1995-97 PRIORITIES AND PROGRESS UNDER THE GREAT LAKES WATER QUALITY AGREEMENT

CHAPTER FOUR: COUNCIL OF GREAT LAKES RESEARCH MANAGERS

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4.1 INTRODUCTION: COUNCIL ACTIVITIES

The **Council of Great Lakes Research Managers** was established in 1984 to enhance the ability of the **International Joint Commission** (IJC) to provide effective leadership, guidance, support and evaluation of Great Lakes research programs with particular reference to programs required or funded pursuant to the provisions of the **Great Lakes Water Quality Agreement**. Its new terms of reference based on the Vision Workshop in 1995 and approved in 1996, direct the Council to compile a research inventory identifying research needs and to coordinate research projects. Additional charges now include assessing the adequacy of the Parties' research programs and promoting the transfer of research findings to basin policymakers, resource managers and the public. Membership consists of individuals managing and coordinating research programs of federal, state and provincial governments in the United States and Canada, and representatives of private institutions.

The primary Council activity for the 1995-97 priority cycle was identification of mechanisms for improving the effectiveness of Great Lakes research. The Council's efforts under this priority are reported in Chapter 4.2. While the Council has the lead for this priority, its members had significant involvement in additional priorities reported in other chapters, most notably the impact on human and ecosystem health (Chapter 1.2), remediation and management of sediment (Chapter 2.2) and the Lake Erie ecological model (Chapter 5). **The Great Lakes - St. Lawrence River Research Inventory** is produced by the Council every year; several recent improvements enhance its utility and accessibility. The status of the Research Inventory is reported in Chapter 4.3.

4.2 IMPROVING THE EFFECTIVENESS OF GREAT LAKES RESEARCH

4.2.1 Introduction

In October 1995, IJC asked the Council to take the lead on the priority, improving the effectiveness of Great Lakes research. The suggested approach was to build on the results of the Public Forum on the Future of Great Lakes Science, held at the 1995 Biennial Meeting in Duluth, Minnesota. The Council was to develop a strategy to involve research managers from both countries in identifying mechanisms to optimize research activities in the Great Lakes basin. Suggested activities included consultation with research managers and the research community through a workshop to develop a report and recommendations on identified mechanisms.

The Council first surveyed the Great Lakes research community to determine the extent of budget reductions and their likely impact on research supporting the Agreement. The Council's analysis of the survey results is summarized in Chapter 4.2.2. A white paper was then prepared to introduce the topic to researchers and others likely to be interested. The white paper explained what the Council was working to accomplish and gave examples of successful areas of Great Lakes research. This is found in Chapter 4.2.3. The Council held a public meeting in November 1996 in conjunction with its fall meeting and the **State of the Lakes Ecosystem Conference** (SOLEC '96). Local researchers and interested public were invited to address the Council on this priority. The meeting is summarized in Chapter 4.2.4. At the request of SOLEC '96 organizers, the Council facilitated a roundtable discussion on the priority during the conference. The results are presented in Chapter 4.2.5. The Council also organized a panel discussion of the priority as a plenary session at the 40th Conference on Great Lakes Research held in June 1997. This discussion is summarized in Chapter 4.2.6. The Council's recommendations to IJC, as a result of these priority activities, are presented in Chapter 4.2.7.

4.2.2 Funding Reductions for Great Lakes Science: Results of November 1995 Research Budget Survey

Background and Methodology

Based on the results of the Public Forum on the Future of Great Lakes Science held at the IJC Biennial Meeting in Duluth in 1995, IJC directed the Council to determine the scope of budget reductions that affect commitments to research called for in the Agreement. The Council co-chairs designed a questionnaire that was sent to all members of the Council (representing 22 research programs) as well as 26 selected research inventory contacts throughout the Great Lakes basin. Due to the urgent nature of the concern, the questionnaire was kept intentionally brief to allow for a timely response. Key findings were presented in IJC's Eighth Biennial Report on Great Lakes Water Quality (released in 1996); these are elaborated on below. Also, this material appeared as a commentary in the Journal of Great Lakes Research, volume 22, number 2, in 1996.

In 1993, the Council estimated total Great Lakes and St. Lawrence River research funding to be approximately $107 million (U.S.) for the period 1991-1992. Most of this total was directed to the topics listed in Annex 17 of the Agreement. The questionnaire used in the 1995 survey was based on the same topics (see Table 9) but the research programs reported included additional topics. However, the total research funding reported below can be compared to the $107 million figure to assess representativeness for the survey. Information on individual projects was not requested because of time constraints.

Results and Potential Impacts

Resource Reductions

Thirty-one of the 48 research programs surveyed responded, including government agencies, as well as academic institutions that fund and conduct Great Lakes research. The programs that responded represented annual funding of as much as $88 million, or greater than 80 percent of the total funding reported in 1991-1992. This funding peaked in 1994 and is projected to decline by as much as 50 percent by 1997 (Table 7 and Figure 5). Similarly, research salary budgets also peaked in 1994 and were projected to decrease by as much as 35 percent by 1997. The number of researchers followed a similar trend (Table 8 and Figure 6). These represent the actual resources available for conducting Great Lakes research. The financial resources could potentially be restored at some point in the future, but the human resources (i.e. total number of researchers) are not easily replaced. If research positions are eliminated, it will be very difficult to regain a similar level of expertise. It is often noted that it takes ten years to train and develop effective researchers. This assumes that the accumulated experience represented by established researchers will be available for inter-generational transfer and mentoring. In addition, the ability to conduct research is affected not only by the expertise of the investigators but also by the achievement of a "critical mass" of researchers at key institutions. Impacts The largest impacts appear to be in the area of mass transfer of pollutants and load reduction models (Table 9). Eighty-five percent of respondents that conduct or fund research in these areas reported that they would experience a decrease in funding for these activities. These reductions would potentially impact the ability to meet research commitments for **remedial action plans** (RAPs) and **lakewide management plans** (LaMPs), dredging, surveillance and monitoring, persistent toxic substances, nonpoint sources, contaminated sediment, airborne toxic substances and contaminated groundwater. Another large impact would be in funding for research on ecotoxicology. Sixty-seven percent of respondents reported that they expected a decrease for this work. This would potentially impact the development of water quality objectives and indicators for rehabilitation of the Great Lakes ecosystem from adverse effects of persistent toxic substances. Other areas of research for which respondents reported budget reductions included the effects of climate change on the water quality, wildlife and habitat of the Great Lakes and the application of the ecosystem approach to fisheries management. The areas targeted for these deep cuts are critical for supporting the type of decisionmaking that led to successes described below.

The Council has compiled four case studies that demonstrate how research budget cuts affect various aspects of the Agreement.

Table 7. **Great Lakes Research Budget for 31 Selected Institutions, 1993-1997 (Actual and Projected)**

	Operating Budget	Salary Budget	Total Budget	% of 1994 Level
	($Million U.S.)			
1993	53.1	29.6	82.7	93
1994	57.2	31.7	88.9	100
1995	52.3	29.4	81.7	91.8
1996	46.8	25.7	72.5	81.5
1997	26.9-43.9*	17.3-21.8*	44.2-65.7*	49.7-73.9*

*best and worst case projections

Table 8. **Great Lakes Research Positions for 31 Selected Institutions, 1993-1997 (Actual and Projected)**

	Total # of Researchers	% of 1994 Level
1993	621	87.7
1994	709	100
1995	697	98.3
1996	495	69.9
1997	269-378*	37.9-53.4*

