Natural Resources, City of Cornwall, Ministry of Environment and Energy.

Action recommended in City of Cornwall Pollution Control Plan 1995 (City of Cornwall 1995)	Related City of Cornwall actions as of 1997
Adopt comprehensive Stormwater Quality Discharge Control program that addresses discharge control in new development areas.	City of Cornwall now requires all Draft Plans of Subdivision to provide for stormwater management.
Investigate sources of organic contaminants in stormwater and storm sewer sediment discharging to Gray's Creek and South Branch of the Raisin River.	Some of these are being investigated now in the Fly Creek Stormwater Pond Retrofit Study Partners are the Raisin Region Conservation Authority, Environment Canada's Cleanup Fund, Ministry of Natural Resources, City of Cornwall, Ministry of Environment and Energy.
Continue discussion with regulatory agencies re. secondary treatment requirements at WPCP.	See Recommendation # 19
Conduct pilot testing program to confirm treatment capabilities of secondary treatment options in relation to Cornwall's sanitary sewage quality; develop detailed facility plan to refine capital cost estimates of secondary treatment options.	See Recommendation # 19
Complete review of MOEE model sewer use bylaw to determine how it compares with City's existing bylaw in terms of enforcing appropriate sewer use limitations within City of Cornwall.	See Recommendation # 25
Review City growth rates every 2-5 years and evaluate relationship to recommendations made in PCP.	Ongoing: City of Cornwall prepares a yearly "Data Book".
Update overall PCP periodically (e.g., every 5 years). Reassess priority of remedial actions and update cost estimates of remaining work.	Not discussed to date
Initiate dry weather inflow/outflow control program.	Not discussed to date

23 *Encourage careful use of water by implementing a volume-based water pricing system.*

ESTIMATED COST:

$3,600,000 CAPITAL COST OF METER INSTALLATION
$125,000 PER YEAR OPERATING & MAINTENANCE OF METERS
$80,000-$125,000 PER YEAR METER READING, BILLING, ADMINISTRATION
(FROM: CORNWALL ENERGY EFFICIENCY TEAM AND CITY OF CORNWALL 1995)

POTENTIAL PARTNERS:

MUNICIPALITY, WITH FEDERAL/PROVINCIAL SUPPORT AND HOMEOWNER CONTRIBUTION

REGULATORY RESPONSIBILITY:

CITY OF CORNWALL / MOEE

IMPLEMENTATION SCHEDULE:

2000

Cornwall's average per capita water consumption of 820 litres/day is high compared with the Ontario average of 262 L/day, but this reflects the high proportion of industries and low population in Cornwall. There are no residential water meters in the City, but all major industrial users are metered and approximately 50% of the commercial, institutional and light industrial sector is provided with meters (Cornwall Energy Efficiency Team & City of Cornwall 1995).

The Cornwall Energy Efficiency Team (discussed under Recommendation # 24 below) recently commissioned a study to develop a strategy for water conservation in the City of Cornwall (Cornwall Energy Efficiency Team and City of Cornwall 1995). The study report provided a number of recommendations including implementation of universal water metering in Cornwall by the year 2001. The study determined that a 10-15% reduction in water consumption is achievable and will help Cornwall to reach the provincial target of zero growth in water use to the year 2011. The intent of the provincial target is to reduce unnecessary flows to sewage treatment plants, thus reducing operating costs and impacts on the environment.

The City of Cornwall Engineering and Environmental Services Department is currently reviewing the findings of the 1995 study and developing a schedule for implementation. The estimated reduction in operating cost with a reduced flow because of water meters is estimated at $35,000.00. However, it should be realized that there will be a significant increase in operating cost (minimum $205,000.00 for the operation and maintenance of water meters including billing and administration).

While considering the implementation of water metering, the City is also supporting the continuation of installing water saving devices via the Energy Efficiency Program. To reduce water usage during the summer months, the City is reviewing the water by-law and will be recommending some revisions including water restrictions.

24 *Require new dwellings to use water-saving devices such as low volume toilets and shower heads and institute a program of retrofitting old houses for water conservation.*

ESTIMATED COST:

$3,000,000

POTENTIAL PARTNERS:

MUNICIPALITY WITH PROVINCIAL SUPPORT AND HOMEOWNER CONTRIBUTION / HOMEBUILDERS ASSOCIATIONS

REGULATORY RESPONSIBILITY:

CITY OF CORNWALL

IMPLEMENTATION SCHEDULE:

2000

The City of Cornwall was named "Canada's Leading Green Community" by MOEE in 1994, due to energy efficiency improvement and environmental protection activities of the Cornwall Energy Efficiency Team in the period 1991-1994. The Team delivered MOEE's Green Communities Initiative, a program with the goals of saving energy and water, reducing waste, protecting the environment and stimulating the economy.

The focus of the program was to carry out "Home Tuneups" which provided an assessment of individual households, direct installation of energy and water saving devices and recommendations for becoming more energy efficient and environmentally friendly. A Home Tuneup included installation of an energy efficient showerhead, tap aerator/flow restrictors, toilet dams, a water heater tank jacket, insulation on hot water pipes above the water heater and other energy efficient devices. During the Home Tuneup the work crew also took time to educate the homeowner about energy and water conservation measures. By October 1995, Home Tuneups had been carried out in more than 10,000 Cornwall homes. This, or a similar program, should be continued and expanded to include homes within the area of concern outside of the City of Cornwall.

Low flow requirements for devices in all new dwellings and installations were introduced into the Ontario Building Code in 1993. As of January 1, 1996 a series of more stringent standards (six litre toilets for example) has gone into effect (N. Levac, City of Cornwall, pers. comm.).

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25 *Recommend that the City of Cornwall review and update its sewer use by-laws by incorporating the latest version of MOEE's Model Sewer Use By-Law.*

ESTIMATED COST:
NONE

POTENTIAL PARTNERS:
CITY OF CORNWALL

REGULATORY RESPONSIBILITY:
CITY OF CORNWALL

IMPLEMENTATION SCHEDULE:
MID-1998

Municipalities can pass a by-law to govern the discharges to their sewer system from commercial entities and industries. Allowable levels are set for a variety of contaminants which could affect the performance of the treatment systems. MOEE has drafted a model by-law which municipalities can tailor to their own situation.

The City of Cornwall expects to approve the amendment of its sewer use by-law to incorporate the latest version of MOEE's Model Sewer Use By-Law once MOEE finalizes it. MOEE expects to release the new version in late 1997. The new by-law will allow the City to increase fines for violations and enter into surcharge agreements with dischargers. The new by-law also includes limits for additional, previously unregulated contaminants.

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26 *Recommend that the City of Cornwall modify the snow dump site to contain surface runoff, and that they undertake a feasibility study to find a more acceptable long term solution to the problem.*

ESTIMATED COST:
APPROXIMATELY $30,000 FOR FEASIBILITY STUDY AND $100,000 FOR MODIFICATION.

POTENTIAL PARTNERS:
CITY OF CORNWALL / SLRIES

REGULATORY RESPONSIBILITY:
CITY OF CORNWALL / MOEE

IMPLEMENTATION SCHEDULE:
END OF 1998

Meltwater from the Cornwall snowdump site at the foot of Brookdale Avenue can run directly into the St. Lawrence River. Snow from city streets is likely to contain hydrocarbons, mercury and other metals, in addition to salt. The snowdump is also a problem from an aesthetic point of view. The site should therefore be bermed or otherwise modified to minimize runoff while investigating the feasibility of using an alternate location for dumping snow. The City has started to investigate the feasibility of moving the site but has not committed itself to any deadline. In the interim, it has banned private snow removal contractors from using the site and they must now dispose of snow on their own properties.

27 *Request that in its Official Plan, the City of Cornwall delineate zones of coal tar contamination and define development constraints for those zones and that a Notice on Title be registered for all of the affected properties.*

ESTIMATED COST:
MINIMAL

POTENTIAL PARTNERS:
CITY OF CORNWALL / MOEE

REGULATORY RESPONSIBILITY:
CITY OF CORNWALL / MOEE

IMPLEMENTATION SCHEDULE:
END OF 1997

Historical coal tar deposits between the Water Street arena and parking lot and at 7th and Cumberland Streets are benign as long as they remain undisturbed. Activities that would result in movement of the deposits should therefore be restricted. This can be achieved by defining development constraints on these lands in the City of Cornwall Official Plan and by ensuring that future owners of the affected properties are made aware of the problem by placing a Notice on Title on the property.

The City of Cornwall will shortly be amending its Official Plan (OP) pending the outcome of its five-year review. This will include modifications to Schedule 4 of the OP, which identifies waste sites. The modified Schedule 4 will include the coal tar sites at Water Street and at 7th and Cumberland, in addition to the municipal waste sites and bark waste sites it now identifies.

28 *Upgrade Glen Walter sewage treatment plant to achieve a compliance limit of 1 mg/L total phosphorus and an objective of 0.5 mg/L.*

ESTIMATED COST:
$75,000

POTENTIAL PARTNERS:
MUNICIPAL AND PRIVATE DISCHARGERS / OCWA / MOEE

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
END OF 1998

In order to reduce the growth of algae in Lake St. Francis, the St. Lawrence River RAP recommends that all municipal and industrial dischargers in the AOC limit the phosphorus content of their effluent to a maximum of 1 mg/L with an objective of 0.5 mg/L.

29 *Recommend phosphorus removal to a compliance limit of 1 mg/L, with an objective of 0.5 mg/L, at all wastewater treatment systems along the St. Lawrence River upstream of Cornwall.*

ESTIMATED COST:
UNKNOWN

POTENTIAL PARTNERS:
MUNICIPALITIES / OCWA / MOEE

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
ONGOING:NEW PLANTS AT INGLESIDE AND LONG SAULT HAVE 1MG/L TOTAL P REQUIREMENT.

The rationale for this Recommendation is the same as for Recommendations # 12 and 28.

30 *Recommend that New York State install treatment facilities for phosphorus removal at its sewage St. Lawrence River and its tributaries.*

ESTIMATED COST:
NONE

POTENTIAL PARTNERS:
CORNWALL RAP RECOMMENDATION TO NYSDEC WHO WOULD BE RESPONSIBLE FOR IMPLEMENTATION.

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA (THROUGH RAP TEAM)

IMPLEMENTATION SCHEDULE:
IMMEDIATE

The GLWQA calls for all sewage treatment plants in the Great Lakes Basin with a capacity of 1 million gallons or more to limit the phosphorus content of their effluent to a maximum of 1 mg/L. New York State interprets this as applying only to sewage treatment plants in the Great Lakes themselves and not to any plants downstream from Lake Ontario. The State therefore sets no guideline for phosphorus discharges from its sewage treatment plants discharging to the St. Lawrence River and does not monitor phosphorus in effluent from those plants.

The Cornwall and Massena RAPs are being carried out under the conditions of the GLWQA. Since the Agreement applies to the St. Lawrence River as part of the Great Lakes ecosystem, its requirements for phosphorus control therefore also apply to the international section of the river. The St. Lawrence River (Cornwall) RAP therefore recommends that all sewage treatment plants draining into the St. Lawrence River in the AOC and upstream to the outlet of Lake Ontario limit their phosphorus discharge to a maximum concentration of 1 mg/L and monitor their effluent to ensure compliance with this limit.

6.5 Reduce Pollution from Rural Sources

Pollution from rural areas enters the St. Lawrence River in surface runoff from tributaries. Surface runoff in agricultural areas contains bacteria from livestock; nutrients such as phosphorus and nitrogen from fertilizers, livestock waste and faulty septic systems; and pesticides. In Lake St. Francis, lead contamination is a problem for waterfowl that inadvertently consume lead shotgun pellets.

31 *Control stormwater discharges from municipalities other than Cornwall, particularly roads and communities along the Raisin and St. Lawrence Rivers, by collecting and treating stormwater.*

ESTIMATED COST:
$25,000 TO COMPLETE STUDY.IMPLEMENTATION COST WILL BE DETERMINED AS PART OF THE STUDY.

POTENTIAL PARTNERS:
UNITED COUNTIES OF STORMONT, DUNDAS & GLENGARRY / MUNICIPALITIES

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
END OF 1997 TO COMPLETE STUDY.

Stormwater in built up areas can be highly contaminated with fecal contaminants and phosphorus from the droppings of birds and domestic pets. Inputs of these contaminants can be controlled by collecting and treating stormwater in communities along the Raisin and St. Lawrence Rivers. A study should be done to assess the situation and measures should be taken to implement proposed solutions arising from the study.

32 *Install proper septic systems on private shoreline properties where land is sufficient and can meet existing regulations; carry out inspections to ensure compliance.*

ESTIMATED COST:
$50,000 TO DO INSPECTIONS. IMPLEMENTATION COST CAN BE DETERMINED AFTER INSPECTIONS ARE COMPLETED. COST OF INSTALLATION OR REPAIRS WOULD RANGE FROM $5000 TO $10,000.

POTENTIAL PARTNERS:
MOEE / EASTERN ONTARIO HEALTH UNIT

REGULATORY RESPONSIBILITY:
EASTERN ONTARIO HEALTH UNIT

IMPLEMENTATION SCHEDULE:
END OF 1998

Faulty septic systems on private shoreline properties release nutrients and fecal microorganisms to the St. Lawrence River. Excess nutrients can cause algal blooms, resulting in taste and odour problems in drinking water, and fecal contaminants are a potential health risk for people who draw private drinking water from or swim in the St. Lawrence River. This can be corrected by emptying, repairing or replacing faulty septic systems.

33 *Where land is not sufficient, install holding tanks and institute municipal or other regulatory agency collection to the sewage treatment plant, with costs included in annual property tax assessments.*

ESTIMATED COST:
NO DIRECT COST: PART OF MUNICIPAL TAXES

POTENTIAL PARTNERS:
MUNICIPALITY

REGULATORY RESPONSIBILITY:
EASTERN ONTARIO HEALTH UNIT / MOEE

IMPLEMENTATION SCHEDULE:
END OF 1998

Some shoreline properties along the St. Lawrence River in the AOC are not large enough to accommodate a septic system and may therefore be discharging sewage directly to the river. These properties should be equipped with holding tanks for the short-term but eventually they should be connected to a municipal sewage collection and treatment system.

34 *As a long-term plan, install sewage treatment plants for river communities, including Summerstown, South Lancaster, Pilon Island, Cornwall Island and Bainsville.*

ESTIMATED COST:
$20,000,000

POTENTIAL PARTNERS:
MOEE / MUNICIPALITIES

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
2005

This Recommendation follows from Recommendation # 33, which deals with the problem of shoreline properties that are too small to accommodate a septic system. It will also overcome the problem of septic systems that leak because they are poorly maintained.

35 *Inspect park and campground sewage disposal systems and correct deficient systems.*

ESTIMATED COST:
$5,000 TO DO INSPECTIONS. THE COST OF CORRECTION WOULD DEPEND ON THE PROBLEM FOUND AND WOULD RANGE FROM $10,000 TO $30,000.

POTENTIAL PARTNERS:
ST. LAWRENCE PARKS COMMISSION / PRIVATE OPERATORS

REGULATORY RESPONSIBILITY:
EASTERN ONTARIO HEALTH UNIT / MOEE

IMPLEMENTATION SCHEDULE:
END OF 1998

Sewage disposal systems in parks or campgrounds should be inspected and leaking systems repaired, to eliminate fecal contaminant inputs from these sources. Priority should be given to those sites near public beaches.

36 *Where feasible, collect and treat stormwater and discharge at downstream end of beach.*

ESTIMATED COST:
APPROXIMATELY $30,000

POTENTIAL PARTNERS:
ST. LAWRENCE PARKS COMMISSION / PRIVATE OPERATORS

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
END OF 1998

Stormwater contaminated with nutrients and fecal microorganisms can be effectively treated by means of an appropriately designed stormwater retention pond or wetland, with the treated water discharged downstream of the public beach. Site visits will be required to assess whether the construction of a retention pond or wetland is feasible at a given beach area.

37 *Eliminate livestock access to surface waters by providing education and financial incentives to farmers and by enforcing existing regulations.*

ESTIMATED COST:
$500,000

POTENTIAL PARTNERS:
LANDOWNER / OMAFRA / FARMING ASSOCIATIONS / RRCA / OMNR / ENVIRONMENT CANADA / MOEE / AGRICULTURE CANADA

REGULATORY RESPONSIBILITY:
OMAFRA / MOEE

IMPLEMENTATION SCHEDULE:
IMMEDIATE AND ONGOING OVER NEXT 5 YEARS.

Livestock with direct access to surface waters draining into the St. Lawrence River contaminate the water with fecal microorganisms and nutrients. This contamination reaches the St. Lawrence River and contributes to the problems of contaminated public and private swimming areas and excessive growth of plants and algae in tributaries and at tributary mouths. The environmental effects of allowing livestock to wade in waterways should therefore be made known to the farmers and financial incentives provided to help them make alternative watering arrangements and build fences to block livestock access to waterways. Projects are under way in several Lake St. Francis tributaries (including Sutherland Creek, Wesley's Creek, Raisin River), to encourage farmers to restrict livestock access, establish vegetated buffer strips along creek banks and improve manure storage.

Stream restoration by fencing out livestock

 # 38 *Inspect manure piles and milkhouse waste disposal systems which have the potential to be sources of surface water contamination, and correct by:*

(1) providing education to farmers on how to correct the problem;

(2 providing financial incentives to farmers;

(3) enforcing existing regulations;

(4) incorporating into municipal zoning by-laws, the Agricultural Code of Practice regarding manure/milkhouse wastes;

(5) establishing a bioconversion facility for production of fertilizer from manure and other organic sludges pending feasibility study (to determine available manure supply, interest in participation etc.)

ESTIMATED COST:

ESTIMATED CAPITAL COST: $1,000,000-2,000,000 *ESTIMATED ANNUAL OPERATING & MAINTENANCE COST: $47,600-$105,000*

POTENTIAL PARTNERS:

LANDOWNER / OMAFRA / FARMING ASSOCIATIONS / RRCA / MNR / MOEE / AGRICULTURE CANADA

REGULATORY RESPONSIBILITY:

OMAFRA / MOEE / FARMERS

IMPLEMENTATION SCHEDULE:

IMMEDIATE AND ONGOING OVER NEXT 5 YEARS.

*Calculations for cost estimates:

1. Cost (1995 $) of manure control system for a 500 head feedlot operation (from MOEE 1990 Overview Economic Assessment of RAPs for the Great Lakes AOCs x 5% annual rate of inflation): $15,320 to $27,235 capital cost $680-$1,500 annual operating and maintenance cost
2. Estimated 70,000 cattle and pigs in AOC watershed.
3. Estimated number of farms 70,000 animals/500 animals per farm = 140 farms
4. Assume 50% of the farms require action.
5. Number of farms requiring action = 140/2 = 70
6. Capital cost estimate low: 70 x $15,320 = $1,072,400 high: 70 x $27,235 = $1,906,450 Estimated capital cost range = $1,000,000-2,000,000
7. Estimated annual operating and maintenance cost low: 70 x $680 = $47,600 high:70 x $1,500 = $105,000

Nutrients and bacteria enter surface waters from manure piles located close to waterways and milkhouse wash water that is allowed to run directly into waterways via surface runoff or groundwater. The pollutants eventually drain into the St. Lawrence River. Contamination from these rural sources can be reduced using the combination of approaches specified by this Recommendation.

 # 39 *Endorse the Farm Environmental Plan program described in* Our Farm Environmental Agenda *as part of the development of an agricultural land stewardship program.*

ESTIMATED COST:

ENDORSEMENT AND FACILITATION.

POTENTIAL PARTNERS:

RAP/PAC / FARMERS / OMAFRA

REGULATORY RESPONSIBILITY:

N/A

IMPLEMENTATION SCHEDULE:

IMMEDIATE AND ONGOING.

This Recommendation coincides with the 1994 COA target: "Support the development and implementation of Environmental Farm Plans". In 1992, the Ontario Federation of Agriculture, the Christian Farmers Federation of Ontario, AGCare (Agricultural Groups Concerned About Resources and the Environment) and the Ontario Farm Animal Council published a report called Our Farm Environmental Agenda. Over 50 farming organizations participated in developing the report, which proposed a farm-specific approach to solving environmental problems associated with agricultural practices. The goal is to have each farmer in Ontario develop an environmental farm plan for their enterprise. The plan would identify key opportunities for environmental enhancement and define an implementation strategy.

This is a farmer-initiated approach to addressing the environmental problems associated with running an agricultural operation. The St. Lawrence River (Cornwall) RAP supports incorporating the Farm Environmental Plan program into the

development of an agricultural land stewardship program. The RAP could contribute to this by promoting or facilitating workshops for farmers in the AOC, and helping to establish a network of farmers as a resource group.

40 *Regulate discharges of grey water fromnew boats.*

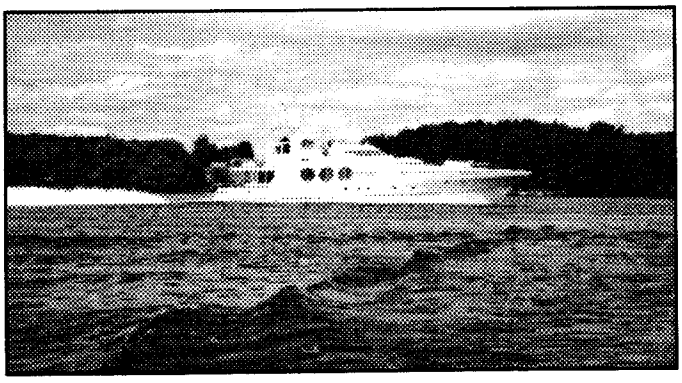
ESTIMATED COST:
INTERNAL COSTS

POTENTIAL PARTNERS:
MOEE / MUNICIPALITY

REGULATORY RESPONSIBILITY:
ENFORCEMENT BY MUNICIPALITY / MOEE

IMPLEMENTATION SCHEDULE:
1995 AND YEARLY THEREAFTER

An MOEE study (Ontario Ministry of the Environment 1991) showed that grey water from pleasure boats contains significant amounts of potentially pathogenic microorganisms as well as nutrients, solids and oxygen-demanding substances. Measures should therefore be taken to stop grey water discharges from pleasure craft. New boats should be retrofitted with holding tanks to contain grey water. Unfortunately, it is physically impossible to retrofit many older boats.



Pleasure boat on the St. Lawrence River

41 *Increase enforcement of existing regulation for discharge of black water.*

ESTIMATED COST:
$15,000
POTENTIAL PARTNERS:
MOEE

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
IMMEDIATELY

Black water (toilet waste) contains fecal pathogens and should never be discharged into waterways. Enforcement of the existing regulation that prohibits the discharge of black water from pleasure craft should be increased. MOEE is the responsible enforcing agency for pleasure boats and the federal Department of Transport is responsible for sea-going vessels. MOEE's Boat Inspection Program was carried out at marinas in the AOC in 1995 and should be continued on a yearly basis. The program includes an education component which is used to educate recreational boaters about the environmental impacts of releasing both black and grey water into the St. Lawrence River.

6.6 Control the Growth of Nuisance Aquatic Plants

Pollution control options to reduce inputs of phosphorus to the St. Lawrence River will not help to control the growth of rooted aquatic plants, as discussed in Chapter 5.5. Controlled physical removal of plants (under permit) is therefore the most effective way to control nuisance aquatic plants, as reflected in the following recommendations.

42 *Support managed mechanical harvesting as a continued option for controlling nuisance aquatic macrophytes in selected areas of Lake St. Francis.*

ESTIMATED COST:
$2,000 PER HECTARE; TOTAL COST DEPENDS ON SIZE OF AREA HARVESTED; WILL PROBABLY NOT EXCEED 50 HECTARES PER YEAR.

POTENTIAL PARTNERS:
SHORELINE LANDOWNERS / COMMERCIAL OPERATORS

REGULATORY RESPONSIBILITY:
MNR / MOEE

IMPLEMENTATION SCHEDULE:
AS MADE POSSIBLE BY FUNDING AND NEED (DEGREE OF PROBLEM MAY CHANGE WITH CHANGING ENVIRONMENTAL CONDITIONS SUCH AS WEATHER).

The priority for this option will be determined by the owners and operators along the shoreline. The program will have to be based on a "proponent pays" (*i.e.*, private sector pays) principle. The RRCA funded program carried out until 1992 will not be reinstated.

43 *Prohibit the use of chemical herbicides by individuals to provide access lanes for boating adjacent to shoreline. The only exceptions to be considered will be in artificial canals with no flow.*

ESTIMATED COST:
NONE

POTENTIAL PARTNERS:
N/A

REGULATORY RESPONSIBILITY:
MOEE HAS THE LEAD / MNR PROVIDES ADVICE

IMPLEMENTATION SCHEDULE:
ONGOING

Application of chemical herbicides to control aquatic plants is not effective in flowing systems such as the St. Lawrence River because the chemicals are rapidly diluted and moved downstream. Such ineffective and unnecessary releases of toxic organic chemicals into the river should be prohibited.

44 *Continue to allow individuals to physically remove (under permit) a pre-determined and limited amount of aquatic vegetation from the water in front of their property.*

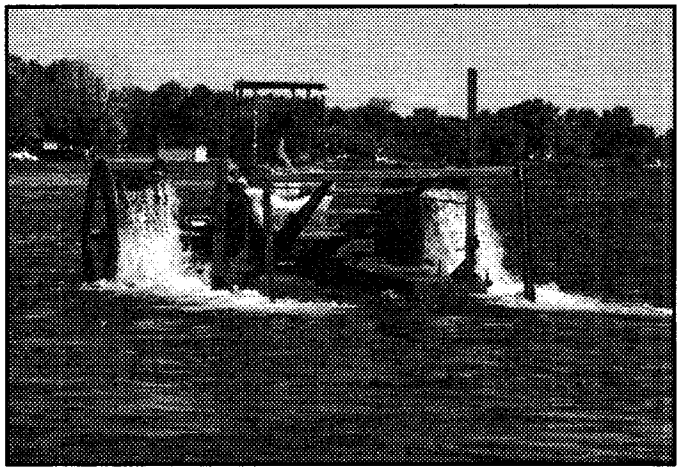
ESTIMATED COST:
BORNE BY LANDOWNER.

POTENTIAL PARTNERS:
N/A

REGULATORY RESPONSIBILITY:
MNR

IMPLEMENTATION SCHEDULE:
ONGOING

Small scale physical removal is an effective method for controlling nuisance aquatic plants. Individual property owners can obtain a permit from MNR to remove and dispose of vegetation for this purpose as long as their actions will not destroy fish habitat. Guidelines exist that set the size and shape of such removals.



Mechanical weed harvester

45 *Mechanically harvest plants over several hectares of Bainsville Bay to improve water circulation and flow in the Bay and increase dissolved oxygen levels.*

ESTIMATED COST:
$15,000 ($2,000 PER HA)

POTENTIAL PARTNERS:
MNR / ENVIRONMENT CANADA (CUF) / RRCA / ADJACENT LANDOWNERSREGULATORY

RESPONSIBILITY:
MOEE / MNR

IMPLEMENTATION SCHEDULE:
CANNOT BE IMPLEMENTED UNTIL SOURCE OF SEDIMENT IS STOPPED BY SHORELINE EROSION CONTROL ALONG POINTE MOUILLÉE (SEE RECOMMENDATION # 61).

This Recommendation ties in with Recommendations # 56 and 61 as part of a three-pronged approach of the Pointe Mouillée-Bainsville Bay erosion control project. In order for this Recommendation to be effective over the long term, the basic reason for excessive plant growth in Bainsville Bay (*i.e.*, erosion of Pointe Mouillée and deposition of a sandbar in the mouth of the Bay) must first be addressed (Recommendation # 61). The process and negotiations related to the erosion control project are ongoing.

6.7 Control or Reverse Habitat Degradation and Destruction

The ecosystem in the St. Lawrence River area of concern is as seriously affected by habitat destruction and degradation as it is by discharges of toxic contaminants to the river. Habitat destruction and degradation can be controlled or reversed by implementing the following recommendations

46 *As a first priority, acquire all wetlands on Lake St. Francis now privately owned.*

ESTIMATED COST:
$600,000-$1,500,000

POTENTIAL PARTNERS:
EHJV / LANDOWNERS

REGULATORY RESPONSIBILITY:
N/A

IMPLEMENTATION SCHEDULE:
INITIATE IN 1997.

Acquisition depends on a willing seller/willing buyer relationship. Initiation will include negotiations with the landowners. Bainsville Bay Marsh and Westley's Creek Marsh are candidate areas.

47 *As a second priority, secure all additional provincially significant wetlands in the watershed.*

ESTIMATED COST:
VARIABLE DEPENDING ON THE LEVEL OF SECUREMENT. COSTS COULD RANGE FROM ZERO (WITH VOLUNTARY PARTICIPATION OF THE LANDOWNER) TO SEVERAL HUNDRED DOLLARS PER HECTARE FOR PURCHASED CONSERVATION EASEMENTS.

POTENTIAL PARTNERS:
EHJV / LANDOWNERS

REGULATORY RESPONSIBILITY:
N/A

IMPLEMENTATION SCHEDULE:
INITIATED IN 1996.

The EHJV management plan for the Five Eastern Counties, expected to be approved in 1997, provides specific strategies and implementation guidelines for wetland securement and will direct this activity in the AOC. Securement would be employed where acquisition was not possible and only with willing landowners.

 # 48 *Encourage municipalities to continue to implement the Provincial Natural Heritage Policy (1996) which requires all planning agencies to have regard for provincially significant wetlands in their planning decisions. The Policy calls for no development in provincially significant wetlands and no development on adjacent lands if the wetland will be affected. This policy is to be interpreted as part of all the new Planning Act policies by municipalities and agencies.*

ESTIMATED COST:
NONE FOR IMPLEMENTATION; ALREADY BEING UNDERTAKEN BY PROVINCIAL GOVERNMENT AGENCIES. LANDOWNERS OF THESE WETLANDS HAVE EXPRESSED THE OPINION THAT THEY ARE BEARING A COST (IN TERMS OF REDUCED LAND VALUE) BECAUSE OF THE IMPLEMENTATION OF THE POLICY.

POTENTIAL PARTNERS:
MMAH / MNR / MUNICIPALITIES / LANDOWNERS / EHJV

REGULATORY RESPONSIBILITY:
MUNICIPALITIES / MMAH

IMPLEMENTATION SCHEDULE:
ONGOING

Municipalities can now protect provincially significant wetlands through Official Plan by-laws that reflect the Provincial Natural Heritage Policy (1996 Planning Act). Recommendation # 48 encourages municipalities to implement the Policy by enforcing the appropriate by-laws. However, the PAC concurs with public input received in response to wetland related preferred remedial options proposed in *Choices for Cleanup: Deciding the Future of A Great River.* That is, that the Wetlands Policy is too rigidly applied in some specific cases. Please see further discussion about this issue in Appendix VII. There is more flexibility at the municipal level in the application of the 1996 Natural Heritage Policies than there has been in the past, but the Province should be asked to address the grave concern regarding the will and capacity of municipality to apply the Policies.

 # 49 *Encourage municipalities to protect wetlands that are not designated provincially significant by requesting that they include development constraints and buffer zones around these areas.*

ESTIMATED COST:
SAME AS FOR RECOMMENDATION # 48

POTENTIAL PARTNERS:
SAME AS FOR RECOMMENDATION # 48

REGULATORY RESPONSIBILITY:
MUNICIPALITIES

IMPLEMENTATION SCHEDULE:
IMMEDIATE

 # 50 *Establish a joint Quebec/Ontario/ Mohawks of Akwesasne committee to coordinate the protection and management of wetlands in Lake St. Francis.*

ESTIMATED COST:
$3,000 PER YEAR

POTENTIAL PARTNERS:
MNR / MOHAWK GOVERNMENTS OF AKWESASNE / QUEBEC MINISTRY OF ENVIRONMENT AND WILDLIFE / ENVIRONMENT CANADA

REGULATORY RESPONSIBILITY:
N/A

IMPLEMENTATION SCHEDULE:
IMMEDIATE

There is a need for an overall strategy to protect and manage wetlands of Lake St. Francis. In order for this to be effective, a partnership of all political jurisdictions bordering the lake needs to be established. This effort would specifically apply to offshore and coastal wetlands.

 # 51 *Continue to use existing legislation (including the federal Fisheries Act, Public Lands Act, Lakes and Rivers Improvement Act, Conservation Authorities Act and Environmental Protection Act) to protect aquatic habitats (including fish habitat and wetlands) where this legislation applies. For fish habitat development applications, continue to require a minimum compensation of 1:1 (new habitat created : habitat altered) for fish habitat harmfully altered by development activities. Minimum compensation should be 1:1 for like habitat on site; 1:2 for like habitat off site or replacement habitat on site; and 1:4 for replacement habitat off site.*

ESTIMATED COST:
INTERNAL AGENCY COSTS ARE APPROXIMATELY $150,000 PER YEAR. PROPONENTS OF DEVELOPMENT PAY THE COST FOR HABITAT COMPENSATION, WHICH IS PROJECT-SPECIFIC.

POTENTIAL PARTNERS:
N/A

REGULATORY RESPONSIBILITY:
MNR / DFO / RRCA / MOEE

IMPLEMENTATION SCHEDULE:
ONGOING

Under existing legislation, MNR advises the Department of Fisheries and Oceans whether to accept or reject a development proposal and whether or not acceptance should include modifications of the proposal in order to protect fish habitat. The Fisheries Act requires a minimum 1:1 compensation of new habitat created:habitat altered, which refers not only to geographic area but also to fish production. Fish production after development must equal production prior to development. Recommendation # 51 ensures that new development proposals not only provide the appropriate fish habitat compensation but, where appropriate, include habitat enhancement as part of the development process.

 # 52 *Change the existing provincial work permit system, to prevent any dredging or filling in any shoreline wetland unless that activity would directly enhance the function or value of the wetland.*

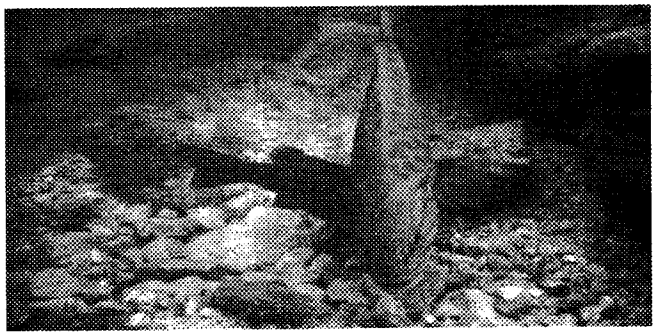
ESTIMATED COST:
NONE TO THE AGENCIES; LANDOWNERS WOULD BE RESTRICTED IN THE USE OF THEIR LAND UNLESS WETLAND VALUE WAS ENHANCED.

POTENTIAL PARTNERS:
MNR (REQUIRES LEGISLATION CHANGE IN PUBLIC LANDS ACT)

RESPONSIBLE AGENCY:
MNR

IMPLEMENTATION SCHEDULE:
UNKNOWN. THE PRESENT REGULATORY CLIMATE IS NOW ONE OF REMOVING RESTRICTIONS ON LANDOWNERS WITH RESPECT TO WETLANDS. THIS RECOMMENDATION MAY TAKE SEVERAL YEARS TO IMPLEMENT.

In Ontario, wetlands are evaluated and classified using a system that considers four groups of wetland values or functions: biological, socioeconomic, hydrological and special features. All of the values have been assigned numeric scores so that they can be used to classify wetlands into different classes.



53 *Develop and implement a program to identify the causes of wetland and aquatic habitat degradation in the area of concern, identify appropriate remedies and ensure their implementation.*

ESTIMATED COST:
$50,000 OVER FIVE YEARS. THIS ESTIMATE DOES NOT INCLUDE GIS-RELATED COSTS BECAUSE A GIS BASED SYSTEM SHOULD BE AVAILABLE NEXT YEAR FOR DATA MANAGEMENT AND ANALYSIS. GROUND TRUTHING IS INCLUDED IN THE ESTIMATE.

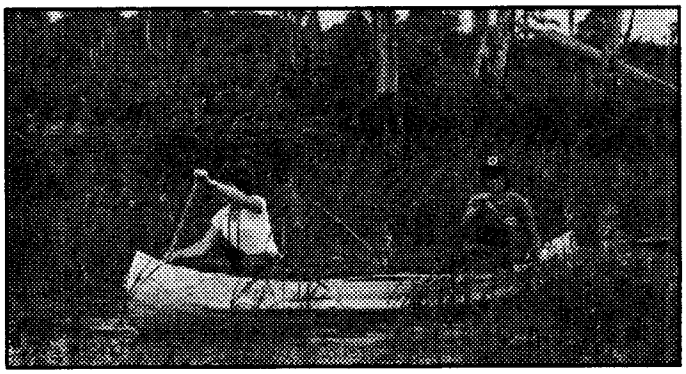
POTENTIAL PARTNERS:
MNR / ENVIRONMENT CANADA / MOEE / MMAH / SLRIES / RRCA / EHJV

REGULATORY RESPONSIBILITY:
NONE. COORDINATION WOULD BE THROUGH A LOCAL WORKING GROUP OF THE PARTNERS. THE FIELD PROGRAM COULD BE COORDINATED BY ANY OF THE PARTNERS. THIS DOES NOT INCLUDE IMPLEMENTATION OF THE REMEDIAL MEASURES.

IMPLEMENTATION SCHEDULE:
BEGAN IN 1996.

This program will target issues such as drainage of wetlands, degradation of water quality in tributaries and development activities along shorelines. Development of the program (identification and analysis of habitat problems) will take a minimum of three years. Implementation is already occurring in some demonstration watersheds (Sutherland Creek) and through the EHJV Management Plan for the Five Eastern Counties. Government agencies and non-government organizations cooperate in a stewardship and education program that utilizes existing programs such as MNR's Land Stewardship Council programs. Actions include the reestablishment of wetland fringes and fish habitat structure along and within creeks, erosion control, management of vegetation along creek banks, and other changes in land use practices.

