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# Use of an Ecosystem Approach to Restore Degraded Areas of the Great Lakes

Two mutually supporting initiatives have arisen under the auspices of the Canada-United States International Joint Commission (IJC) in the context of the evolution of Great Lakes Water Quality Agreements: an ecosystem approach to resolving problems; and the development of comprehensive remedial action plans to restore 42 degraded areas (i.e., Great Lakes Areas of Concern). The ecosystem approach is a deceptively simple idea of taking account of the interrelationships among water, land, air, and all living things, including people; and involving all user groups in management. The remedial-action-plan program represents the first opportunity, on a broad and practical scale, to implement an ecosystem approach in the Great Lakes basin. It is an experiment in setting up the institutional arrangements necessary to implement locally-designed ecosystem approaches to cleaning up Great Lakes Areas of Concern. The key to implementing an ecosystem approach is establishing a basin committee, stakeholders' group, citizens' advisory committee, or comparable group broadly representative of social, economic, and environmental interests in the affected area. Such groups provide an opportunity to change the traditional way of doing business by increasing the level of interaction. As is the case in all IJC activities, group members serve in their personal and professional capacities and not as representatives of agencies that employ them.

## INTRODUCTION

In a global perspective, there are substantial numbers of aquatic ecosystems that have been profoundly altered, depleted, eroded, or contaminated. In many cases, restoration and redevelopment are being pursued simultaneously. Successful restoration and redevelopment programs must not only pursue technical, legal, and economic advances, but bring changes in underlying cultural values and societal conditions that sustain ecosystem integrity and the quality of life of human inhabitants. The requisite harmonization of environmental and societal development goals demands an understanding of the interrelationships between biotic and abiotic resources and the involvement of all human user groups in the management of their ecosystem.

Historically, the Great Lakes basin has been a focal point for the development of international initiatives to improve the harmony between people and nature (1). The first of these was the Boundary Waters Treaty concluded between Canada and the United States in 1909. It established a permanent body, the International Joint Commission (IJC), to advise the Governments jointly on the resolution of problems in which actions on one side of the border threatened health and property on the other side of the border. Significantly, the Commissioners, three from the United States and three from Canada, are not appointed to represent their governments, but to advise the two governments jointly on matters of common concern.

A second major institutional initiative was the Great Lakes Water Quality Agreement (GLWQA) of 1972. This committed the governments of the United States and Canada to a basinwide program of phosphorus control to halt accelerating eutrophication. The program has successfully reversed trends of eutrophication in the Great Lakes.

The third institutional initiative was the GLWQA of 1978. This shifted the agenda from a system external to people (the Great Lakes) to the Great Lakes Basin Ecosystem (a system with air, water, soil, and biota, including people, in it). The ecosystem approach of the 1978 Agreement was consolidated and strengthened in a protocol-revised GLWQA in 1987.

Our aim in this paper is to describe two mutually supporting initiatives that have arisen under the IJC in the context of the evolution of GLWQAs. These are an

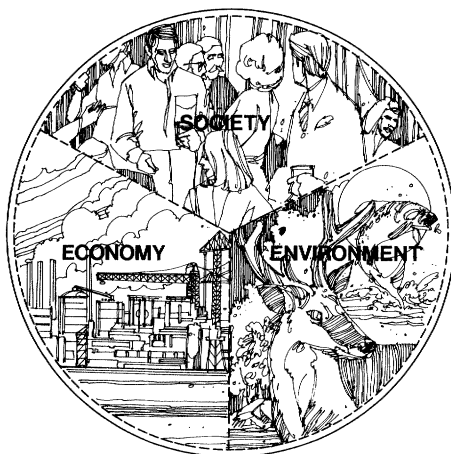


A portion of the concrete channel (constructed for flood control) in the main branch of the Rouge River, Dearborn, Michigan. Note the Detroit-Dearborn Channel which enters the main branch. Annual combined sewer overflow volume entering this channel is approximately 22 million m<sup>3</sup>. Photograph courtesy of Southeast Michigan Council of Governments.

ecosystem approach to resolving environmental problems; and development of remedial action plans to restore degraded areas (i.e., Areas of Concern). It should be noted that there is no legal requirement that remedial action plans be developed and implemented. Implementation is proceeding in large part through moral suasion.