* best & worst case projections

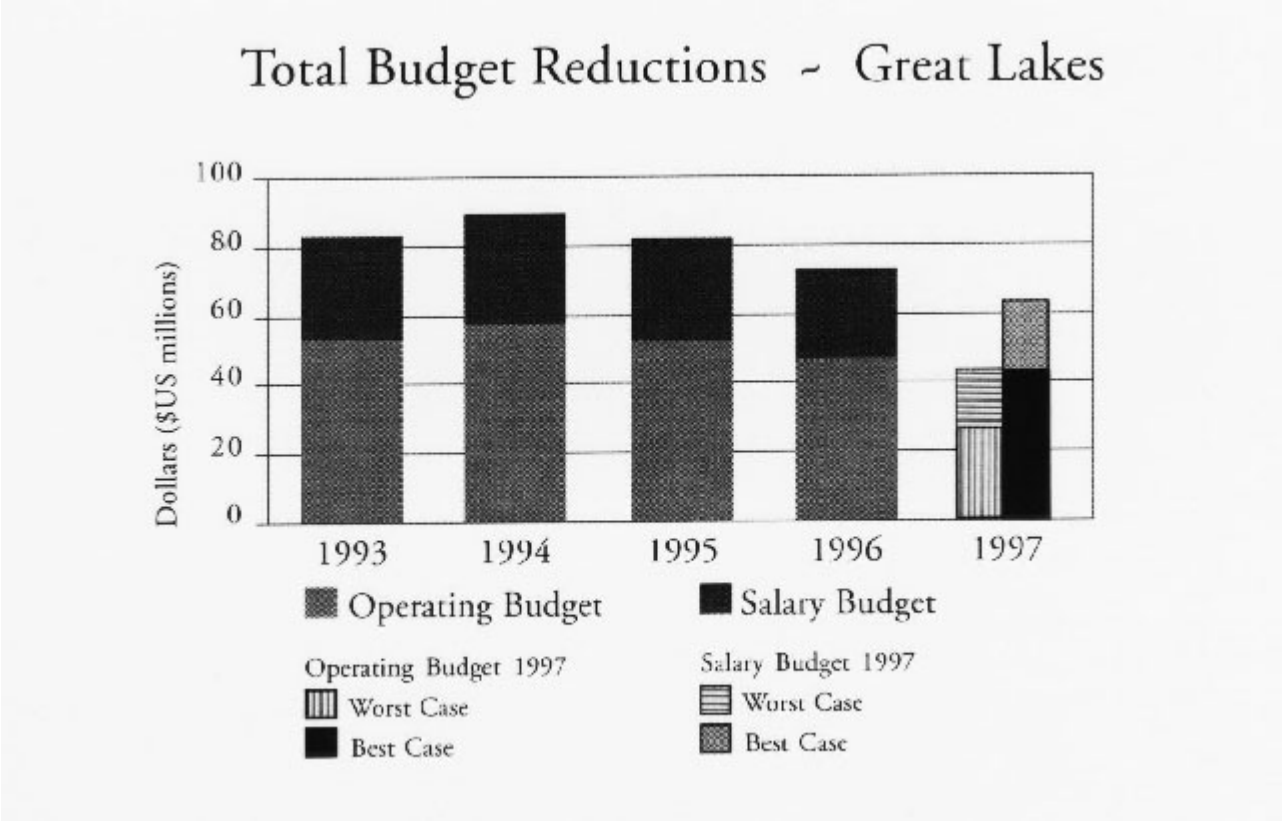

Figure 5 **Results of Research Budget Questionnaire: Total Budget Reductions ~ Great Lakes**

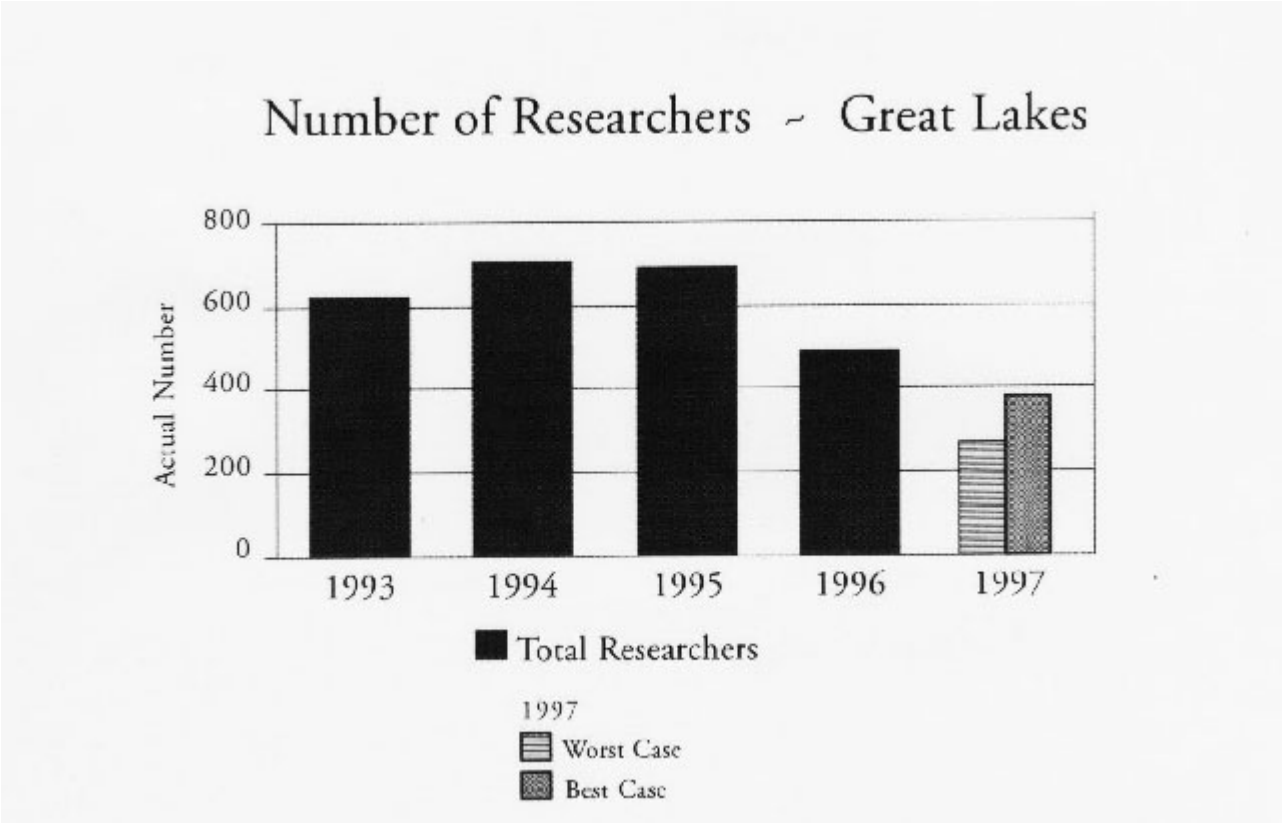

Figure 6 **Results of Research Budget Questionnaire: Number of Researchers ~ Great Lakes**

Lake Ecosystem Objectives

The Agreement as amended in 1987 contains commitments by the Parties to develop lake ecosystem objectives as part of the binational effort to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes basin ecosystem. The Parties developed and included in the 1987 amendments a Lake Superior ecosystem objective:

> "The Lake should be maintained as a balanced and stable oligotrophic ecosystem with lake trout as the top aquatic predator of a cold-water community and the *Pontoporeia hoyi* as a key organism in the food chain."

The Agreement calls for additional ecosystem objectives to be developed for the rest of the boundary waters of the Great Lakes system as the state of knowledge permits. Research is the vehicle to provide the knowledge required to establish such objectives.

Two of the research categories (see Table 9) that have been heavily impacted by reductions in Great Lakes research funding are:

h. ecotoxicity and toxicity effects of pollutants for development of water quality objectives; and
i. impact of water quality and non-native species introductions on fish and wildlife populations and habitats.

Six out of nine programs that indicated that they funded or conducted research in category (h) reported a decrease of funding in this area, while 10 out of 15 programs reported a decrease in funding for category (i). Research in these two categories is the principal means of advancing the "state of knowledge" for lake ecosystem objectives. Without continued funding in these areas, the Council believes that the Parties' obligations under this part of the Agreement will not be met.

Table 9: **Breakdown of Survey Responses by Annex 17 Category**

Categories	**Total Number of Research Programs Responding to each Category (N=31)**	**Total Number of Research Programs Reporting Reductions (out of total responding)**	**%**	**Agreement Annexes Affected**
(a) mass transfer of pollutants between ecosystem components	16	14	87.5	13: Nonpoint Sources 14: Contaminated Sediments 15: Airborne Toxic Substances 16: Contaminated Groundwater
(b) load reduction models for pollutants	11	9	81.8	2: RAPs and LaMPs 11: Surveillance and Monitoring 12: Persistent Toxic Substances 13: Nonpoint Sources
(c) physical and transformational processes of pollutants by tributaries	6	4	66.7	
(d) cause-effect inter-relationships of	10	4	40.0	11: Surveillance and Monitoring

productivity and ecotoxicity				12: Persistent Toxic Substances 13: Nonpoint Sources 15: Airborne Toxic Substances
(e) relationship of contaminated sediments on ecosystem health	11	6	54.5	2: RAPs and LaMPs 12: Persistent Toxic Substances 14: Contaminated Sediments
(f) pollutant exchanges between Areas of Concern and the open lakes	8	3	37.5	2: RAPs and LaMPs 3: Control of Phosphorus 12: Persistent Toxic Substances 14: Contaminated Sediments
(g) aquatic effects of varying lake levels (including wetlands)	6	3	50.0	2: RAPs and LaMPs 11: Surveillance and Monitoring 12: Persistent Toxic Substances 13: Nonpoint Sources 15: Airborne Toxic Substances 16: Contaminated Groundwater
(h) ecotoxicity and toxicity effects of pollutants for water quality objectives	9	6	66.7	1: Specific Objectives
(i) impact of water quality and the introduction of non-native species on fish and wildlife populations and habitats	15	10	66.7	1 & Article IV: Specific Objectives 2: RAPs and LaMPs 11: Surveillance and Monitoring 12: Persistent Toxic Substances
(j) control technologies for treatment (effluents, emissions, waste disposal)	8	5	62.5	2: RAPs and LaMPs 3: Control of Phosphorus 12: Persistent Toxic Substances 15: Airborne Toxic Substances 16: Contaminated Groundwater
(k) action levels for multimedia exposures and	2	1	50.0	1: Specific Objectives 12: Persistent Toxic

interactive effects of chemicals				Substances
(l) population-based studies to determine effects of toxic substances on human health	4	3	75.0	
(m) other (non-Agreement issues)	13	10	76.9	Examples: Ecosystem Approach to Fisheries Management; Ecotoxicology Management Tool Development; Climate Change; Long Range Transport of Pollutants.

Ecosystem Approach

The first guiding principle of Annex 2 of the Agreement is:

> "Remedial Action Plans and Lakewide Management Plans shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in Areas of Concern or in open lake waters."

Research categories in Annex 17 that guide and support this approach are: (b) load reduction models, (c) delivery of pollutants by tributaries, (e) contaminated sediments, (f) pollutant exchange, (g) aquatic effects of varying lake levels and (i) impacts on fish and wildlife populations. All of these areas are targeted for some reductions in funding, and two, (b) and (i) have been identified as heavily impacted. Four important federal research laboratories involved in the biological component of the Great Lakes ecosystem (two in Ann Arbor, Michigan, one in Burlington, Ontario and one in Sault Ste. Marie, Ontario) were in imminent danger because they had been: 1) slated for closure, 2) severely cut back so as to question their effectiveness or 3) given a one-year extension while additional budget cuts are considered.