The full implementation of Recommendation # 53 will be ongoing and is not costed here (although funds will be required based on the number of issues or size of the problems to be addressed).



Exploring wetlands

54 *Restore and enhance wetlands by using, where appropriate and pending the EA and CEAA processes, techniques such as controlled water level impoundments, construction of open water habitats (level ditching) and shoreline reconstruction.*

ESTIMATED COST:
VARIABLE DEPENDING ON THE PROJECT.

POTENTIAL PARTNERS:
EHJV / LANDOWNERS (ONLY IMPLEMENTED WITH WILLING LANDOWNERS AND INCLUDES CONSULTATION WITH ADJACENT LANDOWNERS; SEE 1995 EHJV MANAGEMENT PLAN (EHJV 1995).

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA (THROUGH CEAA).

IMPLEMENTATION SCHEDULE:
THIS SHOULD BE IMPLEMENTED THROUGH THE EHJV MANAGEMENT PLAN WHICH BEGAN PROJECTS IN 1996/97.

A substantial percentage of the wetlands in the AOC are privately owned. It is possible, through a partnership involving land owners and resource agencies, to establish mutually beneficial management agreements for these wetlands. As indicated the EHJV will be responsible for implementation. Their Management Plan is a broad spectrum wetland protection, restoration and creation program targeted at the Five Eastern Counties.

55 *Develop an integrated planning approach for shoreline development based on resource management information which would be collected and managed in a collective GIS-based database. This would include information on fish & wildlife species in the affected area, habitat type and degree of expected alteration, impacts on nearshore water currents and potential erosion impacts, and potential impacts on water quality.*

ESTIMATED COST:

$10,000 ANNUALLY FOR DATABASE MAINTENANCE. INITIALLY THE PROGRAM REQUIRES INTEGRATION OF THE EXISTING DATABASES AND INFORMATION HOLDINGS INTO A DATABASE THAT WILL SUPPORT GIS ACTIVITIES. THIS INITIATIVE IS UNDER WAY IN THE AOC WHICH CAN SUPPORT VARIOUS GIS FORMATS. NEW INFORMATION WILL BE ADDED AS ACQUIRED THROUGH MONITORING AND SURVEILLANCE ACTIVITIES RELATED TO BOTH RAP AND NON-RAP ACTIVITIES. NEW FUNDS WOULD BE REQUIRED FOR DATA COLLECTION SPECIFIC TO RECOMMENDATION # 55 (SEE CHAPTER 10, SECTION 10.8). DATABASE MAINTENANCE WILL REQUIRE IN-KIND CONTRIBUTIONS FROM A VARIETY OF AGENCIES.

POTENTIAL PARTNERS:

MNR / ENVIRONMENT CANADA / MOEE / RRCA / CITY OF CORNWALL / SLRIES

REGULATORY RESPONSIBILITY:

NONE

IMPLEMENTATION SCHEDULE:

AS OF 1993, TASKS WERE BEING UNDERTAKEN TO CONSOLIDATE DATA HOLDINGS AND GIS INFORMATION. THIS IS EXPECTED TO CONTINUE WITH FUTURE PROJECTS THAT WILL UPDATE DATA HOLDINGS AND STREAMLINE THE PROCEDURE FOR INFORMATION SHARING.

The GIS platforms and database reside with different agencies. Effective use of the data will require access to data between agencies. This is the first step necessary to establish an integrated approach to development planning along the shoreline. It would give agencies involved in decision-making access to a common pool of the most comprehensive information available about environmental conditions in the AOC.

56 *Restore shallow-water reef habitat by constructing artificial reefs at various locations including Bainsville Bay-Pointe Mouillée and the Cornwall waterfront, giving priority to areas closer to the power dam.*

ESTIMATED COST:

IN THE BAINSVILLE AREA: UP TO $1,500,000.
ALONG THE CORNWALL WATERFRONT:
$100,000-$200,000 DEPENDING ON WHICH OF THE 15 REMAINING PROJECTS ARE BUILT. IN ADDITION, THE ARTIFICIAL WETLAND AND CREEK COMPLEX NOW BEING CONSTRUCTED AT THE EAST END OF THE CORNWALL CANAL WILL COST AN ESTIMATED $300,000.

POTENTIAL PARTNERS:

SHORELINE LANDOWNERS / CITY OF CORNWALL / LANCASTER TOWNSHIP / RRCA / MNR / ENVIRONMENT CANADA / DFO / SLRIES

REGULATORY RESPONSIBILITY:

PROJECTS GENERALLY LED BY MNR OR RRCA. NO REGULATORY CHANGE REQUIRED. ENVIRONMENT CANADA INVOLVEMENT THROUGH CEAA.

IMPLEMENTATION SCHEDULE:

FOR THE BAINSVILLE AREA, THE PROJECT IS CURRENTLY BEING DISCUSSED WITH THE LANDOWNERS WHO HAVE NOT AGREED TO THE WORK AT THIS TIME. FOR THE CORNWALL WATERFRONT, 3 PROJECTS HAVE BEEN BUILT AND 14 REMAIN TO BE DONE OVER THE NEXT 5-10 YEARS.

There are a number of projects of various sizes within this program, some of which have already been completed (see Chapter 7). The availability of funding and agreement of landowners will largely dictate which projects are done and when. Small projects along the Cornwall waterfront will be the easiest and thus probably the first to be done. Pre-monitoring for the projects has been completed and preliminary post-monitoring has begun at three project sites. Both the total number of fish and the number of species increased after the construction of the nearshore reefs. These increases were consistent among sites and between years.

57 *Work with the Mohawks of Akwesasne to protect fish habitat and prevent shoreline degradation.*

ESTIMATED COST:

NOT AVAILABLE AT THIS TIME. DISCUSSIONS HAVE NOT BEEN INITIATED FOR ANY SPECIFIC PROJECTS.

POTENTIAL PARTNERS:

MNR / MOHAWKS OF AKWESASNE / DFO / ENVIRONMENT CANADA / DEPARTMENT OF PUBLIC WORKS / DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT / SLRIES

REGULATORY RESPONSIBILITY:

NONE

IMPLEMENTATION SCHEDULE:

WILL DEPEND ON DEVELOPMENT OF PARTNERSHIP AGREEMENTS, FUNDING AVAILABILITY AND THE NUMBER AND SCOPE OF THE REHABILITATION PROJECTS. DISCUSSIONS ABOUT PROTECTION INITIATIVES REQUIRE BOTH THE DEVELOPMENT OF A HABITAT DATABASE AND NEGOTIATIONS WITH THE MOHAWKS OF AKWESASNE, WHO AT THIS TIME HAVE INDICATED AN INTEREST IN CO-MANAGING FISHERIES IN LAKE ST. FRANCIS AND HAVE PARTICIPATED IN SOME INITIATIVES SUCH AS THE DEVELOPMENT OF NEW PERCH HARVEST REGULATIONS.

Protection of Lake St. Francis fish habitat is a responsibility shared by several political jurisdictions. Negotiations between the Province of Ontario and the Mohawks of Akwesasne are in progress to establish a closer working relationship for the betterment of this shared resource.

58 *Encourage the enhancement of the protection, number, size, quality and distribution (i.e., reduce fragmentation) of certain terrestrial habitats (i.e., mature and overmature forests, riparian habitats) and their dependent species.*

Note: other scarce habitat types (coastal wetlands, inland riverine wetlands) are covered by other Recommendations (# 46, 47, 48, 49, 50, 52, 53, 54).

ESTIMATED COST:

DEPENDS ON THE AMOUNT OF HABITAT AREA TO BE RESTORED AND HOW MUCH PRESENTLY EXISTS. FIRST STEP IS A GIS-BASED HABITAT SUPPLY ANALYSIS. DEMONSTRATION PROJECTS FOR RIPARIAN HABITAT RESTORATION ON PUBLIC LAND WILL BE INEXPENSIVE (APPROXIMATELY $200/HECTARE OR LESS). ON PRIVATE LAND, COSTS WILL BE HIGHER (UP TO $300/HA) DEPENDING ON THE NATURE OF THE PROJECT. ONE HECTARE OF RIPARIAN HABITAT (30 M WIDTH X BOTH SIDES OF CREEK) WOULD BE 166 M LONG. MATURE/OVERMATURE FOREST PROTECTION AND CREATION WOULD RANGE IN COST FROM ZERO (ALREADY ESTABLISHED WITH WILLING LANDOWNER) TO $500-$700 PER HECTARE FOR ESTABLISHMENT.

POTENTIAL PARTNERS:

MUNICIPALITIES / MNR / RRCA / VOLUNTEERS / WILLING LANDOWNERS / EASTERN ONTARIO MODEL FOREST / SD&G STEWARDSHIP COUNCIL / PARKS CANADA / ENVIRONMENT CANADA

REGULATORY RESPONSIBILITY:

MUNICIPALITIES, UNDER THE PLANNING ACT

IMPLEMENTATION SCHEDULE:

INITIATE ONCE THE ABOVE-MENTIONED HABITAT SUPPLY ANALYSIS (SEE ESTIMATED COST) IS AVAILABLE. DEMONSTRATION PROJECT ON SUTHERLAND CREEK ALREADY UNDER WAY.

These scarce terrestrial habitats require benchmark data collection and establishment of delisting criteria. Species restoration will result from habitat restoration. Recommendation # 58 can be achieved by implementing the section of the Natural Heritage Policy dealing with significant woodlands and significant wildlife habitat, and through various forestry stewardship initiatives for private and Crown land. Municipalities have regulatory tools ranging from zoning protection (Natural Heritage Policy) to tree-cutting by-laws, although implementation of the latter can be problematic.

Streambank erosion

6.8 Control Erosion

 # 59 Using the present regulatory system, continue to permit small, privately-owned shoreline properties to be stabilized on a site-by-site basis (includes shorelines of Lake St. Francis and tributaries) using erosion control techniques such as rip-rapping, revegetation, natural revetments and construction of offshore wave barriers and reefs.

COST:
BORNE BY THE LANDOWNER

POTENTIAL PARTNERS:
LANDOWNERS, WITH MNR AND RRCA PROVIDING ADVICE AND REGULATION.

REGULATORY RESPONSIBILITY:
MNR / RRCA

IMPLEMENTATION SCHEDULE:
ONGOING

Small scale erosion along shorelines occurs when individual landowners remove vegetation and construct unstable slopes. Erosion in these areas causes localized sediment deposition which destroys fish habitat. Shorelines can be stabilized using a variety of techniques including rip-rapping, shoreline revegetation, revetments and construction of offshore wave barriers and reefs.

Using a site-by-site approach, these actions will reduce erosion and protect or restore fish habitat in localized areas. With changes in the business focus of MNR and the RRCA, there may be changes in how these projects are designed and regulated, with a view to decreasing government involvement.

The recent Provincial Policy Statement contains specific direction to municipalities under the Natural Hazards Policy, designed to allow only appropriate development in floodplains.

 # 60 For specific problem areas, design the appropriate stabilization technique and implement the work as a government initiative either with public funding only or on a cost-shared basis with the landowner.

ESTIMATED COST:
THE ONLY PROJECT BEING CONSIDERED FOR THIS AT THIS TIME IS THE BAINSVILLE BAY POINTE MOUILLÉE PROJECT DISCUSSED WITH RECOMMENDATIONS # 56 AND 61.

POTENTIAL PARTNERS:
SEE RECOMMENDATION # 61

REGULATORY RESPONSIBILITY:
N/A

IMPLEMENTATION SCHEDULE:
N/A

Please refer to discussions accompanying Recommendations # 56 and 61.

 # 61 Design a shoreline stabilization project for Pointe Mouillée, based on the completed feasibility study, which incorporates the appropriate wetland and fish habitat protection and enhancement measures.

ESTIMATED COST:
COST COULD BE UP TO $1,500,000 FOR ARTIFICIAL REEFS OR MUCH LESS FOR REGULAR EROSION PROTECTION.

POTENTIAL PARTNERS:
LANDOWNERS / MNR / RRCA / ENVIRONMENT CANADA / DFO / LANCASTER TOWNSHIP

REGULATORY RESPONSIBILITY:
ENVIRONMENT CANADA ROLE IN CEAA.

IMPLEMENTATION SCHEDULE:
UNKNOWN AT THIS TIME. DISCUSSIONS WITH THE LANDOWNERS HAVE INDICATED THAT THEY ARE NOT PREPARED TO PARTICIPATE IN THIS PROJECT AT THIS TIME. FUNDING WILL ALSO BE AN ISSUE GIVEN THE SIZE OF THE PROJECT

At this time this project cannot proceed without further discussions and agreement with the landowners. Discussions are continuing.

6.9 Control Exotic Species

The best protection against exotic species is to prevent new introductions. The following actions can be taken to prevent further introductions of new exotic species and to deal with the effects of exotic species that have already become established in the area of concern.

62 *Recommend that all regulatory agencies ensure that no accidental introductions of exotic species occur in the area of concern and that any planned introductions are subject to the appropriate level of provincial and federal environmental assessment.*

ESTIMATED COST:
NONE TO THE RAP; COSTS WOULD BE ASSOCIATED WITH EACH ASSESSMENT.

POTENTIAL PARTNERS:
FEDERAL NAVIGATION AUTHORITIES (TRANSPORT CANADA) / AGRICULTURE CANADA / CANADIAN AND US COAST GUARDS

REGULATORY RESPONSIBILITY:
AS LISTED FOR PARTNERS.

IMPLEMENTATION SCHEDULE:
AS REQUIRED. FOR CERTAIN ISSUES SUCH AS BALLAST WATER TREATMENT, IMPLEMENTATION SHOULD BE IMMEDIATE.SINCE IT IS VIRTUALLY IMPOSSIBLE TO REMOVE AN EXOTIC SPECIES ONCE IT BECOMES ESTABLISHED, REGULATORY AND EDUCATIONAL MEASURES SHOULD BE TAKEN TO PREVENT THE ACCIDENTAL INTRODUCTION OF NEW EXOTIC SPECIES TO THE GREAT LAKES-ST. LAWRENCE RIVER BASIN. MAJOR VECTORS INCLUDE BALLAST WATER FROM FOREIGN VESSELS WHICH SHOULD BE CONTROLLED TO A GREATER DEGREE TO ELIMINATE THIS SOURCE OF EXOTIC SPECIES.

63 *Recommend mandatory regulation requiring treatment or exchange (or some other technique) to ensure that ballast water cannot be a carrier for the introduction of exotic species into the area of concern.*

ESTIMATED COST:
SEE RECOMMENDATION # 62 ABOVE. COST IS UNKNOWN BUT WOULD NOT BE BORNE BY THE RAP. THIS IS AN INTERNATIONAL GREAT LAKES ISSUE.

POTENTIAL PARTNERS:
TRANSPORT CANADA

REGULATORY RESPONSIBILITY:
TRANSPORT CANADA

IMPLEMENTATION SCHEDULE:
IMMEDIATE

Ocean-going ship

Ballast water is a common vector for the transport of exotic aquatic species into the St. Lawrence River and Great Lakes. Zebra mussels probably arrived in freshwater brought from Europe as ballast in a European ship. A mandatory program of ballast water exchange or some form of ballast water treatment to kill exotic species should be instituted in Canada to ensure that exotic freshwater species are no longer brought into any part of the St. Lawrence River in ships' ballast water. Current procedures followed by the US and Canada do not prevent foreign freshwater organisms from entering the St. Lawrence River anywhere downstream of the Massena locks, which includes all of the St. Lawrence River AOC.

In 1993, the US government made it mandatory for all foreign vessels entering American waters to perform a ballast water exchange at sea. Any foreign vessel which has not done so is not permitted to proceed past the American locks at Massena, NY. All ocean-going vessels wishing to proceed up the St. Lawrence River beyond Cornwall and Massena must go through the American locks at Massena. The American Coast Guard tests the ballast water of every ocean vessel entering the locks and if its ballast water is not seawater, the vessel is detained and its ballast water treated to destroy any possible freshwater organisms. If the vessel is headed for a Canadian destination and a ballast water exchange has not been recorded, Canada's

Department of Transport is informed and they will detain the vessel to inspect its ballast water. If the vessel is planning to discharge its ballast water at any time during its transit, the Department of Transport will require the vessel to treat its water in order to kill any freshwater organisms.

These procedures do not prevent foreign freshwater organisms from entering the St. Lawrence River anywhere downstream of the Massena locks. The Canadian federal government now asks ships planning to enter the St. Lawrence Seaway to perform a seawater ballast exchange, but the program is entirely voluntary. A mandatory program of ballast water exchange or some form of ballast water treatment to kill exotic species should therefore be instituted in Canada to ensure that exotic freshwater species are no longer brought into any part of the St. Lawrence River via ballast water. Amendments are being made to the Canada Shipping Act to give Transport Canada the required authority to enforce a mandatory program.

 # 64 Discontinue chlorination as a control measure for exotic mussels as soon as a more environmentally sound method becomes available.

ESTIMATED COST:
UNKNOWN. DEPENDENT ON THE TECHNOLOGY BUT MUST BE WITHIN A RANGE THAT CAN BE IMPLEMENTED BY THE AGENCIES AND INDUSTRIES THAT ARE AFFECTED.

POTENTIAL PARTNERS:
INDUSTRY / MUNICIPALITY / MOEE / ENVIRONMENT CANADA / INDUSTRY CANADA

REGULATORY RESPONSIBILITY:
MOEE / ENVIRONMENT CANADA

IMPLEMENTATION SCHEDULE:
IMMEDIATE WHEN ALTERNATIVE BECOMES AVAILABLE. RESEARCH IS ONGOING IN CANADA AND THE USA.

At the moment, chlorination is the most effective way to control zebra mussel infestations in municipal and industrial intake pipes. Chlorine used for this purpose moves towards the facility in the direction of water intake flow rather than being released into waterways, but it is still environmentally undesirable to use a toxic contaminant such as chlorine to control zebra mussels. As soon as a more environmentally sound control method is available, the use of chlorine for this purpose should be discontinued in the AOC.

6.10 Education Strategy

In addition to the sixty-four Recommendations of the St. Lawrence RAP discussed in this chapter, the RAP Team and PAC have endorsed a series of actions that should be taken to improve environmental awareness and understanding across various sectors of communities in the AOC. Environmental education for both students and adults will be a crucial component of restoring and protecting the St. Lawrence River AOC. The St. Lawrence RAP Education Recommendations, numbered E1 through E13, are grouped together here to form an education strategy for the AOC.

Use of phosphorus-free products

E1 Encourage, through education, the use of phosphate-free cleaning agents at commercial establishments and light industries in the area of concern.

E2 Establish a public education program to encourage the use of phosphorus-free products.

COST
ONE- TIME PROJECT, $30,000

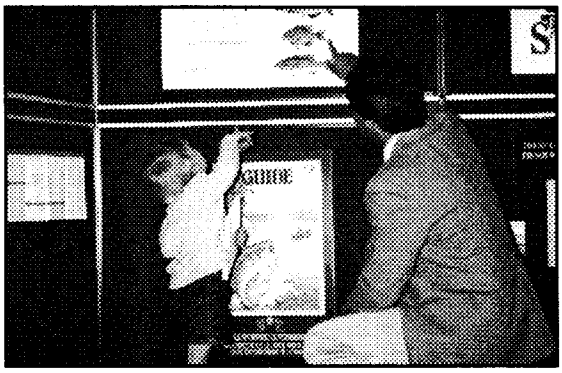
POTENTIAL PARTNERS:
MOEE LEAD / PARTNERS COULD INCLUDE SCHOOLS, MUNICIPALITIES, SLRIES, ENVIRONMENTAL GROUPS AND THE AGENCIES OR GROUPS WITH THE INFORMATION.

REGULATORY RESPONSIBILITY:
N/A

IMPLEMENTATON SCHEDULE:
START IN 1998.

Two separate sets of techniques would be required: one for commercial establishments that use phosphates in cleaning operations and one for general education. Phosphorus is not a major issue in the AOC, but public knowledge around this issue is at a reasonable level and with little effort the message to use phosphate-free cleaning agents can be disseminated. Existing information will be distilled into a small publication and then delivered to the target groups.

To implement Recommendations E1, E3, part of E4, E5 and E8, student programs will be developed in which students distill existing information, develop the written material, produce a small publication and visit the companies in question.



Sharing the science

For delivery of educational materials to commercial establishments, information about phosphorus will be combined with other relevant environmental information related to recommendations in the RAP education strategy.

For education of the general public, a one-page note can be inserted with tax mailouts for each municipality. The information would be distributed to rural and urban residents by piggybacking it onto existing mailings.

Disposal of mercury and other hazardous wastes

E3 Prevent mercury discharges into the sewer system (industries, dentists, pharmacies, laboratories, paint shops etc.) through public education and enforcement of sewer use by-laws.

These sources use various methods to recover mercury in their processes, with varying degrees of success. The amount of mercury entering the sewers (and ultimately the river at some lower concentration) can be controlled by using materials that do not contain mercury or by filtering the mercury at the source.

This education program would be implemented as part of the overall student project described under Recommendation E1. Costs, partnerships and timing would be as listed for Recommendation E1. The education package would include information on the existing sewer use by-laws.

Enforcement of the sewer-use by-laws would not just include an education component, however. After the education program visits, if compliance with the by-laws is identified as a problem then the City will be requested to put a high priority on enforcement of these by-laws (see Recommendation # 25). Information on mercury concentrations allowed by the sewer use by-law and an explanation of why mercury is a problem for these types of commercial establishments, can be distributed to organizations such as the local dentists' and pharmacists' associations.

E4 Implement an education program for the general public and industrial sectors where such a program does not exist, about the handling and disposal of hazardous wastes including spill prevention and cleanup.

COST:
BORNE BY THE MUNICIPALITIES; COORDINATION OF TIMING CAN RESULT IN SAVINGS.

POTENTIAL PARTNERS:
UNITED COUNTIES OF SD&G / CITY OF CORNWALL / MOEE / RAP TEAM

REGULATORY RESPONSIBILITY:
MOEE

IMPLEMENTATION SCHEDULE:
IMMEDIATE

Laws and regulations exist that deal with handling, disposal, spill prevention and cleanup of hazardous wastes. The education material and program (see Recommendation E1) would consist of: (a) ensuring that the industries and groups visited are aware of the existing regulations and requirements; and (b) establishing a United Counties coordinated hazardous waste collection day and then implementing the communications (news releases, public service announcements) so that all residents know when and where the collections can occur.

The City has approved (1997) construction of a permanent hazardous waste depot. Once this is established, partners involved in implementing this Recommendation can work with the City to communicate widely the availability of the depot and the importance of correct disposal of hazardous wastes. Communications should also include information pertaining to consumer goods which contain trace amounts of contaminants such as mercury in fluorescent light fixtures and cadmium in batteries.

MOEE should be encouraged to carry out more inspections to assess compliance with Regulation 347 (Ontario's Hazardous Waste Regulation). A "Yellow Fish Road" system should be developed throughout the City of Cornwall. SLRIES and members of the Green Team could be asked to support such an initiative.

Water conservation

E5 From an education perspective, support the Cornwall Energy Efficiency Team in their public education program about ways of conserving water and the environmental and economic benefits of using less water.

COST:
NOTHING EXTRA

POTENTIAL PARTNERS:
CORNWALL ENERGY EFFICIENCY TEAM AND RAP/PAC

REGULATORY RESPONSIBILITY:
N/A

IMPLEMENTATION SCHEDULE:
ONGOING

This is an ongoing program that the Cornwall Energy Efficiency Team, sponsored by the City of Cornwall, Cornwall Electric and Centra Gas, have implemented over the last 5 years. It has resulted in visits to 16,000 homes in Cornwall and the three United Counties. The Energy Team has also distributed energy education kits to pilot schools. The kits were successful learning tools for teaching children about energy efficiency and the environment. Other educational activities include assisting the Cornwall Planning & Recreation Department in conducting short energy and environmental workshops for children in Cornwall's parks.

The PAC/RAP will work with this group whenever possible or practical (in terms of including their material in our distribution/education program and providing advice for their program upon request).

As well, the City of Cornwall's Department of Engineering and Environmental Services should implement the recommendations of the City of Cornwall's Water Efficiency Strategy (Cornwall Energy Efficiency Team and City of Cornwall 1995).

Reduction of bacteria and other fecal contaminants

E6 Encourage education and posting of signs at parks and campgrounds, regarding the importance of poop and scoop, personal hygiene at beaches, not feeding gulls, and proper garbage control and collection.

This recommendation will have to be implemented with the assistance of the municipalities, St. Lawrence Parks Commission and owners of private parks and campgrounds. Municipalities will be encouraged to pass a poop and scoop by-law, accompanied by an appropriate communications plan. Operators of public and private parks and campgrounds should be encouraged to post signs advising the public about why these measures are environmentally friendly. Concerned agencies should publish appropriate brochures and aid in their distribution.

E7 Educate the public about bacterial levels in private discharges of sewage.

The Eastern Ontario Health Unit should develop information on this topic (if it does not already exist) and distribute the material to the public. The Public Outreach Committee of the PAC can assist by preparing articles for local newspapers.

E8 Inspect manure piles and milkhouse waste disposal systems which have the potential to be sources of surface water contamination, and correct by providing education to farmers about how to solve the problem.

The Public Outreach Committee will encourage OMAFRA to distribute its educational information via soil and crop associations, the Federation of Agriculture and municipalities.

E9 Endorse the Farm Environmental Plan program described in Our Farm Environmental Agenda as part of the development of an agricultural land stewardship program.

OMAFRA will be encouraged to actively promote the Farm Environmental Plan program to farmers, soil and crop associations, the Federation of Agriculture and municipalities.

Wetland protection

E10 Increase public education of landowners (private, municipal and industrial) regarding the value of wetlands, particularly those provincially significant wetlands in the watershed.

The Resource Stewardship Council will be a key partner for implementing this Recommendation and the next (E11). The Ontario Ministry of Natural Resources has created Private Land Stewardship Councils across southern Ontario to advance and implement practical and sustainable resource management. In the AOC, Resource Stewardship SD&G Council is made up of landowners from the three counties of Stormont, Dundas and Glengarry. Its aim is to encourage responsible resource management by private landowners in SD&G through education and partnership.

E11 Through a combination of stewardship and education initiatives, encourage landowners to protect wetlands they own by means of conservation easements or management agreements. Encourage landowners to implement small enhancement projects (nesting boxes, habitat management) and to undertake wetland creation, especially in small headwater areas.

This is a major thrust of the Five Counties EHJV Management Plan.

E12 Inform municipalities, landowners and other agencies involved in shoreline and upland development about fish and wildlife habitat concerns to ensure that these concerns are considered in the planning process.

There is a major initiative under way in Ontario to provide municipalities with natural heritage information (wetlands, areas of natural and scientific interest (ANSIs), significant woodlands and wildlife habitat, significant ravines) which they can use in local land use planning (Official Plans). This information will also be available to individuals. On a broader scale, all resource agencies now have programs to deliver information on habitat protection to individuals and others involved in development. It is proposed to continue to deliver these kind of programs and incorporate, wherever appropriate, RAP-related messages.

Purple loosestrife control

E13 Increase public awareness about purple loosestrife by providing information on how to control small, accessible populations by hand pulling.

OMAFRA and MNR will be encouraged to distribute their information on purple loosestrife.

Nuisance Aquatic Plants

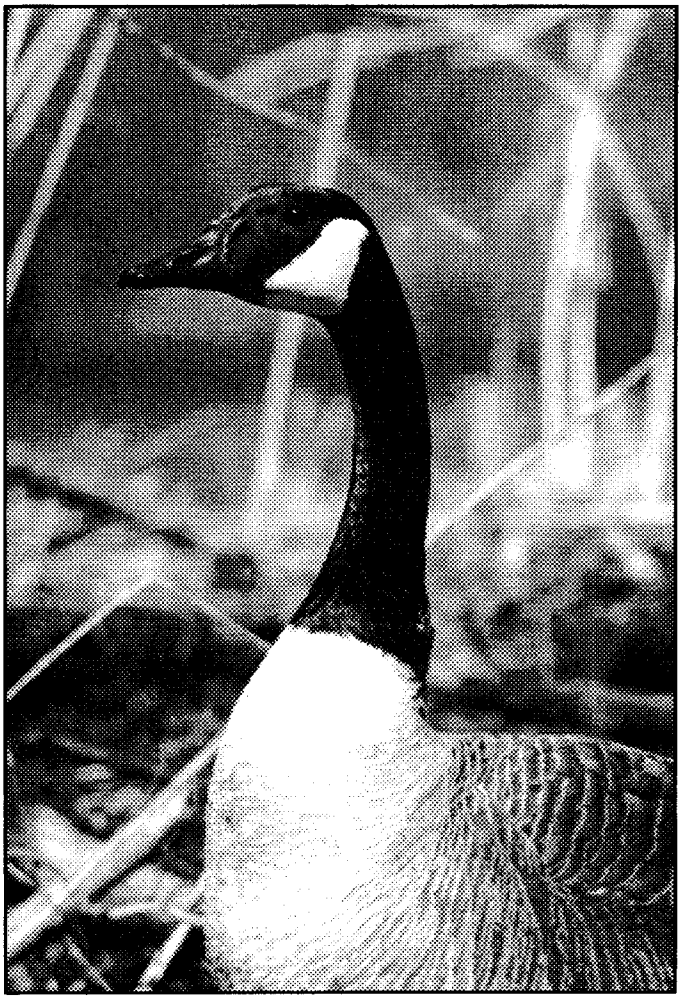
The Public Outreach Committee of the PAC plans to produce fact sheet that will accompany MNR permits to remove limited and specified amounts of nuisance plants from shoreline properties when the problem occurs.

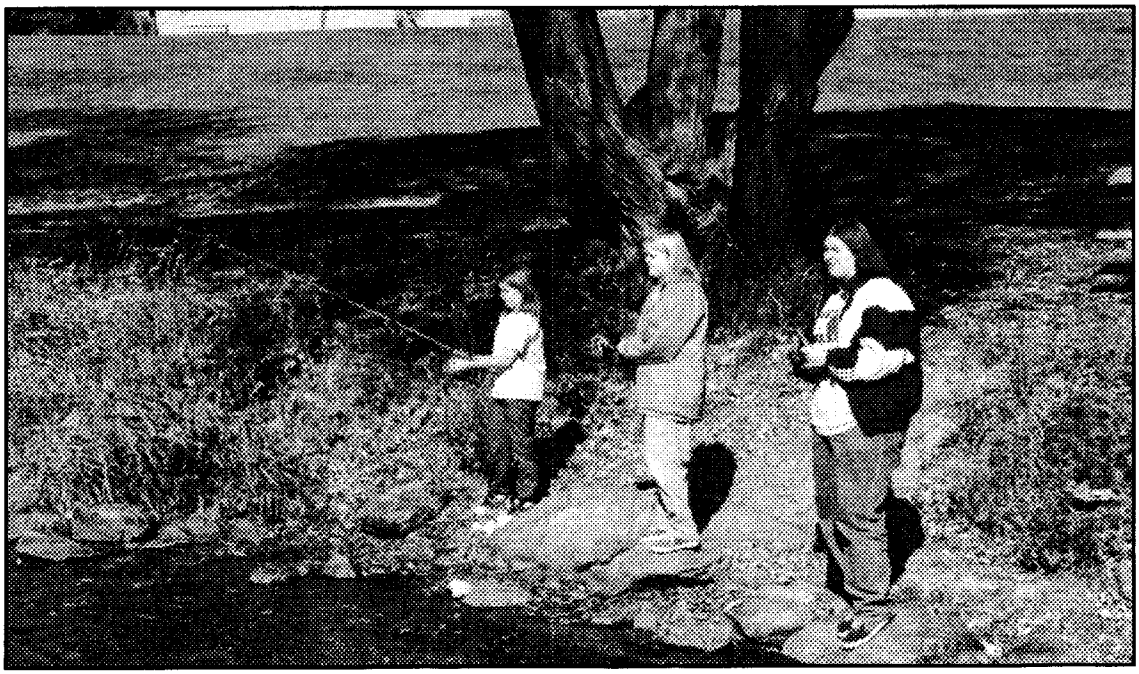
Other Strategies

An education project in September 1997 allowed students in local schools to see real-time film of artificial reefs that have been built along the Cornwall waterfront to restore habitat for fish and other biota. Live TV broadcast signals from both the surface and an underwater camera were distributed via the local cable network. The program included real-time communication between the students and the scientific personnel on-site, including the diver using the underwater camera.

Other delivery methods for environmental education include:

- workshops highlighting different issues for interested citizens
- displays at libraries
- Internet home-page for the AOC
- regular contact with environmental clubs in the schools
- additional cable TV programs
- booths at local shows, fairs and festivals school events such as Envirothon.





7. REMEDIAL ACTIONS COMPLETED OR IN PROGRESS

Implementation of many of the St. Lawrence River (Cornwall) RAP Recommendations is already either completed or in progress, as described below.

1. Lake St. Francis Tributary Restoration

St. Lawrence River (Cornwall) RAP Recommendaton #: 37, 38

Restoration of the tributaries of Lake St. Francis began with a survey of Sutherland Creek in 1992 (Loftus *et al.* 1993). This survey used existing data and field surveys of conditions along Sutherland Creek to identify environmental problems and suggest remedial measures to address them. Several problems were identified including cattle with access to the creek, improper manure handling practices, erosion due to lack of stream bank vegetation and straightening of some parts of the channel.

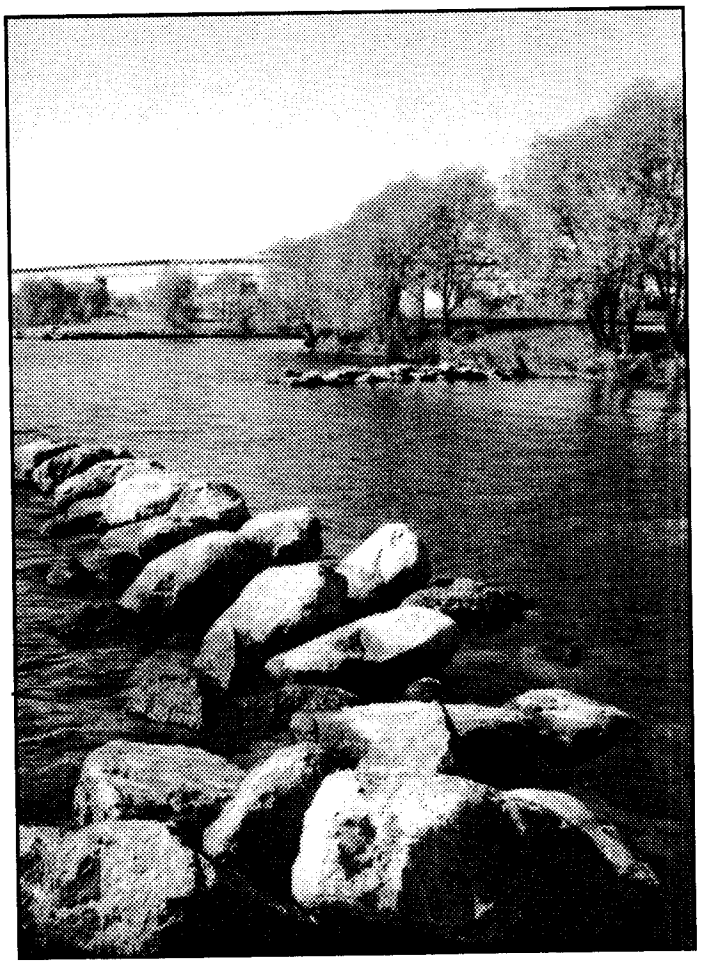
The recommendations of the Sutherland Creek Restoration Study (Loftus *et al.* 1993) began to be implemented in 1994, and in 1996 the restoration efforts along Sutherland Creek were expanded to include all other tributaries of Lake St. Francis. As of August 1997, approximately 19,000 trees and shrubs had been planted along riparian areas. More than twelve kilometres of tributary shoreline have been protected by installation of fencing to restrict cattle access to water and creation of vegetated buffer zones. Eight alternate livestock water sources have been established. Manure storage facilities have been improved on two properties with eleven more planned.

The project also includes initiatives to deal with septic system upgrades and shoreline erosion problems. Baseline water quality data were collected in 1994 (Richman *et al.* 1997) and 1995 (MOEE/MNR unpublished data).

2. Cornwall Littoral Zone Restoration and Fish Community Assessment

St. Lawrence River (Cornwall) RAP Recommendation #: 53, 54, 55, 56

In 1992, Cumming Cockburn Ltd conducted a fish habitat survey along the Cornwall waterfront and suggested that the lack of structural diversity in the littoral zone habitat was limiting the health of the nearshore fish community. This habitat assessment was used to develop conceptual plans for a series of 18 habitat restoration projects along the Cornwall waterfront (Cumming Cockburn Ltd 1996).



Reef along the shoreline at Lamoureux Park, Cornwall

The first of these projects was completed in 1993 and included an artificial island and underwater reef complex which also serves as an anchor for a floating portion of Cornwall's bicycle path (Project 17, Cumming Cockburn Ltd 1996). In 1995 three more reefs were completed along the shoreline at Lamoureux Park (Projects 10 and 11, Cumming Cockburn Ltd 1996). Three more projects are planned for 1997/1998, including the Rotary Project–a 200 metre meandering artificial creek and a wetland at the west end of Lamoureux Park.

In 1993/1994, pre-remediation fish community electrofishing surveys were conducted at the 18 proposed project sites and three control sites (M. Eckersley, MNR, unpublished data). Post-remediation electrofishing surveys have been conducted at three project sites (all projects completed by March 1996) and analysis of the data is under way.

3. Wildlife Monitoring and Recovery

St. Lawrence River (Cornwall) RAP Recommendation #: 57, 58, 61

Volunteer-based monitoring of frogs, marsh birds, red-shouldered hawks and forest birds was initiated in 1994. As of January 1996, 12 marsh monitoring routes, 4 red-shouldered hawk routes and 2 forest bird monitoring sites had been established in or near the AOC. Draft recovery plans have been established for three species: American coot, red-shouldered hawk, and lake sturgeon (Hickey 1996a, 1996b, 1996c).

