Practical Steps to Implement an Ecosystem Approach in Great Lakes Management

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Significant Contributers

The following people, listed in alphabetical order, made substantial contributions to the preparation of this workshop report:

- **Tom Coape-Arnold**, Ontario Ministry of Environment and Energy
- **Sandra Crockard**, Trinity Theatre Toronto
- **Kent Fuller**, U.S. Environmental Protection Agency
- **John E. Gannon**, National Biological Service
- **Steve Gerritson**, Lake Michigan Ozone Project
- **John H. Hartig**, International Joint Commission
- **Neely L. Law**, University of Toronto
- **Gerry Mikol**, New York State Department of Environmental Conservation
- **Kevin Mills**, Environmental Defense Fund
- **Lois New**, New York State Department of Environmental Conservation
- **Alan Richardson**, Trinity Theatre Toronto
- **Kurt Seidel**, Wayne State University
- **Michael A. Zarull**, Canadian National Water Research Institute

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EXECUTIVE SUMMARY

An ecosystem approach is a process framework endorsed by many researchers, planners, and managers to account for the interrelationships among land, air, water, and all living things, including humans, and to involve all user groups in comprehensive management. Although most governments and institutions in the Great Lakes Basin Ecosystem have adopted an ecosystem approach at the conceptual level, considerable efforts are needed to operationalize an ecosystem approach at the practical, working level of resource management.

In November 1994 a binational workshop was convened by U.S. Environmental Protection Agency and Environment Canada, in cooperation with the International Joint Commission and Wayne State University (Detroit, Michigan), to identify practical steps that could be taken in a timely fashion to implement an ecosystem approach at the practical, working level of Great Lakes management. For the purposes of this report, practical steps to implement an ecosystem approach are defined as those pragmatic actions that can be taken in the near term (3-5 years) which: account for economic, environmental, and societal interrelationships; help achieve ecosystem- based goals and objectives; and achieve "win-win" or at least "win-no loss" outcomes.

An ecosystem approach is not a new concept, however, its application in management is. An ecosystem approach is both a way of doing things and a way of thinking. Adopting an ecosystem approach means undertaking holistic planning, research, and management of the Great Lakes Basin. In regulatory and resource management agencies, adopting an ecosystem approach has initiated a shift from a narrow perspective of managing a single environmental medium (e.g. water, air) or a single resource (e.g. fish, trees) to a broader perspective that focuses on managing human uses and abuses of watersheds or bioregions, and that comprehensively addresses all environmental media and resources within the context of a living system.

Historically, the dominant environmental management philosophy has been command-and- control regulation at the end of the pipe or stack. This approach has resulted in substantial reductions in pollutant loadings and improvements in the environment over the last 20 years. However, as the cost of further reductions in point source loadings increases, the relative importance of nonpoint source loadings increases, and the need for multi-media, comprehensive, environmental management increases, greater emphasis is being placed on cooperative approaches to management which stress incentives and education. Proponents of this shift from a command- and-control, regulatory approach to a cooperative, ecosystem-based approach argue that, although regulatory activities are still important, education and incentives are now more important in achieving further reductions in loadings and improvements in the environment. For example, many people argue that a cooperative, multi-stakeholder approach to controlling further nonpoint source loadings, and to preserving and rehabilitating habitats, will be more effective in improving ecosystems than the historical, command-and-control approach to environmental management. Education and cooperative learning are

fundamental to the success of this cooperative, ecosystem- based approach. The underlying assumption is that most people will change their behavior and do the right thing if presented with convincing information in an appropriate educational context.

The basic intent of ecosystem-based management is similar to place-based and watershed management. What comprehensive watershed planning and management and ecosystem-based management are trying to accomplish is to comprehensively address contaminant (e.g. point and nonpoint sources), physical (e.g. flow augmentation, streambank stabilization), and biological (e.g. stocking/harvesting, food web manipulation) management alternatives that will achieve locally- established, ecosystem goals and objectives. Such site-specific, ecosystem goals and objectives are established based on ecosystem characteristics, public needs, and scientific, regulatory, and resource management input.

Resource problems are in a sense not environmental problems, but human problems created under a variety of political, social, and economic conditions. It is important to emphasize that implementing an ecosystem approach is a process. An ecosystem-based process framework is based on adaptive planning and management that recognizes the uncertainties and imperfect knowledge of the interrelationships and interdependencies of economy, society, and environment. Adaptive planning and management is an iterative decision-making process based on trial, monitoring, and feedback. The framework includes all stakeholder groups in defining a vision and goals at the beginning of the planning process. This adaptive planning process emphasizes the need for leadership, commitment to a long-term vision and goals, acceptance of a set of principles to guide the decision-making process, agreement on shared decision-making, and emphasis on continuous improvement. Human resource development and education are essential components from beginning to end.

For governmental managers, another way of helping implement an ecosystem approach at the practical, working level of Great Lakes management is to view the process as a set of key action steps. Presented below is a set of process actions to help implement an ecosystem approach at the practical, working level of environmental and resource management:

- adopt the watershed/bioregion as primary unit for management;
- develop a partnership agreement or other mechanism for cooperative, multi-stakeholder management and ensure commitment of top leaders;
- identify and empower an "umbrella" watershed organization for coordination;
- develop a long-term vision (e.g. > 20 yr), goals, and quantitative indicators for the "desired future state" of ecosystem that can be understood by all partners;
- reach agreement on a set of principles to guide a multi-stakeholder, decision-making process;
- ensure all watershed planning processes acknowledge vision, goals, indicators, and principles;
- establish a geographical information system (GIS) and decision support system capability within watershed organization;
- compile data and information for input into GIS and ensure a strong commitment to research and monitoring to understand the ecosystem and fill knowledge and data gaps;
- set priorities that target major causes of ecosystem health risks, evaluate remedial and preventive options, implement preferred actions, and monitor effectiveness in an iterative fashion (i.e. adaptive management);
- ensure full costs and benefits are assessed for each project in watershed;
- consolidate capital budgets and pool resources to move high priority projects forward;
- create the framework and conditions for private sector involvement and capitalize on its enterprise, initiative, creativity, and capability for investment;
- utilize market forces and economic incentives to achieve ecosystem objectives;
- commit to public, biennial, state-of-the-environment and economy reporting to measure and celebrate ecosystem progress, and to measure stakeholder satisfaction; and
- ensure a strong commitment to broad-based, ecosystem education and human resource development throughout process.

Such a list of process actions can help governmental managers guide local efforts to implement an ecosystem approach or may serve as a starting point in developing a better approach.

Some people have argued that an ecosystem approach provides an excuse to consider everything and solve nothing. Because the ecosystem approach calls for accounting for the interrelationships among air, water, land, and all living things, and calls for integrating societal, economic, and environmental concerns, there may be a tendency to focus attention too broadly and not focus specifically on obvious, high priority, ecosystem problems. It must be remembered that an ecosystem approach is a tool to help comprehensively and systematically address root causes of environmental problems. In the Great Lakes remedial action plan (RAP) program, clarity of focus is being provided by the 14 use impairments identified in Annex 2 of the Great Lakes Water Quality Agreement. These 14 use impairments are being used to help reach agreement on problem definition and reach agreement on quantitative targets or indicators for restoring uses. Such quantitative targets or indicators are being used to drive the RAP process, help stakeholders and organizations pursue a common mission of restoring uses, and help achieve greater accountability. Agreement on quantitative targets and indicators for restoring uses also helps achieve a clear, practical focus for use of an ecosystem approach in the RAP process, and helps establish measurable benchmarks to help maintain focus and measure progress.

Considerable emphasis is being placed on management of places. U.S. Environmental Protection Agency refers to this as "place-based environmental management." Critical success factors for place-based environmental management include:

- government activities being driven by the issues faced by particular ecosystems and the economies founded upon them;
- results measured in terms of restoration and protection of ecosystem integrity, which includes the health of humans and other species;
- use of an ecosystem approach which requires coordinated, integrated action by federal, state, tribal, and local agencies, between government and private enterprises, and, most importantly, between government and the people for whom services are being provided; and
- availability of quality data and information on the resources to be protected for local empowerment that moves communities to action.

Such national emphasis will undoubtedly provide greater impetus to implement an ecosystem approach within local watersheds and bioregions.

Ecosystem-based education will be critical to the success of ecosystem-based management processes. No one has all the answers. Everyone will be learning their way out. The process of cooperative learning must ensure respect for different perspectives, while striving for agreement on common goals and actions. Like "place-based environmental management", ecosystem-based educational processes must be founded on a sense of place that is linked to watershed concepts and bioregionalism.