These reductions included complete termination or phase out of programs directly applicable to the Agreement. For example, the **National Biological Service**'s (NBS) Great Lakes Science Center in Ann Arbor conducts research on fish population dynamics, the effects of physical habitat alterations on fish community structure and function and the effects of persistent toxic substances on reproduction and growth of fish. This laboratory's analytical program was targeted for elimination and its fish health program was to be phased out. Instead, the NBS became the **Biological Resources Division** (BRD) of the U.S. Geological Survey and these programs continue to support Agreement-related work.

The elimination of the Canada **Department of Fisheries and Ocean**'s (DFO) research program for the Upper Great Lakes in spring 1997 undermined management's efforts to restore native fish species, achieve sustainable fish populations and restore habitats. The loss of this expertise and research capability also calls into question the commitment to an ecosystem approach and support for RAPs and LaMPs. In fact, given the state of knowledge in these areas, continued research is the only alternative if a systematic and comprehensive approach is to be taken. Also, substantial cuts to Great Lakes programs of Canada DFO and the **Ontario Ministry of Natural Resources** (OMNR) will radically curtail the science under category (i) that is vital if targets for fish and wildlife populations are to be set and met. Further, such research cuts will undermine the sustainability of the $2-4 billion sport fishing economy in the Great Lakes basin.

The potential elimination of three fish contaminant programs would leave the Parties and jurisdictions without

the ability to assess status and trends of contaminant body burdens in Great Lakes fish. These programs are the **Ontario Ministry of the Environment and Energy**'s (OMEE) sport fish contaminant monitoring program, BRD's cooperative program for fish contaminant trends and DFO's program for contaminants in top predators and forage fish. The combined effects of these cuts would be a weakening of the Parties' ability to assess the state of the lakes. This will ultimately erode IJC's ability to evaluate progress under the Agreement.

The proposed termination of the BRD Great Lakes Science Center's analytical chemistry facility and the major reductions at DFO's Great Lakes Laboratory for Fisheries and Aquatic Sciences also put in jeopardy the Great Lakes fish tissue specimen bank. This sample archive has been used effectively by many cooperators for retrospective monitoring of new and emerging problems as specified in Annex 12. Currently, BRD is cooperating with several universities in the identification of toxaphene-like compounds using the specimen bank. The U.S. EPA-BRD cooperative fish contaminant monitoring program under Annex 11 has detected a substantial increase in toxaphene-like compounds in Lake Superior lake trout.

Beneficial Uses and RAPs

To be effective and efficient, actions restoring and maintaining beneficial uses in **Areas of Concern** (AOC) must be based on an understanding of causes and predicted results. Adequate research and monitoring are essential to define problems, establish cause-and-effect relationships, evaluate options, select remedial and preventive actions and document effectiveness. Yet the categories of (a) mass transfer of pollutants and (b) load reduction models are the two that are experiencing some of the heaviest cuts. Fourteen out of 16 programs funding or conducting research in (a) were experiencing a decrease and 9 of 11 programs in category (b) were seeing funding reductions. However, such research and monitoring are the foundation of ecosystem-based management and, in the end, have proven to save money for both the public and private sectors. For example, in Collingwood Harbour, the only AOC to have all of its beneficial uses successfully restored, research from category (b) was used to save $9.4 million resulting in a win-win situation for the environment and economy (Table 10). Unnecessary expenditures were avoided and existing facilities were optimized. In Lower Green Bay and the Fox River, research from categories (a) and (b) is used to save tens of millions of dollars by selecting specific contaminated sediment hot-spots for remediation that will contribute to the removal of fish consumption advisories. In fact, all successful RAPs have strong research programs as part of the foundation for implementing locally-designed ecosystem approaches for restoring beneficial uses. Indeed, research for RAPs has proven to save money while achieving positive ecosystem results (Table 10). If research programs are eliminated or substantially reduced for RAPs, this will result in a lack of use restoration in most AOCs, which is required for delisting; an uncoupling of management efforts from the scientific method in AOCs; and a stagnation of the Stage 2 RAP process of identifying remedial and preventive actions.

Drinking Water, Beach Closings and Combined Sewer Overflows

Two use impairments that are directly related to human health are restrictions on drinking water consumption and the closing of beaches for swimming. These use impairments also result in economic impacts. In spring 1993, drinking water contaminated by a parasitic protozoan, *Cryptosporidium*, caused illness in 400,000 Milwaukee, Wisconsin residents and contributed to the deaths of about 100 people. This one incident is estimated to have cost Milwaukee over $50 million. The Great Lakes Environmental Research Laboratory of the **National Oceanic and Atmospheric Administration** (NOAA) undertook a study of nearshore hydrodynamics to determine how contaminated water could be prevented from entering the water intake. This research and comparison study convinced Milwaukee to relocate its intake to minimize the problem. Recent concerns with the Collingwood, Ontario water supply suggest that this was not an isolated incident. Closings of beaches in Lake St. Clair and Lake Erie in summer 1995 resulted in the loss of millions of tourism dollars. Major causes of these threats to human health and economic well-being are combined sewer overflows (CSOs), urban runoff and failing septic tanks and tile fields. CSOs and urban runoff, in turn, are driven by meteorological and hydrological events that are still not well understood.

Table 10. **Examples of How Research Has Moved Remedial Action Plan Processes Forward and Achieved Cost- and Ecosystem-Effective Results**

RAP	**Example of Contribution from Research**
Collingwood Harbour (Ontario)	Research in load reduction models was used to optimize phosphorus removal at the Collingwood sewage treatment plant. This resulted in restoring impaired beneficial uses (cultural eutrophication) and resulted in a $9.4 million cost savings, representing a win-win situation for the environment and economy.
Green Bay (Wisconsin)	Research on mass transfer of pollutants and load reduction models identified the most cost- and ecosystem-effective strategy for remediation of contaminated sediment "hot spots." This resulted in progress in use restoration and savings of over $10 million, representing a win-win situation for the environment and economy.
Hamilton Harbour (Ontario)	Applied research on the relationship between loss of habitat and the structure and function of the Hamilton Harbour ecosystem has enabled the leveraging of $19 million from public and private partners to test and implement habitat rehabilitation techniques. This project will: rehabilitate 250 hectares of marsh in Cootes Paradise; enhance the pike spawning marsh in Grindstone Creek; improve the littoral habitat in Hamilton Harbour; rehabilitate the littoral fish community; and provide nesting and loafing sites for colonial waterbirds.
Black River (Ohio)	Research on the cause-and-effect relationship between PAH-contaminated sediments and liver tumors in the brown bullhead population led to agreement on a settlement with USS-KOBE Steel Company to remove over 38,230 m^3 of PAH-contaminated sediments from the river and upland disposal of dredged sediments in a secure landfill on company property.
Nipigon River (Ontario)	Research on the role of water level fluctuations in restoring the fishery resulted in agreement on and implementation of the Nipigon River Water Management Plan. This will benefit the upstream spawning success of walleye and brook trout previously affected by water level fluctuations resulting from hydro-electric power generation.

A bloom of *Microcystis*, a toxic blue-green alga, extended from the western to the central basin of Lake Erie in late summer 1995. This portrays a new and ominous problem of particular concern because of the expenditures and effort to reduce phosphorus loading in the 1970s and 1980s. Furthermore, the zebra mussel became established and has actively filtered out most algae. The exact reasons for this bloom are uncertain. Did increased discharge of nutrients occur? Did the zebra mussel change the water quality and favor productivity of blue-green algae? Will this lead to more taste and odor problems in drinking water supplies? Research managers and decisionmakers will not know without the appropriate focussed research. In the meantime unnecessary funds might be expended on improper and futile control measures. A consortium of academics and federal and state agencies is moving toward collaborative research to address this blue-green algae problem. Research in categories (a) and (b), which have seen some of the heaviest impacts of budget reductions, is needed to identify cost-effective and practical solutions to these problems. Such work has been underway at the Great Lakes Environmental Research Laboratory in Ann Arbor and through research programs in Ontario, programs that have been targeted for reduction or termination.

Conclusions

Based on these survey results and concern raised at the Public Forum on the Future of Great Lakes Science held at IJC's Biennial Meeting in Duluth in 1995, the Council concludes that proposed reductions in research programs will limit timely delivery on Parties' commitments as described in the Agreement and in the Boundary Waters Treaty.

Further, these reductions in research will weaken the Parties' ability to assess the state of the lakes and provide interpretive analysis in a management context. Agencies contributing data on status and trends of the Great Lakes rely heavily on results of research to assess the health of the lakes, identify emerging issues and establish future research needs for ecosystem-based management. In addition, a weakening of the Parties' ability to assess the state of the lakes will ultimately erode IJC's ability to evaluate progress under the Agreement.

As the Agreement has been in place for a quarter century, reflection on the requisite role of research and science in management is appropriate. Without a viable Great Lakes research program in place to address problems as they emerge or to resolve existing problems, the gains of the last 25 years will be lost.

Recommendations

The Council recommends the following.

- **The Parties, in cooperation with the jurisdictions, re-evaluate the direction, substance and mechanisms of proposed research program reductions in order to maintain the scientific foundation for management programs and to deliver on their commitments in the Agreement.**
- **IJC and the Parties take the view that investment in Great Lakes science results in substantial economic and ecosystem benefits.**

Immediate action on this recommendation is warranted.