4. Cornwall Pollution Control Planning Study

St. Lawrence River (Cornwall) RAP Recommendations #: 19, 22, 23, 24

A Pollution Control Plan was prepared for the City of Cornwall in 1995 (City of Cornwall 1995). The Plan addresses the problems associated with sewage and stormwater collection and treatment systems in the City of Cornwall. It makes recommendations to deal with the current problems and to prevent their recurrence in the future as well as to guide future growth in the systems. Water quality treatment will be examined as part of a study of all the storm outlets in the City.

Projects already implemented include the separation of storm and sanitary sewers at Brookdale, which will be completed in 1997 subject to provincial approvals, and separation of the Pitt Street storm and sanitary sewers to Ninth Street.

5. Fly Creek Stormwater Pond Retrofit Plan

St. Lawrence River (Cornwall) RAP Recommendation #: 4, 22

The Fly Creek Stormwater Pond Retrofit Plan's primary purpose is to redesign and reconstruct the Fly Creek Stormwater Retention Pond to provide water quality treatment, and fish and wildlife habitat enhancement. The Environmental Study Report (part of the EA process) is complete. Design work started in March 1997 on the first phase of the preferred design. When implemented, the project will maintain contaminant concentrations below Provincial Water Quality Objectives, will limit biota exposure to contaminants and will provide enhanced habitat both in the pond and in the downstream connecting waterways.

6. Installation of Carbon Filtration at Cornwall Water Treatment Plant

St. Lawrence River (Cornwall) RAP Recommendation #: 20

In recent years, a taste and odour problem has developed every fall in City of Cornwall drinking water. A carbon filtration system was installed at the Cornwall WTP in 1997 to eliminate this problem.

7. Decommissioning at ICI Forest Products, Cornwall Chemicals, Courtaulds Fibres

St. Lawrence River (Cornwall) RAP Recommendation #: 11

Decommissioning at Courtaulds Fibres is almost complete. The company has now submitted its final plans for some of the property and the report is being reviewed by MOEE. A report on the remainder of the property is expected soon.

The decommissioning of Cornwall Chemicals is well under way. A treatment system to reduce contamination in the soil will treat all contaminated soil on the site over the next two years.

At ICI Forest Products, all equipment in the cellroom of the closed mercury cell chlor-alkali plant has been removed. The extent of mercury contamination of the soil on the property has been determined and a proposal for treating the soil has been presented to MOEE to determine whether formal approval is required to proceed with soil remediation.

8. Implementation of Federal Pulp and Paper Regulations at Domtar Papers

St. Lawrence River (Cornwall) RAP Recommendation #: 8

Domtar has installed secondary treatment at a cost of $61 million. The facility has been operating since February 1995 and has been meeting the requirements of both MISA and federal pulp and paper regulations. The first Environmental Effects Monitoring (EEM) cycle report has been submitted.

9. MOEE Air Monitoring Working Group

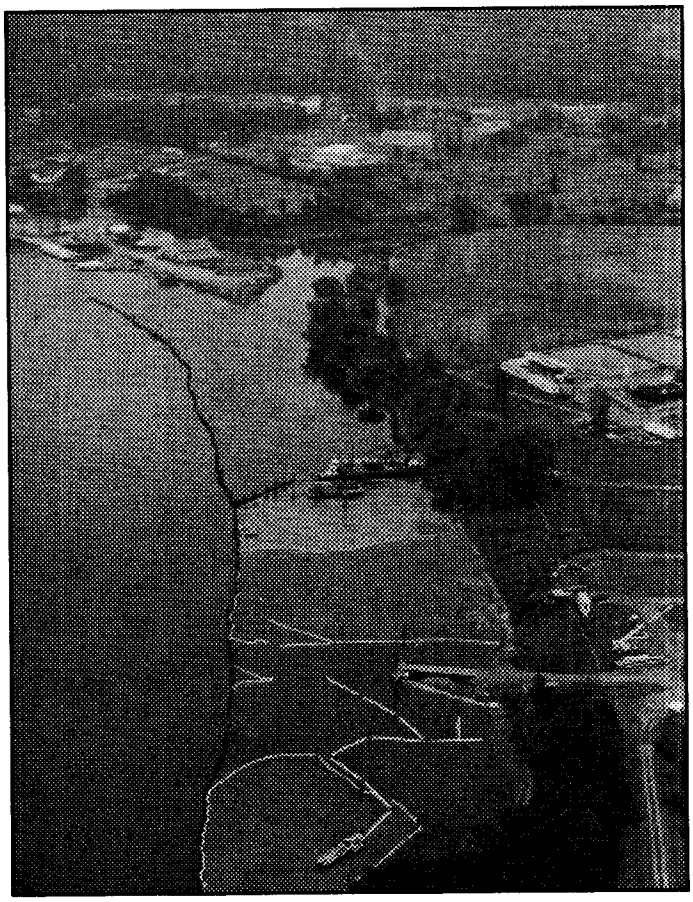
St. Lawrence River (Cornwall) RAP Recommendations#: 13

This MOEE group is still active and currently focussing on emissions from the Domtar Kraft mill. Discussions are continuing with the company regarding certain compounds that are emitted and why discharges of these and other odorous compounds persist. The Cornwall Air Quality Committee is inactive, but a new subcommittee started by the local Chamber of Commerce has been very active and MOEE has participated in its discussions.

10. Monitoring of US Site Remediation Activities

St. Lawrence River (Cornwall) RAP Recommendation #: 14, 15

The United States Environmental Protection Agency (EPA), through its Superfund Program, requires that the three industries (General Motors, ALCOA, Reynolds) in Massena, NY remove highly contaminated sediment in the St. Lawrence and Grasse Rivers (a tributary of the St. Lawrence).



Sediment removal project at General Motors, Massena, New York

Environment Canada provides the lead for Canadian agencies–through the Canadian Review Panel–to review and comment on all cleanup activities at the Massena Superfund sites. Membership on the Review Panel consists of representatives of Environment Canada (Ontario and Quebec Region), Health Canada, and the Ontario and Quebec environment ministries.

Environment Canada, in cooperation with the United States Environmental Protection Agency, United States Army Corps of Engineers and General Motors Powertrain Division, monitored the 1995 sediment removal activities in the St. Lawrence River adjacent to the General Motors site. Environment Canada will continue to participate in future Superfund sediment removal projects in Massena.

In addition Environment Canada, with the Quebec and Ontario environment ministries, has established networks of monitoring sites to assess both short-term and long-term changes in the environmental quality of the St. Lawrence River

11. Cornwall Sediment Management Strategy

St. Lawrence River (Cornwall) RAP Recommendation #: 16, 17

Detailed information on sediment contaminants exists for the area along the Cornwall waterfront from Windmill Point to Pilon Island but data are sparse for the area from Windmill Point to the western extent of the AOC. Environment Canada and MOEE have made commitments to develop a sediment management strategy for the Cornwall waterfront. The strategy will consist of a series of steps to evaluate, select and implement the most appropriate actions for sediment management, consistent with Recommendations # 16 and # 17. Evaluation will include acquisition and review of historical and new chemical and physical data.

12. Cornwall Harbour Investigations

St. Lawrence River (Cornwall) RAP Recommendation #: 18

Transport Canada completed a non-intrusive (*i.e.*, no sampling) Phase 1 assessment of the site in 1993, which led to a Phase 2 site characterization study. Chemical and physical data were collected from boreholes and monitoring wells and an initial site assessment was prepared. A supplemental study was undertaken in 1996 to acquire additional information necessary to fully characterize the site. A remedial action plan is now being prepared for the site based on these assessments.

13. Studies to Resolve the Sediment Toxicity Issue at the Tank Farm Site

Sediment surveys at the "oil tank farm site" in 1992 (MOEE) and 1993 (Environment Canada) provided detailed sediment quality data. Bioassays were performed in 1993 on sediment samples collected from the area and benthic community structure was assessed in the field by Environment Canada. Toxicity was observed in sediment samples from only a few stations, and these were only slightly toxic to laboratory test organisms in sub-lethal tests. In addition, the composition of the benthic community was found to be minimally affected by sediment contamination (Metcalfe-Smith *et al.* 1995).

14. Energy and Water Conservation

St. Lawrence River (Cornwall) RAP Recommendation #: 24

The City of Cornwall was one of the first municipalities in Ontario to develop a Green Community program. Initially, funding came from the former Ontario Ministry of Energy. An active committee called the Cornwall Energy Efficiency Team sponsored numerous energy reduction programs. The principal program involved the development of teams to conduct "energy tune-ups" in residential homes. Several of the energy conservation steps completed during these home visits are also water

conservation steps, such as the installation of low flow showerheads and toilets. The Ontario Building Code (Plumbing) has introduced the use of low flow appliances for new construction. The City of Cornwall supports this and would oppose any move to make the regulations less stringent.

The Green Community home visit program has been very successful, with over eleven thousand visits completed. Since provincial government funding for this program ended, energy-related companies such as Centra Gas and Cornwall Electric have provided financial assistance to keep the Cornwall Energy Efficiency Team going.

15. Environmental Education

St. Lawrence River (Cornwall) RAP
Recommendation #: E1-E13

Education kits are being produced for use in elementary and secondary schools in the AOC. These kits, which include background information and lesson plans for the teacher and activities for the students, are reviewed by MOEE, MNR and Environment Canada scientists for accuracy, by teachers for usefulness, and then given to the Boards of Education in the AOC. Sessions will be offered at teachers' professional days to heighten awareness of the kits.

8. SOCIOECONOMIC CONSIDERATIONS

8.1 Potential Partnerships for Implementation

Due to recent and ongoing changes in the provincial and federal government, it is difficult to define partners or their relationships during Stage 3 of the RAP. Groups that will be encouraged to be partners, in addition to federal and provincial agencies, are: RRCA, SLRIES, IREE, Resource Stewardship SD&G, and environmental committees or departments of municipalities in the AOC.

8.2 Socioeconomic Benefits Assessment

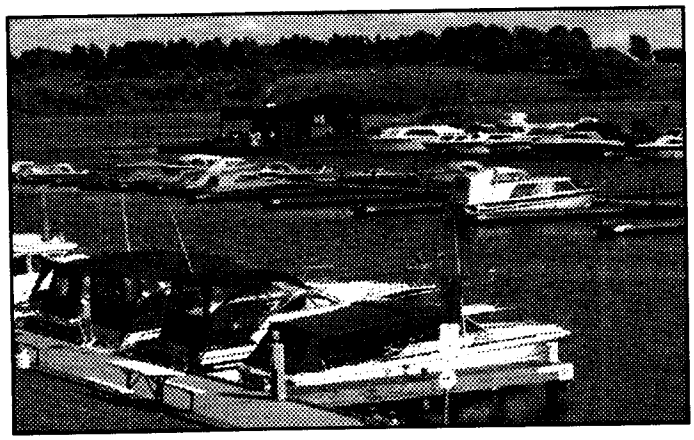
Introduction

Implementation of cleanup and restoration activities in the St. Lawrence River AOC has begun. At Domtar Papers, Cornwall, a secondary treatment facility has been constructed and process changes implemented; the capital cost of these actions was about $61 million. Along the Cornwall waterfront, a number of habitat restoration actions have begun as part of the St. Lawrence River RAP, including construction of artificial reefs and wetlands. ICI Forest Products has phased out the use of mercury in its industrial processes. Cornwall Chemicals, an industrial operation producing carbon tetrachloride, has ceased operations and decommissioning has been initiated. Agricultural practices that reduce environmental impacts on waterways have been implemented at farms along the Raisin River and Sutherland, Westley's and McIntosh Creeks. The City of Cornwall is implementing the recommendations of its Pollution Control Planning Study. Planning for additional restoration works in the AOC is in progress.

From these restoration projects, it is possible to estimate some cleanup costs and describe some of the potential economic benefits and opportunities associated with implementation of St. Lawrence River RAP recommendations.

To this end, theoretical economic impact forecasts have been generated by means of economic modelling, with respect to implementation of selected St. Lawrence River RAP recommendations.

A sub-sample of some of the costed remedial actions for the AOC, totalling $183 million in capital costs and 2.7 million in maintenance/operating costs, was used to model potential impacts of restoration (Sustainable Futures *et al.* 1995). These two cost estimates do not include all restoration efforts and effects, but represent only a sample of the proposed activities. The reason for using a sub-sample was that the full costs for some actions were not available. The overall effect of this on the results of benefits assessment modelling, reported here and in the original benefits assessment study report (Sustainable Futures *et al.* 1995), is that the predictions of the model are not fixed and will change with changes in dollars spent on rehabilitation.



Cornwall's Marina 200

Socioeconomic-Industrial History: A Brief Summary

Many changes have occurred in the socioeconomic and industrial profile of Cornwall and the surrounding region since the first permanent human settlements. Initially, the area supported First Nation and European agricultural activities. In the mid-1800s, industrial

activities were introduced, including manufacturing and resource extraction. Throughout the early- and mid-1900s, industrial development in the region continued to grow and diversify, to include food processing, textiles, chemical production, pulp and paper processing. Since the 1950s, the construction of the St. Lawrence Seaway and hydroelectric power project has had a major impact on the local economy.

More recently, manufacturing in the area has decreased. Many industrial activities have ceased operations and an economic restructuring that builds on the strengths of the community has been initiated. Each shift in the socioeconomic profile and industrial base has introduced change to the local ecosystem. A detailed account of the socioeconomic history of the Cornwall area has been provided by Diogo and Jeena (1995).

Cost

Cost is an important decision-making factor in environmental restoration. Preliminary cost estimates have been developed for the St. Lawrence River RAP. However, final implementation costs will depend on a number of factors, including the development of new restoration technologies (either reducing or increasing costs) and the final planning and design of implementation actions. The discovery of additional and unforeseen pollution problems or costs; an assessment of risk; availability of funds for implementation and other economic considerations (*e.g.*, other priorities, interest rates); decisions to delay or postpone cleanup activities versus a willingness to pay for remediation immediately; and the securement and maintenance of cleanup partnerships all affect costs.

Preliminary cost estimates for remedial actions were developed by:

- undertaking assessment activities such as the Cornwall Pollution Control Planning Study and the Fly Creek Stormwater Pond Retrofit proposal;
- estimating costs from smaller demonstration activities within the AOC, including fish habitat enhancement projects and a proposed sediment removal project in the St. Lawrence River adjacent to the former Courtaulds Fibres operation;
- pro-rating costs from similar remediation activities in other parts of the Great Lakes basin;
- developing "ball-park" estimates based on RAP Team member technical experience; and
- reviewing the published literature and conferring with agency "experts" for costs from similar undertakings.

These preliminary cost estimates were prepared for a selected subset of the restoration activities recommended by the St. Lawrence River RAP. The cost estimate for the subset of activities totalled $181.3 million in capital expenditures, plus an annual operating and maintenance cost of an additional $2.7 million. These values were applied to a benefits assessment economic model as described in Sustainable Futures *et al.* (1995) and summarized briefly below.

Benefits

Offsetting the costs of environmental restoration work are the benefits of such activity. Although benefits cannot always be valued in economic or monetary terms, it is important, as a first step, to identify and describe the range of economic opportunities and sustainable benefits that may arise from the implementation of cleanup work.

Economic opportunities that are measurable include employment, new investment activities, sales of goods and services, taxes and labour income. Applying the economic principle of a "multiplier effect", these measurable opportunities can be expressed in terms of direct impact and induced impact to illustrate the total impact of investing in environmental restoration activities.

Direct impacts

The benefits assessment model reallocated local, provincial and federal spending from other expenditure areas to environmental restoration, in order to determine the direct impacts. It predicted that if $181.3 million was reallocated and spent to delist the St. Lawrence River RAP AOC, the direct impacts in the Cornwall area would be an increased income of $84 million, 278 more person-years

of employment and additional taxes of about $3 million. At the same time, the model predicted negative impacts in other areas of the province due to the reallocation of resources to implementation of St. Lawrence River RAP recommendations.

Induced impacts

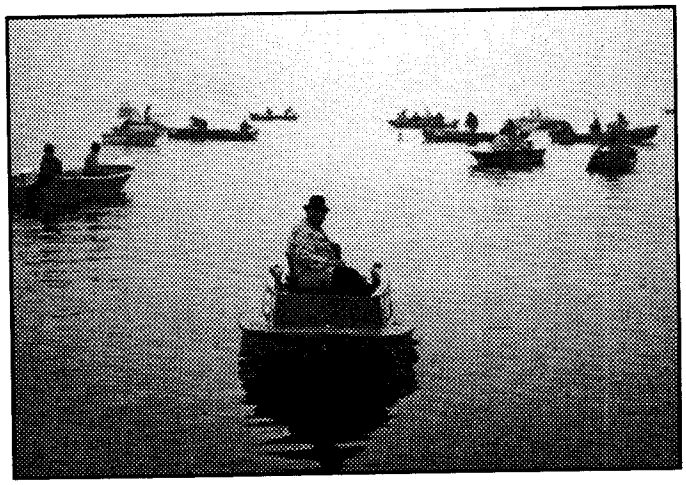
Induced impacts are the new spending and investment opportunities that may occur as a result of direct expenditure of resources for restoration and the resulting improvements in water quality. These impacts were measured for a 20-year period. The model predicted that the initial $181.3 million investment would give rise to potential new capital investment of $204 million locally in the Cornwall area, resulting in increases in income (up $182 million), employment (1632 new person-years or 82 person-years annually) and taxes ($7 million). In addition to these positive local impacts, the induced impacts predicted by the model were also positive for the province as a whole. The annual operating and maintenance expenses generate additional positive potential impacts, with the Cornwall area deriving a high share of the impacts due to the diversification of its industrial and commercial base.

Non-monetary impacts

The non-monetary environmental and cultural benefits of environmental restoration activities include sustainable benefits such as increasing the diversity of the local aquatic ecosystem, enhancing human cultural and spiritual expression based on the natural features of the St. Lawrence River, and avoiding costs such as the costs of illness and health care arising from environmental impairment (see Table 13). These benefits supplement the direct and induced impacts described above.

In summary, the benefits assessment study found that an investment in environmental restoration would provide a net positive gain in all evaluated monetary categories (Sustainable Futures *et al.* 1995). The potential positive impacts, monetary and non-monetary, are substantial if investment is directed toward implementation of the St. Lawrence River RAP.

For a theoretical capital investment of $183 million, the projected direct impact would be an increase, over twenty years, in local income of $84 million, an increase of 278 local jobs and an increase, in taxes collected, of $3 million. Including the indirect projected economic benefits, over twenty years the local income would increase $182 million, 1632 new jobs would be created and taxes collected would increase by $7 million. These estimated dollar values must be interpreted only as indicative of the general magnitude of the economic benefits accruing from RAP implementation. If capital investment or maintenance costs change there will be a corresponding impact on the estimated benefits realized.



Fishing on Lake St. Francis

Table 13. Examples of non-monetary benefits (sustainable benefits and avoided costs) which may arise from an economic investment in environmental restoration.

Sustainable Benefits (Categories)	Potential Benefits (Examples)
Environmental Regulation	• Increased protection and restoration of natural habitats • Increased species diversity of fish and wildlife • Retaining natural ecosystems for future generations • Reduced erosion and sedimentation • Reduced release of contaminants
Provision of Consumable Resources (Production)	• Improved water, land and air quality • Increased extractable resource production
Provision of Consumable Medium (*e.g.*, space)	• Increased land for development and habitation • Increased recreational opportunities • Improved land use practices • Enhanced ability to maintain and attract business • Conservation of water
Cultural and Spiritual Expression	• Enhanced access to green space • Improved linkages between society, environment and economy • Improved community profile • Satisfaction that ecosystem is safe, clean and productive • Preservation of natural heritage and cultural sites
Avoided Costs (Categories)	**Potential Savings (Examples of avoided costs)**
Services	• Health care • Water supply and purification
Infrastructure	• Pollution control • Sewer and waterworks rehabilitation • Loss of recreation and tourism potential
Consumable Resources	• Soil remediation • Restoration of natural habitat • Excessive water use and associated treatment costs

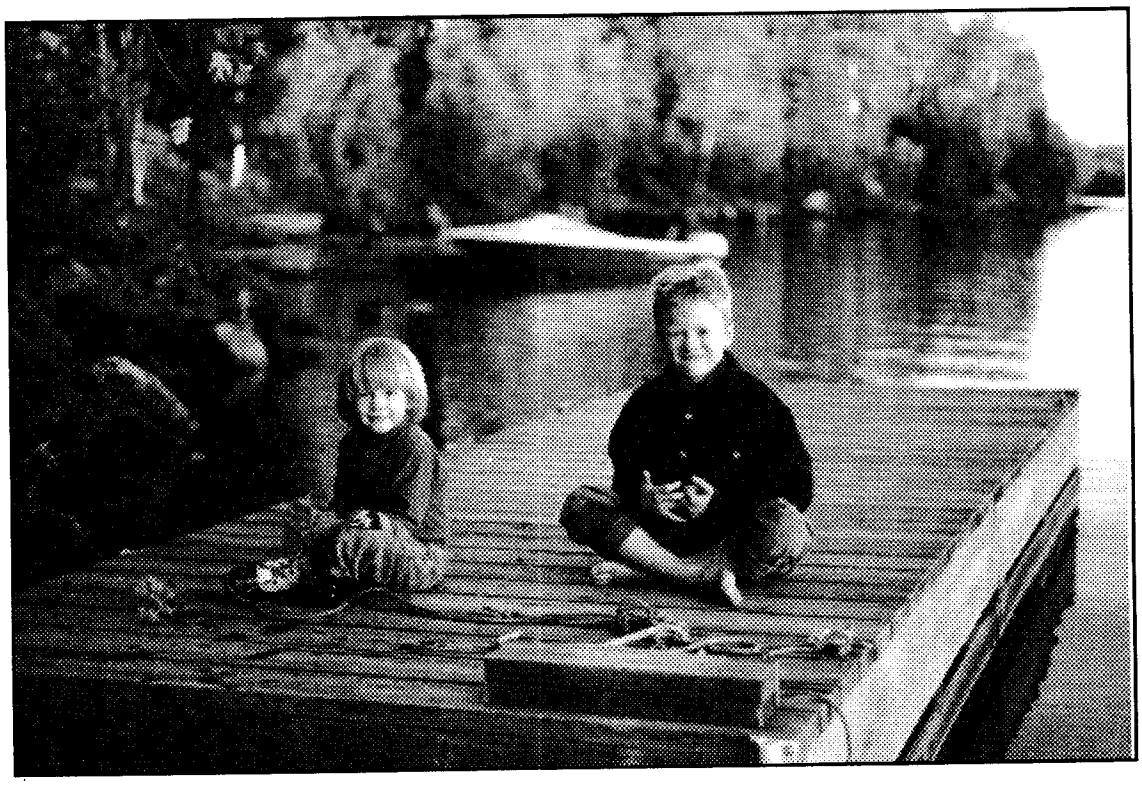
9. DELISTING CRITERIA

Beneficial uses that are, or may be, impaired in the AOC are listed in Table 1, Chapter 2. In order for a beneficial use to be removed from the St. Lawrence River (Cornwall) AOC list of impairments (*i.e.*, "delisted"), specific environmental conditions must exist in the AOC. Those conditions which must be demonstrated to exist are termed delisting criteria.

The tables in Chapter 9 contain delisting criteria (one or more for each beneficial use impairment) that have been developed for the St. Lawrence River (Cornwall) AOC specifically. Some beneficial use impairments have both short-term and long-term criteria assigned to them. Each criterion has been assigned a Roman numeral for reference.

Please note that all criteria are potentially dynamic and some will need to be updated as additional environmental data and methodologies become available.

Environmental monitoring will be required during Stage 3 of the RAP in order to track the effectiveness of remedial actions and determine when individual delisting criteria have been met. Chapter 10 outlines environmental monitoring programs that have been designed to provide the required data for each criterion.



Protecting the river for future generations

Table 14-1. CRITERIA FOR DELISTING ST. LAWRENCE RIVER (CORNWALL) AS A RAP AREA OF CONCERN
(table 1 of 2)

Impairment	Delisting Criteria	Comments
RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION	**I. Fish** **Sportfish** A long term goal of the St. Lawrence PAC is to eliminate restrictions on consumption of fish & wildlife from the AOC. That goal is linked to virtual elimination of toxic contaminants in the Great Lakes-St. Lawrence Basin. In the shorter term, this use impairment will be considered delisted with respect to fish when contaminant levels in fish from the AOC are the same as or less than those in fish from the St. Lawrence River upstream of the Iroquois Dam or when contaminant levels are below consumption guidelines in all fish of species listed in the Guide to Eating Ontario Sportfish. **Commercial Fishery** Will be considered unimpaired when the commercial fishery in the AOC is no longer restricted due to toxic contaminants from sources within the AOC. **I. Snapping Turtles** When there is no advisory in effect regarding consumption of snapping turtles from the AOC.za	**Waterfowl** Waterfowl consumption restrictions are not impaired in the AOC, based on the findings of a recent Environment Canada (CWS) National Survey of Contaminants in Waterfowl (Braune, in prep). Health Canada interpreted the CWS data with respect to implications for health of humans who consume waterfowl. Breast muscle from 5-10 birds per species collected during the fall hunting season was analyzed for organochlorines, PCBs, Hg, Cd, Pb, As, Se and selected pools of samples were analyzed for dioxins and furans. The following species were sampled in Lake St. Francis: lesser scaup, greater scaup, gadwall, common merganser, common goldeneye and mallard. Based on their analysis of the 1988-1992 data, Health Canada has advised that "the contaminant levels reported in the various waterfowl samples analyzed were either non-detectable or very low and would not be considered to pose a hazard to the health of consumers" and that "consumption of the breast muscle and/or egg of the species reported...would not pose a health hazard to the consumer". **Snapping Turtles** Three turtles collected from Cornwall Island in 1988 contained high concentrations of total PCBs in liver tissue but not in muscle tissue (St. Lawrence (Cornwall) RAP Team 1992). The data were insufficient for determining human health effects of consuming turtles from the AOC but, as a precaution, MNR and the Mohawks of Akwesasne advised that snapping turtles from the area should not be consumed. Additional data is required in order for Health Canada to determine consumptibility of AOC snapping turtles. This will include information about the status of contaminant concentrations in AOC turtles as well as the frequency and amount of consumption of AOC turtles by humans. Please refer to Chapter 10 (Monitoring and Surveillance) for an outline of the proposed research.

Impairment	Delisting Criteria	Comments
TAINTING OF FISH AND WILDLIFE FLAVOUR	**(III).** (When the zone of potential tainting extends less than 100 metres from the Domtar diffuser and there are no complaints about fish tainting in the AOC.)	Domtar's 1997 evaluation of the tainting potential of its effluent indicates no tainting potential at the point of discharge to the river. This beneficial use can now be considered unimpaired.
FISH TUMOURS OR OTHER DEFORMITIES	**IV.** To be determined.	This beneficial use is "possibly impaired" and further collections need to be made outside the AOC to determine if whether it is impaired. If so, a delisting criterion will be determined.
BIRD OR [OTHER] ANIMAL DEFORMITIES OR REPRODUCTION PROBLEMS	**V.** To be determined.	This beneficial use is "possibly impaired". Once further research and monitoring on a variety of species is completed, a delisting criterion will be determined. See R-10 (Section 10.9), Tables M-32 and M-34 (Section 10.8), and Chapter 5.8.
DEGRADATION OF BENTHOS	**VI.** This use impairment will be delisted when benthic community structure, diversity and abundance are comparable for sites with similar habitat (sediment grain size, water velocity) in the AOC at locations upstream and downstream of Cornwall industrial and municipal discharges.	It is not possible to set numerical targets for benthos in the Cornwall AOC because there are insufficient baseline data for comparison. A survey by Griffiths (1985) did not cover a wide enough area (no control sites) to serve as benchmark data.
RESTRICTIONS ON DREDGING ACTIVITIES	**VII.** This use impairment will be delisted when appropriate technologies have been identified that will protect against contamination of the river during dredging, transport and disposal of sediment contaminated above the LEL. By design, some contaminated material will be left in place to be covered by natural sedimentation processes as indicated in Recommendations # 16 and 17. Potentially harmful disturbances of contaminated sediment will be prevented by ensuring that the appropriate technology is used for sediment removal or treatment activities in the AOC.	This will require contaminants testing for all proposed sediment removal projects. Environment Canada and MOEE are working to develop a strategy for ensuring that appropriate actions are taken to address the problem of contaminated sediment along the waterfront, in accordance with RAP Recommendations.

Impairment	Delisting Criteria	Comments
EUTROPHICATION OR UNDESIRABLE ALGAE	**VIII.** This use impairment will be delisted when average summer total phosphorus concentrations at tributary mouths and in permanently flowing sections of the tributaries are less than or equal to 0.03 mg/L and there are no fish kills attributable to eutrophication.	The Provincial Water Quality Objective for elimination of excessive plant growth in rivers and streams is 0.03 mg total phosphorus per litre.
RESTRICTIONS ON DRINKING WATER CONSUMPTION OR TASTE AND ODOUR PROBLEMS	**(IX.)** (When effective treatment is in place to remove the taste and odour problem in Cornwall drinking water.)	This use is no longer impaired. Filters were installed at the Cornwall Water Treatment Plant in 1997 and this will eliminate the taste and odour problem.
BEACH CLOSINGS / WATER CONTACT SPORTS	**X.** This use impairment will be delisted when there have been no beach closures in the AOC for two consecutive years and no reports of St. Lawrence River water in the AOC at concentrations exceeding Provincial Water Quality Objectives (100 *E. coli* per 100 ml in 1996), at locations where water is used for body contact recreation.	Fecal coliform densities in Domtar's effluent suggested that it was the major contributor of high fecal coliform observed in the St. Lawrence River at Cornwall in the early 1980s (Kauss *et al.* 1988). It was later determined that the high counts were due to Klebsiella, a type of coliform bacterium commonly associated with pulp and paper mill discharges. An *ad hoc* committee formed to review the significance of *Klebsiella* in the environment concluded that it is not a human health concern (St. Lawrence (Cornwall) RAP Team 1992). Concentrations of *E. coli* at storm sewer outlets along the Cornwall waterfront likely exceed the Provincial Water Quality Objective immediately following storm events. Post-storm concentrations and length of time to clear after a storm event will be determined and this delisting criterion will be revisited, if necessary, based on the findings of the study.

Impairment	Delisting Criteria	Comments
DEGRADATION OF AESTHETICS	See Comments column.	This use was originally listed as impaired because of odours from effluent (Domtar) in ambient water and odours from dead weed masses rotting in nearshore areas. Domtar effluent odours have been greatly reduced now that secondary treatment is in effect. There is no effective remedy for the weed mass problem, which is a natural phenomenon. Leaves of aquatic plants die and break off late in the season, and under certain wind conditions they are blown to shore in some years. Large scale removal of plant masses would damage nearshore habitat, and is therefore not recommended. Shoreline residents can continue to remove, under permit from MNR, limited and specified amounts of nuisance aquatic plants at their waterfront (as per Recommendation # 43).
ADDED COSTS TO AGRICULTURE AND INDUSTRY	See Comments column.	There is an impact on the commercial fishery (please see delisting criterion I). No other added costs to agriculture or industry have been identified as an AOC impairment. For manufacturing industries, "added costs" refers to costs incurred from a requirement to treat intake water prior to use. There are added costs associated with the control of zebra mussels around water intake pipes, but this is not AOC specific and is therefore not considered an AOC impairment.
DEGRADATION OF PHYTOPLANKTON AND ZOOPLANKTON POPULATIONS	**XI.** This use impairment will be delisted when assemblages of phytoplankton and zooplankton from comparable sites within the AOC–at locations upstream and downstream of Cornwall industrial and municipal discharges–show no difference or indication of community impairment or when diatom assemblages resemble those present in the river at the turn of the century (late 1800s-early 1900s).	There are insufficient data to determine whether or not this use is now or has ever been impaired. Based on the high flow of the river at Cornwall, it is unlikely that there has been an adverse impact on phytoplankton and zooplankton populations attributable to local environmental conditions within the AOC. The RAP Team will examine the existing data and determine whether additional research should be done on phytoplankton and zooplankton populations in the AOC.
LOSS OF FISH AND WILDLIFE HABITAT	**XII.** Please see delisting criteria XII-1 to XII-13 in Table 14-2.	

Impairment	Delisting Criteria	Comments
DEGRADATION OF FISH AND WILDLIFE POPULATIONS	**XIII.** Please see delisting criteria XIII-1 to XIII-6 in Table 14-2.	

FISH AND WILDLIFE HABITAT AND POPULATION DELISTING CRITERIA

Introduction

Fish and wildlife populations are closely linked to their habitats. Since these linkages are complex and poorly understood, the RAP Team and PAC have considered populations and habitat jointly in the development of delisting criteria and associated monitoring programs.

Many of the benchmark data required for a monitoring program are not available and consequently this document is dynamic and the monitoring program will be refined as more data become available during implementation.

The following assumptions have been used to develop delisting criteria and associated monitoring programs for the following two fish and wildlife impairments:

- Degradation of fish and wildlife populations, and
- Loss of fish and wildlife habitat.

Otter

ASSUMPTIONS: General

- Criteria have to be measurable and easily obtained under existing, modified or new monitoring programs.
- The monitoring programs will be a multi-agency, multi-group effort including a major volunteer program.
- The time frame of the monitoring will be variable depending on the parameter being measured.
- The monitoring should be adaptable and reflect changes in programs and the ecosystem.
- For some species or communities, habitat protection or enhancement are not the only actions necessary to achieve delisting. Monitoring of species for which other factors such as harvest or contaminants are limiting will necessarily include not only population monitoring but also other contaminant or harvest monitoring to determine if the impairment is being reduced.
- No specific guidelines exist for measuring ecosystem health. The delisting and monitoring program for the AOC must integrate parameters from the population, species, community and landscape levels of the ecosystem. This includes measures of population abundance, reproductive success, biodiversity and degree of habitat fragmentation.

ASSUMPTIONS: Fish and Wildlife Habitat

- Certain types of habitats are lacking in the landscape of the AOC (please note that "landscape" in this context includes both terrestrial and aquatic habitats). Coastal wetlands, interior riverine wetlands, mature and overmature forests, riparian habitats, tributary fish habitat and habitat connectivity (corridors) are all less represented than they should be in the landscape.
- Successional forests, old fields and agricultural habitats are not lacking in the landscape.

ASSUMPTIONS: Fish and Wildlife Populations

- delisting criteria based on habitat and wildlife population health, deformities and reproductive success are dynamic. Further research is required to identify the degree of impairment and the degree of restoration possible or required.
- Certain species are rare, threatened or missing from the landscape and need particular attention (both locally breeding and transient species).

- Some species are designated as endangered, threatened or rare either inside or adjacent to the AOC. Examples include Cerulean warbler and yellow rail. No specific criteria are presented for these species because their status may be the result of an impairment in the ecosystem either not specific to the AOC or not in the AOC at all.

- Certain species that are rare in the AOC but should not be include least bittern, red-shouldered hawk, osprey, migratory shorebirds, some neo-tropical migratory birds (whip-poor-will, Blackburnian warblers), black ducks, redheads, muskellunge , sturgeon, chorus frogs, otter and fisher. These species are limited by one or more of the following factors: habitat loss, historical extirpation, contaminants, competition with other species and harvest.

- Some species such as black tern, great egret and the great black-backed gull are more common in the AOC than in most other areas in the province. These species of colony nesters are not considered to be impaired. However, their susceptibility to habitat loss as colony nesters with few colonies in the AOC makes it necessary to ensure that monitoring will track their status so if they become impaired the appropriate actions can be initiated.

- Some species such as walleye and yellow perch may be less abundant than they should be in the AOC. In the case of perch this is due to overharvest and the problem is being handled by regulation changes.

- There are data specific to Akwesasne territory and other parts of Lake St. Francis, which suggest that contaminants are affecting fish and wildlife populations. Preliminary evidence for the US side of the river from recent Environment Canada (CWS) studies suggest there is a link between contaminants and mudpuppy population structure and limb deformities (Gendron *et al.* 1994). See the delisting criteria for fish and animal deformities for more information. Liver tumour rates in walleye are higher than normal in the AOC but there is no evidence to date that this is affecting the population and there is evidence that this syndrome exists in Lake St. Lawrence and the Bay of Quinte.

- Zebra mussels do and will continue to have a major impact on the aquatic habitats and community in the main river.

Process for Delisting

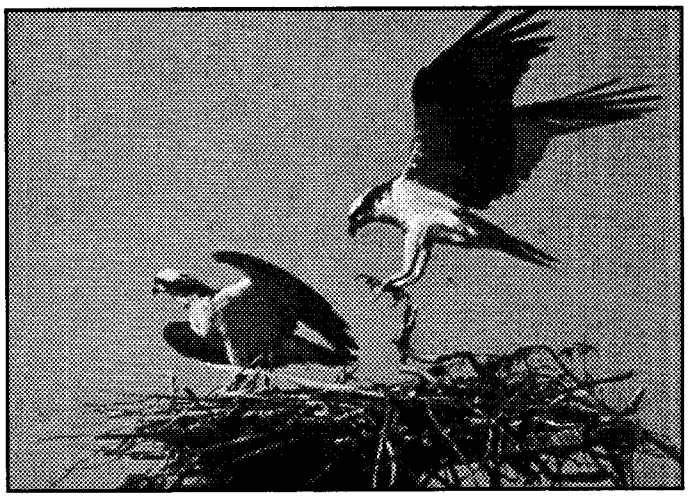
1. Establish a benchmark (existing conditions) for aquatic habitat and the terrestrial system for the monitoring and delisting process. Implement the required research programs (Section 10.9) in order to do this. Existing conditions for aquatic habitat will be determined using the AOC aquatic habitat monitoring plan described in Chapter 10; the terrestrial system benchmark will be determined using GIS-related information at MNR. This process has begun.