Within the process of implementing an ecosystem approach there is a need to initiate short- term actions while undertaking long-term planning. Adaptive management describes this process where priorities are set, actions taken, and monitoring performed in an iterative fashion for continuous improvement. This workshop attempted to synthesize knowledge of practical application of an ecosystem approach at the working level of Great Lakes management. Although the process of full implementation of an ecosystem approach is a long-term endeavor, there are numerous opportunities to move forward with actions. A summary of selected examples of practical steps to implement an ecosystem approach is presented in the matrix table below. Such practical steps are not comprehensive. The key point is that there are numerous practical steps that can be taken immediately to help achieve ecosystem-based management.

Although this report has attempted to compile and synthesize some practical advice on implementing an ecosystem approach at the practical, working level of Great Lakes management, continued emphasis should be placed on learning from different experiences in implementing an ecosystem approach. The 43 locally-designed ecosystem approaches being used in Great Lakes RAPs and the lake-specific ecosystem approaches being used in lakewide management plans serve as laboratories for practical application of ecosystem approach theory. Cooperative learning from these and other examples is essential to realize the Canada-United States commitment to use of an ecosystem approach in restoring and maintaining the physical, chemical, and biological integrity of the Great Lakes Basin Ecosystem.

Table of Selected Examples of Practical Steps to Implement an Ecosystem Approach in Great Lakes Management

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INTRODUCTION

An ecosystem consists of a community of different species (including humans) interacting with one another and with the physical and chemical factors making up its nonliving environment. The interrelationships and interdependencies of the biotic and abiotic elements form a dynamic ecosystem whose boundaries are operationally defined within bioregions, watersheds, or catchments. An ecosystem approach is a process framework endorsed by many researchers, planners, and managers to account for the interrelationships among land, air, water, and all living things, including humans, and to involve all user groups in comprehensive management (Hartig and Vallentyne 1989). Although most governments and institutions in the Great Lakes Basin Ecosystem have adopted an ecosystem approach at the political and conceptual level, considerable efforts are needed to operationalize an ecosystem approach at the practical, working level of resource management.

In November 1994 a binational workshop was convened by U.S. Environmental Protection Agency and Environment Canada, in cooperation with the International Joint Commission and Wayne State University (Detroit, Michigan), to identify practical steps that could be taken in a timely fashion to implement an ecosystem approach at the practical, working level of Great Lakes management. This report presents a summary of the conclusions and recommendations from the workshop. For the purposes of this report, practical steps to implement an ecosystem approach are defined as those pragmatic actions that can be taken in the near term (3-5 years) which: account for economic, environmental, and societal interrelationships; help achieve ecosystem- based goals and objectives; and achieve "win-win" or at least "win-no loss" outcomes. For example, Life Cycle Assessment (LCA) is a process designed to: evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment; assess the impact of those energy and material uses and releases to the environment; and identify and evaluate opportunities to affect environmental improvements (SETAC 1993). Experience has shown that use on LCA techniques results in both environmental improvements and economic benefits for industries and corporations (Richards and Forsch 1994).

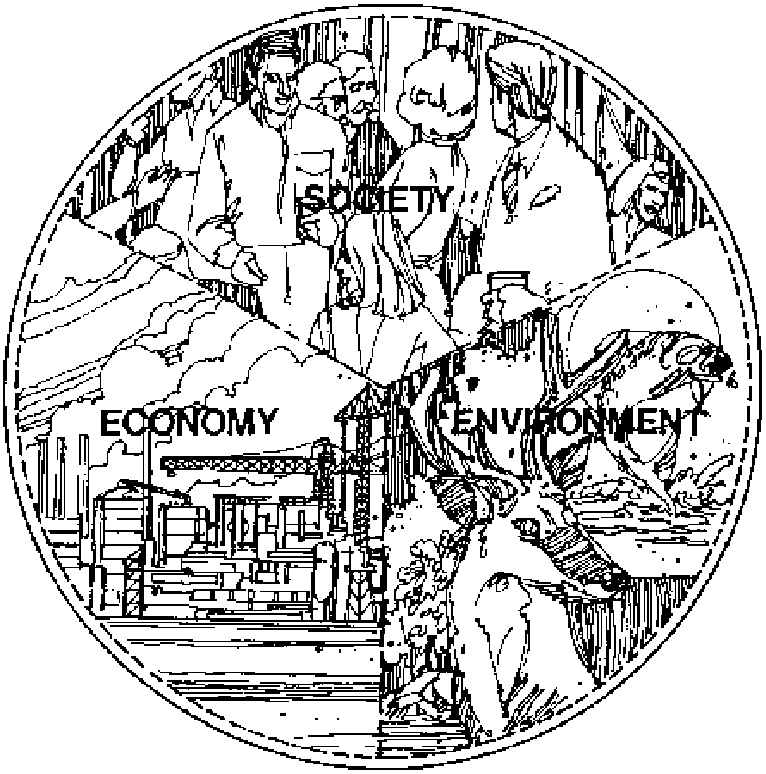
THE CONCEPT OF AN ECOSYSTEM APPROACH

In the Great Lakes Basin, the ecosystem approach received broad-based acceptance following inclusion in the 1978 Great Lakes Water Quality Agreement. The purpose of the Agreement is to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem (United States and Canada 1987). An ecosystem approach is considered a model framework, and indeed a new way of doing business, to help achieve comprehensively and systematically the goal of ecosystem integrity.

An ecosystem approach is generally viewed as the most recent in a succession of approaches to managing human uses and abuses of natural resources (Vallentyne and Hamilton 1987). The traditional approach to environmental and resource management has been media-specific and conducted in a piecemeal fashion. The institutional responsibilities for management have been fragmented so that federal and state/provincial resource management agencies and other organizations are often at odds and sometimes in direct conflict in their attempts to optimize that portion of resource management assigned to them (Cairns 1988). Use of an ecosystem approach through "enlightened self-interest" in environmental and resource management will help account for interrelationships among system compartments within ecosystem boundaries (Rees and Wackernagel 1993; Cairns 1988; Christie et al. 1986).

An ecosystem approach can be symbolized as a circle with three equal compartments representing social, economic, and environmental interests (Hartig and Vallentyne 1989; Figure 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 (i.e. the relatively narrow band around the earth within which life is possible), is closed. The operating principle of an ecosystem approach is that no segment of the circle can be sacrificed and all are essential to maintain a functional and sustainable ecosystem. The limitations of ecosystems must also be recognized based on their ability to maintain functional integrity and productivity (Rees and Wackernagel 1992).

Figure 1. The ecosystem approach.



(Hartig and Valentine 1989)

The essence of an ecosystem approach is that it relates people to ecosystems that contain them, rather than to environments with which they interact. Stated another way, an ecosystem approach views social, economic, and environmental issues within the context of nature and relates political systems to larger ecological systems that contain them, rather than as interacting entities among themselves (Table 1) (Vallentyne and Hamilton 1987). Criteria developed to assess when a set of measures constitutes an ecosystem approach include: 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 (Christie et al. 1986; Lee et al. 1982; Vallentyne and Hamilton 1987).

The concept of an ecosystem approach has had broad academic application in several disciplines over the past 20 to 30 years. Slocombe (1993) highlights its use in the fields of human ecology, cultural anthropology, psychology, and environmental planning. In its broad application, resource problems are in a sense not environmental problems, but human-induced problems created by a variety of political, social, and economic conditions.

The Great Lakes Water Quality Agreement is one example of where the ecosystem approach has been adopted. In Annex 2 of the Great Lakes Water Quality Agreement there is explicit reference to use an ecosystem approach in environmental management planning. Annex 2 states:

> "Remedial action plans and lakewide management plans shall embody a systematic and comprehensive ecosystem approach to restoring and protecting uses in Areas of Concern or in open lake waters. . . The Parties, in cooperation with State and Provincial Governments, shall ensure that the public is consulted in all actions undertaken pursuant to this Annex."

The Great Lakes Remedial Action Plan (RAP) Program has been described as an experiment in adaptive, environmental management where flexible, locally-designed, ecosystem approaches are being used to restore beneficial uses in the 43 Great Lakes Areas of Concern (Hartig and Vallentyne 1989).

Another good example of adoption and use of an ecosystem approach is the Strategic Vision of the Great Lakes Fishery Commission (GLFC) for the Decade of the 1990s. In this vision statement it states:

> "the Commission adopts and advocates an ecosystem approach to management and research of Great Lakes fishes."