In light of these findings, the Council proposes that it perform a more detailed and complete analysis of individual research projects through its Research Inventory. **The inventory has been updated and is accessible via the World Wide Web (http://www.ijc.org/conseil_board/research_greatlakes/cglrm_pub.php).** Further, this analysis led to a series of meetings whose objectives were to find innovative solutions to the problems of reduced budgets and develop creative approaches to continued Great Lakes research. Reports on these activities are presented in Chapters 4.2.5 and 4.2.6 respectively.

4.2.3 White Paper: Improving the Effectiveness of Great Lakes Research

Preamble

In October 1995, IJC asked the Council to take the lead in developing an approach to improving the effectiveness of research in the Great Lakes. This issue emerged from the results of the Public Forum on the Future of Great Lakes Science held at IJC's Biennial Meeting in Duluth, Minnesota in September 1995. The Council surveyed the Great Lakes research community to determine the magnitude of and areas impacted by research budget cuts and then involved researchers and research managers in identifying ways to ensure the continuation of needed research, but accomplish major cost savings. These savings not only will be realized by creating efficiencies in research programs, reducing overlap and setting priorities, but also by strengthening the link between research and management. Management actions not based on science or supported by research are often misguided and more costly than they should be. Management guided by research can help ensure achievement of ecosystem results and avoid many expensive wrong turns.

The Council believes that the quality of Great Lakes research is world class, especially in the area of application of an ecosystem approach to research of aquatic systems. An indication of this is the interest in research results from the Great Lakes throughout North America, Europe, Africa and Asia, and the requests

for collaboration and technical assistance from all over the globe. The white paper was intended to encourage greater dialogue and to foster fruitful discussion on the issue of making this work more effective.

The focus of ecosystem research and management has inevitably been drawn from the open lake towards the nearshore. Much of each lake's productivity occurs in the nearshore zone or is initiated there. Past habitat alterations and losses have been concentrated in the nearshore and adjacent lands. Many of the impacts of exotic species (e.g. zebra mussels, purple loosestrife) are most evident in the nearshore. RAPs have played a significant role in promoting this shift from offshore to nearshore and from a largely chemical view to a broader ecosystem perspective. The LaMP effort should continue the process of integrating offshore, nearshore and watershed information.

The 1996 Great Lakes - St. Lawrence River Research Inventory currently contains 408 research projects and programs representing $71 million (U.S.) in research funding. Nearshore and nearshore-related projects account for 22 percent of the total projects and 35 percent of the total funding. Of the total U.S. funding, 19 percent was devoted to nearshore work, while 60 percent of Canadian funding went to nearshore projects. The current emphasis of Canadian funding reflects recent reductions in spending for open lake programs.

The Research Inventory was searched for projects with keywords relevant to SOLEC '96 topics. Although there was some overlap of topics, 24 projects were identified that dealt with coastal wetlands and 21 projects that addressed land use by the lakes. While there were many projects that assessed the impact of land use, there was only one that considered nearshore land use specifically.

Purpose

The Council notes that Great Lakes problems requiring research support are more complex now than in the past. Not only must researchers strive for better science to meet these challenges but, since long-term, sustaining solutions will be more costly, there is a need to engage members of the Great Lakes community in the identification of cost saving strategies to share information and facilities, and develop partnering approaches to the conduct of research. Also, the research community should be involved in setting research priorities so that areas for budget reduction will be identified logically and new approaches can be found for areas that receive no new funding. Further, the Council seeks to identify research that is most responsive to resource management goals.

Successes and Challenges

Over the past 30 years, the results of Great Lakes research have been applied to a variety of problems. Many of these efforts have been successful, although most still face a number of challenges. The Council perceives a utility in briefly cataloguing some of these successes in the hope that some common threads emerge. Also, the Council wishes to remind researchers and managers alike that it is rarely the case that an environmental problem is solved so completely that some level of follow-up monitoring and assessment is unnecessary.

Lake Erie

One of the greatest successes for ecosystem research and management is the recovery of Lake Erie. Focussed research identified the causes of eutrophication and oxygen depletion that were responsible for the lake being labelled "dead" by the media. Aquatic ecosystem modelling led to target phosphorus loads for Lake Erie. Research on nonpoint pollution identified the contributions to phosphorus loading from agriculture leading to promotion of best management practices. Engineers determined the treatment technology needed to reduce phosphorus in point sources. Also, research to reformulate laundry detergents reduced or eliminated the contribution from this source. When this binational effort was put into action, Lake Erie responded as predicted. Phosphorus concentrations in the lake declined dramatically, blue-green algal blooms were much less evident, and oxygen was depleted at a reduced rate, with no anoxia (absence of oxygen) being observed

during 1994-96. The broad success of phosphorus control efforts in the Great Lakes influenced eutrophication management globally.

Yet challenges remain. The invasion of zebra mussels and other aquatic nuisance species has had repercussions on the upper trophic levels in the lake that have put additional strain on fish populations. Also, subsequent to the zebra mussel invasion, blue-green algal blooms have begun to recur in the Western Basin. This situation points out the need for a continued, viable research effort that can respond to new problems, help elucidate cause-and-effect relationships, and provide advice on lessons learned to other areas of North America and the world.

Remedial Action Plans

Another accomplishment has been the role of research in planning and implementation in the more successful RAPs such as Green Bay and Hamilton Harbour. For example, research has been targeted at the causes of impaired beneficial uses such as contaminated sediments, combined sewer overflows and inefficient treatment facilities. Environment Canada and **U.S. Environmental Protection Agency** (EPA) funded the evaluation of dozens of sediment treatment technologies including demonstrations at bench, pilot and full scale. These programs fostered the development of innovative technologies, and expanded the information base on technologies suitable for use in RAPs. Optimization of control systems for CSOs incorporating collection, storage and treatment components is another fruitful area of research that benefits urban AOCs. Satellite treatment systems are expected to be significantly more cost effective than other options and, if proven feasible, could create potential savings of several hundred million dollars for municipalities with CSO problems.

The challenge that remains is to strengthen the link between research and management for all areas of the Great Lakes. The challenge for the Great Lakes research and development community is to maintain the momentum in the development of cost-efficient remediation technologies that was started with programs such as the Assessment and Remediation of Contaminated Sediments and the Great Lakes Cleanup Fund. Complete remedial actions have been implemented at only a handful of AOCs, and the scale of problems, such as in-place sediment contamination and overloaded sewers, can overwhelm the resources of many RAPs. Further development of several remediation technologies is necessary to optimize their performance and bring them to full-scale capability.

Nipigon Bay

Nipigon Bay on Lake Superior has been subjected to a variety of stresses over the last century, including eutrophication, atmospheric loading of contaminants, alteration of physical habitat, point source discharges and exploitation of forests and fisheries. Since the inception of commercial fishing, walleye and lake sturgeon have been extirpated (complete eradicated) and the abundance of other important species has declined significantly. To address these and other problems, a partnership among the research community, resource management agencies, industry and the public was formed through the Nipigon Bay RAP to:

1. identify the multiple stresses acting upon the Nipigon Bay ecosystem;
2. establish objectives for remediation;
3. prioritize contaminant stresses for reduction;
4. rehabilitate affected habitat;
5. effect change in water management and resource exploitation practices; and
6. track and assess progress in the restoration of beneficial uses.

Although not all stresses on Nipigon Bay have been relieved, the initial results are encouraging and the abundance of two fish species dependent on this ecosystem has increased. The marriage of science, management and remediation in this effort has provided relief from multiple stresses in a logical process

that benefited the entire ecosystem.

Project Quinte

A multi-agency research program, Project Quinte, has tracked a succession of ecosystem changes since 1972 in the Bay of Quinte AOC. The long-term, diverse, multi-trophic research studies, spanning nutrients to fish, have had two major impacts. First, the project has provided a unique, continuous record of a Great Lakes ecosystem responding to phosphorus controls under the Agreement and later to increases in the abundance of the major fish predator, walleye. Now, the ecosystem-wide impacts of the on-going zebra mussel invasion are being assessed. This work has produced significant insights into the dynamics of a large, productive bay. Second, the project provided the basis for the RAP process, beginning in 1985. Existing project data were used to produce the Stage I report. The data and the accumulated experience and expertise of the research team were applied to the identification and evaluation of remedial options in Stage II. Much of the information was synthesized into models allowing alternative options to be evaluated objectively and communicated to decisionmakers. The Bay of Quinte RAP would have been severely hampered if the pool of data and expertise represented by Project Quinte had not existed.

In recent years, the emphasis has shifted to RAP implementation while research budgets and staffs have been overburdened by a widening array of problems as a result of cuts from government downsizing efforts. As a result, the research contribution is reduced and many ecosystem management issues are unresolved. The core Project Quinte assessment studies, which underpinned all past management advice, are barely being sustained. For example, a unique effort to develop a watershed-wide system for phosphorus load quotas and allocation is faltering for lack of research input and resources.

Ecosystem Approach

The evolution of an ecosystem approach through RAPs and LaMPs has broadened the concept of environmental assessment to encompass habitat loss and degradation, the still-growing problems of exotics, and the need to understand productivity in relation to biodiversity. It has increased awareness that actions can no longer be taken "in a vacuum." However, a big challenge that confronts the Great Lakes research community is the quantitative understanding of the effects of multiple stressors (e.g. nutrient loads, persistent toxic chemical loads, flow events and exotics invasions) taken in concert on multiple response end-points (e.g. fish production, water quality, algal growth and bioaccumulation). Major tasks that still need to be completed include: 1) defining the goals and indicators of ecosystem-based management with biodiversity and ecological sustainability being high priorities; 2) developing biologically-based habitat supply goals and management actions thereby directing restoration and creation efforts; 3) coming to grips with anticipatory policies for preventing and managing exotic species; and 4) establishing nutrient load quotas and allocations on a local basis within each basin, securing past successes against population growth and harmonized with socioeconomic development policies.