### ECOSYSTEM APPROACH

An ecosystem approach is the most recent in a succession of approaches to managing human uses and abuses of natural resources. These have been characterized as "ego-systemic" (me only), piecemeal (one-by-one), environmental (air, land, water, and biota, excluding people), and ecosystemic (social-environmental-economic) approaches to problem solving (2). The ecosystem approach can be symbolized as a circle with three equal segments representing social, economic, and environmental interests (Fig. 1). Dashed lines between the segments show that the inner circle (an ecosystem) and its parts are open to exchange of information, energy, and matter with neighboring areas. The outer circle, representing the biosphere, is closed. The principle of the ecosystem approach is that no segment of the circle can be sacrificed; all are essential.



**Figure 1. The ecosystem approach depicted as a circle with three equal segments representing social, economic, and environmental interests. Operating principle: no part of the ecosystem can be sacrificed without detriment to human interest.**

The difference between environmental and ecosystem approaches is comparable to the difference between "house" and "home". House implies something that is external and detached. In contrast, home implies something that we are in, and see ourselves in even when not there.

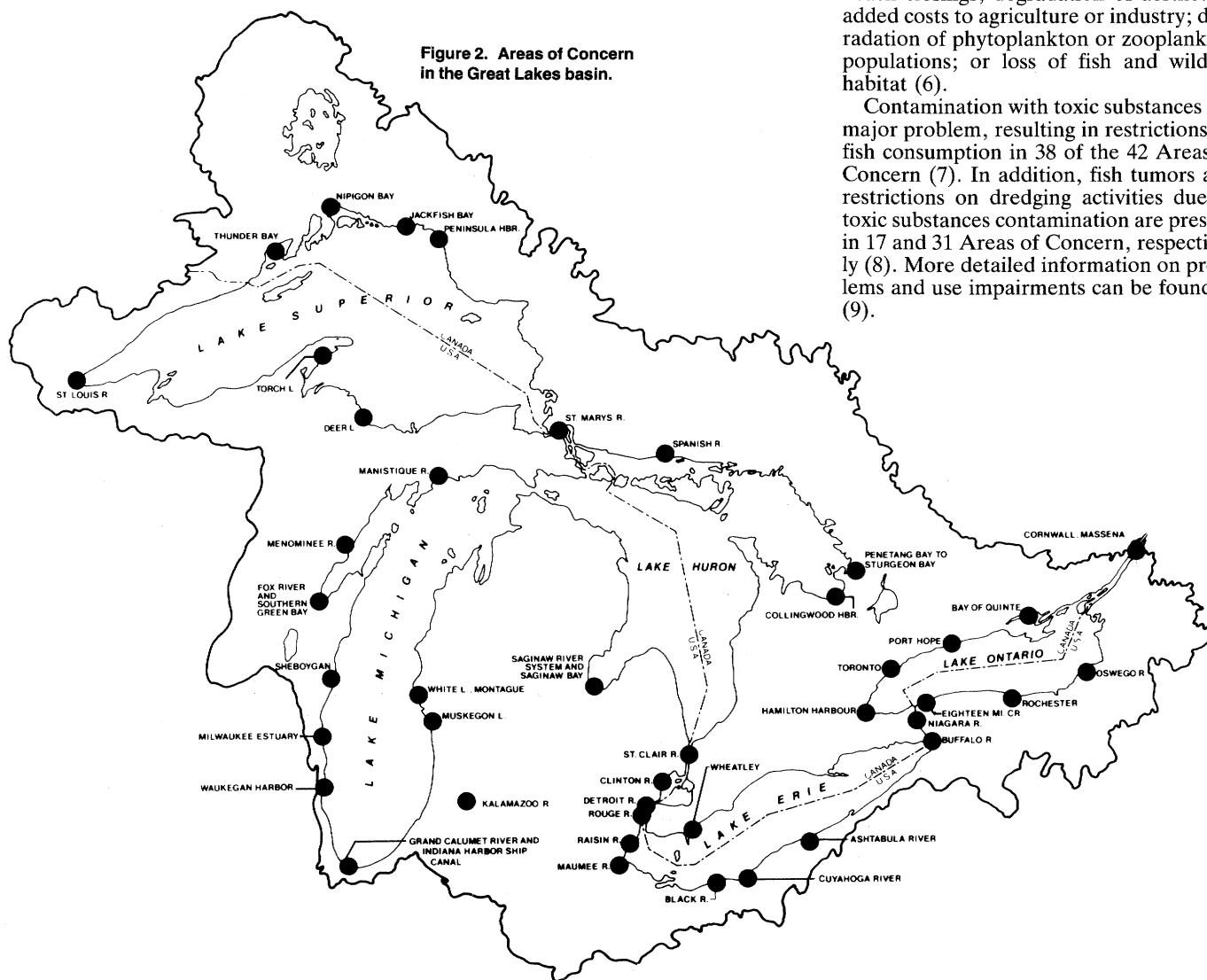
Criteria have been developed (2-4) to assess when a set of measures constitutes an ecosystem approach. These are a focus on integrated knowledge; a perspective that relates systems at different levels of integration; and actions that are ecological, anticipatory, and ethical in respect to nature. The essence of an ecosystem approach is that it relates people to ecosystems that contain them, rather than to environments with which they interact (5).