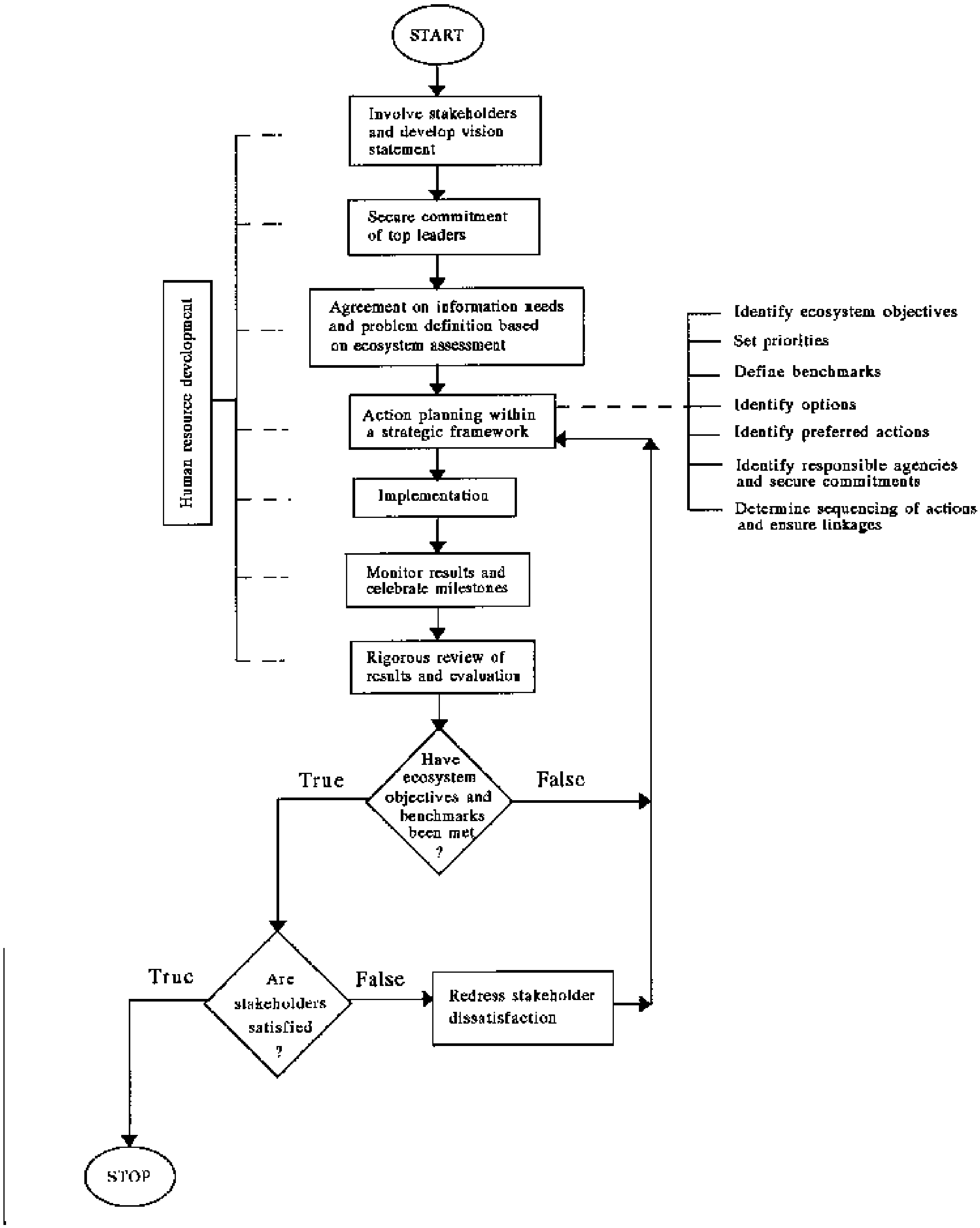
The ecosystem approach is used in decision-making to account for system-level effects from the interactions of all ecosystem components (e.g. nutrients, primary production, forage fish, predatory fish, habitat, chemical contaminants, climate, and human use). The GLFC considers the ecosystem approach well suited to address complex problems with extensive linkages such as introductions of unwanted, non-native species, toxic chemicals in fish, and nonpoint sources of pollution.

There is no doubt that there is an immediate need and unique opportunity to define practical steps to implement an ecosystem approach in order to achieve comprehensive management of resources within ecosystem boundaries, account for interrelationships, recognize interdependencies, and ensure sustainability. Management of the Great Lakes Basin Ecosystem is evolving in response to an increased understanding of human interactions and associated impacts with natural communities at various scales. Although there is general agreement on the need for use of an ecosystem approach, considerable efforts are needed to ensure its practical application. This report is an attempt to learn from the diversity of site-specific, ecosystem approaches that are being developed by Great Lakes institutions and to recommend simple, pragmatic steps that can be taken to implement an ecosystem approach at the practical, working level of Great Lakes management. Such learning from practical experience should help put an ecosystem approach into broader practice.

A PROCESS TO IMPLEMENT AN ECOSYSTEM APPROACH

There is no single best approach to implement an ecosystem approach in Great Lakes management as each defined ecosystem involves a different set of environmental conditions, stakeholders, legislative frameworks, etc.. Figure 2 presents one process framework to implement an ecosystem approach that is guided by eight criteria. The criteria include: stakeholder involvement; leadership; information and interpretation; action planning within a strategic framework; human resource development; results and indicators; review and feedback; and stakeholder satisfaction (Hartig et al. 1994a). The process framework is based upon adaptive, environmental planning and management that recognizes the uncertainties and imperfect knowledge of an ecosystem (National Research Council 1992). Adaptive, environmental planning Figure 2. A model process framework to implement an ecosystem approach. and management is an iterative learning process that integrates the environment with economic and social understanding, and helps reduce uncertainty in management decisions by using information gained from past experiences to reassess priorities for future actions (Holling 1978). It strives for continuous improvement through an iterative decision-making process based on trial, monitoring, and feedback.

Figure 2. A model process framework to implement an ecosystem approach.



An ecosystem approach necessitates the involvement of resource managers, but also other stakeholders who are customers and suppliers of remedial and preventive actions. Stakeholders must be involved at the beginning of a planning process to define a common vision. This encourages empowerment and local ownership of the process. Ideally, top leaders should be committed to a consensus-based process. Their commitment to a common vision and values should be reflected in the planning process, including allocation of resources to meet the plan's needs. For greatest effectiveness, leaders should emerge from stakeholder groups and work in a cooperative manner. Consensus-building among all stakeholders is facilitated by agreement on information needs for decision-making and data interpretation. This might also include defining education needs for stakeholders to develop a common understanding of problems, causes, and sources. Action planning within a strategic framework emphasizes continuous improvement by identifying both short- and long-term priorities to help ensure progress and build a record of success. Adequate assessment, research, and monitoring are essential to the process of adaptive, environmental planning and management, and in the end have proven to save money for both the public and private sectors (Zarull 1994).

In Figure 2, human resource development is shown to be integrated throughout the process to reinforce the need for cooperative learning among all the stakeholders. In such a strategic framework, planning and implementation proceed simultaneously (i.e. actions can be taken before plans are fully complete). Results are evaluated against milestones and benchmarks to measure progress. Improvements in the process are made to help ensure the desired outcome is achieved within established timelines. Frequent and rigorous review and feedback are necessary to ensure the process stays on track and midcourse corrections are made where necessary. Stakeholder satisfaction is also measured. Such a process, if followed, is one possible way to help move resource management from ecosystem theory to practice.

WORKSHOP DESIGN AND FORMAT

Over seventy people participated in the workshop, representing a broad range of disciplines and practical management experiences (see Appendix 1 for list of participants). The workshop began with plenary presentations on the need to operationalize an ecosystem approach in regulatory and resource management programs and two case studies on practical application (i.e. Fox River/Green Bay, Wisconsin and Don River, Toronto, Ontario). Eight facilitated breakout sessions were then used to identify practical steps to implement an ecosystem approach at a working level in Great Lakes management, responsibilities, potential obstacles and challenges, and recommendations to overcome obstacles and address challenges. Each breakout session addressed a different sector with responsibility for ecosystem-based management. The eight sectors and corresponding breakout sessions were: land use planning within a watershed; point source pollution; nonpoint source pollution; transportation; fisheries and wildlife management; habitat management; economic development for sustainability; and human resource development and education. Identifying practical steps to implement an ecosystem approach is an on-going process which is identified under "action planning within a strategic framework" in Figure 2. Presented below are the recommended practical steps to implement an ecosystem approach for each of the eight sectors in the workshop.

Land Use Planning within a Watershed

Watersheds are ecosystems composed of a mosaic of land-uses connected by a network of streams (The Pacific Rivers Council 1993). The types and forms of land-use and development have adversely affected the quality and quantity of air, land, and water resources within a watershed. Traditional management practices, however, have treated each resource as a distinct entity. Through separate legislation, regulations, and government bodies, the ability of local government to participate in ecosystem-based management of the watershed has been limited due to restricted geographical scope and prescribed regulatory responsibilities (Cox 1989).