Persistent Toxic Substance Reduction

Research has played a profound role in developing compelling arguments for toxic substance reduction in the Great Lakes. For example, early in the 1980s, toxaphene was discovered in the tissues of lake trout obtained from Lake Siskiwit on Isle Royale, in Lake Superior. This lake is 60 feet above the level of Lake Superior and has no direct land-based inputs. The only source of toxaphene was from the atmosphere. It was suspected that the origin was from cotton fields in the southern U.S. As a result of this research, a ban on the use of toxaphene in the United States was issued in the mid-1980s.

The Green Bay Mass Balance Study, with the combination of modelling and data collection, was the first formal documentation of the system-wide impacts of resuspension of historically contaminated bottom sediments (i.e. high PCB levels in fish in the bay as a direct result of resuspension events in the Fox River). This study represents the use of state-of-the-art toxic substance mass balance models to quantify the relationship between loadings and concentration of toxic chemicals in water, sediments and biota of the Great Lakes.

Another example is the development of uniform water quality standards for the Great Lakes states. Recent research was brought together to establish new methodologies for water quality criteria for aquatic life, wildlife, and procedures for limiting bioaccumulative chemicals. These methods formed the basis of the Great Lakes Initiative, which became a formal regulation in 1995. The challenge that remains is to implement these new controls and verify the ecosystem improvements that occur through sound monitoring and assessment programs.

Human Health

Great Lakes human health effects research has reported an association between the consumption of contaminated Great Lakes fish and body burdens of persistent toxic substances. Neurobehavioural and developmental effects have been observed in newborn infants of mothers who consumed Great Lakes fish. Recent efforts have harmonized the methodological and analytical protocols across these and other studies. This will allow a basin-wide analysis and evaluation of health effects potentially associated with the consumption of contaminated Great Lakes fish.

Budget Cuts and Research Trends

In response, the Council sees three courses of action: 1) request more money, 2) attempt to do more with less, or 3) do something different and innovative. The first option is to argue to have the funding for Great Lakes research restored to the 1994 level. In the current fiscal climate, more resources are unlikely, and even if an argument could persuade legislators to restore funding this year, the vulnerability to research budget cuts would continue in future years. The second option would threaten the continued quality of Great Lakes research. The third option recognizes the reality of shrinking research dollars and attempts to compensate by improving the efficiency of how research is conducted. However, it also emphasizes new directions for research. There must be a balance between focussed investigation and innovative science. It is this option that the Council wishes to pursue with resource managers, researchers and research managers.

Advice from Forum on the Future of Great Lakes Science

Participants at the Forum on the Future of Great Lakes Science commented that the forum was a good mechanism to share information on budget and program cuts and their potential impacts, and to elevate the concern for the loss of "intellectual capital" (i.e. experienced scientists and researchers) required to meet the commitments under the Boundary Waters Treaty, the Agreement, the Great Lakes Fishery Convention and the Great Lakes Charter. In addition, there were suggestions for actions or activities to compensate for program restraint measures in the Great Lakes basin. In general, these suggested actions and activities can be grouped into the following categories:

- clarify and reach agreement on priorities;
- plan cooperatively;
- share responsibilities in delivery of programs;
- share capital resources;
- build partnerships and cooperatives for better science;
- develop new approaches to science and management issues (i.e. adaptive management); and

- communicate value and benefits of science and research.

Improvements can be made in each of these areas to achieve better value. These actions and activities are not comprehensive or perfect, but are intended as practical steps that can be taken immediately to ensure that the important research and scientific programs survive to provide the necessary foundation for management. The rate of change in environmental and resource issues and programs is accelerating. Therefore, decisionmakers in research, science and management must be willing to change. The suggestions are intended to better manage program constraints, pool resources, form partnerships, target priorities and still improve effectiveness.

Charge to Audience

Using the seven action items listed, participants at the SOLEC roundtable and IAGLR '97 conference were asked:

- to identify where the principle was currently put into practice (i.e. where has it been used successfully?) and where the potential exists for application in the Great Lakes community (i.e. how can we transfer this experience across the Great Lakes basin?).
- ascertain the mechanism for action on each item and define the role of the Council, the **Great Lakes Fishery Commission** (GLFC) and the Great Lakes Commission, as well as other Great Lakes organizations and individual researchers in delivering improvements in the effectiveness of Great Lakes research.
- determine whether there are any proactive steps that can be taken to strengthen the position of Great Lakes research for the future.

The responses are discussed in Chapters 4.2.5 and 4.2.6.

4.2.4 Summary of Public Meeting, November 5, 1996

In accordance with IJC's guidelines for public meetings, the Council prepared and circulated a news release to the media in the Detroit-Windsor area and mailed flyers to nearby universities, non-government organizations and local government agencies. The Council invited public views on four questions that are relevant to the priority, improving the effectiveness of Great Lakes research.

- How can the Great Lakes research community combine efforts and develop cost-saving strategies to continue its world-class work, despite recent budget and staffing cutbacks in Canada and the United States?
- How can it ensure a solid scientific foundation for management programs?
- What areas of research are most valuable to people developing and implementing RAPs for degraded areas around the basin, as well as LaMPs?
- How can these programs' research needs to be communicated more effectively?

Six people addressed the Council; some also provided written comments. For a summary of remarks as well as the discussion with Council members, **please see the Council's home page on the World Wide Web (http://www.ijc.org/php/publications/html/cglrmmtg.html)**. The following are several common threads gleaned from the public meeting.

1. The perceived conflict between science and management and the need to incorporate more science in management decisions. This would lead to better decisions and presumably make managers advocates for science.
2. The need for research partnerships. However, these partnerships must often be international in order to deal with the lakes and connecting channels. Barriers to these collaborative efforts must

be removed, including access to baseline data critical for sound research.

3. Issues associated with long range transport of air pollutants have not been addressed adequately in research to date. These include air-water and air-land transfer and movement of pollutants from a variety of sources. The concept of an "airshed" may be a useful tool for evaluation.
4. RAPs depend on science for sound decision making. However, not all RAPs have sources of technical advice and some RAPs, such as the Detroit River RAP, do not use science as the primary rationale for decisions. This not only hurts the credibility of the plan itself but ultimately is detrimental to the viability of the research community whose advice and research is not used.
5. The Council should continue to champion adequate research, monitoring and assessment in order to achieve the spirit and intent of the Agreement. These provide the foundation for understanding how ecosystems function and how to manage the human component of interaction with the ecosystem.

4.2.5 SOLEC '96 Session: Council of Great Lakes Research Managers

As part of its strategy for addressing the priority on improving the effectiveness of Great Lakes research, the Council sought to engage researchers and managers in discussions that would lead to innovative approaches. The SOLEC '96 conference, held in Windsor, Ontario on November 6-8, 1996 by Environment Canada and U.S. EPA was an opportunity for such discussion. Since the theme of SOLEC '96 was the nearshore of the Great Lakes, the Council's white paper was modified to include information on research in the nearshore and distributed to all SOLEC attendees.

The Council facilitated a roundtable session on the topic of improving the effectiveness of Great Lakes research. Five "focus" questions were prepared and the discussion facilitated by Gail Krantzberg, OMEE and current president of the **International Association for Great Lakes Research** (IAGLR). Council members and researchers from government and university laboratories served as resource persons. The session also was summarized and the highlights reported to SOLEC by Dave Dolan, Secretary of the Council. Approximately 70 people attended, including researchers, research managers and interested members of the public. The "focus" questions and discussion are summarized below.

Question 1. **What kind of cost saving strategies, such as facility and information sharing and partnering approaches, will make Great Lakes research more effective and yet maintain its high quality?**

Some did not accept the premise that further cost savings could be gained from the Great Lakes research community. In many cases, research was already pared to bone. During the past five to ten years, the research budgets of many institutions have been nibbled away at until there is very little excess left. Many of the seven action points suggested in the Council's white paper (see Chapter 4.2.3) already have been carried out and further resources generated from such activity will not be great. Also, some duplication of effort is good in order to check and verify research results. The bottom line is that good decision making cannot be based on bad science.

Nevertheless, there are some strategies that could be followed to make research more efficient. For example, information accessibility could be improved to the benefit of all. All Great Lakes data should be systematically looked at with the aim of producing an information inventory. Existing data should be consolidated and made accessible by publication as a compact disc or at a web site. This would help avoid duplication of effort and allow researchers easy access to baseline data for future studies.

To get public support for research the value of research should be communicated to the general public. One way to accomplish this is to put a dollar value on research. Although this may be difficult, the public can relate to the results. This would require a cooperative binational strategy since it would involve many agencies in both countries.

The Great Lakes Fishery Commission has committees for each Great Lake. These are composed of fisheries managers around the lakes whose purpose is to make recommendations about the fish community. The committees rely heavily on research results concerning the fishery and the aquatic food chain. One strategy to improve research effectiveness would be to expand each committee's scope and involve them in the development of LaMPs. LaMPs also rely heavily on research but are focussed more on identification and control of critical pollutants in the lake and its watershed. Since decisions on the fishery are affected by decisions on managing critical pollutants, the overall efficiency of research supporting these two efforts would be improved if they were better coordinated.