2. Coalesce existing monitoring programs and identify gaps to fill on a priority basis. This process has begun.

3. Establish a reporting mechanism and a coordinating role in an agency.

4. Link RAP monitoring to ongoing or proposed research programs.

5. Periodically compare resource status to the delisting criteria.



Osprey

Table 14-2. CRITERIA FOR DELISTING ST. LAWRENCE RIVER (CORNWALL) AS A RAP AREA OF CONCERN
(table 2 of 2)

Habitat Impairment	Delisting Criteria	Rationale
LOSS OF FISH AND WILDLIFE HABITAT		
Lack in number, size and quality of coastal wetlands	**XII-1** No reduction in the number or total area of coastal wetlands.	1. We have already lost most of our coastal wetlands in the AOC. Creating new coastal marshes may not be feasible but the existing coastal marshes can be protected (1300 ha in five Ontario coastal wetlands).
	XII-2 An increase in the biodiversity of coastal wetlands.	2. No decrease in the population trend (relative abundance) of breeding black terns is an indicator that neither the area nor the diversity of habitat has declined in the coastal wetlands. Black terns use coastal marshes in the AOC and breed in fairly large numbers at Bainsville Bay. Although common in some parts of the AOC they are rare in North America and declining rapidly. Protecting breeding and feeding sites must be a high priority. There are currently a minimum of 50 breeding pairs in 3 colonies (Bainsville, Charlottenburgh and Renshaw Island). An increase in relative abundance of American coot, least bittern, sora, redhead and yellow perch breeding populations would reflect an increase in the biodiversity of the coastal wetlands. The increase should be sufficient to make the populations sustainable. The minimum number of confirmed breeding pairs in the AOC should be 25 for Virginia rail and American coot; 10 for sora, redhead and least bittern. For perch and staging waterfowl and waterbirds an increasing population trend will be the criterion.

Habitat Impairment	Delisting Criteria	Rationale
Lack in number, size and quality of coastal wetlands (cont'd)		These species (except perch) were selected because they are species that are rare in the AOC and their rarity is the result of loss of habitat. The numbers of breeding pairs are based on their current status in the AOC, historical records and breeding densities in other parts of their Ontario range. Perch populations have decreased recently (especially the large size-classes). Newly imposed harvest restrictions will result in perch population increases in the absence of further habitat deterioration. Measuring biodiversity is a new science and better measures will be available in the next few years. Meanwhile, the marsh bird monitoring, amphibian monitoring and the presence/absence of key species will be used to track biodiversity. An increase in biodiversity will be reflected by an increase in the breeding populations of these sensitive species.
A decline in the number and quality of inland wetlands	**XII-3** Wetlands should comprise 7-10 % or more of total tributary watershed, with some (yet to be determined pending GIS analysis) wetland area in each sub-watershed. The wetland areas to be protected and created should reflect the objectives of the Eastern Habitat Joint Venture for the 5 Counties (to be determined pending GIS-based habitat supply analysis). **XII-4** No loss in area, form or function of provincially significant wetlands.	3. The present wetland area is estimated to be 6.6% of the AOC. A 7% criterion represents a net gain of just less than 1000 ha and a 10% criterion would represent a net gain of 7400 ha. This range represents the minimum and maximum criteria and the criterion will be refined once the Eastern Habitat Joint Venture habitat supply analysis has been completed. It should be noted that the EHJV plan calls for wetland protection through both the municipal planning process and through the voluntary stewardship by private landowners of existing wetlands and the interest of private landowners in willingly creating wetlands on their property in partnership with the EHJV partners. 4. This is the Provincial Policy Statement objective for wetlands.

Habitat Impairment	Delisting Criteria	Rationale
A loss of forest cover area and diversity is affecting wildlife populations	**XII-5** A forest cover of 30% in the AOC tributary watersheds. Once the existing forest cover has been measured for each sub-watershed (1997) then delisting criteria will be set at some point between a small increment over existing forest cover and 30% forest cover. **XII-6** Restore forest diversity so that in each sub-watershed, 5% (3700 ha) of the forest cover is in mature or old-growth forest (generally trees over 120 years old). An increase in area of mature native forest containing natural densities of cavity trees, tip-up mounds and downed woody debris. This criterion would be considered met once the areas have been identified and ear-marked to be part of this objective. **XII-7** Establishment in the AOC tributary watershed of forest blocks that are a minimum of 1000 ha in contiguous area, which would represent 10% (7000 ha) of the forest cover in the AOC and would overlap to some degree with those lands with mature forest cover (see XII-6). The area increase required will be determined once the GIS-based habitat supply analysis has been completed.	5. This is a RAP objective for forest cover for all AOCs. A preliminary estimate of forest cover for the watershed is 35.7% but in some sub-watersheds the amount of forest cover is well below that figure and forest cover needs to be re-established in these sub-watersheds (e.g., Sutherland Creek). The overall objective is to protect existing key forest types and promote the increase in area of these forest types. Work from the top of the watershed to the bottom where possible. 6. Measure increase in area using forest inventory data (available). Approximately 5% of the forested area should be in this forest age type (draft Provincial Significant Woodland Guidelines). Determination of the current status for the AOC requires GIS capability so that the number of hectares target for this criterion can be set). Preliminary estimates (for the entirety of the 7 townships in the AOC, i.e., includes more than the AOC) are that of 208,273 ha of land, 74,288 ha (35.7%) are forested. Using these estimates the approximate amount of mature forest required would be 3714 ha, some of which will be met on public land. 7. Measure increase in breeding presence for some species such as fisher, red-shouldered hawk, pileated woodpecker, yellow-bellied sapsucker. These species were selected because of their dependence on mature forest. These species are currently monitored. According to draft RAP forest cover objectives, a contiguous forested area of 1000 ha will protect almost all bird and mammal species present in the AOC which require this habitat type. Benchmark data will be available, with completion of GIS-based habitat supply analysis, to determine how many of these areas exist in the AOC tributary watershed.

Habitat Impairment	Delisting Criteria	Rationale
A loss of forest cover area and diversity is affecting wildlife populations (cont'd)	**XII-8** 5% (10,000 ha) of the AOC tributary watershed to consist of forest cover in which forest extends 200 m from the forest edge and has a core area with a minimum size of 40 ha. There will be some overlap of this forest with the forest land used to meet criteria XII-6 and XII-7. Therefore the maximum forest area for XII-6, XII 7 and XII-8 would be less than 20,000 ha total. The criterion will be refined once the GIS analysis is completed. **XII-9** Establishment of sufficient forested corridors connecting forested areas and wetlands to make the natural heritage system in the AOC ecologically sustainable. No information is available to establish a specific area or number of corridors required (see Rationale column).	8. This is the draft objective from the Provincial Planning guidelines for significant woodlands and also a draft RAP forest cover objective for mid-size forested areas. This will produce habitat for forest-interior wildlife species. Benchmark data will be available, with completion of GIS-based habitat supply analysis, to determine the present status and supply of this habitat in the AOC. 9. Once the GIS habitat supply analysis is finished, the information will be available to specify how many of these corridors need to be established and where. A corridor is considered to be a forested area a minimum of 100 m in width connecting 2 forested areas at least 25 ha in area.

Habitat Impairment	Delisting Criteria	Rationale
A lack of riparian vegetated areas has resulted in degraded wildlife and fish habitats	**XII-10** Revegetate (forest or other permanent vegetative cover) 100% of the riverine shores with 5-30 m wide vegetated strips in each of the AOC tributary sub-watersheds.	10. This would require an increase in vegetation along the streams in the AOC but is ecologically sufficient and achievable. The RAP objective of a minimum buffer strip width of 30 m is desirable but is considered difficult to achieve in this AOC. Based on the warmwater nature of the streams in the AOC, 15 m is the preferred width, but 5 m is acceptable in some cases depending on the nature of the adjacent land use. Measure the increase in km of riparian habitat against the benchmark then establish the required km of riparian corridors (5-30 m wide); establish riparian forests (minimum 100 ha of riparian forest). This will require the GIS habitat supply analysis results before current status of this habitat type can be established. Monitoring of otter population trends will be used as another measure of the effectiveness of this restoration effort as this (along with fish communities in tributaries) will be key to this species recovery.
Other upland habitats (grasslands)	**XII-11** For highly specialized species such as Henslow's sparrow and loggerhead shrike, data are insufficient to develop criteria at this time.	11. Some rare or endangered species which occur in the area at very low levels would have criteria based on presence/absence or number of breeding pairs. Habitat would be protected or restored on a case-by-case basis depending on the occurrence rate of the species in question.
Degraded aquatic habitats in the AOC	**XII-12** A net gain, in Lake St. Francis, of aquatic habitat capable of supporting a biologically diverse fish community. This will be refined in numerical terms once baseline data are available. For more information please refer to delisting criteria for Degradation of Fish and Wildlife Populations.	12. Benchmark data are not available to determine final delisting criteria. Criteria will include the number and quality of special habitats such as spawning areas for uncommon species (muskellunge) or indicator species (walleye). It would also include measures of changes in distribution and relative abundance as determined by existing index netting, seining, electrofishing or angler harvest measures.

Habitat Impairment	Delisting Criteria	Rationale
Tributary fish habitat	**XII-13** Fish communities resemble (in community composition and abundance) those in undegraded streams outside the AOC (there are no undegraded streams in the AOC).	13. Measure improvements by examining changes in the summer fish community in the streams and the spring use of the streams for spawning. Target community would be the typical fish community for undisturbed warmwater streams along the St. Lawrence River. Use presence or absence first; then relative abundance measures as the community recovers.
DEGRADATION OF FISH AND WILDLIFE POPULATIONS		
Species (breeding) that are, but should not be, rare in the AOC	**XIII-1** Increase in relative abundance of American coot, least bittern, sora, redhead and yellow perch breeding populations. The increase should be sufficient to make the populations sustainable. The minimum number of confirmed breeding pairs in the AOC should be 25 for Virginia rail and American coot; 10 for sora, redhead and least bittern. For perch and staging waterfowl and waterbirds an increasing population trend will be the criterion.	These species have been selected because compared to other non-AOC areas they are at lower than expected breeding densities. Measures will include changes in distribution and number of breeding pairs as measured by existing and new monitoring programs. The delisting criteria would include for some species the determination that the population had sufficient density and distribution to be considered self sustaining. For some species, habitat distribution, quantity and quality could initially be used as a criteria. Note that the specific numbers or distribution pattern will depend on the species.
	XIII-2 Presence of successfully reproducing osprey in the AOC for a minimum of 5 years.	Pending results of research projects, delisting criterea on other population parameters may be developed.

Habitat Impairment	Delisting Criteria	Rationale
Migratory waterfowl species which have declined substantially over the last two decades	**XIII-3** The objective of the North American Waterfowl Management Plan is a return to the mid-1970s population status. Specific numbers are not available for an area as small as the AOC but once the EHJV 5 Counties Wetlands and Waterfowl Management Plan has provided habitat and species targets (1997) these targets could be incorporated into the RAP delisting criteria.	The delisting criteria would include two measures: (i) the number of animals by species of concern (i.e., Atlantic Flyway Canada geese, lesser scaup) determined by survey and (ii) the size of habitats created which are required specifically by these species (i.e., migratory shorebirds) and mudflats or shallow ephemeral wet meadows. Please note that because these species are migratory over long distances, there may be no restoration possible within the AOC if, for example, the limiting factor is wintering habitat for neotropical birds. Criteria would cover such things as habitat availability; and contaminant levels as they affect breeding success, harvest and disturbance. Shorebird population criteria cannot be developed at this time due to the almost entire lack of information on these species both within and outside of the AOC.

Habitat Impairment	Delisting Criteria	Rationale
Fish communities and populations	**XIII-4** A return to the sustainable perch population and fishery of the late 1970s-early 1980s. **XIII-5** For muskellunge, sturgeon and walleye, the acceptance for implementation of restoration plans by the responsible agencies. **XIII-6** For tributary communities, the return to a fish community similar to typical non-degraded streams along the St. Lawrence River (Hoasic Creek).	4. For perch, a return to the relative abundance of that period and a return to the angler success rate and size of perch caught. This may or may not be possible given recent postulated reductions in aquatic productivity due to some combination of phosphorous reductions in the lower Great Lakes and the yet to be determined impact of zebra mussels on yellow perch and other species in the AOC. 5. The benchmark data are not available to determine the exact reasons for the decline of these species or to establish what is possible in terms of restoration. The acceptance of restoration plans is therefore considered an acceptable delisting criterion. 6. This criterion requires the development and implementation of a monitoring program for degraded and non-degraded (control) streams. Please note that these delisting criteria imply that populations presently not impaired (or known to be impaired - see Chapter 11, Research) remain at their present levels. If other communities are found to be impaired during the proposed research program, the delisting criteria will be amended as required. Please note that: zebra mussels and phosphorus reductions in the Great Lakes Basin are now thought to have the potential to radically change the Great Lakes and St. Lawrence River fish community in terms of overall productivity (fewer fish) and in community structure (fewer eutrophic species and more mesotrophic or oligotrophic species).The AOC is a mesotrophic system now.

Summary of wetland data for the AOC

These data include all of the wetlands in the Ontario portion of the AOC which have been evaluated (evaluated wetland area) and an estimate for the number and area of unevaluated wetlands in the AOC watershed. The watershed includes all of the Raisin River, and all other tributaries which flow into the Ontario portion of Lake St. Francis as well as the Delisle and Beaudette River watersheds (these two rivers flow into Lake St. Francis through Quebec).

The estimated watershed area is based on the area of each township which is wholly or partly in that watershed. These are the only watershed data available at this time until a GIS analysis can be made of the watershed. The land base area of approximately 208,000 ha therefore includes more area than is in the AOC. Adding Lake St. Francis to the total gives an AOC watershed and river area of approximately 215,000 ha.

On this land base there are 60 wetlands which have been evaluated, including Newington Bog (which lies partially in the South Nation River watershed). Because there are no data to enable the wetland area to be split, all of it is included. Of the 60 evaluated wetlands, 10 are provincially significant and these cover 7455 ha. The remaining 50 evaluated wetlands are not provincially significant and cover 3641 ha (an average of 73 ha each). In total, there are 60 wetlands covering 11096 ha.

Wetlands

On a percentage basis this represents 5.2% of the land base in wetland. However, not all wetlands in the AOC have been evaluated. Based on a 1985 study of local wetlands (M. Eckersley, MNR, unpublished data) it is estimated that approximately one-third of the wetlands have been evaluated. The unevaluated wetlands are small and not provincially significant and, for purposes of this analysis, are assumed to average 25 ha in size. Assuming that another 120 wetlands are present in the AOC (if 1/3, or 60, have been evaluated then the remaining 2/3 would represent 120 wetlands), with an average area of 25 ha each, they would cover another 3000 ha.

Using these assumptions, the number of wetlands in the AOC and its tributary watershed would be 180 covering 14,096 hectares. This represents 6.6% of the land and water base. Please note that of these estimated 180 wetlands only 10, covering some 7455 ha, are provincially significant.

These estimates are a first approximation and the GIS pilot project for this area will help refine both the overall land base area estimate and the number and size of unevaluated wetlands.

It is also relevant to note that Snell (1986) estimated that approximately 60% of the wetlands present prior to settlement were lost prior to 1982 in the three United Counties (Stormont, Dundas & Glengarry). Based on that estimate and the 1985 Eckersley study, it was estimated that 2/3 of the wetlands thought by Snell to be present were in fact no longer wetlands. This means that for every 100 hectares originally in wetland, only 13 remain in this area. There has thus been an 87% loss of wetlands in this area.

10. MONITORING FOR DELISTING

The following surveillance and monitoring plans have been developed such that they will allow the RAP Team to identify when delisting criteria have been met in the Cornwall AOC. The following components of the ecosystem in the AOC will be monitored:

- industrial and municipal effluent (10.1)
- drinking water (10.2)
- surface water (10.3)
- bottom sediment (10.4)
- benthos (10.5)
- native mussels (10.6)
- spottail shiners (10.7)
- fish and wildlife habitat (10.8)
- fish and wildlife populations (10.8)

Several remedial options considered and endorsed by the PAC and RAP Team fell into the category of research (as opposed to remedial actions) and were therefore kept separate from the set of RAP Recommendations. Research activities that have been recommended by the PAC and RAP Team (but do not necessarily constitute part of the monitoring plan *per se*) are included as Section 10.9 of this chapter.

10.1 Industrial and Municipal Effluent

Background

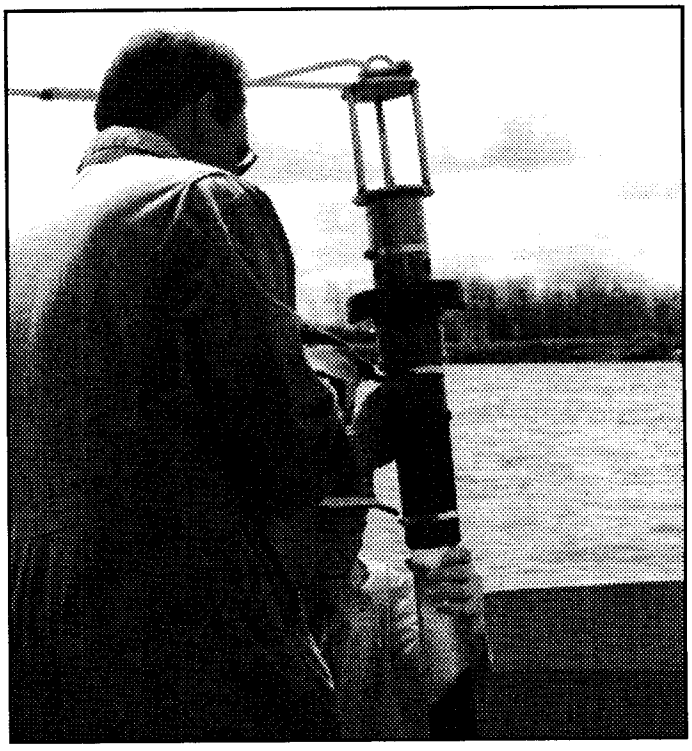
As of December 1995, there were three main industries in the Cornwall AOC discharging effluent to the St. Lawrence River: Domtar Papers, ICI Forest Products and the ICI Conpak plant. Since all these industries operate under MISA regulations, they are required to monitor and report on their effluent quality to MOEE. This information is available from the MOEE Cornwall Area office.

An annual report on the effluent quality of all industrial dischargers in Ontario is released by the MOEE. In addition, staff from Cornwall MOEE conduct an annual inspection which involves taking and analyzing a 24-hour composite sample of the effluent and carrying out a compliance check.

The City of Cornwall is the major municipal effluent discharger in the AOC. Other municipalities discharging effluent are the Township of Charlottenburgh and the Village of Lancaster. Other dischargers of municipal-type effluent are the Creg Quay development, Rheal's Truck Stop and Shell 401 Service Centre in Bainsville. All these dischargers are required to monitor and report to varying degrees on their effluent quality as specified in Tables M1-M3. Monitoring reports are available from the MOEE Cornwall Area office.

MOEE also issues an annual report on the performance of all municipal sewage treatment plants in Ontario. All municipal discharges are inspected by MOEE personnel at least once every four years. These inspections are similar in scope to the industrial inspections.

Tables M-1, M-2 and M3 outline plans for monitoring industrial, municipal and municipal-type effluent. Combined sewer overflow and storm sewer monitoring plans are in Tables M-4 and M-5.



Collecting river bottom sediment samples

Table M-1. Industrial effluent monitoring plan.

Activity	**Monitor effluent from industries discharging directly to St. Lawrence River:** • **Domtar Papers** • **ICI Canada Inc.** • **ICI Canada Inc. (Conpak)**
Status	I. Ongoing monitoring under MISA regulations II. MOEE to work with industry to coordinate comprehensive monitoring designed to address issues related to St. Lawrence RAP Recommendations # 10 (PAHs) and # 21 (PCBs).
Medium	Effluent
Parameters	I. MISA Monitoring: **Domtar** daily - BOD5, TSS weekly - total P, chloroform, toluene, phenol, adsorbable organic halide quarterly - 2,3,7,8-TCDD, 2,3,7,8-TCDF, TEQ + acute toxicity testing **ICI Canada Inc. (Conpak)** daily - TSS weekly - NH3+NH4, nitrate+nitrite,TKN, DOC, total P, Al, Cd, Cr, Cu, Pb, Ni, Zn, Hg, phenolics (4AAP), carbon tetrachloride, chloroform, hexachlorobenzene, hexachloroethane, chloride, sulfate quarterly - Se, oil & grease, 2,3,7,8-TCDD, 2,3,7,8-TCDF, TEQ **ICI Canada Inc.** daily - TSS, Hg weekly - DOC, Al, 1,2,4-trichlorobenzene, hexachlorobenzene, hexachlorobutadiene, hexachloroethane quarterly - nitrate+nitrite, total P, Cu, Pb, Ni, Zn, As, phenolics (4AAP), octachlorostyrene, pentachlorobenzene, oil & grease, 2,3,7,8-TCDD, 2,3,7,8 TCDF, TEQ II. A special study will be designed to address issues related to St. Lawrence RAP Recommendations # 10 (PAHs) and # 21 (PCBs).
Location	on site as required
Frequency	I. as per MISA requirements (see Parameters column); additional annual inspection by MOEE staff (24-hour composite sample and compliance check) II. to be determined
Agencies	MOEE
Delisting Criteria	I, II, III, IV, V, VI, VII, XI
Possibly Linked Impaired Use(s)	Restrictions on fish & wildlife consumption Tainting of fish & wildlife flavour Fish tumours or other deformities Bird or [other] animal deformities or reproduction problems Degradation of benthos Restrictions on dredging activities Added costs to agriculture or industry

Table M-2. Municipal effluent monitoring plan.

Activity	**Monitor effluent of municipal dischargers:** • **City of Cornwall** • **Township of Charlottenburgh** • **Village of Lancaster**
Status	Ongoing; annual MOEE report on performance of all municipal WPCPs MOEE to work with City of Cornwall to coordinate comprehensive monitoring designed to address issues related to St. Lawrence RAP Recommendations # 10 (PAHs) and # 21 (PCBs).
Medium	Influent /effluent comparison
Parameters	**City of Cornwall** monthly - BOD5, TSS, TP, fecal coliform, Total Residual Chlorine (C of A) (actual frequency 2x weekly) MOEE to request monthly monitoring for PCBs and PAHs. **Township of Charlottenburgh** monthly - BOD5, TSS, TP, Total Residual Chlorine, fecal coliform (MOEE Policy) (actual frequency 1x weekly) **Village of Lancaster** (biannual seasonal discharge) 2x weekly during discharge periods - BOD5, TSS, TP, TKN, fecal coliform
Location	on site as required
Frequency	site specific (see Parameters)
Agencies	MOEE
Delisting Criteria	I, II, III, IV, V, VI, VII, XI
Possibly Linked Impaired Use(s)	Restrictions on fish & wildlife consumption Tainting of fish & wildlife flavour Fish tumours or other deformities Bird or [other] animal deformities or reproduction problems Degradation of benthos Restrictions on dredging activities Added costs to agriculture or industry

Table M-3. Commercial effluent (municipal-type) monitoring plan.

Activity	**Monitor other commercial effluent monitoring dischargers of municipal-type effluent:** • **Creg Quay** • **Rheal's Truck Stop** • **Shell Service Centre, Bainsville**
Status	Ongoing MOEE monitoring
Medium	Influent /effluent comparison
Parameters	**Creg Quay** 5x each discharge - BOD5, TSS, TP, NH3 **Rheal's Truck Stop** 2x monthly - BOD5, TSS, TP (C of A) 1x monthly - fecal coliform **Shell Service Centre, Bainsville** no requirements at present time; a C of A with monitoring requirements will be issued soon
Location	on site as required
Frequency	site specific (see Parameters)
Agencies	MOEE
Delisting Criteria	VIII, IX, X
Possibly Linked Impaired Use(s)	Eutrophication or undesirable algae Restrictions on drinking water consumption or taste and odour problems Beach closings

Table M-4. Combined sewer overflow (Brookdale Ave) monitoring plan.

Activity	Monitor combined sewer overflow at Brookdale Ave
Status	Not currently monitored.
Medium	Effluent
Parameters	BOD5, TP, TSS, E. coli, Total PCBs
Location	Brookdale Ave. CSO
Frequency	Sample during two separate storm events within one year. Samples to be taken every half hour for the duration of the overflow up to a maximum of 12 hours, and combined in a single sample for analysis.
Agencies	MOEE, City of Cornwall
Delisting Criteria	VIII, IX, X
Possibly Linked Impaired Use(s)	Eutrophication or undesirable algae Restrictions on drinking water consumption or taste and odour problems Beach closings

Table M-5. Storm sewers monitoring plan.

Activity	Monitor storm sewer outlets
Status	Not currently monitored.
Medium	Effluent
Parameters	BOD5, TP, TSS, E. coli, Total PCBs
Location	Three locations to be selected in consultation with the City of Cornwall. These sites will be based on potential impact and will represent different drainage basin types.
Frequency	During at least two separate storm events within one year, when at least 5 mm of rain has fallen.
Agencies	MOEE, City of Cornwall
Delisting Criteria	VIII, IX, X
Possibly Linked Impaired Use(s)	Eutrophication or undesirable algae Restrictions on drinking water consumption or taste and odour problems Beach closings

10.2 Drinking Water

Table M-6. Drinking water monitoring plan.

Activity	Monitor drinking water at water treatment plants in AOC
Status	Ongoing Ontario Drinking Water Surveillance Program (DWSP)
Medium	Raw water influent & treated water effluent
Parameters	180 parameters divided into four classes: bacteriological, inorganic and physical, organic, radionuclides
Location	City of Cornwall water treatment plant Glen Walter water treatment plant
Frequency	Samples taken every three months.
Agencies	MOEE
Delisting Criteria	IX
Possibly Linked Impaired Use(s)	Restrictions on drinking water consumption or taste and odour problems

10.3 Surface Water

Background

The St. Lawrence River has an average flow of approximately 662 billion litres per day (St. Lawrence River Committee on Gauging 1985-1995). Therefore small incremental increases in contaminant levels in the main body of the river correspond to significant loadings to the system. The river also transports on average 671 tonnes (*i.e.*, 1 mg/L) of suspended particulate matter (SPM) per day. Water monitoring programs must have the capacity to provide sufficient resolution to detect significant changes within the system that, for some organic contaminants, occur at the parts per trillion (ng/L) level. A strategy has been proposed (Biberhofer 1994).

Table M-7. Surface water monitoring plan.

Activity	Implement a comprehensive water column monitoring strategy that will focus on known contaminants of concern within the AOC.
Status	Pending (Planned)
Medium	Ambient water, centrifuged and/or filtered water (large volume samples) and suspended particulate matter.
Parameters	Trace metals, PCBs (including congeners), PAHS, DOC, nutrients, bacteria (E. coli), physical parameters.
Location	To be determined but to include one site upstream of Cornwall waterfront.
Frequency	Twice per year, high flow and low flow. Monitoring for bacteria sampling will require event-specific sampling at local beaches in cooperation with municipal and Health Unit personnel.
Agencies	Environment Canada, MOEE, RRCA, SLRIES
Delisting Criteria	I, II, III, IV, V, VI, VII, XI
Possibly Linked Impaired Use(s)	Restrictions on fish & wildlife consumption Tainting of fish & wildlife flavour Fish tumours or other deformities Bird or [other] animal deformities or reproduction problems Degradation of benthos Restrictions on dredging activities Added costs to agriculture or industry

10.4 Bottom Sediment

Background

Sediment surveys in the St. Lawrence River near Cornwall, Ontario have identified areas of contaminated sediment adjacent to and downstream of the various local point sources that discharge to the St. Lawrence River (Kauss *et al.* 1988; Anderson 1990; BEAK, unpublished data; Richman 1994). Sediment samples collected in the north and south channel exceeded the "severe effect level" (SEL) of the Ontario Sediment Quality Guidelines for contaminants such as lead, copper, zinc and mercury, and oils and greases were present at concentrations above the open water disposal guidelines. As well, sediment bioassays to estimate acute and chronic toxic effects associated with the sediment showed reduced growth in mayfly nymphs and *Chironomus* larvae in sediment collected from the area of Courtaulds' former shore-based discharger (Bedard and Petro 1992).

Bottom sediments have the capacity to act as both a sink for and a source of contaminants within the ecosystem. Contaminants bound to particles which settle to the bottom of the river can eventually be covered up by enough cleaner sediment that the associated contaminants are no longer available to the environment. If this sediment is disturbed, it and the bound contaminants are redistributed over the bottom surface of the river where they are once again available to benthic organisms that can introduce the contaminants into the food chain.

As part of the sediment assessment for the Cornwall RAP, studies have been implemented to determine the stability of the bottom sediment. This is essential to assess the degree of downstream transport of contaminants originating from localized sources. Assessment of spatial distribution of contaminants in sediment identifies areas which may act as contaminant sources to the ecosystem, indicates the relative magnitude of the source and potentially identifies areas that warrant investigation for remedial measures. Temporal information on sediment quality is required to assess how the river system as a whole is responding to events that are within and external to the AOC.

The implementation of remedial actions to address sediment contamination in the AOC will be contingent on the development of the Cornwall Sediment Management Strategy. Long term sediment monitoring plans in the AOC will be influenced by this strategy and the monitoring plan suggested here would be modified accordingly.

Table M-8. Bottom sediment monitoring plan.

Activity	Bottom sediment assessment.
Comments	In order to assess the success of the remedial action(s) that may be taken in the future, long term sediment contaminant monitoring is required to compare conditions before and after the action is taken. All monitoring plans will be linked to the development and completion of the Cornwall Sediment Management Strategy and will reflect the approach recommended in the strategy.
Status	Long Term Sensing sites (LTSS) have been established to determine sediment stability and temporal changes in sediment quality. Temporal baseline samples have been collected and data is pending. There have also been several sediment surveys along the Cornwall waterfront which will be useful as a basis for comparison during monitoring of response to future remedial actions.
Medium	Bottom sediment
Parameters	Metals: mercury, lead, cadmium, zinc, iron, chromium, arsenic, aluminum, manganese, nickel, copper. Nutrients and other sediment characteristics: total P, total Kjeldahl nitrogen, TOC, LOI, particle size, % moisture. Organic contaminants: will include oils & greases, specific PAHs, PCBs and other compounds which are found to be elevated in biota or were/are present in historical or present-day discharges.
Location	Sediment surveys will be used to assess spatial distribution of contaminants. These surveys will be specific to areas of fine-grain sediment along the Cornwall waterfront. Site locations will be based on distribution of sediment types as determined using RoxAnn technology. Six long-term sensing sites (LTSS) have been established to provide temporal information and document improvements in sediment quality within the AOC. One LTSS site is upstream of the AOC in Lake St. Lawrence, two sites are located along the Cornwall waterfront and three sites are positioned in depositional basins in Lake St. Francis.
Frequency	Following completion of any specific sediment remediation activity, monitoring of sediment should continue every five years initially and then be reduced if the area is no longer contaminated and new industries are not discharging to the river. Sampling at the LTSS sites was completed in 1996 and data is pending. The next sampling cycle will be based on information determined by the depositional rates at the sites but is not expected to occur before 2001.
Agencies	MOEE, Environment Canada
Delisting Criteria	I, II, V, VI, VII, XI
Possibly Linked Impaired Use(s)	Restrictions on fish & wildlife consumption Bird or [other] animal deformities or reproduction problems Degradation of benthos Restrictions on dredging activities Added costs to agriculture or industry

10.5 Benthos

A 1985 benthic invertebrate survey by Environment Ontario (Griffiths 1988) showed zones of impaired environmental quality in the north channel at Cornwall. Invertebrate communities were impaired compared with those of the south channel, although the study concluded that considerable improvement in environmental quality had occurred since the previous benthic invertebrate survey carried out in 1966 by Ontario Water Resources Commission (Owen and Veal 1968).
There have been additional significant reductions in local point sources impacting the river ecosystem since 1985 and this beneficial use impairment (Degradation of benthos) may no longer exist. Therefore an initial survey is required to determine whether benthos in the AOC is degraded in relation to benthos at comparable reference sites. If so, additional sampling will be required to track progress towards eventual delisting of the impairment.

Table M-9. Benthic community monitoring plan.

Activity	Assess benthic community health relative to a reference site within the AOC
Status	Site selection in progress.
Medium	Benthic fauna
Parameters	Species diversity or indicator species. Substrate conditions and sediment physical parameters.
Location	Reference site(s) within the AOC. Number and location of sites to be evaluated to be determined.
Frequency	Initial survey required to quantify extent and degree of impact, if any. This initial survey may indicate that recent improvements within the AOC have been sufficient to delist impairment. If impairment is still evident, sampling frequency should be a function of the estimated response time of the system required to show improvement.
Agencies	MOEE, Environment Canada, SLRIES, University of Ottawa
Delisting Criteria	VI
Impaired Use(s)	Degradation of benthos

10.6 Mussels

Background

Measurements of contaminant body burdens in sessile organisms such as indigenous mussels provide information on regional inputs of contaminants to the system. The body burden is a function of the mussel's capacity to assimilate the contaminant from the environment and its inability to degrade or depurate the contaminant.

Environment Canada has established a network of mussel monitoring sites within the Cornwall\Massena reach of the St. Lawrence River. This program has consistently measured increased levels of PCBs in mussel tissue at sites downstream of suspected sources, indicating regional enrichment of PCBs. The data also indicates that the zone of impact persists a considerable distance downstream (Comba *et al.* 1995b).

Table M-10. Mussel contaminants monitoring plan.

Activity	Biomonitoring program for contaminant exposure (PCBs) and uptake by mussels.
Status	Surveys undertaken annually from 1990-1995 (except in 1992). The program is currently being reviewed to determine if zebra mussels or caged mussels collected from a remote site are a suitable substitute to maintain the program. The requirement for change has been brought about by the extirpation of the indigenous mussels due to zebra mussel infestation.
Medium	Indigenous mussels (Elliptio complanata)
Parameters	PCBs
Location	A network of 14 sites has been established within the Cornwall\Massena reach of the St. Lawrence River. Nine of these provide information specific to the St. Lawrence River RAP.
Frequency	Surveys have been conducted yearly in response to concerns at sites at Massena, New York. Once Massena remedial dredging activities are complete, collections should be a function of system response time and at a minimum should coincide with the re-sampling of the LTSS sites.
Agencies	MOEE, Environment Canada, SLRIES
Delisting Criteria	I, II, V, VI, VII
Impaired Use(s)	Restrictions on fish and wildlife consumption Bird or [other] animal deformities or reproduction problems Degradation of benthos Restrictions on dredging activities

10.7 Spottail Shiners

Background

The presence of contaminants in sediment, water and biota in the St. Lawrence River near Cornwall/Massena has been previously discussed. In addition to metals such as mercury and zinc, high concentrations of PCBs are of particular concern. Consequently, consumption advisories for sport fish due to PCB contamination have been in effect in American and Canadian waters. In addition, the concentrations of PCBs in forage fish collected in the north and south channel of the river have exceeded the IJC Aquatic Life Guideline designed for the protection of fish-eating wildlife (100 ng/g).

The most significant sources of PCBs to the AOC are the GM, ALCOA and Reynolds Metals plants at Massena, New York. These industries are located on the south shore of the river. There are no known significant local sources of PCBs on the Canadian shore. PCB contamination in the aquatic ecosystem of the Cornwall AOC is therefore likely due to transboundary movement of PCBs.

Young-of-the year spottail shiners have been used extensively throughout the Great Lakes Basin as effective biomonitors of bioaccumulative substances. Spottail shiners have been collected repeatedly from over 26 stations in the north and south channel since 1979 for analysis of PCBs, organochlorine pesticides and mercury. Continuation of this long term database is essential to monitor the success of remedial actions in the River. Remedial actions include the removal of contaminated sediment from the St. Lawrence River and its tributaries on the US side of the river and containment of contaminants in hazardous waste sites on the south shore.

Collecting spottail shiners

Table M-11. Spottail shiners contaminants monitoring plan.

Activity	Spottail Shiner Monitoring
Comments	A comprehensive database on PCB concentrations in biota is essential in order to assess the effectiveness of US activities to remove PCB-contaminated sediment from the St. Lawrence River and its tributaries and containment of contaminants on land within hazardous waste facilities. The geographical extent of contamination attributed to US sources can be assessed by sampling biota at increasing distances downstream of PCB sources at Massena. Sampling in the north channel will evaluate Canadian sources. Young-of-the-year fish will be analyzed for specific congeners. Variations in distribution patterns of PCB congeners with increasing distance from PCB sources will be evaluated in order to fingerprint sources.
Status	Spottail shiners have been collected from over 26 stations in the north and south channel since 1979. All stations were not sampled every year but there are at least six stations for which there are over five years of data and at least 11 stations with data from three or more years. This database in its entirety serves as a strong baseline to assess the continued improvement in water quality in the AOC and the bioavailability of contaminants in general and is not limited to PCB contamination.
Parameters	PCBs (total and congener-specific), organochlorine pesticides, mercury
Location	North and south Channel/Lake St. Francis (see attached list for stations for which there are one or more years of monitoring data). A core group of stations should be sampled on a routine basis with additional sampling at selected stations based on remedial activities in the AOC, presence of new discharges and pollution sources or other relevant changes in water quality that require monitoring.
Frequency	Sampling should be done annually at a reduced number of selected stations when sediment remediation activities are occurring. Every second year the number of stations monitored can be enhanced to maintain a consistent record of general water quality and bioavailability of contaminants. Sampling can be reduced to every second year after completion of sediment remedial activities.
Agencies	MOEE
Delisting Criteria	I, II, V, VII
Impaired Use(s)	Restrictions on fish and wildlife consumption Bird or [other] animal deformities or reproduction problems Restrictions on dredging activities

.Table M-12. Description of sampling stations for Spottail Shiners

All stations are located in the St. Lawrence River or tributaries	
Station Description	
Maitland	Grasse River (NY) (in river)
Morrisburg	Reynolds Metals
Macdonnell Island	GM Plant
Immediately downstream of Moses-Saunders Power Dam	Raquette River
International Bridge-Cornwall Island	Eastern Tip St. Regis Island
Upstream Marina	South side of St. Regis Island
Cornwall Island North	Regis River (in river)
Training Institute	Regis River (at St. Lawrence)
Pilon Island	Regis Channel
Thompsons Island	Salmon River (in river)
Raisin River (in river)	Salmon River (at St. Lawrence)
Raisin River (at St. Lawrence River)	Buchanon Island
Point Mouillée	Point Dupuis

Please note: A map of station locations is provided in Figure 10

10.8 FISH & WILDLIFE SURVEILLANCE AND MONITORING

Introduction to Fish & Wildlife Monitoring Programs

The following four categories of assessment have been or will be done in the AOC to form the requisite fish and wildlife monitoring program. Benchmark conditions have been established for some of the ecosystem components. Gaps in benchmark data have been identified and need to be filled.