Breakout session participants emphasized the need to view land-use planning as a process that coordinates and disseminates information, and promotes multi-stakeholder, consensus-building on shared interests. This envisioned process is based upon "bottom-up" decision-making that is guided by the leadership of a watershed-based organization (e.g. Conservation Authorities in Ontario, Watershed Councils in the States), in partnership with local planning agencies, regulatory agencies, and resource management agencies. Participants recommended the following overall goal to help ensure land-use planning encompasses an ecosystem approach: "to streamline and better coordinate land-use planning decisions, from plan development to plan approval, relevant to watershed issues on a watershed basis."

The development of a plan is an essential element of watershed planning that can occur at four scales: the watershed (catchment or river basin); subwatershed; the municipal jurisdiction; and site level (where developers and landowners produce site-specific development plans). The catchment or river basin is the preferred and most comprehensive scale. Primary obstacles include: institutional fragmentation; lack of adequate funding; lack of cooperation for watershed planning; and lack of watershed-wide, resource inventories.

The practical steps to implement an ecosystem approach in land-use planning presented in Table 2 represent process actions that can be taken to address these obstacles in a systematic fashion. Roles and responsibilities need to be to be clearly defined at each scale of planning to help overcome obstacles. The practical steps presented in Table 2 can be implemented in the following step-wise fashion to help facilitate the transition to ecosystem-based, land-use planning and management:

- develop a Memorandum of Understanding, partnership agreement, or other mechanism to recognize the watershed as the primary unit for planning and to generate cooperation amongst local planning organizations and other stakeholders, specifically developers and land owners, to pursue watershed planning and management;
- designate an "umbrella" watershed organization (e.g. Watershed Council, Conservation Authority) to help inventory and incorporate essential information on ecosystem features into a planning process database using a geographical information system, and to act as an information clearinghouse to disseminate information to watershed communities (if data gaps exist, surveys or investigations should be performed prior to approval for development);
- identify constraint areas and give priority to issues from an ecosystem perspective, based on the inventory, in order to indicate where development is and is not appropriate;
- develop policies and establish zoning ordinances/by-laws, as needed, to protect and rehabilitate key ecosystem features through planning activities and the development process (e.g. stormwater management issues must be addressed at the beginning of the process to ensure delivery of quantity and quality of water to receiving waters); and
- establish alternative and innovative planning methods and techniques (e.g. encouraging cluster development, applying "bonusing" to protect significant ecosystem features, using environmental evaluation reports to assess how to best integrate development with ecosystem features, and providing site-specific design and development guidelines) to implement ecosystem-based policies.

Public participation, outreach, and education are essential to build support for effective, ecosystem-based planning on a watershed scale. Human resource development must be integrated throughout the process to ensure that sufficient cooperation and partnerships are developed (Figure 2). Review and feedback are also necessary to ensure progress, allow for mid-course corrections, and foster continuous learning.

The legislative differences between the United States and Canada with regard to land-use planning responsibilities and resource management were recognized by the breakout session participants as limiting the cross-fertilization of ideas and implementation of some practical steps. However, these differences should not preclude planning organizations from moving forward and encompassing watershed planning. There is a need to empower watershed "umbrella" organizations in the United States and recognize the influential role Conservation Authorities can play in Ontario.

Breakout session participants emphasized the need "to get on with the job" of watershed planning and management. A pragmatic approach may be to start small (i.e. subwatershed level), using the path of least resistance. Resources must be pooled and practical, pilot-scale projects must be moved forward. As the successes of these projects are recognized, they should be communicated broadly to other watershed communities. One example of a practical project is developing and maintaining continuous green space within designated areas of a region that provides habitat to enhance biodiversity. In Ontario, agreements between a municipality and the developer can be reached to use the 5% parkland conveyance (or cash in lieu) in the 1990 Planning Act towards purchasing or maintaining designated areas in the local community, rather than creating "spaces left over after development" or isolated islands of green space. An assessment of the needs of indigenous wildlife should be made to ensure the type and spatial needs are adequate. Another alternative would be to use abandoned or defunct railway or hydro "rights-of-way" to link areas of green space throughout the watershed. Local communities can work with utility commissions/authorities in site planning and management. Once success has been achieved, that positive experience can serve as the building block to further successes.

Land-use planning within a watershed is one approach to implement sustainable development principles in newly developing areas and retrofitting existing development. As land-use planning is a locally-driven process, guiding principles that reflect an ecosystem approach to planning and sustainable urban development are needed to ensure consistency throughout the watershed. Wherever possible, greater emphasis should be placed on sharing success stories throughout the Great Lakes Basin Ecosystem in order to catalyze other processes.

Point Source Pollution

Historically, point source pollution has been managed from a command-and-control perspective using end-of-pipe or stack technologies. This approach has resulted in substantial reductions in pollutant loadings over the past 20 years. In the future, reductions in point source pollutant loadings will undoubtedly be more difficult and costly, and require a change in approach to include pollution prevention, multi-media strategies, and increased use of auditing and market-based incentives.

In general, the current method for controlling point source pollution is a fractured system with its roots in media-specific legislation. A plethora of command-and-control regulations is forced on the regulated community that does not always factor in the assimilative capacity of the environment surrounding each facility, or the bioregion. Insufficient consideration is given to the long-term impact of new products and services. Efforts to foster pollution prevention are underway in industry and the private sector, but considerably more can be done to achieve broad- based implementation.

The ecosystem approach balances concern for the environment, human health, and the interrelationships among stakeholders, including industry. Management strategy changes are necessary in order to add balance to our current regulatory framework. Stronger efforts need to be made to institute pollution prevention and product stewardship. Quantifying intangible factors (e.g. liability and employee safety) into dollar values would aid business people in making pollution prevention decisions. Sources of persistent, bioaccumulative, toxic substances should be managed as closed loop systems. Assessments should be made that take into account all media loadings, pathways, and impaired usage of the environment.

Breakout session participants identified the following seven practical steps that could be taken in the short-term to implement an ecosystem approach in the area of point source pollution:

- internal full cost accounting;
- toxic pollutant reduction plans;
- Life Cycle Assessment;
- multi-media assessment;
- multi-media permitting;
- enhance existing regulatory systems; and
- technical assistance and information sharing.

Table 3 presents a summary of these recommended practical steps for point source pollution, responsibilities, potential obstacles/challenges, and recommendations for overcoming obstacles and addressing challenges. Implementation of each of these practical steps would result in a win-win scenario. Industries would profit by a streamlined permitting process and unified regulations. The public would benefit in decreased impairment of uses of the ecosystem and less risk to human health from hazardous materials. A binational policy statement needs to be developed supporting these goals before teams can be assembled and pilot projects started. As a priority, point sources should establish explicitly long-term goals of "zero discharge" and "virtual elimination" for persistent toxic substances, and establish assimilative capacities for nonpersistent toxic substances. Frameworks such as Total Quality Environmental Management and Industrial Ecology should be used to comprehensively and systematically achieve such goals. This will help encourage pollution prevention and allow it to be seen as an investment that increases profits and productivity, as opposed to being just an investment to help the environment.

Nonpoint Source Pollution

Nonpoint source pollution impacts significantly the health of ecosystems. However, compared with point source pollution, there has been less focus on reducing pollutant loadings from diffuse sources such as urban and agricultural runoff and air emissions (Ryding 1992). Controlling nonpoint source pollution must be approached in a holistic and comprehensive manner to make significant gains in reducing loadings and ecosystem impacts. In addition, there is a need to identify the critical steps in nonpoint pollution management and make them visible and understandable to a broad range of stakeholders and partners.

Breakout session participants focussed primarily on nonpoint source pollution associated with the land-water interface. Participants initially agreed to the following nonpoint source goal:

> "to provide and protect adequate natural buffering and filtering on riparian lands in order to trap nonpoint source pollutants, preserve habitat, and maintain stream hydrology."

In order to meet this goal, breakout session participants identified a number of practical steps to help implement an ecosystem approach in the area of nonpoint source pollution. Nonpoint source practical steps, responsibilities, potential obstacles/challenges, and recommendations to overcome obstacles and address challenges are presented in Table 4.