Other strategies include multi-agency assaults on Great Lakes problems with more partnering/sharing among all levels of government including municipal agencies and educational institutions including secondary schools. The latter can participate in student training and volunteer monitoring programs. Also, better agency-university links need to be established. For example, agencies could advertise research vessel activities so that university researchers can take advantage of gaps in schedules.

Question 2. **What research is necessary to help achieve nearshore resource management goals?**

Nearshore resource management goals vary from lake to lake and region to region but they have wording such as "achieve a balanced, self-sustaining biotic community." Specific objectives might include:

- restore impaired beneficial uses;
- control exotics;
- exhibit no net habitat loss; and
- restore/maintain native fish.

In order to achieve such goals and objectives, a research approach to nearshore management is needed, including research in four areas: watershed system dynamics, nearshore environmental dynamics, integration of watershed and nearshore, and ecosystem indicators. Also, effort is needed to communicate research results. Among the points raised in discussion, the nearshore area is heavily influenced by associated watershed activities. Therefore, watershed system dynamics must be understood, including answers to such questions as:

- what are important environmental processes taking place within the watershed (e.g. atmospheric deposition, erosion, agricultural runoff and tributary linkages)?; and
- what are important socioeconomic processes within the watershed (e.g. land use, land use decisionmaking processes and population shifts)?

In short, a watershed approach must be applied to understand the influences on the nearshore.

Nearshore and open lake processes are very different. The most important difference that influences nearshore environmental dynamics is scale. Different environmental processes are dominant in the nearshore because of the smaller scale. While the long-term average may be adequate to describe a process in the open lake, episodic events in the nearshore drive the system. This highly dynamic situation results in intensive data needs for study of nearshore processes. In turn, these data needs require generation of information at the necessary time and space scales. Because of the potential expense the most efficient long-term sampling schemes must be identified. Nearshore monitoring can be improved by mathematical models. Therefore, better predictive capability in the nearshore is needed.

Watershed and nearshore dynamics need to be integrated at all levels. Research and long-term ecosystem investigations in the nearshore should include the relevant watershed(s). Monitoring should

also be integrated both among laboratories and across media. Inventories and mapping of resources should be conducted including both watersheds and the nearshore. Mathematical models should include interactions between the two regions. There is often too much focus on individual problems and not enough synthesis.

Because of the complexity of the nearshore, multiple indicators are needed that can be related to specific ecosystem goals. When these indicators are identified and developed, they can be observed for trends and rate of change (i.e. are indicators moving toward or away from an established goal?). However, for the proper development of indicators, statistical analysis is needed to assure their validity and to correctly interpret trends.

Significant effort should be devoted to communicating research findings and needs. It is important to first identify the audience and then explain simply the benefits of continued research (i.e. What's in it for me?). Benefits include increased support for technical assistance and educational efforts, not at the expense of basic research but as a spin-off. Above all, research results have to be transferred to management and the public in a form that will be useful to them. Ambient monitoring programs are always at risk from political, arbitrary and uncoordinated budget cuts because only a small fraction of decisionmakers understand the utility of long-term, uninterrupted ambient data.

Question 3. **What research areas are most useful to RAP and LaMP coordinators, and how can the research needs of these programs be communicated more effectively?**

The research needs of RAPs, LaMPs and resource managers are often poorly defined, partly due to a communication breakdown between those developing plans and the research community. One proven effective way to overcome this is to have researchers directly involved in the development of RAPs and LaMPs. Also, RAPs and LaMPs should invite broader agency involvement (e.g. Sea Grant, Canadian Wildlife Service, U.S. Fish and Wildlife Service, Public Works Canada and the U.S. Army Corps of Engineers).

Better communication also is needed with potential advocates for RAP-related research and potential funding sources. Relevant research and results need to be communicated in plain language beyond the RAP/LaMP coordinators to the advisory councils and the public. These should be thought of as end-users for the research and can be strong advocates if kept informed. Also, RAPs and LaMPs need to identify and communicate research needs for potential funding sources. For example, resources may be needed to adapt and apply research tools on a site-specific basis. Finally, RAPs and LaMPs must complement each other. Research needs are similar, often differing by just a matter of scale. For example, a mathematical model of contaminant fate and transport for Lake Erie may have applicability to AOCs around the lake if adjustments are made for the size of the water body.

A partial list of research areas that were identified based on their applicability to one or more RAP or LaMP includes:

- research on technology for contaminated sediments remediation;
- effective methods for habitat restoration;
- methods to reduce loads and impacts from non-point sources;
- identification of biological community structure and the dynamics of ecological stresses for predictions about the likely result of remedial actions;
- socioeconomic analysis of remedial options;
- cause-effect relationships between remedial actions and restoration of impaired uses;
- quantitative targets to serve as indicators of restoration;
- data to monitor progress in the restoration of beneficial uses (argue that monitoring with guidance of a hypothesis *is* research); and

- establishment and use of standard pollutant loading protocols (include supplemental information such as quality assurance/quality control, flow rates, relevant water chemistry).

Whatever research needs are identified for a RAP or LaMP, a process to complete the work is required. This involves finding the expertise in the research community as well as the necessary funding. One suggestion to ensure future financial resources is to establish RAP endowment funds (for research and data collection) similar to the Great Lakes Protection Fund. Also, since many of the research needs are not unique, an expert system could be developed to help RAPs and LaMPs identify and prioritize research needs (i.e. share a common heuristic knowledge base). Finally, since LaMPs depend on RAPs, good coordination is needed between them, including the identification and implementation of needed research. This is a good opportunity for cost savings, because it could reduce duplication and achieve multiple objectives.

Question 4. **How can multiple disciplines and research institutions be best combined to achieve "critical mass" to address complex research topics?**

Complex research topics, such as tracking pesticide fate and transport or understanding nearshore physical/ecological processes, require multiple disciplines and research institutions. Although much basic research can be conducted by individual researchers and laboratories, applied research that is responsive to management needs must be holistic, coordinated and multi-institutional projects (e.g. the International Field Year for the Great Lakes or the Green Bay Mass Balance). The complexity of the Great Lakes system warrants the combined efforts of researchers and institutions.

Achieving critical mass for a complex research topic means assembling a team of researchers that represents the major disciplines required for the study without leaving gaps or excessive duplication. Necessary prerequisites are:

- need for cooperative planning at the beginning of a project;
- need for research managers and researchers to formulate integrating questions;
- need for a commitment to long-term research funding for multi-discipline research;
- establish a mechanism that allows groups to form for specific problems and gets agencies to commit funding;
- implement post-proposal coordination/cooperation by asking proposers to refine/amalgamate their proposals (e.g. Great Lakes Agricultural Profile Project (Great Lakes Protection Fund), Great Lakes University Research Fund project on Lake Erie);
- investigate the possibility of matching funding from governments, industry, foundations and NGOs;
- explore partnerships; and
- eliminate cross-border funding barriers.

Several areas regarding data and information should be improved in order to support this effort. There is a need to establish a basin-wide, geo-referenced database of researchers, expertise, institutions and study areas as a means to facilitate project coordination. Information and databases should be shared; a sense of trust should be fostered. Public data should be available free of charge and ways of accessing data widely publicized (e.g. training, user manuals). The "good will" factor should be an aspect of mobilizing and sharing multiple data sets. New technology for information management should be used to reach a wider audience and make the overall process of obtaining data easier. If information from private sources is confidential, then it should be kept separate from publicly available data.

One way to use the data base to improve coordination is to cross-reference the Council's inventory by funding agency and use it to generate interagency cooperation. In conjunction with this, the Council could organize a biennial, binational Great Lakes research managers workshop with the following

objectives: share priorities (exchange information on current and future projects and look for possible synergies; eliminate overlap; develop partnerships; and explore ways to share equipment and staff. Such a workshop should be organized and attended by managers and researchers and should provide ample opportunities for communication, networking and coordination.

When discussing complex research, there needs to be a balance with exploratory research that is often best done by individual researchers or small teams. It is important that adequate funding and mechanisms for autonomous, not necessarily problem-solving, basic research be kept available so that the ability to identify new problems is retained.

Question 5. **If research funding must be reduced in certain areas, how can the Great Lakes research community be involved to ensure that reductions will be achieved logically and that vital components do not go unfunded?**

This question is related to Question 4 in two ways. If a clear set of research directions has been identified, including basic and exploratory research, then reductions could be carried out logically. Also, if critical mass has been established for some complex research topics, then these projects have to be allowed to finish before reductions are considered. It is necessary to include the academic community in these decisions.

When reductions have occurred, it is possible to manage them so as to have the least impact. For example, human resources and institutional knowledge should be preserved above all else. This could be achieved by cooperative training and rotation of staff among labs and by mentoring of younger scientists. Vital components of research programs in the nearshore are often field work and the data and information associated with it. Coordinated planning of monitoring can ensure that this area is impacted as little as possible. Also, it is possible that existing data may have utility for purposes other than those for which they were collected. When new data are not available, it may be feasible to connect researchers with existing data (i.e. data mining).

A culture and paradigm shift must occur to recognize science as part of policy and to incorporate advice from the result of scientific study into the decisionmaking process. One way to convince decisionmakers and the public that this shift is needed is to document and market the relevance of research and the return on investment (i.e. quantify the value of research). Once done, it is still necessary to rally support for research. An important part of this is communication to the public (e.g. web pages, laboratory brochures) in order to help the public understand the *real* issues and research needs and the value of good science in support of them.

The above suggestions to reduce the impacts of research budget cuts require constant attention by researchers and managers. A good way to focus this effort is through an annual meeting, such as the IAGLR Conference where a regular session on recommendations, priorities, resource sharing and partnerships could be held and easily reach the target audience. Such a session was held at the IAGLR '97 Conference in Buffalo, New York and was of immediate value in the face of documented research cuts (see Chapter 4.2.6).