Category 1
Historical data from the AOC for fish presence/absence and tributary fish habitat are available from stream surveys. There are also sporadic data on the fish community, such as those gathered as part of a development impact assessment. These data were not collected as part of a coordinated monitoring program and, while they have some value for comparison, the approach is not sufficient to provide an adequate monitoring program and will not be replicated.

Category 2
Some historical data exist (i.e., for walleye spawning success on the Raisin River) which, although there is no ongoing monitoring program, would serve as adequate benchmark data.

Category 3
Some ongoing programs such as the red-shouldered hawk survey, the index netting program and the creel census program not only provide adequate benchmark data but their continuation is planned as part of a future monitoring scheme.

Category 4
These are new programs that will be required to set certain benchmarks and provide a long-term monitoring program.

Category 2, 3 and 4 programs will be the basis of the RAP monitoring program. Category 1 data will be used where possible as an indicator of previous or benchmark conditions but the Category 1 programs themselves in their historical format will not continue.
The naturalized knowledge system of the Mohawks of Akwesasne should be incorporated into the monitoring program.

The fish and wildlife monitoring plan outlined in this section consists of a variety of activities, each of which falls into one of the four categories above. The activities comprise three main programs:

Program 1: aquatic community and habitat monitoring program
Program 2: wildlife population and habitat monitoring program
Program 3: fish and wildlife contaminants monitoring program

PROGRAM 1: Aquatic Community and Habitat Monitoring

For an ecosystem to be judged healthy from a fish community perspective, the community should exhibit several characteristics. It should be stable, consisting of species from a variety of trophic levels. The species mix should be as close as possible to the historical one, although major changes to the St. Lawrence River make this achievable only by selecting a benchmark species mix that is reasonable in the historical context. In addition, the individual populations within the community should be robust enough to withstand variations in habitat conditions and harvest as well as other changes in the aquatic community.

The monitoring program must therefore consider parameters that reflect these characteristics and it will consist of a variety of activities which, in total, will provide information on fish community status in the AOC. The aquatic and habitat community monitoring program consists of historical, ongoing and new programs as indicated by the Category number associated with each Activity.

10.8 Surveillance and Monitoring

Program 1 consists of eight monitoring activies, listed below. Details about each Activity are provided in table format on the pages that follow (Tables M-13 through M-22).

1. General fish community status—relative abundance assessment (Category 3)

2. Sportfish harvest assessment (creel census) (Category 3)

3. Assess use of rehabilitated habitats by fish to judge the success of various habitat rehabilitation techniques (Category 3) (see Chapter 7 for a list and description of these projects).

4. Determine species present and spawning and nursery habitats for specific development proposals (Category 1)

5. Assess status of degraded segments of the fish community (Category 4)

Sub-Activity 5.1
Tributary fish community monitoring using boat and backpack electrofishing, seining and trap nets (Category 4)

Sub-Activity 5.2*
Measure walleye recruitment and population status using a variety of programs (Category 2)

Sub-Activity 5.3* Identification of sturgeon spawning areas and their use as a measure of sturgeon abundance (Category 4)

Sub-Activity 5.4*
Assessment of recruitment abundance and spawning/nursery areas) for muskellunge and changes in adult abundance through a specialized angler-cooperator diary program (Category 4)

* Please note that sub-activities 5.2, 5.3 and 5.4 will be dealt with as research projects (see Section 10.9, Research).

Sub-Activity 5.5
Monitor number and population structure of eels at the eel ladder (Category 3). This is not related directly to an AOC-related impairment but the eel ladder in the AOC remains the most significant monitoring station for eels.

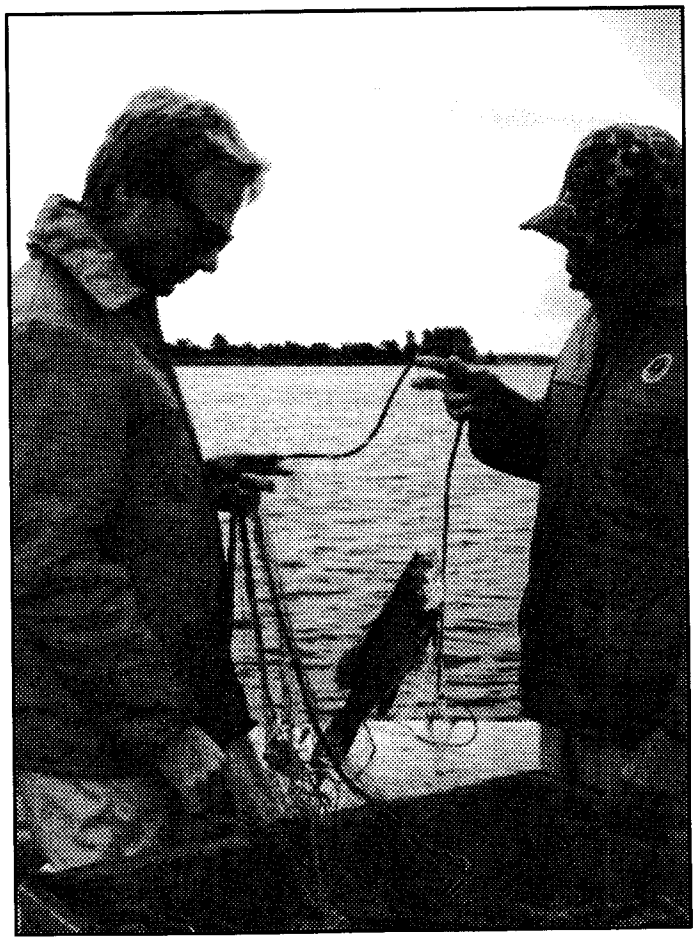
6. Nearshore fish community monitoring (Category 4)

7. Commercial fishery monitoring (Category 3)

8. Aquatic habitat monitoring (Category 1)

There are other research-related initiatives which may lead to monitoring requirements for community segments once the research has been conducted. These include a study of the status of the nearshore fish community in the AOC.

In addition there are ongoing monitoring programs to track the status of other segments of the fish community such as commercially-fished species and other species tracked by the index netting program. No impairments for these segments have been identified, but the monitoring must continue to ensure that information on future impairments becomes available as needed.



Index netting

Table M-13. Aquatic Community and Habitat Monitoring–Activity #1

Activity #1	**General fish community status—relative abundance assessment** ***(Category 3)***
Comments	This activity will track community composition and changes in the relative abundance of a variety of species. Relative abundance is a surrogate parameter used to indicate absolute abundance. A variety of population dynamics information on growth, age at sexual maturity and other measures also contributes to assessment of fish population status.
Status	This activity has been ongoing since 1984 based on index netting done every second year in September, using gill nets set at standard (constant) locations.
Medium	Fish
Parameters	Relative abundance (catch/unit effort), growth rates, age at sexual maturity, year class strength mortality rates. Some species (walleye, sturgeon, muskellunge and smallmouth bass, as well as nearshore species such as largemouth bass and species smaller than approximately 10 cm, i.e., cyprinids) are not effectively monitored by this activity. Yellow perch, northern pike, white suckers and another 12 forage and bottom feeding species are effectively monitored (i.e., changes in population size are detectable).
Location	At 39 constant stations in Lake St. Francis from Glen Walter east to the Quebec border.
Agencies	MNR, as part of the Lake Ontario Management Unit's activities on the St. Lawrence.
Delisting Criteria	XIII-1, XIII-4, XIII-5
Impaired Use(s)	Degradation of fish and wildlife populations
Note	Species collected as part of this activity will also serve as samples for contaminant testing (see Fish and Wildlife Contaminants Monitoring Program, Tables M-32 through M-36).

Table M-14. Aquatic Community and Habitat Monitoring–Activity #2

Activity #2	Sportfish harvest assessment (creel census). *(Category 3)*
Comments	This activity consists of on-water angler interviews, angler counts and catch sampling to provide information on trends in harvest as well as characteristics of the fish harvested. Analysis and design are sophisticated and data are reliable. The census data provide information on angler use and trends in relative abundance of harvested species.
Status	Ongoing program (once every 5 years from April to September).
Medium	Angler interviews; fish measurements
Parameters	Catch/unit effort (relative abundance), growth information, fishing mortality rates, user information and trends in fishing effort for the following species: walleye, yellow perch, northern pike, smallmouth and largemouth bass, brown bullhead, rock bass, pumpkinseed, sunfish and muskellunge. (Note that data on muskellunge are too sporadic to be useful for monitoring this species.)
Location	Lake St. Francis from the Moses-Saunders power dam east to the Quebec border.
Frequency	Generally once every 5 years.
Agencies	MNR, as part of the Lake Ontario Management Unit's monitoring program.
Delisting Criteria	XIII-1, XIII-4, XIII-5
Impaired Use(s)	Degradation of fish and wildlife populations

Table M-15. Aquatic Community and Habitat Monitoring–Activity #3

Activity #3	**Assess use of rehabilitated habitats by fish to judge the success of various habitat rehabilitation techniques. *(Category 3)***
Comments	This activity uses boat electrofishing to capture all fish in rehabilitated and control areas to determine if species diversity and abundance have increased. It is implemented on a project-by-project basis as necessary. Pre- and post construction monitoring are both required.
Status	Pre-monitoring is completed for the 17 projects proposed for the Cornwall waterfront; post-construction monitoring has been done for one constructed project. Some pre-monitoring has been done at the Bainsville Bay-Pointe Mouillée project site. In addition, two other projects (Cooper Marsh habitat creation and a shoreline protection project on some St. Lawrence River islands) have been assessed, although they were compensation projects, not RAP-directed projects.
Medium	Fish
Parameters	Catch/unit effort by species; life history stage (young-of-the-year, juvenile, adult) by species.
Location	Control sites and rehabilitation project locations.
Frequency	Once during pre-construction phase; once or twice post-construction (with replicates).
Agencies	MNR
Delisting Criteria	XII-12 XIII-1, XIII-2, XIII-4
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-16. Aquatic Community and Habitat Monitoring-Activity #4

Activity #4	**Determine species present and spawning and nursery habitats for specific development proposals. *(Category 1)***
Comments	For some major in-water development proposals such as pipeline crossings, intakes and large erosion protection works, the proponent (or historically MNR) has undertaken site-specific habitat and fish community descriptions to determine if and how the Fisheries Act and habitat compensation will be applied. The existing database has 43 such locations in the AOC. These historical data will be entered into the GIS database by location and habitat type. However, the different methods of fish collection, lack of replication and inadequacy of sample size make this information potentially useful only as a form of benchmark data for monitoring. It will not be useful as a future monitoring program.
Status	In the late 1980s and early 1990s site-specific data were collected at 33 sites. This activity is now done infrequently, if at all, by MNR but development proponents are still required to collect these data for impact assessment purposes.
Medium	Fish; habitat
Parameters	Presence/absence and numbers of different species and their life history stage. Habitat types described by substrate, current, aquatic vegetation, in-water and shoreline cover.
Location	As per proposed development location.
Frequency	As per proposed developments.
Agencies	Historically MNR and proponents; now only proponents.
Delisting Criteria	XII-12, XII-13 XIII-1, XIII-4, XIII-5, XIII-6
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-17. Aquatic Community and Habitat Monitoring–Activity #5

Activity #5	Assess status of degraded segments of the fish community. *(Category 4)*
Comments	Several species such as sturgeon, muskellunge and walleye have not been sufficiently monitored in the AOC in terms of population degradation. Tributary fish communities (seasonally and year-round) have not been well characterized either. None of the other proposed Category 2, 3 or 4 activities cover these species or this community. The migratory population of migratory American eel has declined rapidly in recent years. The eel ladder at Cornwall is the only consistent measure for recruitment and survival of this population. While the problem is thought to be one outside the AOC it is important that monitoring of this species continue within the AOC. Sturgeon, muskellunge and walleye are excellent measures of ecosystem health. For sturgeon this is because they are long-lived bottom feeders and hence reflect long-term changes at that trophic level. Sturgeon are also rare in the AOC now, whereas historically they were not. Walleye and muskellunge are both top order predators (i.e., sensitive indicators) which are declining or have declined in the AOC. The first 3 sub-activities listed below require a research project first (see Section 10.9, Research) prior to the determination if a monitoring program is necessary or feasible let alone what that program should consist of. The monitoring of the eel population at the eel ladder is related to a non-AOC impairment but the monitoring activity will occur in the AOC. This activity consists of the following **Sub-Activities:** **5.1** tributary fish community monitoring **5.2** measure of walleye spawning abundance and success in the Raisin River combined with adult assessment using creel census and a trap net program in Lake St. Francis, **5.3** special studies of sturgeon in Lake St. Francis to identify existing spawning areas and their use, **5.4** a seining/electrofishing program for young muskellunge to identify recruitment combined with a special angler diary program to determine catch rates (relative abundance) and age structure. **5.5** continue to monitor the number and age structure of eels using the eel ladder. Note that all of these sub-activities will also identify key habitat areas for these species (see Aquatic Habitat Monitoring Program, Table M-22).

Table M-18. Aquatic Community and Habitat Monitoring–Activity #5, Sub-activity 5.1

Activity #5	**Assess status of degraded segments of the fish community**
Sub activity 5.1	**Tributary fish community monitoring using boat and backpack electrofishing, seining and trap nets.** ***(Category 4)***
Status	New
Medium	Fish
Parameters	Presence/absence; relative abundance and life history stage of fish that use the tributaries in the spring (non-resident) and fall (resident) periods.
Location	Several stations (by habitat type and replicated at least 3 times) on the main tributaries (Raisin River, Gray's Creek, Westley's Creek, McIntosh Creek, Sutherland Creek, Wood Creek, Gunn Creek). Use non-AOC creek (Hoasic Creek) as control site.
Frequency	Total of eight creeks. One creek (all stations) sampled each year. Two years per creek (spring sampling one year and fall sampling the next). Each creek therefore sampled every fourteen years, for two years in a row.
Agencies	MNR; volunteer partners (fish and game clubs); DFO
Delisting Criteria	XII-13 XIII-6
Impaired Use(s)	Loss of fish and wildlife habitat [using fish populations as an indicator of habitat improvement] Degradation of fish and wildlife populations

Please note: **Sub-activities 5.2, 5.3 and 5.4 require research and are covered in Section 10.9, Research**

Table M-19. Aquatic Community and Habitat Monitoring–Activity #5, Sub-activity 5.5

Activity #5	Assess status of degraded segments of the fish community
Sub activity 5.5	**Monitor number and population structure of eels at the eel ladder.** ***(Category 3)***
Status	Ongoing dataset dates back to the 1970s
Medium	Biota
Parameters	Numbers and age structure of migrating eels
Location	Eel ladder
Frequency	Annually
Agencies	MNR, Ontario Hydro
Delisting Criteria	N/A (because caused by factors outside of AOC)
Impaired Use(s)	Degradation of fish & wildlife populations (caused by factors outside the AOC).

Table M-20. Aquatic Community and Habitat Monitoring–Activity #6

Activity #6	Assessment of trends in nearshore fish community. *(Category 4)*
Comments	Most of the production in an aquatic system occurs in the nearshore and shallow sections of the water body. In the past, little assessment of this community has been done except for piecemeal data collection associated with rehabilitation projects or development proposals. Some comparative information is available but a full benchmark data set has not been acquired. However, shoreline development has reduced production in this area. This activity will measure trends in the nearshore community in cyprinids (forage fish) and young-of-the-year and juveniles for a variety of species such as perch, smallmouth bass, largemouth bass, northern pike and panfish species.
Status	Piecemeal data available; full benchmark data set required
Medium	Fish
Parameters	Catch/unit effort (relative abundance) using boat electrofishing in August. Trend data by life history stage will be available for young-of-the-year perch and other species of interest. Population dynamics (growth) data will also be measured to assess trends.
Location	At 40 index sites, stratified by habitat type in Lake St. Francis.
Frequency	Once a year for 2 years to establish benchmark data; once every 3 years thereafter.
Agencies	MNR
Delisting Criteria	XII-12 XIII-4, XIII-5
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-21. Aquatic Community and Habitat Monitoring–Activity #7

Activity #7	**Commercial fishery monitoring. *(Category 2)***
Comments	Commercial anglers now fish for a limited number of species (white sucker, eel, crappie, sunfish, brown bullhead and some yellow perch). They are required to report their effort (number of nets) and harvest (weight) monthly. While not very accurate in terms of assessing annual changes in these populations, long-term trends in harvest can reflect population status.
Status	Ongoing; required by regulation.
Medium	Fish
Parameters	Weight of harvest by species; effort (monthly) measured by number of nets fished.
Location	Lake St. Francis
Frequency	Annually
Agencies	MNR
Delisting Criteria	XIII-4
Impaired Use(s)	Degradation of fish and wildlife populations

Table M-22. Aquatic Community and Habitat Monitoring–Activity #8

Activity #8	**Aquatic habitat monitoring.** ***(Category 4)*** Note: (a) this does not include tributary habitat, which is considered in Table M-18; (b) see also Table M-31, Habitat Diversity and Quality Monitoring, for monitoring of coastal marshes
Comments	Aquatic habitat diversity in Lake St. Francis is a major factor contributing to the existing high production and species diversity in Lake St. Francis. In general, the habitat has been reasonably stable (water levels don't fluctuate) since the Seaway was constructed. However, some key elements are reduced in area or have not yet been identified (i.e., muskie and sturgeon spawning areas). Habitat type, diversity, distribution and abundance are critical to a stable fish community. Sampling by habitat type is part of the assessment fish community status and these data on habitat are required to support that assessment. The benchmark data collected will be used to identify habitat types that require special protection because of their rarity in the AOC.
Status	An integrated and complete data set exists for habitat.
Medium	Physical; chemical; biota
Parameters	Using MNR's Guidelines for Collecting Baseline Aquatic Habitat Data in Great Lakes AOCs (MNR 1995), measure a series of parameters tied by a global positioning system (GPS) to a GIS database. For a full list of parameters, see the Guidelines. These guidelines apply to shallow waters (maximum 2-3 m depth). For deeper waters, existing data on substrate, current and depth will be used as habitat quality measures.
Location	Lake St. Francis
Frequency	Three years to establish the benchmark data set; once every 10 years thereafter. All changes in habitat due to development, restoration or other activities will be added to the database as they occur.
Agencies	MNR; RRCA; MOEE; Environment Canada; DFO
Delisting Criteria	XII-12
Impaired Use(s)	Loss of fish and wildlife habitat

PROGRAM 2: Wildlife Population and Habitat Monitoring

Table M-23. Wildlife Population and Habitat Monitoring–Marsh monitoring program

Activity	Marsh Monitoring Program
Comments	This activity includes monitoring for marsh birds and anurans. Both components use point counts at permanent stations. The marsh bird component uses fixed distance semicircular plots allowing the density of breeding birds to be estimated for some species. Because the anuran surveys are conducted after dark, fixed distance plots are not feasible but population trends (but not absolute density) estimates are possible.
Status	This is an ongoing program that began in the AOC in 1994. The program will be expanded in 1996.
Medium	Terrestrial (and semi-aquatic) wildlife.
Parameters	Species abundance; biodiversity; population trends (breeding density for some species).
Location	Per monitoring plan (6 sites including one non-AOC reference site)
Frequency	Annually: two or three samples per year (April-July) for birds and anurans respectively.
Agencies	MNR; Environment Canada-Cleanup Fund; Long Point Bird Observatory; volunteer groups
Delisting Criteria	XII-1, XII-2, XII-3, XII-4 XIII-1, XIII-3
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-24. Location and year sampling was initiated for marsh bird and anuran components of the Marsh Monitoring Program.

Location	Route	Year Initiated	
		Marsh Birds	Anurans
Bainsville	Bainsville Bay	1994	1995
Bainsville	Bainsville Isles	1994	1995
Coopers Marsh	East	1994	1995
	West	1994	1995
	Heron Trail	1995	-
Loch Garry		1995	1995
Summerstown Swamp1		-	1995
U. Cda Migratory Bird Sanctuary2,3		1996	1996

1 Not a marsh but we are using the same protocol to monitor anurans in other wetland types.
2 Route has been established and monitoring will begin in 1996.
3 This is a control site upstream of the AOC.

Table M-25. Wildlife Population Monitoring–Red-shouldered hawk, spring woodpecker survey.

Activity	Red-shouldered Hawk, Spring Woodpecker Survey
Comments	This is a roadside survey using permanent sampling points along a 19 km route (i.e., 20 points at 1 km intervals). It provides estimates of population trends although extrapolating to population density may be possible for red-shouldered hawks.
Status	This is an ongoing program that began (in the AOC) in 1994 and was expanded in 1995.
Medium	Terrestrial wildlife, specifically red-shouldered hawk, piliated woodpecker and yellow-bellied sapsucker. Other raptors are monitored to a lesser extent by this program.
Parameters	Species abundance; biodiversity (for raptors); population trends (breeding density for red-shouldered hawk).
Location	As indicated in Table M-26, below.
Frequency	Annually (one survey per year).
Agencies	MNR; Environment Canada-Cleanup Fund; Long Point Bird Observatory; volunteer groups
Delisting Criteria	XII-7
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-26. Location and year initiated for red-shouldered hawk and spring woodpecker surveys in the AOC.

Route Location	Year Initiated
Glen Roy	1994
Greenfield	1994
Lemeux	1995
U. Cda Migratory Bird Sanctuary[1]	1995

[1] This is a control site upstream of the AOC.

Table M-27. Wildlife Population Monitoring–Forest bird monitoring program.

Activity	Forest Bird Monitoring Program
Comments	These routes consist of a series of permanent plots in which point counts are conducted. The data provides information about the relative abundance, population trends and biodiversity of forest birds.
Status	This is a new program in the AOC: the first route(s) will begin in 1996.
Medium	Terrestrial wildlife (forest birds).
Parameters	Species abundance; biodiversity; population trends (breeding density for some species)
Location	To be determined (Summerstown forest will be a high priority in the early stages).
Frequency	Annually (two surveys per year).
Agencies	MNR; Environment Canada-Cleanup Fund; Long Point Bird Observatory; Environment Canada-CWS; volunteer groups
Delisting Criteria	XII-7
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-28. Wildlife Population Monitoring–Amphibian road call counts (anurans).

Activity	Amphibian Road Call Counts (anurans)
Comments	This survey uses unlimited distance point counts at 0.8 km intervals along a 7.2 km route (i.e., 10 sample points per route).
Status	New (in the AOC). This program will begin in 1996.
Medium	Terrestrial (and semi-aquatic) wildlife: anurans.
Parameters	Species abundance; biodiversity; population trends (breeding density estimates may be possible for some species).
Location	To be determined based on the availability of volunteers.
Frequency	Annually (three surveys per year).
Agencies	MNR; Environment Canada-Cleanup Fund; Long Point Bird Observatory; volunteer groups
Delisting Criteria	XII-2
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-29. Wildlife Population Monitoring–Osprey monitoring.

Activity	Osprey Monitoring
Comments	Although osprey populations have recovered in many parts of North America including parts of Ontario, there are no recent nesting records from the AOC. Five osprey nesting platforms have been constructed in or near the AOC and they will be monitored annually. In addition, volunteers participating in other monitoring programs will be asked to report osprey sightings.
Status	Ongoing
Medium	Terrestrial wildlife osprey.
Parameters	Population trends and breeding density.
Location	Throughout the AOC.
Frequency	Annually
Agencies	MNR; Environment Canada-Cleanup Fund; Environment Canada-CWS; Long Point Bird Observatory; volunteer groups
Delisting Criteria	XIII-2
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-30. Wildlife Population Monitoring–Fisher and otter population monitoring.

Activity	Fisher and Otter Population Monitoring
Comments	Methods are to be determined for assessing relative abundance and population size. Qualitative information will be developed by analyzing the rate of incidental captures by trappers, road kills and incidental sightings by MNR staff and volunteers.
Status	Ongoing
Medium	Terrestrial wildlife: otter and fisher.
Parameters	Population trends
Location	Throughout the AOC.
Frequency	Annually
Agencies	MNR; Environment Canada-Cleanup Fund; volunteer groups
Delisting Criteria	XIII
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

Table M-31. Wildlife Population and Habitat Monitoring–Habitat diversity and quality monitoring.

Activity	Habitat Diversity and Quality Monitoring
Comments	Habitat quality and diversity will be monitored using a GIS data base generated from air photo interpretation, forest resources inventories (FRI), field inventories, and MNR wetland evaluations combined with federal GIS databases. This will provide not only critical data for establishing benchmarks for some of the monitoring programs but will provide an analytical tool for assessing progress in remediation.
Status	Started but will not be completed until 1997.
Medium	Terrestrial habitat in the AOC.
Parameters	Habitat type, quantity, quality and diversity (number of hectares and distribution of coastal marsh, riverine marsh, riverine forest, mature swamp, mature forest, corridors etc.).
Location	Throughout the AOC.
Frequency	Once the initial habitat inventory is completed and placed in a GIS data base it will be reassessed every 5 years.
Agencies	MNR; Environment Canada, Cleanup Fund; volunteer groups
Delisting Criteria	XII and XIII
Impaired Use(s)	Loss of fish and wildlife habitat Degradation of fish and wildlife populations

PROGRAM 3: Fish and Wildlife Contaminants Monitoring

The activities for this monitoring program consider contamination of fish and wildlife species as it relates to:

(1) Animal deformities
(2) Fish tumours
(3) Ecosystem health indicators
(4) Degradation of fish and wildlife populations

Program 3 consists of the monitoring Activities listed below.

(1) Animal Deformities
Measure deformity rates for some species and use control sites outside AOC and upstream within AOC to compare to Great Lakes rates, or compare to a zero tolerance criterion (i.e., no deformities).

(2) Fish tumours
Fish tumour monitoring.

(3) Ecosystem health indicators
Measure contaminant levels in certain species to provide data on trends in biota contaminant levels as a measure of ecosystem health. Incorporate contaminant monitoring in sport and commercial fish as part of this program, to monitor suitability of fish for human consumption.

Sub-Activity 1 Contaminants in Sport Fish – Document changes in contaminant concentrations in edible portions of fish over time to evaluate the responses to remedial actions in the AOC.

Sub-Activity 2 Contaminants in Commercial Fish – Monitor trends in contaminant levels (and therefore suitability for sale and consumption) in Lake St. Francis commercial fish.

(4) Degradation of fish and wildlife populations
(Mudpuppies only. See Ecosystem Health Indicators, above)

(1) Animal deformities

Table M-32. Fish and Wildlife Contaminants Monitoring–Animal deformities

Activity	**Measure deformity rates for some species and use control sites outside AOC and upstream within AOC to compare to Great Lakes rates, or compare to a zero tolerance criterion (*i.e.*, no deformities).**
Comments	Measure deformity rates for some species and use control sites outside AOC and upstream within AOC to compare to Great Lakes rates, or compare to a zero tolerance criterion (*i.e.*, no deformities). Link this to research program (R10 in Section 10.9) and Table M-34.
Status	Research ongoing for some species
Medium	Biota
Parameters	Potential for monitoring mudpuppies and snapping turtles are still being assessed
Location	Mudpuppies and snapping turtles - Locations to be determined, and sampling of mudpuppies would be on a catch and release basis (no destructive sampling).
Frequency	Every 3 years.
Agencies	Environment Canada
Delisting Criteria	V
Impaired Use(s)	Bird and other animals [besides fish] deformities Degradation of wildlife populations

Table M-33. Fish and Wildlife Contaminants Monitoring–Fish tumours.

Activity	Fish tumour monitoring.
Status	Two collections of walleye (1990 and 1995) have been analyzed: from the Raisin River (1990 and 1995) and upstream at Hoople Creek (1995).
Medium	Biota (walleye and white suckers)
Parameters	Tumour rates; age; sex of walleye and suckers collected; bile levels of PAHs; blood enzyme levels; analyses of walleye and sucker population structures.
Location	Raisin River and Hoople Creek plus a control site not in the St. Lawrence River.
Frequency	Once every 10 years.
Agencies	MOEE; MNR; Environment Canada; University of Guelph
Delisting Criteria	IV
Impaired Use(s)	Fish tumours or other deformities.

(3) Ecosystem health indicators

Table M-34. Fish and Wildlife Contaminants Monitoring–Ecosystem health indicators.

Activity	**Measure contaminant levels in certain species to provide data on trends in biota contaminant levels as a measure of ecosystem health. Incorporate contaminant monitoring in sport and commercial fish as part of this program.**
Sub Activity #1	**Bird and Amphibian Monitoring.**
Status	Benchmark data for waterfowl are available (related to consumption guidelines as well). Mudpuppy research began in 1996. Population size is undetermined but may be too small to support monitoring. Herring gulls have been monitored for contaminants since 1986. Black crowned night-herons: there is no data available. However, there are some egg contaminant data from other AOCs for comparison. Tree swallow/red winged blackbird data are available for south shore of Lake St. Francis (and some non-AOC sites). Data on contaminants in AOC snapping turtle eggs are available. No top-order avian predator data available.
Medium	Biota
Parameters	Concentrations of various contaminants in: (1) herring gull eggs. (2) black crowned night-herons: eggs (to be evaluated) (3) local and migratory waterfowl (scaup, mallard, gadwall): muscle tissue (4) mudpuppy to be determined (5) tree swallow and/or red-winged blackbird egg (6) snapping turtle egg (7) osprey egg (once a sustainable population of osprey is present in the AOC)
Location	Throughout the AOC as per existing programs or at affected and control sites for new programs.
Frequency	Depends on parameter and species. Herring gulls: Annually Black crowned night-herons: Potential to be evaluated. Waterfowl: local and migratory every 5 years Mudpuppies: to be determined Tree swallows, red-winged blackbirds: to be determined Snapping turtles: to be determined Osprey: to be determined
Agencies	Environment Canada; MNR; MOEE
Delisting Criteria	I, XI
Impaired Use(s)	Restrictions on consumption of fish and wildlife Degradation of wildlife populations Animal deformities

Table M-35. Fish and Wildlife Contaminants Monitoring–Ecosystem health indicators, Sub activity #1.

Activity	**Measure contaminant levels in certain species to provide data on trends in biota contaminant levels as a measure of ecosystem health. Incorporate contaminant monitoring in sport and commercial fish as part of this program.**
Sub activity #2	**Contaminants in Forage & Sport Fish:** **Document changes in contaminant concentrations in spttail shiners and the edible portions of fish over time to evaluate the responses to remedial actions in the AOC, with respect to human consumption of sport fish.**
Status	This is a continuation of the Sport Fish Contaminant Program with some modifications.
Medium	Spottail shiner program is ongoing Analysis of contaminants in fish tissue - fillets. Collect species of fish normally used for human consumption (walleye). Samples should include fish from several size classes (i.e., 20 to 25 fish covering a range of sizes). We will review existing data to determine the variability in contaminant concentrations for different size classes.
Parameters	Spottail shiners body burdens as per existing program Sportfish fillets for PCB/OC scan, Hg and other metals, dioxins, % lipid, fish length, weight, sex
Location	Upstream reference site with species similar to downstream). Lake St. Lawrence; Lake St. Francis, north and south channel. Collect fish from locations representative of the commercial and recreational fishery.
Frequency	Spottail shiners: annually Walleye-once per year Other species-every two years, during Index Netting program
Agencies	MOEE, MNR
Delisting Criteria	I
Impaired Use(s)	Restrictions on fish and wildlife consumption

Table M-36. Fish and Wildlife Contaminants Monitoring–Ecosystem health indicators, Sub activity #2.

Activity	**Measure contaminant levels in certain species to provide data on trends in biota contaminant levels as a measure of ecosystem health. Incorporate contaminant monitoring in sport and commercial fish as part of this program.**
Sub activity # 3	**Contaminants in Commercial Fish: Monitor trends in contaminant levels (and therefore suitability for sale and consumption) in Lake St. Francis commercial fish.**
Status	Ongoing
Medium	Biota
Parameters	Composite, whole body burden contaminant levels compared to established commercial sale thresholds set by DFO for all commercial species thought to be at or over the consumption threshold.
Location	Lake St. Francis
Frequency	As deemed necessary by DFO.
Agencies	DFO
Delisting Criteria	I, XI
Impaired Use(s)	Restrictions on fish and wildlife consumption Added costs to agriculture or industry

(4) Degradation of fish and wildlife populations

The only impairment at this time may be in mudpuppies. See Table M-34 for required collection parameters.

10.9 Recommended Research

This section of the report deals with research activities deemed necessary to carry out one or more of the St. Lawrence RAP Recommendations. These research activities are separate from the surveillance and monitoring proposals outlined in preceding sections of this chapter in that they are generally one-time research activities or programs. They are designed to provide information necessary to either implement a specific recommendation or establish a monitoring program for a particular delisting criterion. The research recommendations (R1 through R10) discussed in this section were derived from originally-proposed remedial options that were deemed to be non-remedial in and of themselves.

R1. Continue to develop new shoreline-friendly construction techniques.

Continue to pursue the development and application of a range of fish and wildlife-friendly development and construction techniques. (*i.e.*, non-intrusive docks, backshore boathouses, use of rip-rap or vegetation for shoreline stabilization instead of solid retaining walls, elimination of plastic or fabric carpets for aquatic plant control, etc.). This work will not be undertaken specifically as part of RAP implementation. The information will be developed by agencies such as MNR or DFO as part of their ongoing technology development program, then applied as appropriate in the AOC.

R2. Investigate impacts of toxic contaminants on fish habitat.

Investigate impacts of contaminated sediment on spawning beds and hatching survival of young fish, and investigate mobilization of contaminants from benthic invertebrates and sediment into young fish.

R3. Investigate flow modification techniques and island nearshore and terrestrial habitat management program for habitat enhancement.

Study the relationship between hydrology and ecology of Lake St. Francis and develop an ecological model for flow and water level management in Lake St. Francis. Install offshore protection against wave impacts. Use engineered structures to manipulate nearshore flows, in order to reestablish bulrush beds at the expense of submergent vegetation and reduce wave wash action of large ships.

R4. Subject all measures for controlling nuisance aquatic plants to a rigorous assessment of their positive and negative effects on the Lake St. Francis ecosystem. Include as design considerations, methods to enhance the ecosystem values which can be incorporated into control programs.

Options for controlling nuisance plants include mechanical harvesting, application of chemical herbicide (but see Recommendation # 43) and physical removal. An assessment of the implications associated with these measures is required to address site-specific areas with excessive plant growth.

R5. Research effect of boat wakes on shoreline erosion in specific areas of the River. Establish boating speed limits if required.

While speed limits already apply to commercial navigation on Lake St. Francis, there is a concern that these limits might be too high and that there are no established speed limits for other boats operating on the lake. In 1996 the St. Lawrence Seaway Authority conducted a study of wave action at Pte. Mouillee in relation to commercial vessel activities. The maximum wave action observed at the shoreline in relation to vessel movement was 77 mm (3 inches). Further study is required to determine if boat wakes of various types are contributing to bank erosion problems in Lake St. Francis.

R6. Assess walleye spawning habitat, spawning success and size of spawning run (with tagging to determine post-spawning distribution in the Raisin River).

During the 1970s and again in the mid- to late-1980s, a trap-netting program was used to capture and tag walleye in the Raisin River, the major walleye spawning run in the AOC. In the mid-1980s an assessment of spawning habitat and reproductive success was undertaken on walleye spawning beds in the Raisin River. These are the only data specific to walleye in the AOC (with the exception of Creel census data) regarding population size, structure and relative abundance.

Historical surveys done every 10-15 years provide good benchmark data on walleye spawning in the Raisin River. Note that in 1990, fish from this program were used in a tumour monitoring program. In 1995, fish for tumour monitoring were obtained by electrofishing. Data collected to assess the spawning population of walleye would include number, age, sex, year class size, distribution post-spawning in Lake St. Francis, number of eggs deposited/m^2 and the classification of walleye spawning microhabitats. The three spawning beds (Williamstown, McIntyre's Rapids and Martintown) in the Raisin River would be the target areas.

R7. Identify sturgeon spawning areas and use as a measure of sturgeon abundance.

Identification of sturgeon spawning areas and their use can be used as a measure of sturgeon abundance. This will require spring sampling (gill nets and diving) to confirm spawning areas used by sturgeon. Measurements will include size of spawning areas, catches of fish (population structure and abundance) and egg deposition/hatch rates in these areas.

R8. Assess recruitment abundance and spawning/nursery areas as well as changes in adult abundance for muskellunge.

A specialized angler-cooperator diary program, seining and electrofishing have been used in other parts of the St. Lawrence River for this purpose. Both would be new initiatives in Lake St. Francis. Data collected for muskellunge harvested by diary anglers would include the number of young-of-the-year muskie, number of spawning sites actually used, number and population structure (age, year class strength, growth). The angler diary would be done yearly, assessment of benchmark spawning areas every year for next three years and monitoring of spawning areas every fifth year.

R9. Participate in EHJV projects on Lake St. Francis and in the AOC tributary watershed.

There are a number of proposed EHJV projects including a GIS-based habitat supply analysis, a stewardship program and database development, and monitored wetland restoration or creation projects.

R10. Establish a benchmark research program to examine levels of contaminants in wildlife species and their biochemical and potential biological effects.