### REMEDIAL ACTION PLANS FOR AREAS OF CONCERN

Currently, there are 42 Areas of Concern in the Great Lakes Basin Ecosystem where failure to meet the general or specific objectives of the GLWQA has caused or is likely to cause impairment of beneficial use or of the area's ability to support aquatic life (Fig. 2). Impairment of beneficial use means a change in the chemical, physical, or biological integrity sufficient to cause any of the following: restrictions on fish and wildlife consumption; tainting of fish and wildlife flavor; degradation of fish and wildlife populations; fish tumors or other deformities; bird or animal deformities or reproductive problems; degradation of benthos; restrictions on dredging activities; eutrophication or undesirable algae; restrictions on drinking water consumption, or taste and odor problems; beach closings; degradation of aesthetics; added costs to agriculture or industry; degradation of phytoplankton or zooplankton populations; or loss of fish and wildlife habitat (6).

Contamination with toxic substances is a major problem, resulting in restrictions on fish consumption in 38 of the 42 Areas of Concern (7). In addition, fish tumors and restrictions on dredging activities due to toxic substances contamination are present in 17 and 31 Areas of Concern, respectively (8). More detailed information on problems and use impairments can be found in (9).

**Figure 2. Areas of Concern in the Great Lakes basin.**



As a result of a 1985 recommendation of the IJC's Great Lakes Water Quality Board, the eight Great Lakes states and the Province of Ontario committed themselves to developing remedial action plans to restore beneficial uses in each Area of Concern within their political boundaries (10).

Specifically, each remedial action plan must:

- Define the environmental problem, including geographic extent of the area affected, using detailed maps and surveillance information;
- identify beneficial issues impaired;
- describe the causes of the problems and identify all known sources of pollutants;
- identify remedial actions proposed to restore beneficial uses;
- identify a schedule for implementing remedial actions;
- identify jurisdictions and agencies responsible for implementing and regulating remedial actions;
- describe the process for evaluating remedial program implementation and regulating remedial measures; and
- describe the surveillance and monitoring activities that will be used to track program effectiveness and eventual confirmation that uses have been restored.