An essential step in the process is to adopt the watershed or catchment as the primary unit for planning and management (Table 4). Watershed management attempts to take a comprehensive view of physical, chemical, and biological components necessary to achieve locally-based water use goals. Site-specific goals and uses are established based on water body characteristics and public, scientific, and regulatory input. There are efforts underway amongst federal, state, provincial, and local natural resource management agencies to align programs on a watershed basis. These efforts toward comprehensive watershed planning and management can be the foundation upon which to implement the other practical steps identified in Table 4. Strong partnerships will be needed to ensure the communication, coordination, and cooperation necessary to achieve an ecosystem approach. Greater use of economic and technical assistance incentives will also be needed.

The importance of atmospheric nonpoint source pollution was also recognized, however, time at the workshop did not permit in-depth discussion. One example of a practical step to implement an ecosystem approach in the area of atmospheric nonpoint source pollution might be to adopt "the bubble concept" for air quality regulations as a cost-effective means for achieving target load reductions. In this system, "transferable pollution rights" encourage those having the best knowledge and practical means of reducing pollution sources to do so, trading this savings in mass emissions for profit to those with lesser technology or means. Transfer of pollution rights should be set differently for various types of pollutants (Ryding 1992). Care must be taken to ensure those industries with emissions below the required standard do not trade or sell the difference to another facility that does not meet the standard, even though the average mass emission between the two facilities meets the air quality standards.

Transportation

The goal of transportation management is to meet the needs of all community members for affordable mobility (or accessibility) and a clean environment. Overdependence on automobiles as the predominant mode of transportation, continually fueled by sprawling development patterns, poses a major threat to the sustainability of the Great Lakes Basin Ecosystem. Currently, transportation demand often exceeds the supply of transportation facilities and services as trips per capita and distances travelled have increased between home, workplace, and non-work destinations. To apply an ecosystem approach, transportation systems, urban form, land uses, and human activities need to be considered as an integrated whole, rather than separate functions.

Breakout session participants felt that there are many problems facing the transportation sector. Major problems include:

- lack of transportation options (i.e. limited transportation modes) which the current system provides;
- congestion;
- expansion and urban sprawl;
- oversubsidization of the automobile, fuel, roads, etc. and deficit financing;
- threat to national security which comes from overdependence on a limited resource (i.e. oil);
- conspicuous consumption and its expansion into recreational activities;
- pollution;
- loss of community and the human scale of everyday life;
- public misperceptions (e.g. the key problem is the culture of dependence on the automobile, rather than not enough parking and safety, etc.);
- lack of comprehensive planning;
- economic dependence on the automobile (both national and individual);
- distortions in social equity (disadvantaged communities less served by transportation infrastructure, children can't drive, elderly don't want to drive or may not be able to drive); and
- politics and "pork barrel" projects versus good planning.

In general, breakout session participants felt that society is being impacted by the effects of poor and/or unduly narrow planning. What has resulted is a transportation system almost totally dependent on the automobile, a loss of community and human scale development, distortions in social equity, and a public perception that nothing is wrong. Historically, transportation planning has been skewed by the clout of land-use developers, highway department personnel, and the major automobile companies. Growth and urban sprawl is currently driving, and is being driven by, transportation development.

The solutions to such transportation problems will not be simple. In general, breakout session participants agreed that there is a need to provide options for what transportation modes and practices are available and better planning to design improved transportation systems. For example, options as alternatives to the automobile include a balanced intermodal mix of: walking, biking, public transit, aviation, and trucks/freight. Other important solutions include technological advances, transportation demand management, transportation supply management, good land-use planning, legislation, and education.

From an educational perspective, there is a need to sensitize the next generation of transportation engineers and planners on their important role in designing environmentally- sustainable transportation projects. Transportation engineers and planners have historically been responsible for meeting demands of safety and cost effectiveness, but not environmental sustainability. Transportation engineers and planners need to change transportation trends, not accommodate them. To change transportation trends will also require transportation engineers to work with developers and land-use planners in a truly integrated fashion.

Dramatic changes in transportation patterns and practices are not likely in the short-term. Even slowing down some of the current transportation trends will be difficult. Improved public awareness of transportation-environment problems will be an important and significant step. However, breakout session participants identified a number of practical steps to help implement an ecosystem approach in the transportation sector, responsibilities, potential obstacles/challenges, and recommendations for overcoming obstacles and addressing challenges (Table 5). These practical steps represent a range of actions from strategic efforts to help ensure a comprehensive and systematic approach to short-term pragmatic actions which will result in a "win" for both transportation and the environment.

One example to move forward in a practical, timely, and realistic manner on urban transportation issues would be for a nonprofit organization, a coalition of nonprofit organizations, or a public-private partnership to implement the following strategy:

- build a coalition among groups/organizations with a vested interest in a relatively short-term project like reducing automobile use;
- develop a voluntary, public participation plan which identifies 3-4 positive, collective elements the average person could do relatively easily to reduce automobile use (e.g. bike parking racks, rental or free bikes, bike paths, telecommuting programs, rideshare programs, cashing out parking subsidies);
- identify one group of stakeholders per issue to prepare a detailed action plan (secure professional staff or project manager to build large cadre of volunteers so that the burden is shared);
- implement detailed action plan and a unified public relations campaign which focuses on positive elements and aspects, gives people a reason to "buy-in", and makes the project a broad- based, team initiative (find highly visible public figure or celebrity to head up the effort, network with other groups, involve media and schools); and
- review and celebrate progress, and proceed with follow-up based on project successes.

By focussing on a limited, specific, reasonable agenda, the organization or coalition can: build a track record of success; teach the public that social change can be positive, beneficial, and non- threatening; and create a self-sustaining interest in further experiment.

Fisheries and Wildlife Management

In the Great Lakes Basin Ecosystem there is a long history of successful management of fish and wildlife. For example, the salmon and trout recreational fishery has resulted in annual economic benefits estimated at $2-4 billion. Despite such success, a number of challenges remain. These include: achieving self-sustaining populations; restoring native species; addressing species invasions; reducing toxic substances contamination; and rehabilitating habitat. Use of an ecosystem approach in fish and wildlife management will require extensive linkages among different programs and sectors.

Breakout session participants came primarily from fishery agencies. Therefore, the discussions and recommended practical steps were slanted toward fishery issues. However, some of them will also relate to management of wildlife. Participants identified numerous opportunities to move forward with an ecosystem approach to management of the

Great Lakes. Table 6 presents a summary of practical steps to help implement an ecosystem approach in the area of fishery management, responsibilities, potential obstacles/challenges, and recommendations to overcome obstacles and address challenges. Breakout session participants also identified a number of related issues which should be addressed in conjunction with implementing the practical steps identified in Table 6. These related issues include:

- current loadings and levels of toxic substances create a conflict between consumer needs and ecosystem-based management for some native species (e.g. rehabilitation of lake trout);
- impacts of local habitat management on fish and wildlife populations must be considered (e.g. fish attractors, modification of wetlands adjacent to contaminated sites);
- the knowledge base must be improved to identify and monitor changes in key stressors, interrelationships, and habitat conditions, and must be improved to evaluate past management practices and historical fish communities;
- scale must be considered; and
- current toxic substance loadings and levels inhibit fishery management due to exposure of some long-lived species.

The Great Lakes Fishery Commission (GLFC) has recognized the substantial role of institutional arrangements and stakeholder partnerships in implementing an ecosystem approach in Great Lakes management and addressing the issues and practical steps presented above. Specifically, the Great Lakes Fishery Commission (1992) encourages:

> "the delivery of complementary programs focussed upon achievement of Fish Community Objectives as adopted by the Lake Committees for each Great Lake through: leadership from the Lake Committees, coordination of fish management programs, development of coordinated programs for research, integration of sea lamprey and fish management programs, recognition of Fish Community Objectives by environmental agencies as they implement their programs, and strengthened and broadened partnerships among fish management agencies and non-agency stakeholders."

One possible mechanism for moving forward on strengthening institutional arrangements and broadening partnerships for ecosystem-based management might be to combine the program efforts of U.S. Environmental Protection Agency and Environment Canada on the biennial State- of-the-Lakes Ecosystem Conference with the program efforts of the Strategic Great Lakes Fishery Management Plan. This cooperative initiative could be facilitated jointly by the Great Lakes Fishery Commission (GLFC) and the International Joint Commission (IJC). Such a cooperative initiative could help establish formal linkages and accountability for management of interrelated issues like the Strategic Great Lakes Fishery Management Plan (SGLFMP), lakewide management plans (LAMPs), and remedial action plans (RAPs) necessary to achieve ecosystem-based management and help implement some of the practical steps identified in Table 6.

Habitat Management

Breakout session participants agreed that one of the major challenges in the area of habitat management is that "habitat has no home" (i.e. physical habitat often "falls through the cracks" and does not receive adequate attention in traditionally separate water quality management and fish and wildlife management programs). To address this challenge there must be a concerted effort to ensure that habitat is an integral part of community master plans. Critical components of a process to ensure that habitat is incorporated into community master plans include:

- compile habitat inventory;
- develop public participation;
- form intergovernmental coordinating committee; and
- develop public/governmental partnership in plan development.