Contaminants in certain wildlife species (tree swallows, red-winged blackbirds, snapping turtles and mudpuppies) have been studied for sites at Akwesasne and along the south shore of the St. Lawrence River, near areas of PCB-contaminated sediment (Struger *et al.* 1993; Bonin *et al.* 1995; Bishop et al. 1995; Bishop *et al.*, in prep.a, in prep.b; Gendron *et al.*, in prep.; Gendron *et al.*, in press). This research has provided preliminary evidence of biochemical and biological impacts of contaminants on some species of wildlife in the St. Lawrence River (Massena) AOC. A research program needs to be established to examine contaminants and wildlife health in the St. Lawrence River (Cornwall) AOC. The program should be linked to research efforts in the rest of Lake St. Francis and should examine wildlife species already studied on the south shore, as well as other species at different trophic levels.

11. REFERENCES

Anderson, J. 1990. St. Lawrence River Environmental Investigations. Volume 4. Assessment of Water and Sediment Quality in the Cornwall Area of the St. Lawrence River, 1985. Environment Ontario. ISBN 0-7729-7562-0.

Anderson, J. and J. Biberhofer. 1991. Water and Suspended Sediment Quality in the St. Lawrence River at Cornwall/Massena: 1988 Data Report. St. Lawrence River RAP Technical Report No. 2. Environment Canada & Environment Ontario.

Apogee Research. 1990. Overview Economic Assessment of Remedial Action Plans for the Great Lakes' Areas of Concern. Report prepared for MOEE Policy and Planning Branch. ISBN #0-7729-7074-2.

Baumann, P.C., I.R. Smith and C.D. Metcalfe. 1996. Linkages between chemical contaminants and tumours in benthic Great Lakes fish. *J. Great Lakes Res.* 22(2): 131-152.

BEAK Consultants (unpublished data report). (For TransCanada PipeLines Ltd.)

Belrose, F. 1976. *Ducks, Swans and Geese of North America.* (Stackpole Books: Harrisburg, PA).

Bendig, A. 1995. 1994 Lake St. Francis index netting program. In: 1995 Annual Report, St. Lawrence River Sub-Committee to the Lake Ontario Committee and the Great Lakes Fishery Commission. Ontario Ministry of Natural Resources. March 1995. p. 13-17.

Biberhofer, J. 1995. Concentrations and loadings of trace organic compounds measured in the St. Lawrence River headwaters at Wolfe Island 1989-1993.

Biberhofer, J. 1994. A proposed sampling strategy for the international section of the Cornwall/Massena reach of the St. Lawrence River. Environment Canada, Internal Report.

Bishop, C.A., D.V. Weseloh, N.M. Burgess, J. Struger, R.J. Norstrom, R. Turle, K.A. Logan. 1992. An Atlas of Contaminants in Eggs of Fish-eating/Birds of the Great Lakes (1970-1988), 2 vols. Technical Report No. 152. Canadian Wildlife Service, Ontario Region.

Bishop, C.A., R.J. Brooks, J.H. Carey, P. Ng, R.J. Norstrom and D.R. S. Lean. 1991. The case for a cause-effect linkage between environmental contamination and development in eggs of the common snapping turtle (*Chelydra s. serpentina*) from Ontario, Canada. *J. Toxicol. and Environ. Health* 33:521-547.

Bishop, C.A., G.P. Brown, R.J. Brooks, D.R.S. Lean and J.H.Carey. 1994. Organochlorine contaminant concentrations in eggs and their relationship to body size, and clutch characteristics of the female snapping turtle (*Chelydra serpentina serpentina*) in Lake Ontario, Canada. *Arch. Environ. Contam. Toxicol.* 27:82-87.

Bishop, C.A., M.D. Koster, A.A. Chek, D.J.T. Hussell and K. Jock. 1995. Chlorinated hydrocarbons and mercury in sediments, red-winged blackbirds (*Agelaius phoeniceus*) and tree swallows (*Tachycineta bicolor*) from wetlands in the Great Lakes-St. Lawrence Basin. *Environ. Toxicol. and Chem.* 14:491-501.

11. References

Bishop, C.A., Ng, P., Norstrom, R.J., Brooks, R.J., Pettit, K.E. 1996. Temporal and geographic variation of organochlorine residues in eggs of the Common Snapping Turtle *(Chelydra serpentina serpentina)* (1981-1991), *Archiv. Environ. Contam. Toxicol.* 31 (4): 512-524.

Bishop, C.A., P. Ng, K.E. Pettit, S.W. Kennedy, J.J. Stegeman, R.J. Norstrom and R.J. Brooks. (in prep.*a*). Environmental contamination and developmental abnormalities in eggs and hatchlings of the common snapping turtle (*Chelydra serpentina serpentina*) from the Great Lakes-St. Lawrence River basin (1989-1991).

Bishop, C.A., N.A. Mahony, S. Trudeau and K.E. Pettit. (in prep.*b*). Organochlorine contamination, reproductive success and biochemical effects of chemical exposure in tree swallows (*Tachycineta bicolor*) from wetlands in the Canadian Great Lakes-St. Lawrence River basin.

Bonin, J., DesGranges, J.-L., Bishop, C.A., Rodrigue, J., A. Gendron, J.E. Elliott. 1995. Comparative study of contaminants in the mudpuppy (Amphibia) and the common snapping turtle (Reptilia), St. Lawrence River, Canada. *Arch. Environ. Contam. Toxicol* 28:184-194.

Braune, B. (in prep.). National survey of contaminants in waterfowl, 1988-1992. Canadian Wildlife Service, Environment Canada.

Bunce, N.J. 1994. *Environmental Chemistry*. 2nd Ed. (Winnipeg: Wuerz Publishing Ltd.), ISBN 0-920063-65-9.

Canada and United States. 1987. Revised Great Lakes Water Quality Agreement of 1978 as amended by Protocol signed November 18, 1987. Consolidated by the International Joint Commission.

Canadian Coast Guard. 1993. Environmental audit of public ports facility, Cornwall, Ontario. Report prepared for Harbours & Ports Branch, Canadian Coast Guard by MacLean Environmental Studies Inc., Phyper & Assoc. Ltd., OCL Services Ltd. May 1993. 21 pp. & Appendices.

Carignan, R., S. Lorrain and K. Lum. 1994. A 50-yr record of pollution by nutrients, trace metals, and organic chemicals in the St. Lawrence River. *Can. J. Fish. Aquat. Sci.* 51: 1088-1100.

Cholmondeley, R. 1989. The 1987 Thousand Islands warmwater assessment. St. Lawrence River Fisheries Management Unit Report, 1989-03. Ontario Ministry of Natural Resources. 64 pp.

City of Cornwall. 1995. Cornwall Pollution Control Plan, Final Report. Prepared for the City of Cornwall by CH2MHill Engineering Ltd. (Waterloo) and M.S. Thompson & Associates Ltd. (Cornwall). May 1995. 215 pp. + Appendices A-D.

COA. 1994. Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem. Environment Canada, Department of Fisheries and Oceans, Department of Agriculture and Food, Health Canada, Ministry of Environment and Energy, Ministry of Agriculture, Food and Rural Affairs, Ministry of Natural Resources, Ministry of Health. 12 pp.

Comba, M.E., K.L.E. Kaiser and S.M. Backus. 1993. Distribution of polychlorinated biphenyl congeners in spottail shiners from the St. Lawrence River. NOI Research Report RAP-100-92. No. 1.

Comba, M.E., V.P. Palabrica and S.M. Backus. 1995a. Polychlorinated biphenyl congeners in spottail shiners from the St. Lawrence River. AEH Research Report. RAP-100-92. No. 2.

Comba, M.E., S. Backus, V.P. Palabrica, D. Boyter and K.L.E. Kaiser. 1995b. Occurrence, characterization and distribution of PCB in the Cornwall/Massena Reach of the St. Lawrence River. Environment Canada, National Water Research Institute, Burlington, Ontario.

Cornwall Energy Efficiency Team and City of Cornwall. 1995. City of Cornwall Water Efficiency Strategy. July 1995. Prepared by M.S. Thompson & Associates Ltd. 31 pp. + Tables & Appendices.

Cumming Cockburn Ltd. 1996. Littoral zone habitat restoration study: Cornwall, Ontario. Prepared for OMNR, Environment Canada and Raisin Region Conservation Authority. March 1996. 44 pp. + App. A and B.

Dennis, D.G. 1990. Lead ingestion studies on Ontario waterfowl, 1980-1987. Canadian Wildlife Service. Unpublished report.

Dickson, K.M. and A.M. Scheuhammer. 1993. Concentrations of lead in wing bones of three species of ducks in Canada. In: Kennedy, J. and S. Nadeau (eds.) 1993. Lead shot contamination of waterfowl and their habitats in Canada. Canadian Wildlife Service Technical Report Series No. 164, 109 pp. Canadian Wildlife Service Headquarters, Ottawa.

Diogo, B. and A. Jeena. 1995. The St. Lawrence ecosystem: from Iroquois Dam to the Beauharnois Dam, a socioeconomic profile. Research Paper No. 3, July 1995. University of Ottawa, Institute for Research on Environment and Economy (IREE). 56 pp.

Ecological Services for Planning. 1996. Environmental Effects Monitoring (EEM) First Cycle Report for Domtar Fine Papers, Cornwall, Ontario. Final Report. February 1996. 74 pp. + Appendices A-F + Technical Appendices A-E.

Edwards, C.J., P.L. Hudson, W.G. Duffy, S.J. Nepszy, C.D. McNabb, R.C. Haas, C.R. Liston, B.A. Manny and W.N. Busch. 1989. Hydrological, morphometrical and biological characteristics of the connecting rivers of the International Great Lakes: a review. In: D.P. Dodge (ed.) Proceedings of the International Large River Symposium, p. 240-264. *Can. Spec. Publ. Fish. Aquat. Sci.* 106.

EHJV. 1995. Waterfowl and wetlands in the five eastern counties: a draft management plan. Prepared by The Five Eastern County Working Group, November 1, 1995, for Eastern Habitat Joint Venture. 69 pp.

Environment Canada. 1978. Observations on bacteriological conditions in the St. Lawrence River, 1973-1977. Unpublished report, Canada Centre for Inland Waters, Environment Canada, Burlington, Ontario.

Environment Canada. 1985. Unpublished bacteriological data for the St. Lawrence River collected in June and August, 1985. NAQUADAT Data Base, Conservation and Protection, Quebec Region, Environment Canada, Longueuil, Quebec.

Environment Canada and Health Canada. 1994. Canadian Environmental Protection Act, Priority Substances List Assessment Report: Polycyclic Aromatic Hydrocarbons. Ministry of Supply & Services Canada, Cat. No. En40-215/42E. ISBN 0-662-22209-1. 61 pp.

11. References

Environment Canada, OMOEE, OMNR and NYSDEC. 1994. The St. Lawrence River Area of Concern Cornwall-Lake St. Francis & Massena Remedial Action Plans Stage 1 Summary. A Binational Statement Prepared by Environment Canada, Ontario Ministry of Environment & Energy, Ontario Ministry of Natural Resources, New York State Department of Environmental Conservation, United States Environmental Protection Agency. ISBN 0-662-20930-3. Department of Supply and Services Cat. No. En40-470/1-1993E. 17 pp.

Environment Canada, Ontario Ministry of Natural Resources and Ontario Ministry of Environment and Energy. 1996. Identifying habitat rehabilitation targets and priorities in Great Lakes Areas of Concern: upland systems. An interim report for circulation and comment. January 1996. 76 pp.

Experience. 1975. A survey of water quality of the St. Lawrence River adjacent to the City of Cornwall. Experience '75 unpublished report.

Findlay, D.M. and V.A. Naish. 1979. Nature and sources of tainting in a kraft mill. Prepared for Environment Canada, Environmental Protection Service by Domtar Research Centre. CPAR Report No. 775-2. 59 pp.

Findlay, D.M., P. Gregoire, S.R. Megraw, V.A. Naish and R.F. Ross. 1983. An evaluation of the dispersion, dilution and tainting characteristics of the Cornwall effluent plume–1983. Domtar Research Report, Project No. 82-6210-01.

Frank, R. , H. Lumsden, J. F. Barr and H. E. Braun. 1983. Residues of organochlorine insecticides, industrial chemicals, and mercury in eggs and in tissues taken from healthy and emaciated common loons, Ontario, Canada, 1968-1980. *Arch. Environ. Contam. Toxicol.* 12: 641-654.

Gendron, A.D. C.A. Bishop, S. Trudeau, P.A. Spear, J-L. DesGranges, G.J. VanDerKraak, A. Hontela and R. Fortin. (in prep.). High prevalence of skeletal deformities in organochlorine-exposed populations of mudpuppy (Amphibia): Are reproductive and developmental disruptors involved?

Gendron, A.D., C.A. Bishop, R. Fortin and A. Hontela. (in press). In vivo testing of the functional integrity of the corticosterone-producing axis in mudpuppy (Amphibia) exposed to chlorinated hydrocarbons in the wild. *Env. Toxicol. and Chem.*

Gendron, A., R. Fortin and A. Hontela. 1994. Multi-level detection of toxic stress in the mudpuppy *(Necturus maculosus)*, an aquatic salamander. Progress report to the Canadian Wildlife Service & the St. Lawrence River Remedial Action Plan. Département des Sciences Biologiques, Université de Québec à Montréal. November 1994. 41 pp.

Griffiths, R.W. 1988. St. Lawrence River Environmental Investigations, Volume 2: Environmental quality assessment of the St. Lawrence River in 1985 as reflected by the distribution of benthic invertebrate communities. Report prepared for MOE, Water Resources Branch, Great Lakes Section. February 1988. ISBN 0-7729-3560-2 (vol. 2); ISBN 0-7229-3558-0 (3 vol. set). 33 pp. + Appendices 1-3.

Griffiths, R.W., D.W. Schloesser, J.H. Leach and W.P. Kovolak. 1991. Distribution and dispersal of the zebra mussel (*Dreissena polymorpha*) in the Great Lakes Region. *Can. J. Fish. Aquat. Sci.* 48: 1381-1387.

Hayes, M.A. and C. Portt. 1996. Liver pathology of walleye from Raisin River and Hoople Creek. Final Report to St. Lawrence RAP Team. 5 pp. + Appendices.

Hayes, M.A. and C. Portt. (draft). Liver pathology of walleye from the Salmon River, with comparisons to walleye from the Raisin River and Hoople Creek.

Hayes, M.A. and C. Portt. 1996. Liver pathology of walleye from Raisin River and Hoople Creek. Final Report to Environment Canada and St. Lawrence Remedial Action Plan. 1/28/96. 5 pp. + Appendices 1-3.

Heath, A. G., J.J. Cech, J.G. Zinkl, B. Finlayson and R. Fujimura. 1993. Sublethal effects of methyl parathion, carbofuran, and molinate on larval striped bass. *Am. Fish. Soc. Symp.* 14: 17-28.

Hebert, C.E., V. Glooschenko, G.D. Haffner and R. Lazar. 1993. Organic contaminants in snapping turtle (*Chelydra serpentina*) populations from southern Ontario, Canada. *Arch. Environ. Contam. Toxicol.* 24:35-43.

Hebert, P.D.N., B.W. Muncaster and G.L. Mackie. 1989. Ecological and genetic studies on *Dreissena polymorpha* (Pallas): a new mollusc in the Great Lakes. *Can. J. Fish. Aquat. Sci.* 46:1587-1591.

Hendrick, A. 1991. 1990 Lake St. Francis index netting survey. St. Lawrence River Fisheries Management Unit Report, 1991-03. Ontario Ministry of Natural Resources. November 1991. 36 pp.

Hickey, M.B.C. 1996a. American Coot (*Fulica americana*): Recovery Plan for the Cornwall Area of Concern. Prepared for MNR (Cornwall) and Environment Canada Great Lakes Cleanup Fund. 6 pp.

Hickey, M.B.C. 1996b. Red Shouldered Hawks (*Buteo lineatus*): Recovery Plan for the Cornwall Area of Concern. Prepared for MNR (Cornwall) and Environment Canada Great Lakes Cleanup Fund. 7 pp.

Hickey, M.B.C. 1996c. Lake Sturgeon (*Acipenser fulvescens*): Recovery Plan for the Cornwall Area of Concern. Prepared for MNR (Cornwall) and Environment Canada Great Lakes Cleanup Fund. 5 pp.

IJC. 1914. Progress report of the International Joint Commission on the Reference by the United States and Canada regarding the pollution of boundary waters. IJC, Windsor, Ontario. January 1914.

IJC. 1969. Report of the International Joint Commission on the pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River: Volume 3, Lake Ontario and the international section of the St. Lawrence River. The International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence River Water Pollution Board, IJC, Windsor, Ontario.

Jardine, C.G. 1992. St. Lawrence River RAP fish tainting evaluation. St. Lawrence River Technical Report Series # 3. Environment Ontario, Ontario Ministry of Natural Resources, Environment Canada. ISBN 0-7778-0087-X.

Kauss, P.B., Y.S. Hamdy and B.S. Hamma. 1988. St. Lawrence River Environmental Investigations. Volume 1. Background: Assessment of water, sediment and biota in the Cornwall, Ontario and Massena, New York section of the St. Lawrence River 1979-1982. Environment Ontario report. ISBN 0-7729-3559-9. 156 pp.

11. References

Kennedy, J. and S. Nadeau (eds.) 1993. Lead shot contamination of waterfowl and their habitats in Canada. Canadian Wildlife Service Technical Report Series No. 164, 109 pp. Canadian Wildlife Service Headquarters, Ottawa.

Liskauskas, A. 1991. 1991 Lake St. Lawrence fisheries assessment. Ontario Ministry of Natural Resources. March 1991. 30 pp.

Loftus, K.K., V.H. Young, R.E. Elliott, L.J.D. Alexander, R.J. Bennett, R.M. Schollen, B. Greenwood, A.G. Price, and A.A. Crowder. 1992. Point Mouilleé/Bainsville Bay integrated land use and habitat restoration study. Report prepared for The Raisin Region Conservation Authority, MNR, Twp of Lancaster, Environment Canada, and the EHJV. LGL Project No. TA 943.

Lorrain, S., V. Jarry and K. Guertin. 1993. Repartition spatiale et evolution temporelle des biphenyles polychlores et du mercure dans les sediments du lac Saint-Francois, Centre Saint-Laurent, Environment Canada.

Metcalfe, J.L. and M.N. Charlton. 1990. Freshwater mussels as biomonitors for organic industrial contaminants and pesticides in the St. Lawrence River. *The Science of the Total Environment* 97/98:595-615.

Metcalfe-Smith, J., L. Richman, R. Santiago, J. Biberhofer and J. Anderson. 1995. Chemical characterization of St. Lawrence River sediments in the vicinity of the oil tank storage area, Cornwall, Ontario. St. Lawrence River Remedial Action Plan Technical Report No. 6. January 1995. 17 pp. + Tables, Figures & Appendices.

MISA Monitoring. 1988. Thirty-seven municipal water pollution control plants. Pilot monitoring study. Volume II. Appendix "A". Environment Ontario. Municipal/Industrial Strategy for Abatement. December 1988.

MNR. 1995. Guidelines for Collecting Baseline Aquatic Habitat Data in the Great Lakes Areas of Concern (Interim). March 1995.

MOE. 1979. Concentrations of mercury in sediments and fish in the St. Lawrence River, 1975. Second edition. Ontario Ministry of the Environment, Southeastern Region. 94 pp.

MOEE/MNR Guide to Eating Ontario Sport Fish. Published every second year.

MOEE. 1996. Western Lake Erie clean up: phosphorus control or zebra mussel effect? An example of the value of long-term data. MOEE-STB Technical Bulletin No. AqSS-11. August 1996.

Morin, J. P. Boudreau and M. Leclerc. 1994. Lac Saint-François: les bases de la modélisation hydrodynamique. Rapport de recherche No R-412. Octobre 1994. INRS-Eau, Québec.

Mousseau, P. 1996. Black-crowned night heron. *In: The Breeding Birds of Quebec* (J. Gauthier and Y. Aubry, eds.). Canadian Wildlife Service, Environment Canada, Quebec Region. pp. 254-257.

Mudroch, P. (in prep). St. Lawrence RAP Technical Report No. 5. Assessment of sediment quality at the Cornwall area of the St. Lawrence River, 1991. Environment Canada. March 1992.

Nicholls, K. 1996. Western Lake Erie cleanup: phosphorus control or zebra mussel effect? An example of the value of long-term data. MOEE, STB Technical Bulletin No. AqSS-11. August 1996. 3 pp.

NYSDEC (New York State Department of Environmental Conservation). 1990. St. Lawrence River at Massena Remedial Action Plan: Stage 1. November 1990.

OMOE. 1991a. Preliminary report on the first six months of process effluent monitoring in the MISA pulp and paper sector (January 1, 1990 to June 30, 1990). Environment Ontario. Municipal/Industrial Strategy for Abatement. February 1991.

OMOE. 1991b. Preliminary report on the second six months of process effluent monitoring in the MISA pulp and paper sector (July 1, 1990 to December 31, 1990). Environment Ontario. Municipal/Industrial Strategy for Abatement. February 1991.

Ontario Ministry of the Environment. 1979. Concentration of mercury in sediments and fish in the St. Lawrence River, 1975. Second edition. OMOE Southeastern Region Report. 94 pp.

Ontario Ministry of the Environment. 1991. Grey water disposal from pleasure boats. January 1991. OMOE report. 48 pp.

Owen, G.E. and D. M. Veal. 1968. Report on preliminary biological surveys of the St. Lawrence River 1966-1967. Ontario Water Resources Commission. December 1968. 39 pp.

Persaud, D., R. Jaagumagi and A. Hayton. 1992. Guidelines for the protection and management of aquatic sediment quality in Ontario. Environment Ontario report (June 1992) ISBN 0-7729-9248-7. PIBS 1962. 23 pp.

Pettit, K.E., C.A. Bishop, D.V. Weseloh, R.J. Norstrom. 1994. An Atlas of Contaminants in Eggs of Fish-eating/Birds of the Great Lakes (1989-1992), 2 vols. Technical Report No. 194. Canadian Wildlife service, Ontario Region.

Pilon, R.E. and S.B. Karl. 1992. Raisin Region Conservation Authority St. Lawrence Beaches Study Final Report. 24 pp. + Appendices A-E.

Poulton, D.J. 1994. 1991 Cornwall low-level metals survey. Ontario Ministry of Environment and Energy. PIBS 2824. ISBN 0-7778-1317-3. 63 pp. + App. A-E.

Raloff, J. 1992. From tough ruffe to quagga. *Science News* 142: 56-58.

Ricciardi, A., F.G. Whoriskey and J.B. Rasmussen. 1995. Predicting the intensity and impact *Dreissena* infestation on native unionid bivalves from *Dreissena* field density. *Can. J. Fish. Aquat. Sci.* 52: 1449-1461.

Richman, L. 1996. St. Lawrence River sediment assessment, 1994, Cornwall, Ontario. St. Lawrence RAP Technical Report No. 7. 62 pp. + App. A1-A8.

Richman, L. 1994. St. Lawrence River sediment and biological assessment 1991. Ontario Ministry of Environment and Energy. ISBN 0-7778-2743-3.

11. References

Richman, L.A., G. Rupert and H. Young. 1997. Water Quality of Sutherland Creek, 1994, Cornwall, Ontario. St. Lawrence RAP Technical Report No. 8. Lake St. Francis Tributary Restoration, Sutherland Creek Rehabilitation Project. MOEE, MNR.

Riley, J.L. and P. Mohr. 1994. The Natural Heritage of Southern Ontario's Settled Landscapes. A Review of Conservation and Restoration Ecology for Land-Use and Landscape Planning. OMNR, Southern Region, Aurora, Ontario. 78 pp.

Rukavina, N. 1996. Site selection and GIS analysis of contaminated sediment distribution and volume for the proposed Courtaulds' dredge site, Cornwall, Ontario. NWRI Contribution No. 96-204. 13 pp. + 11 Figures + 6 Tables.

Rukavina, N. and J. Biberhofer. 1993. St. Lawrence River bottom sediment distribution at the Tank Farm site, Cornwall, Ontario. NWRI Technical Note No. LRB-93-TN-(draft). 15 pp.

Russell, R. W., S.J. Hecnar and G. D. Haffner. 1995. Organochlorine pesticide residues in southern Ontario spring peepers. *Environ. Toxicol. and Chem.* 14: 815-817.

Ryan, F.A. and A.E. Edmonds. 1992. Municipal-Industrial Strategy for Abatement (MISA) Twelve Month Monitoring Data Report, Inorganic Chemical Sector. (Periods covered: December 1, 1989 to November 30, 1990; February 1, 1990 to January 31, 1991). MOEE. Queen's Printer for Ontario, March 1992.

Schroeter and Associates. 1993. Toxic contaminant loadings from municipal sources in Ontario RAP sites. Final report submitted to Wastewater Technology Centre, Canada Centre for Inland Waters, Burlington, Ontario. Contract No. KA168-2-2215.

Sloterdijk, H. 1991. Mercury and organochlorinated hydrocarbons in surficial sediments of the St. Lawrence River (Lake St. Francis). *Water Poll. Res. J. Canada* 26:41-60.

Smith, V.E., J. M. Spurr, J.C. Filkins and J.J. Jones. 1985. Organochlorine contaminants of wintering ducks foraging on Detroit River Sediments. *J. Great Lakes Res.* 11: 231-246.

Snell, E.A. 1986. Wetland loss in southern Ontario. Working Paper, Lands Directorate, Sustainable Development Branch, Environment Canada, Ottawa, Ontario.

St. Lawrence RAP Team. 1992. Remedial Action Plan for the Cornwall-Lake St. Francis Area. Stage 1 Report: Environmental Conditions and Problem Definitions. Environment Canada & Environment Ontario. ISBN 0-662-19958-8.

St. Lawrence RAP Team. 1994. Addendum to the Stage 1 Report of the St. Lawrence RAP (Cornwall-Lake St. Francis). Environment Canada and Ontario Ministry of Environment & Energy.

St. Lawrence RAP Team and St. Lawrence (Cornwall) Public Advisory Committee. 1994. Choices for Cleanup: Deciding the Future of A Great River. St. Lawrence River Remedial Action Plan Options Discussion Paper. August 1994. 85. pp.

St. Lawrence River Committee on Gauging. 1985-1995. Report of the St. Lawrence River Committee on Gauging to the international River Board of Control. Reports 37-47 (1985-1995).

Struger, J., J.E. Elliott, C.A. Bishop, M.E. Obbard, R.J. Norstrom, D.V. Weseloh, M. Simon and P. Ng. 1993. Environmental contaminants in eggs of the common snapping turtle (*Chelydra serpentina serpentina*) from the Great Lakes-St. Lawrence River basin of Ontario, Canada (1981-1984). *J. Great Lakes Res. 19: 681-694.*

Suns, K. and G. Hitchin. 1991. Spatial and temporal trends of organochlorine contaminants in spottail shiners (*Notropis hudsonius*) from the Great Lakes and their connecting channels (1975-1988). Water Resources Branch, Ontario Ministry of the Environment.

Suns, K., G. Hitchin, D. Toner. 1993. Spatial and temporal trends of organochlorine contaminants in spottail shiners from selected sites in the Great Lakes (1975-1990). *J. Great Lakes Res.* 19(4):703-714.

Sustainable Futures, IndEco Strategic Consulting Inc, Ottawa University Institute for Research on Environment and Economy, Econometric Research Ltd and Anacapa Consulting Services. 1995. Development potential and other benefits from restoration, enhancement and protection of the St. Lawrence (Cornwall) Area of Concern. Report prepared for Environment Canada. 79 pp.

Swabey, Y. 1964. A study of the flavour of fishes from Lake St. Lawrence, St. Lawrence River and Lake St. Francis. Division of Laboratories. Ontario Water Resources Commission. 24 pp.

Thomas, V.G. 1992. Legislative, socio-political and economic analysis of toxic versus non-toxic ammunition use in Canada. Report to the Canadian Wildlife Service, Ottawa.

Thomas, V.G. and M.A. Pokras (in press). International analysis of non-toxic shot adoption for waterfowling. Proceedings of the International Union of Game Biologists XXI Congress, 15-20 August 1993. Halifax, Nova Scotia.

Trudel, L. 1991. Dioxins and furans in bottom sediments near 47 Canadian pulp and paper mills using chlorine bleaching. Environment Canada, Ottawa. 88 pp.

Tuszynski, T.M. 1992. Twelve Month Monitoring Data Report, Organic Chemical Manufacturing Sector (Period covered: October 1, 1989 to July 31, 1991). MOEE. Queen's Printer for Ontario, September 1992. ISBN 0-7778-0032-2.

United States Fish and Wildlife Service. 1986. Use of lead shot for hunting migratory birds in the United States. Final Supplemental Environmental Impact Statement. US Dept. of Interior, Fish and Wildlife Service, Washington, DC.

Weseloh, D.V., T.W. Custer and B.M. Braune. 1989. Organochlorine contaminants in eggs of common terns from the Canadian Great Lakes, 1981. *Environ. Pollut.* 59: 141-160.

Weseloh, D.V. , P. Hamr, C. A. Bishop and R.J. Norstrom. 1995. Organochlorine contaminant levels in waterbird species from Hamilton Harbour, Lake Ontario an IJC Area of Concern. *J. Great Lakes Res.* 21: 121-137.

White, D.H., W.J. Fleming and K.L. Ensor. 1988. Pesticide contamination and hatching success of waterbirds in Mississippi. *J. Wildl. Manage.* 52: 724-729.

APPENDIX I. REJECTED REMEDIAL OPTIONS

During Stage 2 of the Cornwall RAP, the PAC and the RAP Team undertook a detailed examination of 233 remedial options in the process described elsewhere in this report. Some of these options were accepted, some were combined to form a single option, and others were rejected. The table in Appendix I lists remedial options that were rejected during the options review process. In Fall 1994, the PAC consulted with the broader public in the AOC and incorporated the input received into the final set of accepted remedial options.

Remedial options rejected during Stage 2 of Cornwall RAP
* Acronyms used in the table: M=mercury; OC=other contaminants besides mercury and PCBs; PCB=PCBs; B=bacteria; NAP=nuisance aquatic plants; H=habitat degradation and destruction; E=exotic species.

Issues	Rejected Remedial Option	Comments/Explanation Regarding Decision to Reject
M*	Impose tighter restrictions on allowable mercury loadings based on BATEA.	This option was rejected in favour of recommending that ICI replace its mercury cell process with a process that does not require mercury. With the March 1995 closure of ICI's chlor-alkali plant, options dealing with discharges of mercury from ICI were replaced by Recommendations # 11 and 13.
M	Impose tighter restrictions on allowable mercury loadings to allow unlimited consumption of fish.	Rejected because it is not consistent with the RAP's long-range goal (Recommendations # 1 and 4) of ensuring that mercury use in the Great Lakes basin is eventually eliminated entirely.
M	Stay with ICI mercury cell process and change in-plant process to eliminate liquid effluent (i.e., evaporate effluent).	This is an end-of-pipe change, not a process change, and would generate contaminated sludge which would still have to be disposed of.
M	Go to US BAT levels (15 g/day) in ICI liquid effluent.	This option was rejected in favour of recommending that ICI replace its mercury cell process with a process that does not require mercury. With the March 1995 closure of ICI's chlor-alkali plant, options dealing with discharges of mercury from ICI were replaced by Recommendations # 11 and 13.
M	Strengthen existing federal regulations for the allowable release of mercury from chlor-alkali plants.	This option was rejected in favour of recommending that ICI replace its mercury cell process with a process that does not require mercury. With the March 1995 closure of ICI's chlor alkali plant, options dealing with discharges of mercury from ICI were replaced by Recommendations # 11 and 13.

Issues	Rejected Remedial Option	Comments/Explanation Regarding Decision to Reject
M	Retrofit ICI ventilation systems with emission controls.	This option was rejected in favour of recommending that ICI replace its mercury cell process with a process that does not require mercury. With the March 1995 closure of ICI's chlor-alkali plant, options dealing with discharges of mercury from ICI were replaced by Recommendations # 11 and 13.
M	Reduce ICI air emissions of mercury to BAT levels.	This option was rejected in favour of recommending that ICI replace its mercury cell process with a process that does not require mercury. With the March 1995 closure of ICI's chlor-alkali plant, options dealing with discharges of mercury from ICI were replaced by Recommendations # 11 and 13.
M B	Reduce bacterial contamination and mercury recycling in the river by removing dead eels and dead aquatic weeds.	Rejected as unfeasible and not particularly effective.
M OC	Do nothing more about upstream sources of mercury and other contaminants. Concentrate efforts on controlling local sources, by relying on implementation of MISA program.	Rejected because upstream sources are significant contributors and it was decided that the RAP should make a statement about virtual elimination.
M OC	Totally eliminate Cornwall Chemicals effluent by evaporation.	Carbon tetrachloride and chloroform are contained in the effluent. Since they are volatile compounds, they would contaminate the vapour created by this process.
OC	Remove fuel tanks from Universal Terminals site.	There is insufficient evidence of environmental problems associated with the tanks to warrant this action.
M OC PCB	For Canadian hot spots influenced by US remediation efforts, hold decision on Canadian cleanup until cleanup is completed on American side.	No hotspots have been identified that fit this category.
B	Control populations of gulls and geese at beaches.	The beaches on which gulls and geese are a problem are not located within the AOC.
B	Replace contaminated sediment at beach areas.	The problem is not severe enough to warrant such intrusive and potentially disruptive measures.
B	Disinfect contaminated sediment at beach areas.	The problem is not severe enough to warrant such intrusive and potentially disruptive measures.
B	Increase flow at beaches and other public swimming areas by removing breakwaters and harvesting weeds.	There is inadequate evidence indicating that this approach would be effective.

Appendix I

Issues	Rejected Remedial Option	Comments/Explanation Regarding Decision to Reject
B	Close or relocate problem beaches.	Since the Great Lakes Water Quality Agreement cites closed beaches as an impairment of beneficial use, this is not an adequate solution to the problem of bacterially contaminated beaches.
B	Increase water quality guideline level to 200 E. coli/100 ml.	This is not acceptable because it is a reduction in water quality standards.
NAP	Install phosphorus removal for effluent from Domtar, ICI, Cornwall Chemicals.	Rejected in favour of Recommendation # 12. Domtar effluent already has phosphorus at 0.6 mg/L, although Domtar's flow/loading are about 2.5 times greater than Cornwall WPCP. The RAP could strive for a ceiling on phosphorus loadings from all sources (using pollution credits) but there is no indication that this is needed for the St. Lawrence AOC.
NAP	Upgrade treatment facilities at Cornwall and Glen Walter plants by requiring P control to 0.3 ppm level.	These plants already require secondary treatment, which can achieve 0.5 mg/L total P. It is therefore not worthwhile in terms of cost to require phosphorus removal.
NAP	Upgrade sewage treatment facilities by installing tertiary treatment.	The cost of this option is not justified to reach 0.3 mg/L since secondary treatment can achieve 0.5 mg/L.
NAP	Upgrade sewage treatment facilities by requiring denitrification.	This option would do nothing to control nuisance aquatic plants because nitrogen is not limiting for plant growth in Lake St. Francis.
NAP	Relocate the Cornwall WPCP diffuser to ensure that all flow enters the main current.	This approach cannot be justified technically and was rejected as too great a cost for too little return.
NAP	Install the appropriate treatments at municipal water treatment plants to eliminate odour & taste problems caused by algae. Alternatives to chlorine treatment would include ozonation, UV.	The problem is not serious enough to justify the cost of this option.
NAP	Reduce allowable speed limit for large ships.	The speed of large ships is already regulated and monitored by Seaway officials. Maximum speed is set at the minimum required to allow steerage.
NAP	Find an alternative area (other than the river) for disposal of harvested vegetation.	The problem is not great enough to warrant the expense. Also, studies on the environmental effects of cut, grind and return method and showed that the impact is minimal.

Issues	Rejected Remedial Option	Comments/Explanation Regarding Decision to Reject
NAP	Allow the use of chemical herbicides by individuals to provide access lanes for boating adjacent to their shoreline.	Chemical herbicides are not effective in flowing systems. This option was therefore rejected as an unnecessary addition of toxic chemicals to waterways.
NAP	Allow the dredging of aquatic vegetation (plants & substrate).	Rejected because dredging would have too many negative effects.
NAP	Increase the flow down the Raisin River by directing water from Lake St. Lawrence to the Raisin River to increase water levels and flows in the Raisin River as it enters Lake St. Francis.	Rejected as too large a project for too little environmental return.
NAP	Add lime, alum, iron or a nitrate injection to reduce availability of phosphorus.	Rejected because feasibility is questionable.
NAP	Investigate the use of zebra mussels for providing nearshore reductions in algal densities.	Rejected because we want to discourage, not encourage, colonization by zebra mussels.
NAP	Introduce herbivorous fish species such as grass carp for grazing.	The problem doesn't warrant such an ecologically intrusive measure.
NAP	Lower Lake St. Francis water levels in the winter.	It is not feasible or desirable to do this because of the impact it would have on shoreline properties.
H	Require developers of shoreline wetlands to replace these areas along the shoreline.	Rejected because replacement areas built by developers are usually of inferior quality.
H	Increase enforcement of the Fisheries Act and the Public Lands Act by increasing the amount of time and money spent on detecting and prosecuting violations.	Rejected by virtue of selecting Recommendation # 51.