### DEVELOPING AND IMPLEMENTING REMEDIAL ACTION PLANS USING AN ECOSYSTEM APPROACH

The development of remedial action plans represents a challenging departure from most historical pollution control efforts, where separate programs for regulation of municipal and industrial discharge, urban runoff, and agricultural runoff are implemented without full consideration of overlapping responsibilities. This new process calls upon the interactive talents available in a wide array of programs, including the involvement of local communities, citizens, and a wide range of organizations and government agencies.

The remedial-action-plan program represents the first systematic and comprehensive effort to restore beneficial uses in Areas of Concern in the Great Lakes basin and offers a unique opportunity to break down institutional barriers at a practical level. All affected organizations, agencies, and communities must work together on common goals and objectives, explicitly accounting for interrelationships between ecosystem compartments.

The two-dimensional diagram presented in Figure 3 depicts a bureaucratic view of the roles and responsibilities of different agencies, organizations, and programs involved in developing remedial action plans (7). The vertical axis depicts the range of responsibilities and interests from international and national governments to public interest groups and concerned citizens. The horizontal axis depicts the diverse program responsibilities within a jurisdiction. The jurisdictions responsible for developing remedial action plans are at the center of the diagram where the vertical and horizontal axes cross. The challenge has been to integrate these different responsibilities.

An ecosystem approach calls for a functional rearrangement of the organizations and interests as equal members of a team. Thus, the bureaucratic diagram is rearranged into a circle with open compartments (Fig. 4). In this model, each

member of the team works around the table with all other members of the team to accomplish the common goal of restoring their Area of Concern.

This change in the structure and level of interaction between groups and jurisdictional responsibilities represents a challenging departure from most historical pollution control efforts. Under an ecosystem approach, all organizations, agencies, and citizens affected by or affecting an Area of Concern come together as "stakeholders" to work cooperatively. Table 1 compares piecemeal, environmental, and ecosystem approaches to resolving problems in the 42 Areas of Concern.

The key to implementing an ecosystem approach is establishing a basin committee or comparable organization broadly representative of social, economic, and environmental interests within the affected area. Such groups provide an opportunity to change the traditional way of doing business and the level of interaction. As is the rule in all IJC activities, committee members serve in their personal and professional capacities rather than as representatives of agencies that employ them.

The IJC's Great Lakes Science Advisory Board has posed the following questions to determine the adequacy of a remedial action plan (11).

1. Does the plan embody an ecosystem approach?
2. Have human health issues been adequately and comprehensively addressed?
3. Can restoration of beneficial uses be sustained?
4. Have stakeholder roles and responsibilities been considered in plan development and implementation?
5. Have effects been adequately linked to causes and addressed in a balanced way in terms of societal, technological, and ecological elements?
6. Does the plan identify opportunities for pollution prevention?
7. Is the plan set in the appropriate time frame?
8. Is there provision for periodic review and updating?