The common threads from the discussion at the SOLEC '96 session included:

- the research community should market the value of their research in terms relevant to the general public;
- research and monitoring in the face of budget cuts requires a long-term, integrated approach;
- innovative funding alternatives must be sought, such as partnerships, where barriers are removed including cross-border funding obstacles;
- better data integration and availability are needed to foster cooperative research efforts;

- sampling and field work require advanced coordination, especially in complex research efforts;
- all affected groups should be involved in research decisionmaking, particularly the academic community; and
- there is a communication barrier between some RAP teams and researchers. Researchers should participate as members of RAP teams and have an equal voice.

4.2.6 IAGLR Plenary Session, June 4, 1997

As part of its strategy for addressing the priority on improving the effectiveness of Great Lakes research, the Council engaged researchers and managers in discussions at the IAGLR '97 Conference held in Buffalo, New York and sponsored by Buffalo State College and the State University of New York (SUNY) at Buffalo. The approximately 70-80 attendees reflected a variety of interests including physics, chemistry, biology, engineering and policy. The Council's white paper, Improving the Effectiveness of Great Lakes Research, served as the basis for discussion.

The Council facilitated a plenary session entitled Improving the Effectiveness of Great Lakes Research. Dr. Joe DePinto (SUNY Buffalo) presented a summary of the results of the SOLEC '96 session on research. During an interactive discussion, four panelists summarized how their agencies were managing this topic.

Presentations

Mike Quigley (NOAA) discussed the IAGLR '97 plenary session, Sharing and Leveraging Scarce Resources -- Great Lakes Science Partnerships through the 90s and Beyond. At that plenary, panelists discussed partnerships and shared resources on a national level. One example of a formal partnership in the U.S. is the Sea Grant program. There is an active university grant program for each of the Great Lakes states and the process places added value on partnerships among grantees. The Consortium for Oceanographic Research and Education, a coalition of agencies and universities, has been formed to speak with one voice regarding resource needs for research and education in ocean programs. Examples of partnerships in Canada include the **Canada-Ontario Agreement** (COA), the **Upper Lakes Environmental Research Network** and the **Great Lakes Cleanup Fund**. The University-National Oceanographic Laboratory System coordinates oceanographic ship schedules and research facilities.

Mr. Quigley also described the Great Lakes Research Vessel Coordination Workshop held in Detroit on March 11-12, 1997. Seeing the need for a similar coordinating body in the Great Lakes, NOAA and other agencies and universities convened the workshop, which brought together Great Lakes research vessel operators and managers. One result was an Internet-based coordination system and an inventory of research vessels. Currently, there are about 60 vessels and their capabilities and characteristics will be listed. To continue saving money by exchanging equipment, current plans call for a workshop every year. As the resource decline continues, accountability for efficient use of remaining resources is increased and coordination of vessel use demonstrates this concern.

Harvey Shear (Environment Canada) noted that as a result of a program review by Environment Canada, their program experienced a 30 percent reduction in people and budgets nationally. Ontario Region programs in support of the Agreement, such as surveillance and monitoring, the **National Water Research Institute** and the **National Wildlife Research Centre** suffered somewhat less than this. Some programs have been restored by internal reallocation, but cuts at the provincial level also necessitate a reassessment of the partnering through COA.

To deal with these cuts, priorities have been set, such as ecosystem objectives in support of LaMPs and reports on indicators. The result is targeted, mission-oriented research and the linking of science to

policy. This may limit scientific freedom because researchers may not have as much flexibility. Research managers are working to establish the right blend of basic research versus targeted research so that researchers will still have some freedom to pursue interesting avenues.

Another approach is an expanded effort to rely on university research, including efforts that synthesize the work of previous researchers and moves away from narrowly defined projects. The concept of "mining" data sets from previous work that may still contain relevant information to establish baselines needs to be furthered with university researchers. It is difficult to convince some university departments that such projects have merit. There is also the need to market research through such events as SOLEC to reach decisionmakers. Researchers should avoid jargon so that their results are understood by the interested public.

Vic Cairns (Department of Fisheries and Oceans) summarized the major resource cuts to their Great Lakes science program: a 40 percent reduction of staff, a 70 percent reduction of operating funds and loss of one research vessel, the R/V *Lauzier*. In response, a new research paradigm for Great Lakes science was identified. Table 11 compares the old ways of doing science with future needs.

Table 11. Old Paradigm vs. New Paradigm

OLD PARADIGM	NEW PARADIGM
Focus on problem identification	Science more focussed on solutions (focus on common goal)
Tend not to look beyond internal capability to solve problems	Expand horizons to include other scientists to solve problems (lend or borrow expertise, training, incentives, flexibility in budgets)
Sense of responsibility for complete solutions sometimes constrained by mandate, capability and interest (someone else's problem)	More sharing of responsibility and mandate (empowerment of local agents, universities for problem solving), e.g. RAPs
Reactive science -- issues already here (lamprey)	Should be more proactive, e.g. risk assessment for new invaders
Variety of science initiatives, including some curiosity driven science, could be afforded	Strictly bounded by resources. Pragmatic and focussed with almost no opportunity for "want to know" effects (less distinction between academia and government for same funds)
Detailed examination of complex issues encouraged	Movement toward indicators of individual and community health, habitat quality.
Planning model (planning, doing, evaluating) 10:80:10	As resources decline and partnerships (and data) increase, much more emphasis on planning and synthesis and less on doing 40:20:40. Change in expertise needed?
High level of resource intervention (habitat restoration)	Conservation and prevention vs. rehabilitation.
Science funded almost entirely from government	Government monies used to lever outside resources. Science priority increasingly reflects

	third party priorities. Becoming more difficult to fund long-term (20-year) ecosystem studies, forcing science community into short-term studies. Need to find way to weave short-term priorities into long-term programs
Science priority planning tends to be internalized	Research priorities need to be defined by much larger community (e.g. LaMPs), role for more active involvement from Council, IJC and GLFC in science priorities.

DFO has taken eight steps toward establishing the new paradigm.

1. Emphasis has moved from activities to science products that are more focussed on client needs.
2. Discussions have been initiated with OMNR to establish a formal mutual priority setting process.
3. Initial steps have been taken to develop partnerships with universities and other governments through the Upper Lakes University Research Network (for example, listing research priorities, identifying who is doing what, collaborating on calls for proposals).
4. More reliance has been placed on collaborative partnerships with university researchers, including support for more graduate students and post-doctoral fellowships. Projects are usually client driven and supported and focussed on needed questions.
5. Research staff are seconded (assigned) to work with fisheries habitat resource managers to better understand what the operations-people need from science.
6. Collaborative agreement has been reached with OMNR to assign an expert to work with DFO staff to solve a mutual problem, improving the lower trophic model to fit the Lake Erie Ecosystem Model.
7. Internal collaboration is slowly increasing. People and equipment are borrowed internally to meet peak demands, for example, fish health biologists to conduct habitat surveys.
8. Operational partnerships have been established with outside agencies (such as the Metro Toronto Region and the Hamilton Region Conservation Authorities) where specialised equipment and trained staff are shared in return for similar favors.

DFO has identified five important issues that need to be resolved in the near future.

1. **Science planning**. Because of lack of communication, some important issues (exotics, habitat management) and programs in support of the Agreement and COA are scrambling for funding. A mechanism is needed for setting priorities and more communication among agencies.
2. **Information on fish stocks to assess status and predict response to environmental change**. Long-term monitoring is required for an appropriate suite of environmental indicators, as is more information about fish stocks on the upper lakes. To ensure data homogeneity among lakes, a basic suite of information for all lakes will be recommended and relevant monitoring parameters carefully selected.
3. **Science based guidance for fisheries managers** will help them understand how chemical contaminants and multiple or even single alterations to phosphorus, exotics, habitat, fish stocking and exploitation affect fish stocks, water quality, and ecosystem stability and influence resource management.
4. **Exotic species management**. Since control is difficult, prevention is the top priority. A risk assessment framework is required to evaluate potential damage and influence decisionmakers.
5. **Science based guidance for habitat management** is required to quantify and assess impacts of habitat alterations on fish communities and to link habitat alterations and fish production. Science results must be transferred into prevention and enhancement activities, not regulation.

Steve Lozano (U.S. EPA) noted that his agency also is going through a paradigm shift. On the national level, U.S. EPA's **Office of Research and Development** (ORD) has an expanded grants and fellowship program with $100 million going to extramural investigator-initiated grants in 1997. The ORD strategic plan includes the creation of four "mega-labs" around the country organized around risk and representing movement away from stressors towards an ecosystem approach. One of the national programs is EMAP II (**Environmental Monitoring and Assessment Program**) emphasizing indicator development, integrated assessment and information management. The latter includes public data access via the Internet. **Regional EMAP** (REMAP) makes approximately $2 million per year available to U.S. EPA regions for EMAP-like projects such as the St. Louis River sediment project. The Mid-Continent Ecology Division, located in Duluth, Minnesota, is currently adding post-doctoral positions through the ORD fellowship program. The Ecology Branch is working on Lake Superior to establish long-term monitoring at 45- and 100-metre sites and to track transfer of material through trophic levels from watersheds.