Options to be considered in plan development include:

- no action alternative (no development can result in habitat preservation, however, it can also translate into an economic "loss" for communities, depending upon the situation, by passing up an opportunity to modify hardened shorelines and enhance habitat);
- fully engineered alternative (construction of breakwalls and marinas is viewed as a "win" for development, yet a "loss" for habitat because such construction is often limited in or devoid of sinuosity or habitat value); and
- soft engineering alternative (ensures a "win" for development through marina construction or other development and a "win" for habitat by achieving sinuosity of shorelines and modification of structures to enhance habitat).

Breakout session participants suggested that higher priority should be given to soft engineering alternatives to achieve "win-win" outcomes for habitat and economic development, and so as not to preclude future options.

From a strategic perspective, greater emphasis needs to be placed on "piggy backing" habitat protection and rehabilitation on other local and regional planning and development initiatives. For example, communities can capitalize on the opportunity of waterfront redevelopment to ensure that habitat gets incorporated into master plans. Effective communication and strong partnerships will be essential to achieve this. Although a systematic and comprehensive process of habitat conservation, rehabilitation, and restoration will be a long-term endeavor, considerable opportunities exist to move forward with short-term actions which will benefit habitat and other issues (e.g. land use, economy, agriculture, recreation). Table 7 presents a summary of recommended practical steps to implement an ecosystem approach in the area of habitat management. These practical steps should be viewed as both strategic efforts that will ensure a comprehensive and systematic approach, and practical, short-term actions which will result in habitat conservation, rehabilitation, and restoration. Such practical steps, if implemented, will help address the recommendation of Environment Canada and U.S. Environmental Protection Agency to improve implementation of habitat-related laws, policies, and programs, and ensure a strategic approach to habitat protection and restoration, making use of all levels of partnerships (Dodge and Kavetsky 1994).

Economic Development for Sustainability

Historically, economic development has neglected environmental factors. Today, virtually all sectors in society acknowledge the linkages and mutual dependencies between environment and economy, and the need for environmentally sustainable economic development.

To achieve sustainability we must develop an ecological economics that goes well beyond the conventional disciplines of ecology and economics to a truly integrative synthesis (Costanza 1991). Costanza (1992) defines sustainability as a relationship between dynamic human economic systems and larger dynamic, but normally slower-changing, ecological systems in which: 1) human life can continue indefinitely; 2) human individuals can flourish; 3) human cultures can develop; but in which 4) the effects of human activities remain within bounds, so as not to destroy the diversity, complexity, and function of the ecological life-support system.

Herman Daly, senior economist for the World Bank, has called for operationalizing sustainability through use of a set of accounting rules for calculating rates of return on projects. For renewable resources, Daly (1991) suggests that:

- the offtake from the renewable resource that is being exploited should not be greater than the sustainable yield defined by ecologists;
- the harvest rates should be within the capacity for regeneration of the resource; and
- waste emission rates should be within the capacity of the local ecosystem to absorb and assimilate within natural bio-geochemical cycles.

For nonrenewable resources, he suggests that:

- waste emission rates should be within the capacity of the local ecosystem to absorb and assimilate within natural bio-geochemical cycles; and
- part of the net revenue from the project should be set aside and reinvested in a long-term renewable substitute so that as you deplete a nonrenewable resource you simultaneously build up a renewable resource (i.e. by the time you have depleted the nonrenewable resource you have built up the renewable substitute to a level such that its sustainable yield will be equal to the amount that you were consuming out of nonrenewable receipts each year).

Sustainability does not imply a static economy (Costanza 1992). Economic growth, which is an increase in quantity, cannot be sustainable indefinitely on a finite planet. Economic development, which is an improvement in the quality of life without necessarily causing an increase in the quantity of resources consumed, may be sustainable. Sustainable growth is an impossibility. Sustainable development must become our primary, long-term goal (Costanza 1992).

Breakout session participants felt that the current challenge is how to achieve environmentally sustainable economic development in a practical and meaningful way. Breakout session participants recognized the difficulty and enormity of this task, however, they felt that certain short-term actions could be taken to help link explicitly environment and economy, and to address win-win outcomes. Table 8 presents some practical steps to implement an ecosystem approach in the area of environmentally sustainable economic development, responsibilities for action, obstacles/challenges, and recommendations to overcome obstacles and meet challenges. These practical steps are not comprehensive, but represent short-term actions which could have an immediate impact. For example, governments, in consultation with industry, business, and other stakeholders, need to develop and make greater use of economic or market-based instruments as incentives to use natural resources more efficiently and make it economically disadvantageous to generate waste. The market is more likely to produce the desired environmental behavior, especially from small dispersed pollution sources, more rapidly than the slower process of developing command-and-control regulations.

Environmentally sustainable economic development is best understood as a dynamic process of continuous improvement in which the allocation of resources, the direction of investments, the orientation of technology, the form of laws and institutions, and the mechanisms for decision- making at all levels are shaped not only to meet the needs of the present, but to protect the ability of future generations to meet their own needs within the capacity of natural systems. To accomplish that, we must open dialogue, link explicitly environment and economy in decision- making processes, and assess and measure progress (see process framework presented in Figure 2).

Human Resource Development and Education

Education is key to the long-term change in the way people understand and value local and global ecosystems. However, education needs to go beyond the classroom to help relate individual activities with local ecosystems in order to develop a stewardship ethic and a sense of responsibility for local ecosystems. Formal and informal learning experiences provide citizens with the knowledge, skills, and commitment to participate in and support ecosystem restoration and protection efforts (Great Lakes Educators Advisory Council 1993).

Ecosystem-based education must be viewed as a process. Such a process must nurture multiple perspectives to a given ecosystem. The nurturing process must get all sectors of society involved in defining perspectives, goals, and actions. To be successful, ecosystem-based education must be based on a personal sense of place that is linked to watershed concepts and bioregionalism.

Breakout session participants first addressed the question of "What practical steps can be taken to help achieve a stewardship ethic throughout society?" Participants felt that a strong stewardship ethic throughout society is essential to implement fully an ecosystem approach in watersheds and bioregions. Table 9 presents activities and examples of their practical application for use of an ecosystem approach to develop a stewardship ethic. Such strategic process activities must be evaluated routinely and follow-up performed in order to ensure progress toward a stewardship ethic. In addition, a number of barriers to achieving a stewardship ethic exist which must be addressed in order to be successful. Potential barriers and recommendations to overcoming them are presented in Table 10.

Next breakout session participants addressed the question of "What practical steps can be taken to develop the human resources in all sectoral planning and management initiatives to better understand and use an ecosystem approach?" This relates to five key audiences: federal, provincial, and state agencies; local governments; businesses; formal education systems; and special interest groups and environmental shareholders. A strategy that targets federal, provincial, and state agencies is presented in Table 11. This strategy addresses both internal (education and human resource development) and external (how decision-makers can use an ecosystem approach to establish a stewardship ethic among stakeholders) needs. Selected examples of activities identified by other breakout sessions which will help foster use of an ecosystem approach in sectoral planning and management initiatives are presented in Table 12.

The key message is to achieve ecosystem communication and education by involving stakeholders. No one can have all the answers. Answers and solutions will arise from a cooperative learning enterprise. Cooperative learning can be described as common learning that involves stakeholders working in teams to accomplish a common goal, under conditions that involve both positive interdependence (all stakeholders cooperate to complete a task) and individual and group accountability (each stakeholder is accountable for the complete final outcome). Such cooperative learning is essential to achieve the paradigm shift necessary to implement fully an ecosystem approach within society and to rehabilitate and preserve ecosystems for future generations (Milbraith 1989).