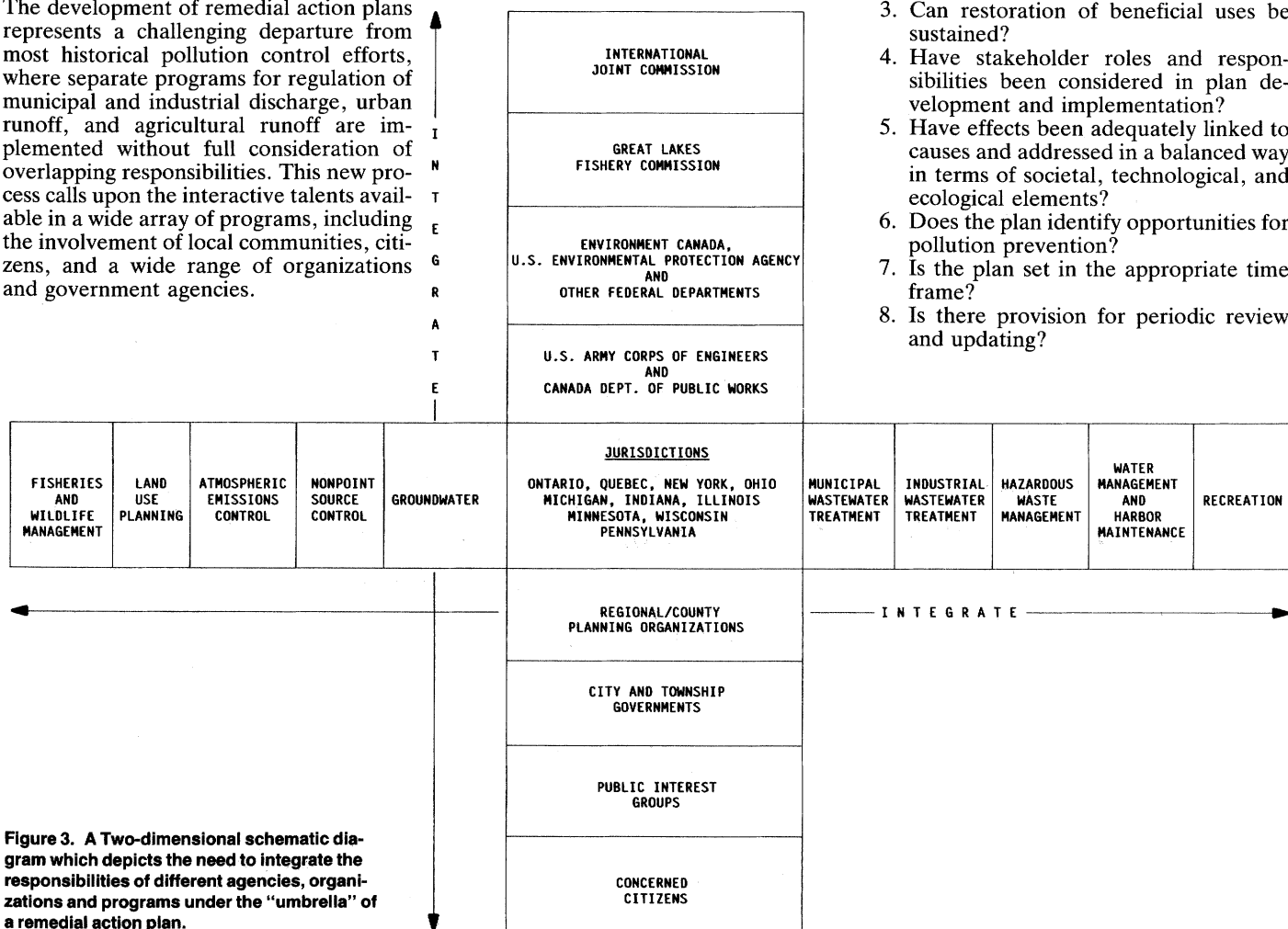
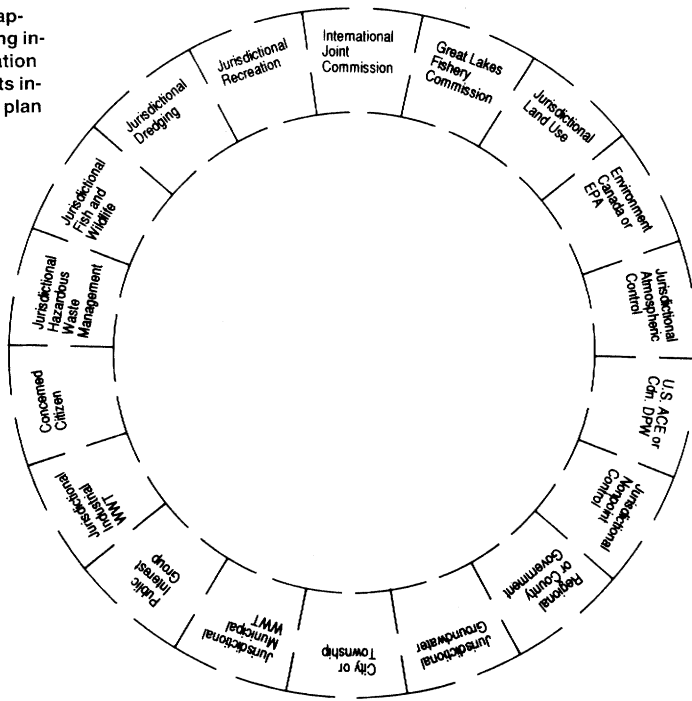