Issues	Rejected Remedial Option	Comments/Explanation Regarding Decision to Reject
H	Establish a seasonal water level management program with the International Seaway Board of Control and the province of Quebec to seasonally flood shoreline and mid-winter wetlands in Lake St. Francis.	This degree of flooding would not be allowed under Plan 1958D, International St. Lawrence River Board of Control.
H	Alter water levels and manage flows under Plan 1958 D and in cooperation with the province of Quebec to protect or enhance specific fish and wildlife habitats by providing a more suitable and natural variation in water levels.	Rejected as not feasible because sufficient water level variation would require flooding in Quebec.
H	Where development projects are proposed for wetlands and nearshore aquatic plant beds, ensure that wetland value enhancement is incorporated into the project.	Rejected because replacement habitats built by developers are usually of inferior quality. Wetland protection provided for through implementation of Recommendations 46, 47, 48 and 49.
E	All regulatory agencies should take appropriate actions to ensure that there are no intentional or accidental introductions of non-indigenous organisms.	Rejected because agencies may in some cases decide to intentionally introduce exotic species for specific purposes (e.g., MNR has experimentally released a European beetle that preys on purple loosestrife).
E	Continue to request voluntary ballast water exchange for international shipping.	Rejected in favour of Recommendation 63 (mandatory treatment or exchange) because not 100% effective on a voluntary basis.
E	Regulate purple loosestrife as a noxious weed under federal and provincial legislation.	Rejected as ineffective and difficult to enforce. Decided to include purple loosestrife in education strategy instead.
E	Discourage the sale of purple loosestrife as a horticultural species.	Rejected as ineffective. Decided to include purple loosestrife in education strategy instead.

APPENDIX II. LINKAGE BETWEEN RAP RECOMMENDATIONS AND GOALS OF THE CORNWALL PUBLIC ADVISORY COMMITTEE

During Stage 1 of the RAP, the PAC developed a set of goals which are the cornerstone of the PAC's agenda and the development of the Stage 2 report. The Goals Subcommittee led the PAC discussion on amendments to the goals and their final adoption, after which this subcommittee was disbanded. This Appendix indicates the linkages between each RAP Recommendation and the PAC Goals.

GOALS OF THE ST. LAWRENCE RIVER (CORNWALL) PAC

Use Goals

Ecosystem Health

Restore the ecosystem in the area of concern such that populations of flora and fauna including humans be robust and self-sustaining in a balanced community, by:

- rehabilitating and protecting required habitats;
- ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects;
- preventing adverse impacts resulting from the introduction of non-native species.

Municipal Use of Water

Have an unlimited quantity of aesthetically pleasing water for municipal use, free from toxic or other potentially hazardous substances and effects.

Consumptive Use of Fish and Wildlife

Improve the quality of fish and wildlife for sustained human consumption, by:

- eliminating persistent toxic substances in fish and wildlife;
- reducing the level of naturally occurring metals to background (natural) levels; and
- ensuring that the odour and taste of fish and wildlife are not impaired by water quality.

Swimming

Ensure that swimming or other water contact sports are not impeded by water quality.

Boating

Improve recreational boating in current areas of use, principally by improving the usefulness of existing channels.

Recreational

Increase the enjoyment provided by other recreational uses such as wildlife viewing, hunting and sport fishing by:

- restoring the required flora and fauna;
- improving the aesthetics of the river and the shore; and
- maintaining access to these resources.

Industrial Use of Water

Ensure an adequate quantity and quality of water for industrial use.

Navigation

Maintain sufficient water depth for legitimate and safe seaway operation.

Power Generation

Maintain the use of St. Lawrence River water resources for the production of electricity in conjunction with environmental considerations.

Source Goals

Municipal Discharge

Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.

Industrial Discharge

Industries shall provide proper treatment for their effluent and, where necessary, modify their processes to ensure their effluents will be free from toxic and other potentially hazardous substances and effects.

Other Sources

Control the impacts from other sources by eliminating toxic and other potentially hazardous substances and effects.

Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging.

Activities for achieving this goal include:

- controlling erosion into tributaries and along shorelines;
- reducing nutrient inputs;
- preventing ground water contamination;
- eliminating atmospheric deposition of toxic and other potentially hazardous substances in the watershed;
- reducing bacterial inputs;
- controlling the impacts of sediment resuspension.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#1 Ask the federal and provincial governments to show more tangible evidence of their commitment to the goal of virtual elimination of persistent toxic contaminants by using their legislative authorities to ban the use of mercury and production of persistent toxic compounds like dioxins and dibenzofurans.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife and reducing the level of naturally occurring metals to background (natural) levels. Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects. Industries shall provide proper treatment for their effluent and, where necessary, modify their processes to ensure their effluents will be free from toxic and other potentially hazardous substances and effects. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects.
#2 Recommend that lead shot be banned from the Great Lakes-St. Lawrence Basin and replaced by a non-toxic, non-bioaccumulating type of shot. Encourage anglers to switch to non-toxic sinkers and jigs through voluntary exchange programs such as Bay of Quinte RAP's Take A Little Lead Out! program.	Increase the enjoyment provided by...recreational uses such as wildlife viewing, hunting and sport fishing by restoring the required flora and fauna. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects.
#3 Recommend that parties to the Great Lakes Water Quality Agreement negotiate an agreement regarding long-range transport of airborne mercury and PCBs into the area of concern.	Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating atmospheric deposition of toxic and other potentially hazardous substances in the watershed.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#4 Recommend that the governments of New York State, Ontario, the United States and Canada develop and implement the Niagara River Toxics Management Plan and the Lakewide Management Plans and recommend that these plans call for elimination of the production, use and release of mercury and other persistent toxic substances like dioxins and dibenzofurans.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife and reducing the level of naturally occurring metals to background (natural) levels. Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects. Industries shall provide proper treatment for their effluent and, where necessary, modify their processes to ensure their effluents will be free from toxic and other potentially hazardous substances and effects. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects.
#5 Establish federal and provincial regulations banning the manufacture and sale of all detergents containing phosphates.	Have an unlimited quantity of aesthetically pleasing water for municipal use, free from toxic or other potentially hazardous substances and effects. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include reducing nutrient inputs.
#6 Recommend that OMAFRA vigorously pursue its pesticides reduction goal in the Great Lakes-St. Lawrence River Basin by encouraging improved chemical herbicide/pesticide application practices, integrated pest management and other alternative farming practices that reduce the environmental impact of pest and weed control.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife... Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include preventing groundwater contamination.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#7 Recommend that all authorities involved in managing public lands, transportation routes and transmission corridors in the Great Lakes-St. Lawrence River Basin do the following: (1) provide an inventory of their herbicide and pesticide use, and (2) develop and implement strategies that will reduce their use of these chemicals in the Basin by 50% by the year 2002.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife... Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include preventing groundwater contamination.
#8 Ensure enforcement of legal limits set by MISA and Federal Pulp and Paper Regulations.	Industries shall provide proper treatment for their effluent and, where necessary, modify their processes to ensure their effluents will be free from toxic and other potentially hazardous substances and effects.
#9 Install state-of-the-art technologies that reduce or concentrate Domtar effluent.	Industries shall provide proper treatment for their effluent and, where necessary, modify their processes to ensure their effluents will be free from toxic and other potentially hazardous substances and effects.
#10 Identify sources of PAHs in Domtar effluent and take steps to control or eliminate them.	Industries shall provide proper treatment for their effluent and, where necessary, modify their processes to ensure their effluents will be free from toxic and other potentially hazardous substances and effects.
#11 Track decommissioning of Courtaulds Fibres, ICI Forest Products (mercury cell process), Cornwall Chemicals and other closed plants via participation of RAP Team through MOEE and public consultation with PAC.	Control the impacts from other sources by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include: controlling erosion into tributaries and along shorelines; reducing nutrient inputs; preventing ground water contamination; eliminating atmospheric deposition of toxic and other potentially hazardous substances in the watershed; reducing bacterial inputs; controlling the impacts of sediment resuspension.
#12 Recommend that current and all future industries that are direct dischargers in the area of concern operate plants to achieve a compliance limit of 1 mg/L (monthly average) total phosphorus and an objective of 0.5 mg/L.	Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include reducing nutrient inputs.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#13 Although air quality issues not affecting water quality are outside the RAP mandate, they are integral to ecosystem health. It is therefore recommended that the activity of the existing MOEE air monitoring working group for the City of Cornwall and surrounding area should be continued and expanded to include identification of remedial actions This MOEE working group should be extended to include a public participation component.	Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating atmospheric deposition of toxic and other potentially hazardous substances and effects.
# 14 Implement a Canada/US monitoring program to track site-specific and AOC-wide impacts of American sediment remediation efforts.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include controlling the impacts of sediment resuspension.
#15 Develop appropriate federal/provincial positions on remediation of the Reynolds Metals, ALCOA and GM sites by means of the Canadian Review Panel, which reviews the various cleanup plans for PCBs, PAHs, dioxins and dibenzofurans.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include controlling the impacts of sediment resuspension.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#16 In areas where contaminant levels in sediment are below the severe effect level but above the lowest effect level, implement source control measures to prevent further contamination of sediment and allow remediation of contaminated sediment to occur by means of burial by the natural sedimentation process.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include controlling the impacts of sediment resuspension.
#17 In areas where contaminant levels in sediment exceed the severe effect level for mercury, PCBs or other persistent toxic contaminants or where the sediment is found to be acutely toxic (i.e., the "hot spots"), prevent further contamination by implementing source control measures and remediate sediment by the most appropriate state-of-the-art technology (e.g., dredging, capping, in situ treatment).	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife and reducing the level of naturally occurring metals to background (natural) levels. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include controlling the impacts of sediment resuspension.
#18 Participate in additional studies to determine whether the land-based contamination at Cornwall Harbour is affecting the River. If there is an impact, ensure that the appropriate corrective actions are taken to protect the River.	Control the impacts from other sources by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include preventing ground water contamination.
#19 Upgrade Cornwall sewage treatment plant to secondary treatment or equivalent treatment consistent with the MOEE Municipal MISA program.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#20 Recommend that the City of Cornwall provide carbon filtration treatment (or equivalent) for its drinking water to eliminate taste and odour problems.	Have an unlimited quantity of aesthetically pleasing water for municipal use, free from toxic or other potentially hazardous substances and effects.
#21 Find and eliminate the source of PCBs in spottail shiners collected from the Cornwall waterfront.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects. Improve the quality of fish and wildlife for sustained human consumption, by eliminating persistent toxic substances in fish and wildlife.
#22 Monitor progress in implementing recommendations of the City of Cornwall's Pollution Control Plan (PCP) to ensure that pollution problems associated with the City's sewer systems are corrected as recommended in the Plan.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#23 Encourage careful use of water by implementing a volume-based water pricing system.	Have an unlimited quantity of aesthetically pleasing water for municipal use, free from toxic or other potentially hazardous substances and effects.
#24 Require new dwellings to use water-saving devices such as low volume toilets and shower heads and institute a program of retrofitting old houses for water conservation.	Have an unlimited quantity of aesthetically pleasing water for municipal use, free from toxic or other potentially hazardous substances and effects.
#25 Recommend that the City of Cornwall review and update its sewer use by-laws by incorporating the latest version of MOEE's Model Sewer Use By-Law.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#26 Recommend that the City of Cornwall modify the snow dump site to contain surface runoff, and that they undertake a feasibility study to find a more acceptable long term solution to the problem.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#27 Request that in its Official Plan, the City of Cornwall delineate zones of coal tar contamination and define development constraints for those zones and that a Notice on Title be registered for all of the affected properties.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by ensuring that the reproduction and health of individuals is not impaired by toxic and other potentially hazardous substances and effects.
#28 Upgrade Glen Walter sewage treatment plant to achieve a compliance limit of 1 mg/L total phosphorus and an objective of 0.5 mg/L.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#29 Recommend phosphorus removal to a compliance limit of 1 mg/L, with an objective of 0.5 mg/L, at all wastewater treatment systems along the St. Lawrence River upstream of Cornwall.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#30 Recommend that New York State install treatment facilities for phosphorus removal at its sewage treatment plants discharging into the St. Lawrence River and its tributaries.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#31 Control stormwater discharges from municipalities other than Cornwall, particularly roads and communities along the Raisin and St. Lawrence Rivers, by collecting and treating stormwater.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#32 Install proper septic systems on private shoreline properties where land is sufficient and can meet existing regulations; carry out inspections to ensure compliance.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#33 Where land is not sufficient, install holding tanks and institute municipal or other regulatory agency collection to the sewage treatment plant, with costs included in annual property tax assessments.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#34 As a long-term plan, install sewage treatment plants for river communities, including Summerstown, South Lancaster, Pilon and Cornwall Islands and Bainsville.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#35 Inspect park and campground sewage disposal systems and correct deficient systems.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#36 Where feasible, collect and treat stormwater and discharge at downstream end of beach.	Municipalities shall provide proper treatment of sewage and stormwater before discharge to the river. The treatment should ensure that municipal effluent is free from toxic and other potentially hazardous substances and effects.
#37 Eliminate livestock access to surface waters by providing education and financial incentives to farmers and by enforcing existing regulations.	Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include controlling erosion into tributaries and along shorelines, reducing nutrient inputs and reducing bacterial inputs.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#38 Inspect manure piles and milkhouse waste disposal systems which have the potential to be sources of surface water contamination, and correct by: (1) providing education to farmers on how to correct the problem; (2) providing financial incentives to farmers; (3) enforcing existing regulations; (4) incorporating into municipal zoning by-laws, the Agricultural Code of Practice regarding manure/milkhouse wastes; (5) establishing a bioconversion facility for production of fertilizer from manure and other organic sludges pending feasibility study (to determine available manure supply, interest in participation etc.)	Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include controlling erosion into tributaries and along shorelines, reducing nutrient inputs and reducing bacterial inputs.
#39 Endorse the Farm environmental Plan program described in Our Farm Environmental Agenda as part of the development of an agricultural land stewardship program.	Restore the ecosystem in the area of concern such that populations of flora and fauna including humans be robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include controlling erosion into tributaries and along shorelines, reducing nutrient inputs and reducing bacterial inputs.
#40 Regulate discharges of grey water from new boats.	Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include reducing nutrient inputs and reducing bacterial inputs.
#41 Increase enforcement of existing regulation for discharge of black water.	Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Activities for achieving this goal include reducing nutrient inputs and reducing bacterial inputs.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#42 Support managed mechanical harvesting as a continued option for controlling nuisance aquatic macrophytes in selected areas of Lake St. Francis.	Improve recreational boating in current areas of use, principally by improving the usefulness of existing channels.
#43 Prohibit the use of chemical herbicides by individuals to provide access lanes for boating adjacent to shoreline properties. The only exceptions to be considered will be in artificial canals with no flow.	Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects.
#44 Continue to allow individuals to physically remove (under permit) a predetermined and limited amount of aquatic vegetation from the water in front of their property.	Ensure that swimming or other water contact sports are not impeded by water quality. Improve recreational boating in current areas of use, principally by improving the usefulness of existing channels.
#45 Mechanically harvest plants over several hectares of Bainsville Bay to improve water circulation and flow in the Bay and increase dissolved oxygen levels.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.
#46 As a first priority, acquire all wetlands on Lake St. Francis now privately owned.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.
#47 As a second priority, secure all additional provincially significant wetlands in the watershed.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#48 Encourage municipalities to continue to implement the Provincial Natural Heritage Policy (1996) which requires all planning agencies to have regard for provincially significant wetlands in their planning decisions. The Policy calls for no development in provincially significant wetlands and no development on adjacent lands if the wetland will be affected. This policy is to be interpreted as part of all the new Planning Act policies by municipalities and agencies.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.
#49 Encourage municipalities to protect wetlands that are not provincially significant by requesting that they include development constraints and buffer zones around these areas.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.
#50 Establish a joint Quebec/Ontario/Mohawks of Akwesasne committee to coordinate the protection and management of wetlands in Lake St. Francis.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#51 Continue to use existing legislation (including the federal Fisheries Act, Public Lands Act, Lakes and Rivers Improvement Act, Conservation Authorities Act and Environmental Protection Act) to protect aquatic habitats (including fish habitat and wetlands) where this legislation applies. Continue to require a minimum compensation of 1:1 (new habitat created : habitat altered) for fish habitat harmfully altered by development activities. Minimum compensation should be 1:1 for like habitat on site; 1:2 for like habitat off site or replacement habitat on site; and 1:4 for replacement habitat off site.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.
#52 Change the existing provincial work permit system, to prevent any dredging or filling in any shoreline wetland unless that activity would directly enhance the function or value of the wetland.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.
#53 Develop and implement a program to identify the causes of wetland and aquatic habitat degradation in the area of concern, identify appropriate remedies and ensure their implementation.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#54 Restore and enhance wetlands by using, where appropriate and pending the EA and CEAA processes, techniques such as controlled water level impoundments, construction of open water habitats (level ditching) and shoreline reconstruction.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include controlling erosion into tributaries and along shorelines. Increase the enjoyment provided by...recreational uses such as wildlife viewing, hunting and sport fishing by restoring the required flora and fauna and improving the aesthetics of the river and the shore.
#55 Develop an integrated planning approach for shoreline development based on resource management information which would be collected and managed in a collective GIS-based database. This would include information on fish & wildlife species in the affected area, habitat type and degree of expected alteration, impacts on nearshore water currents and potential erosion impacts, and potential impacts on water quality.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include controlling erosion into tributaries and along shorelines. Increase the enjoyment provided by...recreational uses such as wildlife viewing, hunting and sport fishing by restoring the required flora and fauna and improving the aesthetics of the river and the shore.
#56 Restore shallow-water reef habitat by constructing artificial reefs at various locations including Bainsville Bay-Pointe Mouillee and the Cornwall waterfront, giving priority to areas closer to the power dam.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include controlling erosion into tributaries and along shorelines. Increase the enjoyment provided by...recreational uses such as wildlife viewing, hunting and sport fishing by restoring the required flora and fauna and improving the aesthetics of the river and the shore.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#57 Work with the Mohawks of Akwesasne to protect fish habitat and prevent shoreline degradation.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include controlling erosion into tributaries and along shorelines. Increase the enjoyment provided by...recreational uses such as wildlife viewing, hunting and sport fishing by restoring the required flora and fauna and improving the aesthetics of the river and the shore.
#58 Encourage the enhancement of the protection, number, size, quality and distribution (i.e., reduce fragmentation) of certain terrestrial habitats (i.e., mature and overmature forests, riparian habitats) and their dependent species.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats.
#59 Using the present regulatory system, continue to permit small, privately-owned shoreline properties to be stabilized on a site-by-site basis (includes shorelines of Lake St. Francis and tributaries) using erosion control techniques such as rip-rapping, revegetation, natural revetments and construction of offshore wave barriers and reefs.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include controlling erosion into tributaries and along shorelines. Increase the enjoyment provided by...recreational uses such as wildlife viewing, hunting and sport fishing by restoring the required flora and fauna and improving the aesthetics of the river and the shore.

Cornwall RAP Recommendation	Cornwall PAC Goal Addressed
#60 For specific problem areas, design the appropriate stabilization technique and implement the work as a government initiative either with public funding only or on a cost-shared basis with the landowner.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include controlling erosion into tributaries and along shorelines. Increase the enjoyment provided by...recreational uses such as wildlife viewing, hunting and sport fishing by restoring the required flora and fauna and improving the aesthetics of the river and the shore.
#61 Design a shoreline stabilization project for Pointe Mouillee, based on the completed feasibility study, which incorporates the appropriate wetland and fish habitat protection and enhancement measures.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by rehabilitating and protecting required habitats. Control the impacts from other sources [besides municipal and industrial dischargers] by eliminating toxic and other potentially hazardous substances and effects. Other sources include, but are not limited to, dredging, dumping, filling, landfill leachate, spills from shipping and bilging. Activities for achieving this goal include controlling erosion into tributaries and along shorelines. Increase the enjoyment provided by...recreational uses such as wildlife viewing, hunting and sport fishing by restoring the required flora and fauna and improving the aesthetics of the river and the shore.
#62 Recommend that all regulatory agencies ensure that no accidental introductions of exotic species occur in the area of concern and that any planned introductions are subject to the appropriate level of provincial and federal environmental assessment.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by preventing adverse impacts resulting from the introduction of non-native species.
#63 Recommend mandatory regulation requiring treatment or exchange (or some other technique) to ensure that ballast water cannot be a vector for the introduction of exotic species into the area of concern.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by preventing adverse impacts resulting from the introduction of non-native species.
#64 Discontinue chlorination as a control measure for exotic mussels as soon as a more environmentally sound method becomes available.	Restore the ecosystem in the AOC such that populations of flora and fauna including humans are robust and self-sustaining in a balanced community, by preventing adverse impacts resulting from the introduction of non-native species.

APPENDIX III. LINKAGE BETWEEN CORNWALL RAP RECOMMENDATIONS AND COA (1994) GOALS AND TARGETS

The following table shows the linkage of each St. Lawrence RAP Recommendation with the goals and targets of the 1994 Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA). The Agreement was signed by ministers of the following federal and provincial agencies:

Federal: Environment Canada, Department of Fisheries and Oceans, Department of Agricuture and Food, Health Canada,

Provincial: Ministry of Environment and Energy, Ministry of Agriculture, Food and Rural Affairs, Ministry of Natural Resources, Ministry of Health.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#1 Ask the federal and provincial governments to show more tangible evidence of their commitment to the goal of virtual elimination of persistent toxic contaminants by using their legislative authorities to ban the use of mercury and production of persistent toxic compounds like dioxins and dibenzofurans.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem. Seek a 90% reduction in the use, generation or release of the remaining seven substances [benzo(a)pyrene, hexachlorobenzene, alkyl lead, mercury, octachlorostyrene, dioxins and furans] by the year 2000.
#2 Recommend that lead shot be banned from the Great Lakes-St. Lawrence Basin and replaced by a non-toxic, non-bioaccumulating type of shot. Encourage anglers to switch to non-toxic sinkers and jigs through voluntary exchange programs such as Bay of Quinte RAP's Take A Little Lead Out! program.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 ha of wetland habitat and 600 km of riparian habitats.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#3 Recommend that parties to the Great Lakes Water Quality Agreement negotiate an agreement regarding long-range transport of airborne mercury and PCBs into the area of concern.	The identification of atmospheric inputs of toxic chemicals, and their impacts, derived from worldwide sources, will provide a basis for supporting international negotiations to reduce loadings in the Great Lakes Basin Ecosystem. Improvements in and integrations of existing air toxic data networks and management systems to track the deposition of contaminants within the Great Lakes Basin Ecosystem will support these international negotiations. Canada and Ontario will work with the US Federal and State governments to establish a common strategy, by 1996, to eliminate the discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem.
#4 Recommend that the governments of New York State, Ontario, and the United States and Canada develop and implement the Niagara River Toxics Management Plan and the Lakewide Management Plans and recommend that these plans call for elimination of the production, use and release of mercury and other persistent toxic substances like dioxins and dibenzofurans.	Canada and Ontario reiterate their commitment to existing targets and targets under development, for toxics reductions under binational initiatives. Reduction targets will be pursued under the Niagara River Toxics Management Plan and Lakewide Management Plans. By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem. Toxic Reduction Plans for major industrial sectors will be incorporated into Lakewide Management Plans for Lakes Ontario and Superior by 2000.
#5 Establish federal and provincial regulations banning the manufacture and sale of all detergents containing phosphates.	This is linked with the overall objective of reducing phosphorus inputs from human activities as reflected in COA goals of (i) upgrading 8 primary sewage treatment plants to secondary treatment and (ii) enhancing phosphorus removal at 15 sewage treatment plants in AOCs.
#6 Recommend that OMAFRA vigorously pursue its pesticides reduction goal in the Great Lakes-St. Lawrence River Basin by encouraging improved chemical herbicide/pesticide application practices, integrated pest management and other alternative farming practices that reduce the environmental impact of pest and weed control.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#7 Recommend that all authorities involved in managing public lands, transportation routes and transmission corridors in the Great Lakes-St. Lawrence River Basin do the following: (1) provide an inventory of their herbicide and pesticide use, and (2) develop and implement strategies that will reduce their use of these chemicals in the Basin by 50% by the year 2002.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem.
#8 Ensure enforcement of legal limits set by MISA and Federal Pulp and Paper Regulations.	Seek a 90% reduction in the use, generation or release of...seven substances [benzo(a)pyrene, hexachlorobenzene, alkyl lead, mercury, octachlorostyrene, dioxins and furans] by the year 2000.
#9 Install state-of-the-art technologies that reduce or concentrate Domtar effluent.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem. Collaborate with, and provide support for, voluntary programs by industry and others to reduce the use, release or generation of Tier II substances, and establish specific timelines and targets for achieving their virtual elimination. Significant, measurable reductions in the generation and release of hazardous wastes from all sources will be the focus of cooperative activities with waste generators.
#10 Identify sources of PAHs in Domtar effluent and take steps to control or eliminate them.	Seek a 90% reduction in the use, generation or release of...seven [Tier I] substances [including the PAH benzo(a)pyrene] by the year 2000. Collaborate with, and provide support for, voluntary programs by industry and others to reduce the use, release or generation of Tier II substances, and establish specific timelines and targets for achieving their virtual elimination. [Tier II substances include 17 PAHs] Significant, measurable reductions in the generation and release of hazardous wastes from all sources will be the focus of cooperative activities with waste generators.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#11 Track decommissioning of Courtaulds Fibres, ICI Forest Products (mercury cell process), Cornwall Chemicals and other closed plants via participation of RAP Team through MOEE and public consultation with PAC.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem.
#12 Recommend that current and all future industries that are direct dischargers in the area of concern operate plants to achieve a compliance limit of 1 mg/L (monthly average) total phosphorus and an objective of 0.5 mg/L.	This is linked with the overall objective of reducing phosphorus inputs from human activities as reflected in COA goals of (i) upgrading 8 primary sewage treatment plants to secondary treatment and (ii) enhancing phosphorus removal at 15 sewage treatment plants in AOCs.
#13 Although air quality issues not affecting water quality are outside the RAP mandate, they are integral to ecosystem health. It is therefore recommended that the activity of the existing MOEE air monitoring working group for the City of Cornwall and surrounding area should be continued and expanded to include identification of remedial actions This MOEE working group should be extended to include a public participation component.	The identification of atmospheric inputs of toxic chemicals, and their impacts, derived from worldwide sources, will provide a basis for supporting international negotiations to reduce loadings in the Great Lakes Basin Ecosystem. Improvements in and integration of existing air toxic data networks and management systems to track the deposition of contaminants within the Great Lakes Basin Ecosystem will support these international negotiations.
#14 Implement a Canada/US monitoring program to track site-specific and AOC-wide impacts of American sediment remediation efforts.	The prevention and control of spills, by improving federal [and] provincial...spill prevention, preparedness and response programs...will further reduce pollutant loadings.
#15 Develop appropriate federal/provincial positions on remediation of the Reynolds Metals, ALCOA and GM sites by means of the Canadian Review Panel, which reviews the various cleanup plans for PCBs, PAHs, dioxins and dibenzofurans.	The prevention and control of spills, by improving federal [and] provincial...spill prevention, preparedness and response programs...will further reduce pollutant loadings.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#16 In areas where contaminant levels in sediment are below the severe effect level but above the lowest effect level, implement source control measures to prevent further contamination of sediment and allow remediation of contaminated sediment to occur by means of burial by the natural sedimentation process.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem.
#17 In areas where contaminant levels in sediment exceed the severe effect level for mercury, PCBs or other persistent toxic contaminants or where the sediment is found to be acutely toxic (i.e., the "hot spots"), prevent further contamination by implementing source control measures and remediate sediment by the most appropriate state-of-the-art technology (e.g., dredging, capping, in situ treatment).	Describe effects, demonstrate and implement the clean up of severely contaminated sediments, with emphasis on contamination at priority sites in RAP Areas of Concern. Demonstrate and implement new and innovative technologies directly contributing to the restoration of beneficial uses through green industry strategies and other programs of both governments.
#18 Participate in additional studies to determine whether the land-based contamination at Cornwall Harbour is affecting the River.If there is an impact, ensure that the appropriate corrective actions are taken to protect the River.	Significant, measurable reductions in the generation and release of hazardous wastes from all sources will be the focus of cooperative activities with waste generators.
#19 Upgrade Cornwall sewage treatment plant to secondary treatment or equivalent treatment consistent with the MOEE Municipal MISA program.	Upgrade eight RAP primary sewage treatment plants to secondary treatment.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#20 Recommend that the City of Cornwall provide carbon filtration treatment (or equivalent) for its drinking water to eliminate taste and odour problems.	Upgrade eight RAP primary sewage treatment plants to secondary treatment.
#21 Find and eliminate the source of PCBs in spottail shiners collected from the Cornwall waterfront.	Seek to decommission 90% of high-level PCBs in Ontario, to destroy 50% of the high-level PCBs now in storage, and accelerate the destruction of stored low-level PCB waste, by the year 2000.
#22 Monitor progress in implementing recommendations of the City of Cornwall's Pollution Control Plan (PCP) to ensure that pollution problems associated with the City's sewer systems are corrected as recommended in the Plan.	Upgrade eight RAP primary sewage treatment plants to secondary treatment. Undertake 25 stormwater quality pilot projects in Areas of Concern. Abate 40% of combined sewer overflows in Areas of Concern by implementing municipal Pollution Control Plans (PCPs).
#23 Encourage careful use of water by implementing a volume-based water pricing system.	Implement water efficiency initiatives to reduce per capita water use in the Great Lakes Basin.
#24 Require new dwellings to use water-saving devices such as low volume toilets and shower heads and institute a program of retrofitting old houses for water conservation.	Implement water efficiency initiatives to reduce per capita water use in the Great Lakes Basin.
#25 Recommend that the City of Cornwall review and update its sewer use by-laws by incorporating the latest version of MOEE's Model Sewer Use By-Law.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem.
#26 Recommend that the City of Cornwall modify the snow dump site to contain surface runoff, and that they undertake a feasibility study to find a more acceptable long term solution to the problem.	By 1996, develop a Canada-US strategy to eliminate discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#27 Request that in its Official Plan, the City of Cornwall delineate zones of coal tar contamination and define development constraints for those zones and that a Notice on Title be registered for all of the affected properties.	Protect and promote human health through education, long term monitoring and stewardship. (This includes the following goal): By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants.
#28 Upgrade Glen Walter sewage treatment plant to achieve a compliance limit of 1 mg/L total phosphorus and an objective of 0.5 mg/L.	Linked with the overall objective of reducing phosphorus inputs from human activities as reflected in COA goals of: (i) upgrading 8 primary sewage treatment plants to secondary treatment and (ii) enhancing phosphorus removal at 15 sewage treatment plants in AOCs.
#29 Recommend phosphorus removal to a compliance limit of 1 mg/L, with an objective of 0.5 mg/L, at all wastewater treatment systems along the St. Lawrence River upstream of Cornwall.	Linked with the overall objective of reducing phosphorus inputs from human activities as reflected in COA goals of: (i) upgrading 8 primary sewage treatment plants to secondary treatment and (ii) enhancing phosphorus removal at 15 sewage treatment plants in AOCs.
#30 Recommend that New York State install treatment facilities for phosphorus removal at its sewage treatment plants discharging into the St. Lawrence River and its tributaries.	Linked with the overall objective of reducing phosphorus inputs from human activities as reflected in COA goals of: (i) upgrading 8 primary sewage treatment plants to secondary treatment and (ii) enhancing phosphorus removal at 15 sewage treatment plants in AOCs.
#31 Control stormwater discharges from municipalities other than Cornwall, particularly roads and communities along the Raisin and St. Lawrence Rivers, by collecting and treating stormwater.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants. Undertake 25 stormwater quality pilot projects in Areas of Concern.
#32 Install proper septic systems on private shoreline properties where land is sufficient and can meet existing regulations; carry out inspections to ensure compliance.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#33 Where land is not sufficient, install holding tanks and institute municipal or other regulatory agency collection to the sewage treatment plant, with costs included in annual property tax assessments.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants.
#34 As a long-term plan, install sewage treatment plants for river communities, including Summerstown, South Lancaster, Pilon and Cornwall Islands and Bainsville.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants.
#35 Inspect park and campground sewage disposal systems and correct deficient systems.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants.
#36 Where feasible, collect and treat stormwater and discharge at downstream end of beach.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants.
#37 Eliminate livestock access to surface waters by providing education and financial incentives to farmers and by enforcing existing regulations.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants. By 2000, 80% of the population will have significantly increased their understanding and taken action in order to protect their health through involvement in environmental stewardship. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting...600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish Habitat with a goal of net gain in productive capacity of fish habitat basin-wide.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#38 Inspect manure piles and milkhouse waste disposal systems which have the potential to be sources of surface water contamination, and correct by: (1) providing education to farmers on how to correct the problem; (2) providing financial incentives to farmers; (3) enforcing existing regulations; (4) incorporating into municipal zoning by-laws, the Agricultural Code of Practice regarding manure/milkhouse wastes; (5) establishing a bioconversion facility for production of fertilizer from manure and other organic sludges pending feasibility study (to determine available manure supply, interest in participation etc.)	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants. By 2000, 80% of the population will have significantly increased their understanding and taken action in order to protect their health through involvement in environmental stewardship. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting...600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish Habitat with a goal of net gain in productive capacity of fish habitat basin-wide.
#40 Regulate discharges of grey water from new boats.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants.
#41 Increase enforcement of existing regulation for discharge of black water.	By 2000, achieve for the general population a 30% reduction in human health risks associated with exposure to environmental contaminants.
#42 Support managed mechanical harvesting as a continued option for controlling nuisance aquatic macrophytes in selected areas of Lake St. Francis.	Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish Habitat with a goal of net gain in productive capacity of fish habitat basin-wide.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#43 Prohibit the use of chemical herbicides by individuals to provide access lanes for boating adjacent to shoreline properties. The only exceptions to be considered will be in artificial canals with no flow.	Canada and Ontario will work with the US Federal and State governments to establish a common strategy, by 1996, to eliminate the discharge of persistent, bioaccumulative and toxic substances to the entire Great Lakes Basin Ecosystem.
#44 Continue to allow individuals to physically remove (under permit) a predetermined and limited amount of aquatic vegetation from the water in front of their property.	Apply the principles of the Federal Policy for the Management of Fish Habitat with a goal of net gain in productive capacity of fish habitat basin-wide.
#45 Mechanically harvest plants over several hectares of Bainsville Bay to improve water circulation and flow in the Bay and increase dissolved oxygen levels.	Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish Habitat with a goal of net gain in productive capacity of fish habitat basin-wide. Implement the Great Lakes Wetlands Conservation Action Plan in 1994 to protect coastal and basin wetlands.
#46 As a first priority, acquire all wetlands on Lake St. Francis now privately owned.	Implement the Great Lakes Wetlands Conservation Action Plan in 1994 to protect coastal and basin wetlands. Secure a network of protected areas representative of terrestrial and aquatic natural areas in the Great Lakes Basin by 1999.
#47 As a second priority, secure all additional provincially significant wetlands in the watershed.	Implement the Great Lakes Wetlands Conservation Action Plan in 1994 to protect coastal and basin wetlands. Secure a network of protected areas representative of terrestrial and aquatic natural areas in the Great Lakes Basin by 1999.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#48 Encourage municipalities to continue to implement the Provincial Natural Heritage Policy (1996) which requires all planning agencies to have regard for provincially significant wetlands in their planning decisions. The Policy calls for no development in provincially significant wetlands and no development on adjacent lands if the wetland will be affected. This policy is to be interpreted as part of all the new Planning Act policies by municipalities and agencies.	Implement the Great Lakes Wetlands Conservation Action Plan in 1994 to protect coastal and basin wetlands. Secure a network of protected areas representative of terrestrial and aquatic natural areas in the Great Lakes Basin by 1999.
#49 Encourage municipalities to protect wetlands that are not provincially significant by requesting that they include development constraints and buffer zones around these areas.	Implement the Great Lakes Wetlands Conservation Action Plan in 1994 to protect coastal and basin wetlands. Secure a network of protected areas representative of terrestrial and aquatic natural areas in the Great Lakes Basin by 1999.
#50 Establish a joint Quebec/Ontario/Mohawks of Akwesasne committee to coordinate the protection and management of wetlands in Lake St. Francis.	Implement the Great Lakes Wetlands Conservation Action Plan in 1994 to protect coastal and basin wetlands. Secure a network of protected areas representative of terrestrial and aquatic natural areas in the Great Lakes Basin by 1999.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#51 Continue to use existing legislation (including the federal Fisheries Act, Public Lands Act, Lakes and Rivers Improvement Act, Conservation Authorities Act and Environmental Protection Act) to protect aquatic habitats (including fish habitat and wetlands) where this legislation applies. Continue to require a minimum compensation of 1:1 (new habitat created : habitat altered) for fish habitat harmfully altered by development activities. Minimum compensation should be 1:1 for like habitat on site; 1:2 for like habitat off site or replacement habitat on site; and 1:4 for replacement habitat off site.	Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide. Secure a network of protected areas representative of terrestrial and aquatic natural areas in the Great Lakes Basin by 1999.
#52 Change the existing provincial work permit system, to prevent any dredging or filling in any shoreline wetland unless that activity would directly enhance the function or value of the wetland.	Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide. Implement the Great Lakes Wetlands Conservation Action Plan in 1994 to protect coastal and basin wetlands.
#53 Develop and implement a program to identify the causes of wetland and aquatic habitat degradation in the area of concern, identify appropriate remedies and ensure their implementation.	Implement the Great Lakes Wetlands Conservation Action Plan in 1994 to protect coastal and basin wetlands. Secure a network of protected areas representative of terrestrial and aquatic natural areas in the Great Lakes Basin by 1999. Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#54 Restore and enhance wetlands by using, where appropriate and pending the EA and CEAA processes, techniques such as controlled water level impoundments, construction of open water habitats (level ditching) and shoreline reconstruction.	Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide.
#55 Develop an integrated planning approach for shoreline development based on resource management information which would be collected and managed in a collective GIS-based database. This would include information on fish & wildlife species in the affected area, habitat type and degree of expected alteration, impacts on nearshore water currents and potential erosion impacts, and potential impacts on water quality.	Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide.
#56 Restore shallow-water reef habitat by constructing artificial reefs at various locations including Bainsville Bay-Pointe Mouillee and the Cornwall waterfront, giving priority to areas closer to the power dam.	Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#57 Work with the Mohawks of Akwesasne to protect fish habitat and prevent shoreline degradation.	Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide.
#58 Encourage the enhancement of the protection, number, size, quality and distribution (i.e., reduce fragmentation) of certain terrestrial habitats (i.e., mature and overmature forests, riparian habitats) and their dependent species.	Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem.
#59 Using the present regulatory system, continue to permit small, privately-owned shoreline properties to be stabilized on a site-by-site basis (includes shorelines of Lake St. Francis and tributaries) using erosion control techniques such as rip-rapping, revegetation, natural revetments and construction of offshore wave barriers and reefs.	Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide.
#60 For specific problem areas, design the appropriate stabilization technique and implement the work as a government initiative either with public funding only or on a cost-shared basis with the landowner.	Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide.