U.S. EPA is involved with several partnerships at both the national and Great Lakes level. Nationally, U.S. EPA partners with universities and other agencies through the EMAP program. The Lake Michigan Mass Balance Study is a good example of partnering that includes several agencies and universities. Smaller projects include the St. Louis River REMAP project which uses an EMAP design to test sediment in the AOC and the Lake Superior Forage Fish Assessment. U.S. EPA can now enter into a cooperative research agreement that allows for sharing of equipment and expertise including the use of U.S. EPA boats by universities.

Discussion

Following on the idea of seconding (temporarily assigning) researchers to universities and other agencies, the suggestion was made that researchers could be seconded to communities (e.g. by researchers joining RAP teams). This would permit easier identification of RAP research needs as well as adapting work from other areas to meet individual RAP requirements. This kind of coordination already occurs for some RAPs. How can this arrangement be fostered for all RAPs? One common RAP research need is the development of relevant, credible indicators of progress in remediation efforts. However, indicators may be misleading because there is often not enough information to make indicators useful.

The extremely broad **Requests for Proposals** (RFPs) that universities respond to currently are in opposition to the suggestion that agencies conduct targeted, mission-oriented research. The suggestion was made that the Agreement annexes are clear about research needs and these could be used to target RFPs. Research managers who create RFPs would respond to pressure to focus their research direction. Currently, managers are not getting the message on the value of research; they need constant reminders. Researchers should work with program managers to develop research agendas.

It may be dangerous for IAGLR to presume that more research has to be done with less resources. When Great Lakes research is compared to other government programs, the budgets appear tiny and the results substantial. However, the lack of resources may be because the marketing of the benefits of Great Lakes research has not been done. Planning needs to be devoted to this. Also, money is available to support research if searched for, but that should not stop efforts to make research more efficient.

One way that IAGLR and the Council could help improve research planning would be to sponsor a workshop with those involved in the Lake Ontario LaMP and researchers at the next IAGLR meeting. One theme of IAGLR '98, to be held at McMaster University in Hamilton, Ontario, is the state of Lake Ontario.

The need for more synthesis of existing information is not new, but there are barriers to conducting

such projects, including lack of academic credit and lack of project funding. One solution is to reserve a certain amount of funding for synthesis projects. Also, if the synthesis included socioeconomic concerns and was media friendly, then marketing of the results would be easier. However, training would be needed to accomplish this. An example is a course taught to engineers and lawyers where each experienced the other's discipline.

The example of the Wildlife Habitat Council was brought up as a potential industrial partner. This is a group of individuals, conservation organizations and corporations (including over 100 industries) established to help large landholders manage their unused lands in an ecologically sensitive manner for the benefit of wildlife. In the Great Lakes, the St. Clair River Waterways for Wildlife Project includes as partners Detroit Edison, Terra International, Ontario Hydro, Environment Canada and the Joyce Foundation.

Five common threads were identified in this plenary session:

1. Mechanisms for establishing partnerships exist and are in use in many areas of Great Lakes research. These need to be used more frequently and in more creative ways.
2. Targeted, solution-oriented research needs must be given higher priority by program managers. This includes continued and expanded use of graduate students and post-doctoral fellows to conduct issue-driven research. University departments should be urged to accept projects that are applied in nature or are syntheses of previous work as valid academic endeavours. Agencies should set aside funding for such work.
3. The benefits of Great Lakes research need to be better marketed, including addressing the socioeconomic implications of projects as well as effectively communicating with the news media. This will require additional skill acquisition by researchers.
4. Better planning of research projects is important. RFPs should not be developed in a vacuum but with the full participation of the research community. The Council and IAGLR could work together to convene a workshop bringing together researchers and Lake Ontario LaMP planners.
5. Suggestions for improving the effectiveness of RAP-related research include:
    - second (assign) researchers to RAP teams, thus eliminating communication barriers that some RAPs are facing; and
    - increase effort on indicator research, an area that many RAPs rely on for goal and target setting. Research from other AOCs can be adapted to RAPs that may not have had the benefit of a focussed research project initially. An example is the Green Bay Mass Balance Study where models developed are applicable to several other AOCs.

4.2.7 Conclusions and Recommendations

Under the priority, improving the effectiveness of Great Lakes research, the Council surveyed Great Lakes researchers to ascertain the magnitude of budget cuts and their impact on research programs in support of the Agreement. IJC used the results in its Eighth Biennial Report on Great Lakes Water Quality. In addition, the Council engaged the research community in discussion to identify mechanisms to increase effectiveness. The Council used three venues with different formats to reach audiences essential to address the topic.

- At the public meeting, researchers and interested members of the public presented their concerns and suggestions.
- A roundtable at SOLEC '96 engaged managers and others through five "focus" questions.
- A plenary session at IAGLR '97 engaged researchers through a panel and discussion.

The Council reached a reasonable cross-section of the Great Lakes research community. Judging from the number of suggestions received and the attendance at these events, especially the SOLEC and

IAGLR sessions, the interest of researchers, managers and the public is strong. As described in this chapter, mechanisms are in place that, if fully used, could help make Great Lakes research more effective. Highlighted below are recommendations derived from these sessions.

Research partnerships currently exist both in the Great Lakes and at the national level. Innovative use of this mechanism should continue, especially for federal-provincial partnerships in Canada and federal-state partnerships in the U.S. However, research on the lakes and connecting channels is often international in nature and barriers to partnerships of this nature should be removed. Barriers include access to data and equipment and cross-border funding. To increase the effectiveness of Great Lakes research, the Council recommends the following.

- **The use of existing partnership mechanisms continue and new mechanisms for establishing research partnerships be crafted with special emphasis on the formation of international partnerships.**

One partnership mechanism that has been in existence since the signing of the original Agreement is university-government cooperation. In both countries there has been a recent, renewed emphasis on cooperative research projects that utilize graduate students and post-doctoral fellows. This can be an efficient mechanism as long as the projects result in targeted, mission-oriented research. Some of these projects should represent syntheses of previous work. University departments should be willing to give academic credit for synthesis projects. The Council recommends the following.

- **Government agencies collaborate with universities on focussed, client-driven research projects that will result in an improved scientific basis for management decisions.**

Much of the research conducted in the Great Lakes basin currently is done in support of RAPs and LaMPs. These plans depend on good science for sound decisionmaking. Yet not all of these efforts, especially RAPs, have the benefit of this research, because of communications barriers between researchers and some RAP teams. This hinders both the identification of RAP research needs, and implementation of research results. The Council recommends the following.

- **Researchers be actively involved in the decisionmaking processes of RAPs and LaMPs through membership on RAP and LaMP teams and advisory councils. In addition, research results must be incorporated in all RAP and LaMP reports to strengthen research management linkages.**

A recurring theme in all of the events that the Council held was "marketing" the benefits of Great Lakes research. The Council's white paper (Chapter 4.2.3) includes examples of successful applications of research and attempts to initiate marketing efforts. However, scientists not trained in this area find it difficult to deal effectively with the public and the news media. The Council recommends the following.

- **IJC, as a priority for the 1997-99 biennial cycle, address the effective communication of research results.**

An important initiative being conducted by NOAA and other agencies and universities is the Great Lakes Research Vessel Coordination Workshop and associated vessel inventory. A major expense of lake research is ship time. This effort to coordinate and optimize the use of research vessels is a major step towards improving the effectiveness of research. The Council recommends the following.

- **Coordination of Great Lakes research vessels continue and IJC sponsor future vessel coordination workshops.**

Research planning has often been under-emphasized in the past. Managers have tended to establish research priorities in a vacuum and wrote broadly scoped RFPs. With the reality of reduced budgets, planning is more important than ever before and researchers should have a voice in establishing RFPs that will lead to focussed research. The Council recommends the following.

- **To establish research priorities, government agencies share the responsibility with both scientists who are familiar with Great Lakes research needs and also users of research results.**

The size and complexity of the Great Lakes system is such that one funding agency cannot hope to cover all aspects of a given research problem. Agencies need a way to leverage their research resources by combining funds with other agencies in collaborative studies. Examples of such projects include the Green Bay Mass Balance Study and the Lake Michigan Mass Balance Study. These studies are not binational, however. What is needed for Lake Ontario or Lake Erie is a study that is both binational and lakewide (e.g. International Field Year for the Great Lakes). The Council recommends the following.

- **Government agencies support the concept of a lakewide, binational, coordinated, multi-institutional project that would cover all aspects of a given problem domain in a given system.**

4.3 STATUS OF THE GREAT LAKES - ST. LAWRENCE RIVER RESEARCH INVENTORY

In the fall of 1995, the Council began to re-design the Research Inventory and to make it accessible through the **Great Lakes Information Network** (GLIN). The objective in improving the inventory and making it more timely and accessible is to promote the transfer of information on research programs to Great Lakes basin policymakers, resource managers and the public. The project description form was revised to make it easier to complete, improve the quality of information, and facilitate its adaptation into an electronic form available through GLIN; and the data base was revised to make it easier to search. These changes were implemented for the 1996 version of the Research Inventory.

In January 1996, the revised project description forms were mailed to approximately 1,000 addressees known to conduct relevant research on the Great Lakes and St. Lawrence River. Included were instructions on how to access and complete the electronic form or to submit a hard copy, either of which would result in exactly the same information being entered in the data base. Mandatory items have been designated on both versions of the form. The requirement to submit mandatory information has improved the integrity of the data base.

The 1996 Great Lakes - St. Lawrence River Research Inventory currently contains 432 research projects and programs, representing approximately $71 million (U.S.) in research funding. **It is available on the Internet at http://www.ijc.org/php/publications/html/ri96home.html(.)** New search capabilities have been added including keyword, agency and principal investigator. The research categories have been made more relevant. The 1997 inventory is currently being assembled and should be accessible in the fall.

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