Figure 3. A Two-dimensional schematic diagram which depicts the need to integrate the responsibilities of different agencies, organizations and programs under the "umbrella" of a remedial action plan.

Figure 4. An ecosystem approach model of promoting interaction and communication between different interests involved in remedial action plan development.



Three examples of successful processes underway to implement locally-designed ecosystem approaches to restore beneficial uses in Areas of Concern are presented below.

### ROUGE RIVER, MICHIGAN

The Rouge River flows through metropolitan Detroit and empties into the Detroit River near the western end of Lake Erie. The drainage basin is 1134 sq km, of which over 50% is urbanized (population: 2,500,000). Approximately 64 km of the river do not meet water quality standards (9). Problems include: bacterial contamination, fish kills, contaminated sediments, fish tumors, impacted benthos, and health advisories on fish.

The Rouge River is a classic example of what happens when an ecosystem approach is not followed. The major causes of the problems have been summarized as follows (12):

"In disregard for the manner in which these hydrologic systems function, interact, and transport pollutants, the planning in the Rouge Basin has not been established along sub-drainage basin boundaries but rather along political boundaries. As such, operation of the sewer interceptor systems and pollution control planning have not been coordinated in a basin-wide effort to control the discharge of pollutants, but rather in an effort by powerful political entities to secure multi-million dollar federal construction grants to enhance their sewage transport facilities within their own jurisdiction with little regard for the benefits or impacts such measures might have on Rouge River water quality, particularly outside their own jurisdictions."

As a result of the immense problems within the Rouge River watershed, the Michigan Water Resources Commission passed a resolution in October 1985 imple-

menting a strategy and public participation process to develop a remedial action plan to restore beneficial uses in the Rouge River. The strategy established some initial goals and initiated a process of comprehensive planning. It allocated resources within Michigan Department of Natural Resources (MDNR), formed a link between MDNR and Southeast Michigan Council of Governments (SEMCOG), identified when specific planning activities should be completed, initiated compilation and review of the existing data base, and identified when short-term remedial actions would be implemented.

The Rouge River Basin Committee was formed to promote local participation and to facilitate institutional cooperation. This committee includes over 100 individuals representing different institutional, environmental, and industrial interests. This process represents the first serious attempt at breaking down institutional barriers to cooperate on efforts to restore the Rouge River.

The Michigan Water Resources Commission, which has formal responsibility for issuing permits and enforcing standards, approved the initiative. MDNR provides staff support to the Michigan Water Resources Commission. An executive steering committee functions as a decision-making body and as liaison between the Michigan Water Resources Commission, Rouge River Basin Committee, and project staff. The Rouge River Basin Committee provides stakeholder input to the executive steering committee and project staff. Technical advisory committees have been formed as needed.

The end result has been local "ownership" of the remedial action plan. Concerned citizens have formed Friends of the Rouge, a non-profit citizens' group which promotes public education and involvement. Friends of the Rouge have been very successful at generating "grassroots"

support, via annual Rouge River Rescue days to remove debris and logs (over 2000 people participate). In an Interactive Rouge River Water Quality Project, students from 16 high schools collect water quality data and share the data by computer.

An Infrastructure Financing Committee was also formed to develop a mechanism for funding anticipated infrastructure improvements. One significant recommendation has been to establish a drainage district to facilitate coordination and set priorities.