Cornwall RAP Recommendation	Linked COA (1994) Target/Goal
#61 Design a shoreline stabilization project for Pointe Mouillee, based on the completed feasibility study, which incorporates the appropriate wetland and fish habitat protection and enhancement measures.	Rehabilitate ecosystem function and structure of diverse self-sustaining native biological communities in 12 AOCs and other priority degraded areas in the Great Lakes Basin Ecosystem. Increase the extent of productive aquatic habitats in the Great Lakes Basin Ecosystem, including AOCs, by rehabilitating and protecting 6000 hectares of wetland habitat and 600 km of riparian habitat. Apply the principles of the Federal Policy for the Management of Fish habitat with a goal of net gain in productive capacity of fish habitat basin-wide.
#62 Recommend that all regulatory agencies ensure that no accidental introductions of exotic species occur in the area of concern and that any planned introductions are subject to the appropriate level of provincial and federal environmental assessment.	Develop and implement by 1997, joint federal and provincial action plans to control the introduction of undesirable species and mitigate the negative impacts of non-indigenous nuisance species, such as zebra mussels and ruffe.
#63 Recommend mandatory regulation requiring treatment or exchange (or some other technique) to ensure that ballast water cannot be a vector for the introduction of exotic species into the area of concern.	Develop and implement by 1997, joint federal and provincial action plans to control the introduction of undesirable species and mitigate the negative impacts of non-indigenous nuisance species, such as zebra mussels and ruffe.
#64 Discontinue chlorination as a control measure for exotic mussels as soon as a more environmentally sound method becomes available.	Develop and implement by 1997, joint federal and provincial action plans to control the introduction of undesirable species and mitigate the negative impacts of non-indigenous nuisance species, such as zebra mussels and ruffe.

APPENDIX IV. RECOMMENDATIONS ENDORSED BY THE ONTARIO PUBLIC ADVISORY COUNCIL

THE OPAC DOCUMENT OF RAP RECOMMENDATIONS

SOURCE

The OPAC Document of RAP Recommendations is a collection of recommendations that have their origin in the Stage Two Reports of the Canadian PACs and binational PACs (BPACs).

Only recommendations that were considered to be applicable to all Areas of Concern have been included in the OPAC document.

Some recommendations have been altered slightly from their original forms in order to meet the above criteria.

When more than one PAC or BPAC has submitted similar recommendations, those recommendations have been combined to avoid duplication.

The following PACs and BPACs have submitted their recommendations for inclusion in this document:

Bay of Quinte	(BQ)
Hamilton Harbour	(HH)
Metro Toronto & Region	(MT)
Niagara River	(NR)
Nipigon Bay	(NB)
Severn Sound	(SS)
St. Clair River	(SCR)
St. Lawrence River	(SLR)

PURPOSE

OPAC intends to use these recommendations to formulate its own future action plans. By drawing from this document OPAC will be able to take a more active role in initiating action for implementation of those recommendations that will have a beneficial impact on all RAPs.

Many of the recommendations, although considered important enough to be included in individual RAP Stage Two Reports, are proving to be difficult for any one PAC or BPAC to implement on its own. OPAC intends to help individual PACs or BPACs achieve their goals by campaigning for implementation of these recommendations on a universal front, using the support of all Canadian PACs and BPACs.

THE RECOMMENDATIONS OF THE ONTARIO PUBLIC ADVISORY COUNCIL

RE: GOVERNMENT REVISIONS

1. OPAC recommends that the governments of Canada and Ontario should acknowledge the environmental restoration and protection effort of local program groups and individuals. (BQ)

2. OPAC recommends that, as a priority action, the 1986 Canada-Ontario Agreement Respecting Great Lakes Water Quality (COA) should be renegotiated to clearly define the roles and cost-sharing responsibilities of the federal, provincial and municipal governments respecting RAPs and their implementation. (BQ)

3. OPAC recommends that the Ontario and Federal Governments develop an integrated cooperative ecosystem approach to management from its agencies. (NR)

4. OPAC recommends the establishment of a foundation to fund PAC initiatives within each Area of Concern. (MT)

5. OPAC recommends that the Provincial Government establish specific government funding programs for RAP implementation. (NR) (BQ)

6. OPAC recommends that the Ontario Ministries cooperate to develop improved funding programs in support of individual farm remediation activities. (MT)

7. OPAC recommends that the Federal and Provincial Agencies and the Conservation Authorities cooperatively develop watershed/subwatershed management plans. (SCR)

8. OPAC recommends that the parties to the Great Lakes Water Quality Agreement negotiate an agreement regarding long-range transport of airborne mercury and PCBs into areas of concern. (SLR)

9. OPAC recommends that the federal governments and the associated states and provinces of the United States and Canada develop and implement the Lakewide Management plans and through these plans accelerate their efforts to develop and implement the measures necessary to control and virtually eliminate toxic inputs into the Great Lakes. (BQ) (SLR)

10. OPAC recommends that the federal and provincial governments should show more tangible evidence of their commitments to the goals of virtual elimination and zero discharge of persistent toxic contaminants by making greater use of their legislative authority to ban the production and use of such substances. (SLR)

11. OPAC recommends that federal and provincial regulations be established banning the manufacture and sale of all detergents containing phosphates. (SLR)

12. OPAC recommends that Environmental Farm Plans be developed incorporating RAP objectives through the Ministry of Agriculture and Foods. (SS)

13. OPAC recommends the development of individual farm RAPs that integrate crop, soil, livestock and water management issues and maximize farmer's knowledge of, and access to financial assistance programs. (MT)

14. OPAC recommends that the province complete and finalize a lakefill policy to ensure that any lakefilling will be carried out in an environmentally sound manner. (MT)

15. OPAC recommends constant upgrading of provincial guidelines for the disposal of dredged material, so that the most up-to-date scientific information is constantly applied to the management of dredging operations. (MT)

16. OPAC recommends that in areas where contaminant levels in sediment exceed the severe effect level for mercury, PCBs or other persistent toxic contaminants or where the sediment is found to be acutely toxic (i.e. the "hot spots") prevent further contamination by implementing source control measures and remediate sediment by the most appropriate state-of-the-art technology (e.g. dredging, capping, in situ treatment).

17. OPAC recommends that the Ministry of Environment and Energy prepare a formal policy statement requiring municipalities to adopt the Ministry's model sewer use by-law, as an interim measure until MISA municipal regulations are in place. (MT)

18. OPAC recommends that recognition be secured for Remedial Action Plans as having fulfilled some of the requirements of the Environmental Assessment Process. (NR)

    (Remedial Action Plans and the Environmental Assessment Process are complementary and hierarchial documents. There are five features that are key to successful planning under the EA Act. These features are:
    - consult with affected parties
    - consider reasonable alternatives
    - consider all aspects of the environment
    - systematically evaluate net environmental effects
    - provide clear, complete documentation

    It is suggested that the public consultation process that the RAPs go through to develop their consensus based remedial action plans, should count as credit towards some of the requirements of the environmental assessment process.)

19. OPAC recommends that the finalization of the Ministry of Environment and Energy Municipal/Industrial Strategy for Abatement (MISA) regulations be accelerated and that all MISA programs be implemented. (The goal is the virtual elimination of persistent toxic contaminants from all discharges in Ontario waterways.) (SS) (MT)

20. OPAC recommends that the Ontario program to control air emission sources to be continued in order to eliminate visual and odorous emissions to make the (Great Lakes Watershed) more aesthetically pleasing. (HH)

RE: NON-POINT SOURCE DISCHARGES

21. OPAC recommends that to maintain water quality conditions (in the Great Lakes Watershed) that the Province of Ontario develop strategies to cope with projected increases in population and industry taking account of needs such as:
    - technology development,
    - drinking water intakes and waste effluent locations,
    - regulations/certificates of approval/legislation,
    - funding for municipalities faced with especially restrictive waste treatment requirements. (HH)

22. OPAC recommends that all Municipalities should be required to implement water conservation programs to reduce the wastage of water and that the Provincial Government change the relevant codes to mandate the use of water conserving fixtures in new and renovated homes. (HH) (BQ)

23. OPAC recommends that full cost pricing for water be implemented in all municipalities and that incentives be given to use water conservation devices. The RAP further recommends that revenue generated from water supply be used to upgrade the drinking and wastewater system. (MT)

24. OPAC recommends that municipalities be encouraged by MOEE to develop and improve the availability of household hazardous waste facilities. (HH)

25. OPAC recommends that all snow disposal sites should be properly designed to retain solids and leachates, and prevent off-site release of persistent toxic contaminants. (BQ)

26. OPAC recommends the use of methods to reduce the total amount of sodium chloride and other chemicals used on area roads. (MT)

27. OPAC recommends that municipalities review and update their sewer use by-laws, by incorporating the latest MOEE guidelines. (SLR)

28. OPAC recommends that all Municipalities should be required to implement and enforce long range strategies for sewer system inspection, rehabilitation replacement and maintenance. (BQ)

29. OPAC recommends that the replacement of faulty or substandard private sewage systems with properly operating systems according to Environmental Protection Act Regulations be enforced. (SS)

30. OPAC recommends that storm water management be developed by municipalities on a watershed basis. (SS)

31. OPAC recommends that all municipalities should be required to enact and enforce bylaws prohibiting the release of water from roof drains and sump pumps into their sanitary sewers. (BQ)

32. OPAC recommends that a planning legislation be encouraged for all new development proposals to include retention and treatment of stormwater during and after construction. (SS)

33. OPAC recommends better enforcement of existing guidelines for control of sediment loss from construction activities. (MT)

34. OPAC recommends that increased financial support be given to private landowners in order that they may carry out projects to reduce sediment loadings from their land. (MT)

35. OPAC recommends that the Ontario Ministry of Agriculture and Food should vigorously pursue its pesticides reduction goal by encouraging alternate application practices, and integrated pest management. (BQ)

36. OPAC recommends that the stricter regulations on the use of pesticides be investigated and developed. (MT)

37. OPAC recommends that livestock access to surface water be eliminated by providing education and financial incentives to farmers and by enforcing existing regulations. (SLR)

38. OPAC recommends that all areas of concern endorse the Farm Environmental Plan program as part of the development of an agricultural land stewardship program. (SLR)

39. OPAC recommends that all authorities involved in managing public lands, transportation routes and transmission corridors should be required to (1) provide an inventory of their herbicide and pesticide use and (2) develop and implement strategies that will reduce their use of these chemicals by 50% within five years. (BQ)

40. OPAC recommends that all municipalities should be required to enact and enforce domestic pet litter bylaws and that private campground be encouraged to regulate in a similar manner. (BQ)

41. OPAC recommends that enforcement of existing regulation for discharge of black water from boats (EPA Reg. 305 + 310) be increased. (SLR) (SS)

42. OPAC recommends that regulations to control the discharge of greywater from boats and ships into the Great Lakes and St. Lawrence River be developed and enforced. Onboard storage of pleasure boat greywater should be encouraged. (SS) (SCR) (SLR)

RE: HABITAT

43. OPAC recommends that the federal and provincial governments should provide the resources necessary to (1) complete the inventory and classification of the littoral and wetlands of the Areas of Concern, (2) develop a comprehensive management plan for littoral zone and wetlands rehabilitation and protection, 93) undertake wildlife inventories in the Areas of Concern and assess the requirements needed to maintain wildlife diversity and integrity (GAP analysis), and (4) develop wildlife protection strategies. (BQ) (SCR)

44. OPAC recommends that OMNR and Environment Canada be required: to undertake identified habitat restoration and enhancement projects; expand candidate sites; maximize fish use of delta habitats; encourage maintenance/enhancement of riparian vegetation; expand list of special status species. (SCR)

45. OPAC recommends that OMNR and Environment Canada be required to improve coordination amongst conservation/protection agencies. (SCR)

46. OPAC recommends that Fisheries and Oceans Canada and the Ontario Ministry of Natural Resources should continue to vigorously enforce the fish habitat protection provisions of the Fisheries Act to ensure that there is no further net loss of fish habitat and continue to actively pursue net gains. (BQ)

47. OPAC recommends that RAPs endorse and implement the Fish Habitat Management Plan. (SS) (The Fish Habitat Management Plan is an agreement by the Federal Department of Fisheries and Oceans, the Ontario Ministry of Natural Resources and the local municipalities to ensure no net loss of fish habitat.)

48. OPAC recommends that the Ontario government and Environment Canada be required to strengthen wetland protection measures. (SCR) (SLR) (BQ)

49. OPAC recommends that municipalities be encouraged to implement the Provincial Wetlands Policy (June 1992) which requires all planning agencies to have regard for provincially significant wetlands in their planning decisions. (SLR) (SS)

50. OPAC recommends that the governments of Canada and Ontario should ban the use of lead in shotgun shells and in fishing weights from the Great Lakes St. Lawrence Basin and require that a non-toxic, non-bioaccumulating type of substance be used as a replacement. (SLR) (BQ)

51. OPAC recommends that all regulatory agencies takes measures to ensure that no accidental introductions of exotic species occur in the areas of concern and that any planned introductions are subject to the appropriate level of provincial and federal environmental assessment. (SLR) (SCR)

52. OPAC recommends that mandatory regulations be required for treatment or exchange (or some other technique) to ensure that ballast water cannot be a vector for the introduction of exotic species into the St. Lawrence River and the Great Lakes. (SLR)

53. OPAC recommends that chlorination as a control measure for exotic mussels by discontinued as soon as a more environmentally sound method becomes available. (SLR)

54. OPAC recommends that the federal and provincial governments increase public awareness about purple loosestrife by providing information on how to control small, accessible populations by hand pulling. (SLR)

55. OPAC recommends that the Canadian Coast Guard be required to reduce ship wakes and surges and minimize impacts from winter shipping for areas adversely affected. (SCR)

RE: RESEARCH

56. OPAC recommends the investigation of methods to reduce or eliminate viral contamination of wastewater and associated health effects. (MT)

57. OPAC recommends that OMOEE be required to acquire additional information to improve modelling accuracy. (SCR)

58. OPAC recommends that additional research be conducted on the effect of contaminants on biota and their predators. (MT)

59. OPAC recommends additional research into alternatives to sodium chloride for use on area roads. (MT)

60. OPAC recommends that a study be initiated to establish design standards for roads and parking areas so that those areas can be adequately drained while preserving the quality of stormwater runoff and maintaining or restoring the natural hydrologic cycle. (MT)

61. OPAC recommends that further scientific research be conducted to provide the information and technology necessary for conservation, restoration and development of aquatic habitats. (MT)

RE: EDUCATION

62. OPAC recommends support of public and formal education programs that heighten awareness of water biological integrity and the sources and fates of environmental pollutants. (MT)

63. OPAC recommends that OMOEE and Environment Canada be required to conduct total reduction education to aid citizens and businesses in reducing their use of environmentally damaging toxic chemicals. (HH) (SCR)

64. OPAC recommends that the provincial government establish a public education program to encourage the use of phosphorus-free products in homes and the use of phosphate-free cleaning agents in commercial establishments and light industries. (SLR)

65. OPAC recommends that a comprehensive communications program should be initiated to provide consumers with information about the persistent toxic compounds contained in marketed products and safe alternative choices. (BQ)

66. OPAC recommends the creation of better educational programs for the construction industry by providing them with improved methods of erosion and sediment control. (MT)

67. OPAC recommends that the Ministry of Agriculture and Food develop an improved educational program to inform the agriculture community about water quality problems and solutions. (MT)

68. OPAC recommends improved public education programs on the proper use of fertilizers and pesticides and their effects on the environment. (MT)

APPENDIX V. 1997-1998 SPORTFISH CONSUMPTION GUIDELINES FOR THE ST. LAWRENCE RIVER IN THE CORNWALL AOC

Location	Species	Fish size in centimetres (inches) 15-20 (6-8)	20-25 (8-10)	25-30 (10-12)	30-35 (12-14)	35-45 (14-18)	45-55 (18-22)	55-65 (22-26)	65-75 (26-30)	>75 (>30)
St. Lawrence River 12. Thousand Islands area	Walleye			◁	◁	◁	◁	④	②	
	Northern Pike	◁	◁	◁	◁	◁	◁	④	④	④
	Smallmouth Bass	◁	◁	◁	◁	④	②			
	Yellow Perch	◁	◁	④						
	Rock Bass	◁	◁							
	Pumpkinseed	◁	◁							
	Brown Bullhead	◁	◁	◁	◁					
	Carp							④	④	②
	White Sucker					◁	◁	◁		
	American Eel						◁	④	④	④
St. Lawrence River 13. Middle Corridor	Walleye					◁	◁			
	Northern Pike					◁	◁	④	④	②
	Smallmouth Bass		◁	◁	◁	④				
	Yellow Perch	◁	◁	◁	④					
	Rock Bass	◁	◁							
	Pumpkinseed	◁	◁							
	Brown Bullhead		◁	◁	◁	④				
	Carp						④	②	①	①
	White Sucker			◁	◁	◁	◁	④		
	American Eel						◁	◁	④	④
St. Lawrence River 14. Lake St. Lawrence	Walleye			◁	◁	◁	◁	④	②	
	Northern Pike				◁	◁	◁	◁	④	④
	Smallmouth Bass	◁	◁	◁	◁	④	◀			
	Yellow Perch	◁	◁	◁						
	White Perch	◁	◁	◁						
	Rock Bass	◁	④							
	Black Crappie	◁	◁	◁						
	Brown Bullhead	◁	◁	◁	◁	◁				
	Carp						◁	◁	④	②
	White Sucker			◁	◁	◁	◁			
	American Eel		◁	◁	◁	◁	④			
St. Lawrence River 15. Lake St. Francis	Walleye				◁	◁	④	④	②	
	Northern Pike				◁	◁	◁	④	④	②
	Smallmouth Bass			◁	④	④	②			
	Yellow Perch	◁	◁	◁	◁					
	Rock Bass	◁	④							
	Pumpkinseed	◁	◁							
	Brown Bullhead	◁	◁	◁	◁					
	Channel Catfish					④	②	①	◀	
	White Sucker					◁	◁	④		
	Redhorse Sucker				◁	◁	◁			
16. Lake St. Francis at Raisin River (spawning run)	Walleye					◁	④	②	◀	◀
	White Sucker					◁	④			

Consumption advice symbols table

Fish symbol	Consumption advice (meals/month)
◁	consumption up to eight meals/month*
④	consumption restricted to four meals/month
②	consumption restricted to two meals/month
①	consumption restricted to one meal/month
◀	no consumption advised

*Many fish in the ◁ category can be safely consumed much more frequently than eight meals/month (see section To whom does this guide apply?).

It is strongly recommended that, in addition to the advice provided above, women of childbearing age and children under 15 not eat fish in the ① category (see section Advice for women of childbearing age and children).

A meal is considered to be 227 grams (eight ounces)

Contaminants analysed

The number beside the fish species name identifies the contaminant or group of contaminants for which the fish was tested:

1 Mercury
2 Mercury, PCBs, mirex and pestcides
3 PCBs, mirex and pesticides
4 Mercury, PCBs and mirex
5 Mercury, other metals, PCBs, mirex and pesticides
6 Mercury, other metals
7 Dioxins and furans
8 Mercury, PCBs, mirex, pesticides, chlorinated phenols and chlorinated benzenes
9 Polynuclear aromatic hydrocarbons (PAHs)

Acknowledgement:

Guide to Eating Ontario Sport Fish 1997-1998

Public Information Centre
Ministry of Environment and Energy
135 St. Clair Ave. West
Toronto, Ontario M4V 1P5

VI. PCB Data Tables, MOEE 1992 Survey

Appendix VI: Total PCB concentrations in indigenous mussels and sediment collected from the St Lawrence River, 1992. (unpublished MOE data).

Station Number	Station Description	N	Total PCB (ng/g) Mussels (wet wt.)	N	Total PCB (ng/g) Sediment (dry wt.)	TOC (mg/g)	LOI (mg/g)	SUM 1 Clay (%)	SUM 2 Silt (%)	SUM 3 Sand (%)
109	Below the Dam	3	ND	3	ND	ND	6.3	4	10	86
			ND		ND	2.90	6.9	4	10	86
			ND		ND	ND	6.7	4	11	85
124	Downstream of Domtar	2	60	3	ND	100.00	230.0	5	25	70
			80		ND	170.00	350.0	9	44	47
					ND	160.00	350.0	11	48	41
111	Downstream of Courtlands	3			ND	46.00	76.0	28	67	5
					ND	14.00	64.9	23	65	12
					ND	33.00	79.0	21	64	15
112	Southside of Pilon Island	3	ND	3	ND	27.00	66.0	32	64	4
			ND		ND	44.00	81.0	32	67	2
			ND		ND	35.00	77.0	27	68	5
114	East of Tip of Saint Regis Island	13	ND (40)	3	ND	6.50	15.0	10	23	67
					ND	7.20	15.0	7	19	73
					ND	8.40	18.0	23	62	15
115	Downstream of Danis Point	3	ND	3	ND	15.00	36.0	16	52	33
			ND		60	23.00	46.0	19	57	24
			ND		40	22.00	52.0	19	57	24
117	Upstream of Mouth of Raisin River	3	ND	3	ND	9.80	22.0	5	25	70
			ND		ND	11.00	26.0	7	34	59
			ND	3	ND	14.00	26.0	6	30	64
119	East of Point Mouillees	4	ND	3	ND	4.00	9.3	4	20	76
			ND		ND	7.10	13.0	5	25	71
			ND		ND	6.90	18.0	6	32	62
			ND							

ND-Below the Detection Limit.
SD-Standard Deviation.

Station Number	Station Description	N	Total PCB (ng/g) Mussels (wet wt.)	N	Total PCB (ng/g) Sediment (dry wt.)	TOC (mg/g)	LOI (mg/g)	SUM 1 Clay (%)	SUM 2 Silt (%)	SUM 3 Sand (%)
110	Mouth of the Grasse River	13	200	3	300	8.70	34.0	27	63	10
			300		240	16.00	20.0	10	22	68
			220		160	9.10	20.0	10	22	68
			240							
			320							
			260							
			260							
			400							
			200							
			160							
			280							
			280							
			340							
	mean (SD)		266.2 (65.0)							
123	Downstream of Reynolds	12	440	3	1160	56.00	98.0	24	70	5
			500		1570	40.00	88.0	21	71	8
			500		960	41.00	79.0	21	68	11
			420							
			240							
			340							
			480							
			500							
			460							
			440							
			500							
			680							
	mean (SD)		458.3 (104.6)		15000	21.00	40.0	16	40	44
125	In front of G.M.	4	2800	3	23600	20.00	40.0	17	40	43
			4720		12300	19.00	45.0	15	40	45
			1400							
			2540							
	mean (SD)		2865.0 (1378.1)							
113	South side of ST. Regis Island	3	40	3	ND	6.20	15.0	37	63	0
			60		ND	4.80	16.0	35	65	0
			60		ND	ND	5.9	4	9	87

ND-Below the Detection Limit.
SD-Standard Deviation.

Station Number	Station Description	N	Total PCB (ng/g) Mussels (wet wt.)	N	Total PCB (ng/g) Sediment (dry wt.)	TOC (mg/g)	LOI (mg/g)	SUM 1 Clay (%)	SUM 2 Silt (%)	SUM 3 Sand (%)
116	South of Ile Christatie	3	200	3	540	29.00	59.0	14	51	35
			100		760	39.00	60.0	15	53	32
			60		700	25.00	60.0	15	52	32
118	East of Point Dupuis	3	ND	3	ND	5.10	8.6	3	14	83
			ND		ND	4.80	11.0	3	12	85
			ND		ND	3.40	10.0	3	13	84
120	Point Genier	3	ND	3	30	15.00	29.0	8	38	54
			ND		ND	16.00	31.0	8	39	52
			ND		ND	17.00	34.0	8	42	50
121	East of Grenadier Ile	3	ND	3	ND	6.20	19.0	9	32	58
			ND		ND	8.90	21.0	11	35	55
			ND		40	9.60	20.0	9	31	60
122	Baie des Brises	3	ND	3	ND	7.10	26.0	52	48	0
			ND		ND	7.20	27.0	54	46	0
			ND		ND	6.40	26.0	54	46	0

ND-Below the Detection Limit.
SD-Standard Deviation.

APPENDIX VII. PAC ADDENDUM: PUBLIC INPUT REGARDING WETLANDS PROTECTION

During public consultation in Stage 2, the most controversy raised in response to the preferred options in *Choices for Cleanup: Deciding the Future of a Great River* (1994) was about options that dealt with wetlands protection.

The objections which were most vehemently expressed included the following points:

1. The provincial wetlands policy imposes restrictions on land use without compensation. Landowners feel that the burden of providing for the public good as spelled out in the provincial wetlands policy falls on the landowners, and cancels any expectations they have had of realizing any value from their land.

2. The value of wetlands has not been absolutely established.

3. The relevance of wetlands, especially inland wetlands, to the St. Lawrence Remedial Action Plan is not clearly established.

4. The cooperation of property owners is necessary for the preservation of wetlands and for the stabilization of the area which is now rapidly eroding into the St. Lawrence River. This cooperation will not be obtained by the imposition of a rigid wetland policy.

5. Development (rather than preservation of wetlands) is needed for the economic health of the area.

6. Wetlands do not contribute to the pollution of the St. Lawrence, and thus are not relevant to the St. Lawrence Remedial Action Plan.

7. The administration of the provincial wetlands policy is too rigid.

8. The largest significant wetland in the area is adjacent to Akwesasne, and is not addressed in the recommendations.

9. The province does not manage its public lands efficiently now.

Submissions which supported the *Choices for Cleanup* recommendations can be summarized:

1. The wetlands are an important component of the ecosystem.

2. Wetlands are an increasingly rare resource.

3. Purely regulatory measures should not be the only method used to ensure the preservation of wetlands.

4. Property owners should receive compensation for the restriction on the development of their property.

5. The recommendations should provide for sustainable development.

A cooperative plan was developed in 1992 by staff from the Ontario Ministry of Natural Resources, the Raisin Region Conservation Authority, the Township of Lancaster, and the property owners to work out a compromise for the wetlands in the Bainsville Bay-Pointe Mouillée areas, which would allow for some development without a net loss of wetland area. The Minister of Natural Resources did not support the resulting plan, which left the other partners, particularly the property owners feeling that their cooperation had not been treated in good faith. The Remedial Options Review Committee concluded that the rejection of the solution in such a bureaucratic manner was unacceptable.

At the time of the public input on the *Choices for Cleanup* document, it was expected that the provincial government would require the municipalities to "be consistent with" the provincial wetlands policy. This was considered to be stricter than the requirement that the municipalities "have regard for" the provincial wetland policy. The current requirement to "have regard for" indicates that there will be a less rigid implementation of the wetland policy than originally anticipated.

Those making submissions regarding wetlands protection were invited to the Nov 17/94 Remedial Options Review (RORC) Committee meeting, which considered the public input, and to the Public Advisory Committee meeting (Feb 21/95) at which the RORC recommendations would be presented. At the RORC meeting, Choices for Cleanup option #58 was supported by the majority of the committee. A majority of the committee favoured removing Choices for Cleanup option #5 from the Remedial Action Plan.

At their Feb 21/95 meeting, the PAC agreed with the decisions summarized in the minutes of the RORC meeting of Nov 17/94. A complete record of the submissions from the following individuals are on file at MOEE and the Cornwall Public Library:

(a) submissions for changes to the *Choices for Cleanup* recommendations regarding wetlands were made by: Paul Sabourin, Kay Stone, Ron MacDonell, Rhoda Ross, Stephen Sangster, Ian McLeod, Janet McDonald, Ray Rock, Corporation of the Township of Lancaster.

(b) submissions supporting the recommendations regarding wetlands were made by: Glen Runions, Dr. P.J. Crabbé, St. Lawrence River Institute for Environmental Sciences, Brian Hickey, Norm Levac for the City of Cornwall.

TERMS & ACRONYMS USED IN THE REPORT

AOC
Great Lakes Area of Concern as defined by the International Joint Commission

ALCOA
Aluminum Company of America

ASL
above sea level

BATEA
best available technology economically achievable

beneficial use impairment
inability of an AOC to provide for a particular beneficial use of the aquatic ecosystem (from the set of fourteen beneficial use impairments listed in the Great Lakes Water Quality Agreement)

benthic
living at the bottom of a lake, river or ocean

benthos
the organisms that live in or on the ground immediately under a water body

bioaccumulation
the process by which the concentration of a toxic contaminant increases as it passes up through the food chain from algae to top predators

biomagnification
see bioaccumulation

bypass
rerouting of sewage around a facility such as a sewage treatment plant during periods of high flow. Bypassing is done to prevent a washout of the facility, but it results in the release of raw, untreated sewage to the receiving body of water (lake, river or ocean).

carcinogen
any substance that causes cancer

COA
Canada-Ontario Agreement Respecting Great Lakes Water Quality

Canada-Ontario Agreement Respecting Great Lakes Water Quality
a formal agreement between the Governments of Canada and Ontario, to jointly implement the terms of the Great Lakes Water Quality Agreement, including the preparation and implementation of Remedial Action Plans

CEAA
Canadian Environmental Assessment Act (governs federal environmental assessments)

coliform bacteria
rod-shaped bacteria, most of which live in the intestines of warm-blooded animals

combined sewers
pipes that take both domestic wastewater and surface runoff to the sewage treatment plant. They are usually located in the older parts of municipal sewage systems.

combined sewer overflow
a valve that opens to allow the contents of an overfilled combined sewer pipe to overflow into another pipe that takes the excess sewage directly to the river or other receiving water body, without being treated at the sewage plant

conventional pollutant
before persistent toxic substances became an environmental concern, several other types of substances were known to pollute waters. These are now referred to as conventional pollutants and include phosphorus and nitrogen (nutrients); chemical oxygen demand and biological oxygen demand (i.e., substances that decompose using oxygen in the process); oils and greases; volatile solids; total and fecal coliform bacteria; and chlorides.

CSO
combined sewer overflow

DDT; DDE
dichlorodiphenyltricloroethane; dichlorodiphenylethane (a common breakdown product of the pesticide DDT)

delisting
removal of an AOC from the list of Great Lakes Areas of Concern because of all beneficial uses at that AOC have been restored

delisting criteria
a set of AOC-specific criteria that are used to determine when each of the impaired beneficial uses can be considered as no longer impaired. When all beneficial uses are restored, the AOC is "delisted"

DFO
Department of Fisheries and Oceans (Canada)

EA
Environmental Assessment (provincial environmental assessment process)

effluent
the liquid waste discharged from an industrial facility or municipal sewage treatment plant. Industries discharge effluent either directly to surface waters or to wastewater sewers that take it to a sewage treatment plant. Sewage treatment plants discharge their effluent (treated sewage) to surface waters.

EHJV
Eastern Habitat Joint Venture

Eastern Habitat Joint Venture
an international partnership whose goal is to restore and enhance wetlands and associated wildlife populations in Eastern North America.

EEM
Environmental Effects Monitoring

Environmental Effects Monitoring
monitoring designed to determine the effects of pulp and paper mill effluent on the aquatic ecosystem in the vicinity of their discharges. Pulp and paper mills in Canada are federally required to do this monitoring under the Pulp and Paper Effluent Regulations of the Fisheries Act.

EPA
Environmental Protection Agency (United States)

eutrophication
a process of excess plant growth and oxygen depletion in an aquatic ecosystem. Unnaturally high inputs of nutrients such as phosphorus stimulate excessive growth of aquatic plants, which in turn results in an increased amount of dead plants being decayed by bacteria. The bacteria, which use oxygen to live, deplete oxygen dissolved in the water and the lack of dissolved oxygen kills fish.

exotic species
plants or animals that have been accidentally or intentionally introduced to an area they did not previously inhabit

fecal coliform
rod-shaped bacteria that inhabit the intestines of warm-blooded animals including humans and are used to indicate the presence of animal waste (fecal matter) in water

flow
amount (volume) of water or wastewater running through an area in a given length of time (e.g., number of gallons per day or number of cubic metres per day)

food chain
a series of organisms (beginning with plants and ending with the largest carnivores) each dependent on the next for food

GIS
geographic informaton systems (geographic mapping software)

GLWQA
Great Lakes Water Quality Agreement

Great Lakes Water Quality Agreement
a joint agreement between Canada and the United States, which legally commits the two countries to develop then implement plans to restore and maintain the many desirable uses of the water in the Great Lakes Basin

guide line
a suggested (not legally binding) maximum acceptable concentration of a pollutant in surface water, drinking water, sediment, fish and wildlife, effluent

ICI
Imperial Chemical Industries (formerly CIL Ltd.)

IJC
International Joint Commission

International Joint Commission
an independent body with equal binational representation, that advises the governments of the US and Canada on matters pertaining to environmental quality in transboundary waters such as the Great Lakes and St. Lawrence River

IREE
Institute for Research on Economy and the Environment (Ottawa University)

LaMP
Lakewide Management Plan

leachate
water that percolates through solids such as soils, solid wastes and rock layers and may contain dissolved or suspended contaminants

LEL
lowest effect level as specified in Provincial Sediment Quality Guidelines

load(ing)
the total amount of a pollutant entering a water body over a specific time (e.g., grams per day of mercury). Loadings give a clear picture of how much of a given contaminant is being discharged because they take into account the volume of effluent being discharged over time. In contrast, concentrations (e.g., milligrams of mercury per litre of effluent discharged) can be misleading because even though the concentration of a pollutant may be low, if a large enough volume of effluent is being discharged the total load to the environment is high.

lowest effect level
the contaminant concentration that would be detrimental to some of the species of organisms living in the sediment. LELs for various contaminants are listed in MOEE's Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (June 1992).

LTSS
long term sensing sites

MDL
method detection limit

MISA
Municipal-Industrial Strategy for Abatement — an Ontario Ministry of Environment & Energy regulatory program. The ultimate goal of MISA is to regulate municipal and industrial discharges of toxic substances and conventional pollutants to the point where they are virtually eliminated from the environment.

MNR
Ministry of Natural Resources

MOE
Ministry of Environment (1972-1992)

MOEE
Ministry of Environment & Energy (1993-1997)

morphometry
shape of the land underlying a body of water

N
number of samples

ND
not detected

non-point source
a source of pollution that spreads pollutants over a wide area (e.g., rural runoff or atmospheric emissions from a smoke stack) rather than to a distinct, identifiable location.

nutrient
a chemical that is an essential raw material for the growth and development of organisms. In reference to the aquatic environment, the term nutrient generally refers to the substances that act as plant food (phosphorus, nitrogen).

NYSDEC
New York State Department of Environmental Conservation

OMOE; OMOEE
Ontario Ministry of Environment; Ontario Ministry of Environment & Energy

OMNR
Ontario Ministry of Natural Resources

OPAC
Ontario Public Advisory Council

Ontario's Drinking Water Objectives
a set of maximum acceptable concentrations of substances which could affect people's health if present in drinking water

overflow
a sewage overflow occurs when excess sewage and stormwater cause a valve to opens so that the excess volume can be rerouted away from the regular sewage collection system that leads to the sewage treatment plant. Overflows result in discharges of untreated sewage to surface waters such as the St. Lawrence River.

PAC
Public Advisory Committee

PAH
polynuclear aromatic hydrocarbon = polyaromatic hydrocarbon = polycyclic aromatic hydrocarbon

PCB
polychlorinated biphenyl

persistent toxic substance
any toxic substance that is difficult to destroy or degrades slowly (i.e., has a half-life in water greater than eight weeks)

POC
Public Outreach Committee (of the St. Lawrence River PAC)

point source
a source of pollution that is distinct and identifiable

primary treatment
a process of sewage treatment in which sewage is held temporarily in a large settling chamber where solids settle to the bottom. The clarified liquid is then chlorinated to kill pathogenic microorganisms and discharged to a river, lake or ocean.

Provincial Sediment Quality Guidelines
a set of guidelines that specify maximum acceptable levels of various pollutants in sediment. The Guidelines were released in 1992 by the Ontario's Ministry of Environment & Energy and replace the ministry's 1976 Open Water Disposal [of dredged material] Guidelines.

Provincial Water Quality Objectives
a set of maximum acceptable concentrations of pollutants designed for the protection of aquatic life and recreation in and on the water (not the same as Ontario's Drinking Water Objectives)

RAP
Remedial Action Plan

resuspension
the remixing of sediment particles and pollutants back into the water by storms, currents, organisms and human activities such as dredging

RORC
Remedial Options Review Committee (of the St. Lawrence River PAC)

RRCA
Raisin Region Conservation Authority

SD
standard deviation

SDG
(United Counties of) Stormont, Dundas and Glengarry

secondary treatment
primary sewage treatment combined with a period of bacterial action to remove (decompose) organic matter in the waste

sediment
solid particles that settle to the bottom of a liquid

SEL
severe effect level as specified in Provincial Sediment Quality Guidelines

severe effect level
the contaminant concentration that would be detrimental to most species of organisms living in the sediment. SELs for various contaminants are listed in MOEE's Guidelines for the Protection and Management of aquatic Sediment Quality in Ontario (June 1992).

SLRIES
St. Lawrence River Institute for Environmental Sciences

STP
sewage treatment plant

suspended sediment
particles of bottom sediment that have not yet settled out of the water to the bottom of a water body
toxic substance
a substance that can cause illness, death, birth defects, genetic mutations or reproductive impairment in any organism or its offspring

WPCP
Water Pollution Control Plant (=sewage treatment plant)

ZIP
zone d'Intervention Prioritaire: a series of contiguous zones along the entire Quebec portion of the St. Lawrence River, for which environmental restoration programs similar to RAPs are being carried out under the auspices of the Government of Quebec