SYNTHESIS AND CONCLUDING REMARKS

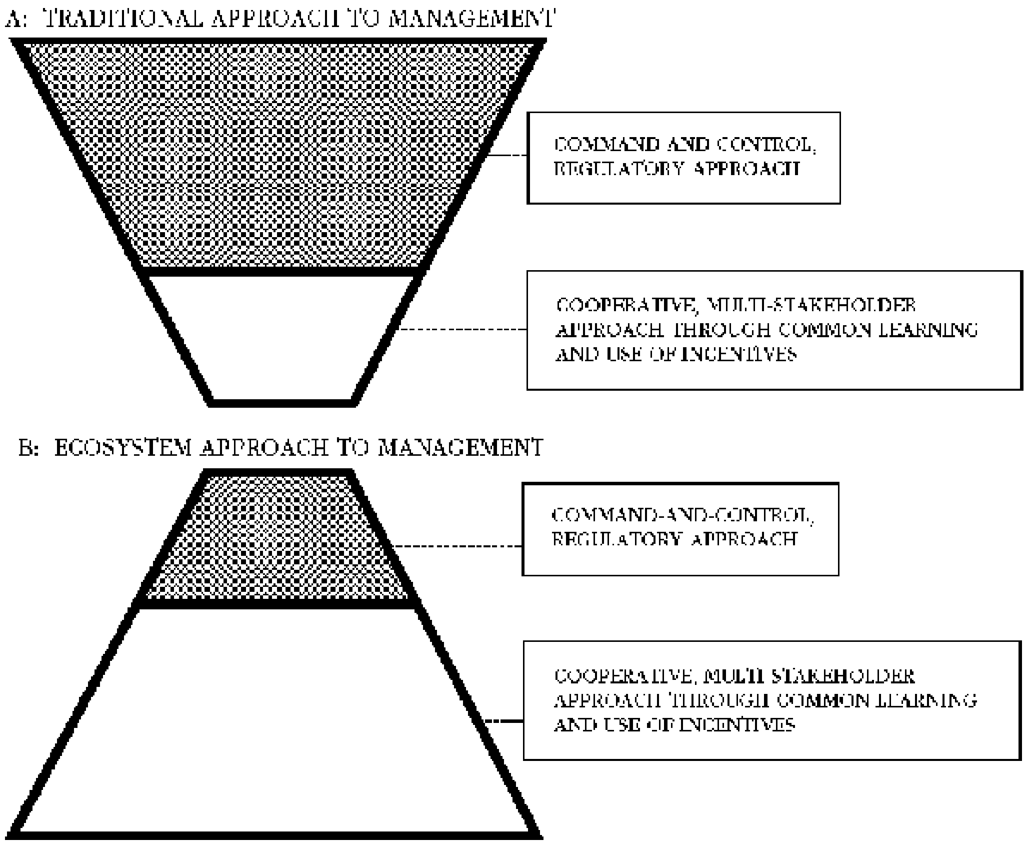
An ecosystem approach is not a new concept, however, its application in management is. An ecosystem approach is both a way of doing things and a way of thinking. Crombie (1992) has identified the following themes inherent in an ecosystem approach:

- an ecosystem as "home" (i.e. humans are part of ecosystems, not separate from them; it is the difference between "house" that is viewed as external and detached, and "home" where people see themselves in even when not there);
- everything is connected to everything else (i.e. the interconnectedness of all ecosystem components, including society, economy, and environment);
- sustainability (i.e. a commitment to environmentally-sustainable economic development);
- understanding places (i.e. the more people understand the bioregion in which they live, the more they will perceive it as "home" and the more they will harmonize their decision-making accordingly); and
- integrating processes (i.e. integrating economic decision-making with environmental decision- making).

Adopting an ecosystem approach means undertaking holistic planning, research, and management of the Great Lakes Basin. In regulatory and resource management agencies, adopting an ecosystem approach has initiated a shift from a narrow perspective of managing a single environmental medium (e.g. water, air) or a single resource (e.g. fish, trees) to a broader perspective that focuses on managing human uses and abuses of watersheds or bioregions, and that addresses all environmental media and resources in a comprehensive and systematic fashion.

Historically, the dominant environmental management philosophy has been command-and- control regulation at the end of the pipe or stack. This approach has resulted in substantial reductions in pollutant loadings and improvements in the environment over the last 20 years. However, as the cost of further reductions in point source loadings increases, the relative importance of nonpoint source loadings increases, and the need for multi-media, comprehensive, environmental management increases, greater emphasis is being placed on cooperative approaches to management which stress incentives and education. Proponents of this shift from a command- and-control, regulatory approach to a cooperative, ecosystem-based approach argue that, although regulatory activities are still important, education and incentives are now more important in achieving further reductions in loadings and improvements in the environment. Education and cooperative learning are fundamental to the success of this cooperative, ecosystem-based approach. Figure 3 depicts this shift from the historical, command-and-control, regulatory approach (i.e. the traditional approach to management) to a cooperative, multi-stakeholder approach through common learning and use of incentives (i.e. ecosystem approach to management). In general, the width of the trapezoid scale depicts relative effectiveness in improving ecosystems. For example, Figure 3a depicts that the traditional approach to management historically had the greatest impact on improving ecosystems. However, Figure 3b depicts that an ecosystem approach to management will have the greatest impact on improving ecosystems in the future (e.g. a cooperative, multi-stakeholder approach to controlling further nonpoint source loadings, and to preserving and rehabilitating habitats, will be more effective in improving ecosystems). The underlying assumption is that most people will change their behavior and do the right thing if presented with convincing information in an appropriate educational context (Behm 1994).

Figure 3. A comparison between the traditional, command-and-control, regulatory approach and an ecosystem approach that emphasizes cooperative, multi-stakeholer partnerships through common learning and use of incentives.



A comparison between the traditional, command-and-control, regulatory approach and an ecosystem approach that emphasizes cooperative, multi-stakeholder partnerships through common learning and use of incentives.

The basic intent of ecosystem-based management is similar to watershed management. What comprehensive watershed planning and management and ecosystem-based management are trying to accomplish is to comprehensively address contaminant (e.g. point and nonpoint sources, contaminated sediment remediation), physical (e.g. flow augmentation, streambank stabilization, physical habitat modification), and biological (e.g. stocking/harvesting, wetland restoration and enhancement, food web manipulation) management alternatives that will achieve locally-based, ecosystem goals (Freedman et al. 1994). Such site-specific, ecosystem goals are established based on ecosystem characteristics, public needs, and scientific, regulatory, and resource management input.

Resource problems are not environmental problems in a sense, but human problems created under a variety of political, social, and economic conditions. It is important to emphasize that implementing an ecosystem approach is a process. The process framework presented in Figure 2 is based on adaptive planning and management that recognizes the uncertainties and imperfect knowledge of the interrelationships and interdependencies of economy, society, and environment. Adaptive planning and management is an iterative decision-making process based on trial, monitoring, and feedback. The framework includes all stakeholder groups in defining a vision and goals at the beginning of the planning process. This adaptive planning process emphasizes the need for leadership, commitment to a long-term vision and goals, acceptance of a set of principles to guide the decision-making process, agreement on shared decision-making, and emphasis on continuous improvement. Human resource development and education are essential components from beginning to end.

For governmental managers, another way of helping implement an ecosystem approach at the practical working level of Great Lakes management is to view the process as a set of key action steps. Table 13 presents a checklist of process actions to help implement an ecosystem approach at the practical, working level of environmental and resource management. Such a checklist can help governmental managers guide local efforts to implement an ecosystem approach or may serve as a starting point in developing a better approach.

Some people have argued that an ecosystem approach provides an excuse to consider everything and solve nothing. Because the ecosystem approach calls for accounting for the interrelationships among air, water, land, and all living things, and calls for integrating societal, economic, and environmental concerns, there may be a tendency to focus attention too broadly and not focus specifically on obvious, high priority, environmental problems. It must be remembered that an ecosystem approach is a tool to help comprehensively and systematically address root causes of environmental problems. In the Great Lakes remedial action plan (RAP) program, clarity of focus is being provided by the 14 use impairments identified in Annex 2 of the Great Lakes Water Quality Agreement. These 14 use impairments are being used to help reach agreement on problem definition and reach agreement on quantitative targets and indicators for restoring uses (see Appendix 2 for examples). Such quantitative targets or indicators for restoring uses are being used to drive the RAP process, help stakeholders and organizations pursue a common mission of restoring uses, and help achieve greater accountability (Hartig et al. 1994b). Agreement on quantitative targets and indicators for restoring uses also helps achieve a clear, practical focus for use of an ecosystem approach in the RAP process, and helps establish measurable benchmarks to help maintain focus and measure progress.

Considerable emphasis is being placed on management of places, instead of simply managing programs. U.S. Environmental Protection Agency refers to this as "place-based environmental management" (i.e. the work of agencies and organizations should be driven by ecological, economic, and social needs of communities and ecosystems; Perciasepe et al. 1994). Critical success factors for place-based environmental management include:

- government activities being driven by the issues faced by particular ecosystems and the economies founded upon them;
- results measured in terms of restoration and protection of ecosystem integrity, which includes health of humans and other species;
- use of an ecosystem approach which requires coordinated, integrated action by federal, state, tribal, and local agencies, between government and private enterprises, and, most importantly, between government and the people for whom services are being provided; and
- availability of quality data and information on the resources to be protected for local empowerment that moves communities to action.