The Rouge River experience has been very successful in promoting local ownership and breaking down institutional barriers. The goals are realistic, including restoring beneficial uses in the river by the year 2005. Current cost estimates for infrastructure improvements alone range from USD 312 million to USD 1200 million.

### HAMILTON HARBOUR, ONTARIO

Hamilton Harbour is located at the western end of Lake Ontario. The drainage basin is 497 sq km, of which approximately 45% is urbanized (population: 500,000). Pollution by bacteria, nutrients, suspended solids, and oxygen demanding materials has been obvious for decades (9). Recent concern has focussed on toxic substances and loss of fish and wildlife habitat.

Development of the Hamilton Harbour remedial action plan involves three groups: a scientific writing team; a stakeholders' group (composed of user groups); and the public. The remediation process was initiated by the writing team in 1985 with preparation of a technical summary of a number of recent harbor investigations (9). This was used to brief the stakeholders and the general public. The stakeholders reached consensus on goals for the harbor. This led to decisions to adopt an ecosystem approach, to support research to re-establish a naturally reproducing warmwater fishery, and to reject a proposal to pipe effluent into the lake.

Concurrent with the stakeholders' and general public participation processes, the writing team summarized the environmental data base (9). Specific objectives were proposed for the goals identified by the stakeholders, and several remedial options were explored to achieve those objectives. Upon identification of the remedial options, cost-benefit analysis will be performed for specific remedial actions. On reaching consensus, the plan will be submitted to the Canada-Ontario Review Board (i.e., a federal-provincial mechanism to cooperate on programs and issues of mutual responsibility) for approval to be submitted to the IJC for its independent review.

The Hamilton Harbour initiative has been precedent-setting in that stakeholders and the general public have worked side-by-side with the writing team in the process. This strategy has been effective in reaching consensus on goals for the harbor, generating political will, and promoting local ownership of the plan.

**FOX RIVER/SOUTHERN GREEN BAY, WISCONSIN**

Green Bay is located on the northwestern shore of Lake Michigan. The Fox River (the major tributary to Green Bay) drains 17200 sq km of land, of which 13% is urban (population: 750 000) and 69% is agriculture. Despite some improvements in water quality and a return of a sport fishery in the lower Fox River since the early 1970s, major problems remain. These include: toxic substances, excess nutrients and turbidity, and loss of habitat (9). Use impairments include: fish consumption advisories on some sport fishes, a closed commercial carp fishery, reproductive impairments of some wildlife, and closed public swimming beaches.

The remedial action plan was developed by the Wisconsin Department of Natural Resources (WDNR) in cooperation with other agencies and local citizens. The plan explicitly adopted an ecosystem approach, with a goal of restoring beneficial uses by the year 2000 (13). Plan development was initiated in 1985 with preparation of a scope of study and establishment of four technical advisory committees (i.e., Biota and Habitat Management, Toxic Substances Management, Nutrients and Eutrophication Management, Institutional Arrangements) and a Citizen's Advisory Committee.

**Table 1. Comparison of three different approaches to resolving problems in Areas of Concern (modified from ref. 4).**

PROBLEM	APPROACH		
	PIECEMEAL	ENVIRONMENTAL	ECOSYSTEMIC
TOXIC CHEMICALS	Treat one-by-one; pollution havens	Zero discharge	Non-toxic alternatives; recycling
CONTAMINATED SEDIMENTS	Dredge; open lake disposal	Dredge; confined disposal facility	Source control; destruction or inactivation of contaminants
EUTROPHICATION	Discharge downstream	Phosphorus control	Nutrient recycling
ORGANIC WASTE	Discharge downstream	Reduce biochemical oxygen demand (BOD)	Energy recovery; nutrient recycling
INFECTIOUS DISEASE	Conduits, combined sewer overflows	Public health programs	Prevention
HABITAT PROTECTION	Dredge and fill wetlands	Purchase remaining wetlands	Habitat management through use of indicator organisms
INSTITUTIONAL ARRANGEMENTS	No recognition of overlapping responsibilities	Annual meetings to discuss programs and priorities	Stakeholder management; "Round Table"
WATERFRONT REDEVELOPMENT	Tax incentives to industry	Build condominiums	Land-use planning for improved public access; sustainable development
FOCUS OF EDUCATION	Textbook supplements on pollution	Integration; natural resources	Adopting ecosystem approach curricula
ATTITUDE TO NATURE	Cost/benefit	Environmental management	Stewardship; ecosystem ethic
VIEW TO FUTURE	Linear, predictable	Wary of surprises	Emergent, adaptive, evolving

**Industrial development on the shore of Hamilton Harbour at the western end of Lake Ontario. Photograph courtesy of J.R. Vallentyne.**



The technical advisory committees prepared individual reports, which provided the foundation for the plan, and identified options. The Citizen's Advisory Committee, composed of individuals representing different interests, gave priority to problems, evaluated alternatives, and made recommendations to WDNR.

Throughout the process, WDNR held numerous public meetings and a public hearing to obtain additional input. This process culminated in an integrated plan which was approved by WDNR in 1988. Approval meant that the plan had formally become part of Wisconsin's Water Quality Management Plan and signalled transition to implementation.

The Green Bay remedial action plan has been widely recognized for its exemplary public participation process, broad community support, and its effective use of stakeholder management. A public interest group (i.e., Lake Michigan Federation) funded a full-time staff person to help ensure effective public participation. An Implementation Committee has been established to facilitate and coordinate implementation. Costs for implementing high priority remedial actions were estimated to range from USD 54 million to USD 554 million (13). The wide range of costs is due to the uncertainty of the costs of cleaning up contaminated sediments and nonpoint source pollution.

## CONCLUDING REMARKS

The remedial action-plan-program represents the first opportunity, on a broad and practical scale, to implement an ecosystem approach in the Great Lakes basin (8-9, 14-16). Considerable progress is being made in many of the 42 Areas of Concern. This program is experimental, setting up flexible institutional arrangements necessary to implement locally-designed ecosystem approaches to cleaning up degraded areas in the Great Lakes.

The key to implementing an ecosystem approach is establishing a basin committee, stakeholders' group, citizens' advisory committee, or comparable organization within the Area of Concern. Such groups provide an opportunity to change the traditional way of doing business by increasing the level of interaction.

One of the reasons why remedial action plans have received widespread support is that local citizens can relate to each other and to their Area of Concern. Concerned citizens are assuming "ownership" of their plan, helping to bring the necessary stakeholders around a table, and helping to generate the political will necessary to implement the plans (8, 16).

Remedial action plans are reactive to known problems. It is important to recognize that proactive programs are also essential to ensure that old problems do not recur or new ones emerge. To implement an ecosystem approach and prevent adverse effects of toxic substances will require profound behavioral changes within society. Society must become less reliant upon land/water disposal and proactively pursue waste reduction, recycling, and use of destruction/detoxification technologies.

Society will also have to learn to live without certain products and processes in order to restore and sustain the use of its resources. Such behavioral changes can be facilitated by "grass roots" efforts underway to develop and implement remedial action plans.

Throughout the Great Lakes Basin Ecosystem, the remedial action-plan program is being viewed as a program "whose time has come." Three primary reasons why people are excited and optimistic about the program include: 1) stakeholder involvement in decision-making; 2) identifying when specific remedial actions will be taken and who is responsible, to increase accountability; and 3) IJC indepen-

dently reviewing the adequacy of remedial action plans and tracking implementation progress.

In stark reality, the cost of implementing remedial action plans to restore the 42 Areas of Concern will undoubtedly be thousands of millions of dollars. These clean-up costs are the result of short-term economic gains over a 20-50-year time period. While there is considerable concern over who will pay these costs, polluters and citizens must recognize that they must pay their fair share of the costs. Federal and state/provincial incentives will be needed to assist local communities to do what is, first and foremost, in their own interest.

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