Such national emphasis will undoubtedly provide greater impetus to implement an ecosystem approach within local watersheds and bioregions.

Ecosystem-based education will be critical to the success of ecosystem-based management processes. No one has all the answers. Everyone will be learning their way out (Milbraith 1989). The process of cooperative learning must ensure respect for different perspectives, while striving for agreement on common goals and actions. Like "place-based environmental management", ecosystem-based educational processes must be founded on a sense of place that is linked to watershed concepts and bioregionalism.

Within the process of implementing an ecosystem approach there is a need to initiate short- term actions while undertaking long-term planning. Holling (1978) described this process as adaptive management where priorities are set, actions are implemented, and monitoring of effectiveness is performed in an iterative fashion for continuous improvement. This workshop entitled "Practical Steps to Implement an Ecosystem Approach in Great Lakes Management" attempted to synthesize the knowledge of practical application of an ecosystem approach at the working level of Great Lakes management. Although the process of full implementation of an ecosystem approach is a long-term endeavor, there are numerous opportunities to move forward with actions that: account for environmental, economic, and societal interrelationships; help achieve ecosystem-based goals and objectives; and achieve "win-win" or at least "win-no loss" outcomes. A summary of selected examples of practical steps to implement an ecosystem approach in the eight different sectors corresponding to the eight workshop breakout sessions is presented in Table 14. Such practical steps should not be viewed as being comprehensive. They represent practical advice on operationalizing an ecosystem approach at the working level of Great Lakes management. The key point is that there are numerous practical steps that can be taken immediately to help achieve ecosystem-based management.

This report has attempted to compile and synthesize practical advice on implementing an ecosystem approach at the practical, working level of Great Lakes management. Continued emphasis should be placed on learning from different experiences in implementing an ecosystem approach. The 43 locally-designed ecosystem approaches being used in

Great Lakes remedial action plans and the lake-specific ecosystem approaches being used in lakewide management plans serve as laboratories for practical application of ecosystem approach theory. Cooperative learning from these and other examples is essential to realize the Canada-United States commitment to use of an ecosystem approach in restoring and maintaining the physical, chemical, and biological integrity of the Great Lakes Basin Ecosystem (United States and Canada 1987).

Appendix 1

LIST OF WORKSHOP PARTICIPANTS

MARY LYNN BECKER
CANADIAN CONSULATE
600 RENAISSANCE CTR., STE. 1100
DETROIT, MI 48243-1704

JANIS BOBRIN
WASHTENAW DRAIN COMMISSION
P.O. BOX 8645
ANN ARBOR, MI 48107

MARK BREEDERLAND
INT. JOINT COMMISSION
P.O. BOX 32869
DETROIT, MI 48232-2869

PAUL BUBELIS
ENVIRONMENT CANADA
25 ST. CLAIR AVE. E., RM. 324
TORONTO, ONT. M4T 1M2 CANADA

GARY BURK
CITY OF OWOSSO
301 W. MAIN ST.
OWOSSO, MI 48867

RICHARD BURTON
WATER RESOURCES BOARD
704 EAST HENRIETTA RD.
ROCHESTER, NY 14623

JAN BUSH
25 LAKE AVENUE
ELYRIA, OH 44035

JIM BUSH
EAST MICHIGAN ACTION COUNCIL
18674 MUIRLAND
DETROIT, MI 48221-2203

JEFF BRAUNSCHEIDEL
MICHIGAN DNR
38980 SEVEN MILE ROAD
LIVONIA, MI 48152

TOM COAPE-ARNOLD
ONT. MIN. ENV. & ENERGY

135 ST. CLAIR AVE. W.
TORONTO, ONT. M4V 1P5 CANADA

JENNY CARTER
TMACOG
123 N. MICHIGAN AVE.
TOLEDO, OH 43624

LYNDA CORKUM
UNIVERSITY OF WINDSOR
DEPT. OF BIOLOGICAL SCIENCES
WINDSOR, ONT. M9B 3P4 CANADA

SANDRA CROCKARD
TRINITY THEATER
6 MAIN STREET
TORONTO, ONT. M4E 2V4 CANADA

BEV CROFT
INT. JOINT COMMISSION
P.O. BOX 32869
DETROIT, MI 48232-2869

JOE DELVECCHIO
USDA SOIL CONSERVATION SVC.
100 S. CLINTON ST., ROOM 771
SYRACUSE, NJ 13260

LESLIE DEMAL
ONTARIO MNR
380 ARMOR RD. P.O. BOX 7000
PETERBOROUGH, ONT. K9J 8M5
CANADA

MARGARET DOCHODA
GREAT LAKES FISHERY COMM.
2100 COMMONWEALTH BLVD. STE. 209
ANN ARBOR, MI 48105

DAVE DOLAN
INT. JOINT COMMISSION
P.O. BOX 32869
DETROIT, MI 48232-2869

MIKE DOLKOWSKI
GREATLAKES ENV. SERVICES
22077 MOUND ROAD
WARREN, MI 48091

RON FADOIR
DEPARTMENT OF PUBLIC HEALTH
5454 SOUTH VENOY
WAYNE, MI 48184

AIMEE FLANERY
WAYNE STATE UNIVERSITY
DEPT.CIVIL AND ENV. ENG.
DETROIT, MI 48202

ADELE FREEMAN
TORONTO CONSERV. AUTHORITY
5 SHORELINE DRIVE
TORONTO, ONT. M3N 1S4 CANADA

KENT FULLER
U.S. EPA
77 W. JACKSON ST.
CHICAGO, IL 60604

JOHN GANNON
NATIONAL BIOLOGICAL SURVEY
1451 GREEN RD.
ANN ARBOR, MI 48105

STEVE GERRITSON
LAKE MICHIGAN OZONE PROJECT
2350 E. DEVON ST.
DES PLAINS, IL 60652

WILL GIBSON
CUMMINS AND BARNARD
2058 S. STATE ST.
ANN ARBOR, MI 48104

MARKUS GINDER
ENVIRONMENT CANADA
25 ST. CLAIR AVE. E., 9TH FLOOR
TORONTO, ONT. M4T 1M2 CANADA

MARY GINNEBAUGH
GREAT LAKES UNITED
P.O. BOX 548, STATION A
WINDSOR, ONT. N9A 6M6 CANADA

JIM GRAHAM
FRIENDS OF THE ROUGE
220 BAGLEY #950
DETROIT, MI 48226

RICHARD GREENWOOD
U.S. EPA
77 W. JACKSON BOULEVARD(GL-9J)
CHICAGO, IL 60604-3509

VICKY HARRIS
WISCONSIN DNR
1125 MILLITARY AVE., P.O. BOX 10048
GREENBAY, WI 54307

JOHN HARTIG
WAYNE STATE UNIVERSITY
DEPT. CIVIL AND ENV. ENG.
DETROIT, MI 48202

BOB HAYES
CITY OF WINDSOR
CITY HALL, ROOM 400
WINDSOR, ONT. N9A 6S1 CANADA

REBECCA HEAD
DEPT. ENV. AND INFRASTRUCTURE
P.O.BOX 8645
ANN ARBOR, MI 48107-8645

CHUCK HERSEY
SEMCOG
660 PLAZA DRIVE, STE.1900
DETROIT, MI 48266

DON HUGHES
ONTARIO MNR
611 9TH AVE, EAST
OWENSOUND, ONT. N4K 3E4 CANADA

THOMAS HUNT
ESSEX CONSERV. AUTHORITY
360 FAIRVIEW AVE., WEST
ESSEX, ONT. N8M 1Y6 CANADA

PEGGY JOHNSON
CLINTON RIVER WATERSHED COUNCIL
1970 EAST AUBURN RD.
ROCHESTER HILLS, MI 48307-4803

RIMI KALINAUSKAS
ENVIRONMENT CANADA
25 ST. CLAIR AVE., EAST
TORONTO, ONT. M4T 1M2 CANADA

MARIE LAGIMODIERE
ENVIRONMENT CANADA
867 LAKESHORE RD.
BURLINGTON, ONT. L7R 4A6
CANADA

NEELY LAW
262 HOWLAND AVE.
TORONTO, ONTARIO M5R 3B6
CANADA

JULIE LETTERHOS
OHIO EPA
1800 WATERMARK DR., P.O. BOX 1049
COLUMBUS, OH 43266-0149

JOAN MARTIN
HURON RIVER WATERSHED COUNCIL
1100 N. MAIN ST, STE. 210
ANN ARBOR, MI 48104

BRIAN McHATTIE
CANADIAN WILDLIFE SERVICE
BURLINGTON, ONTARIO L7R 4A6
CANADA

GERRY MIKOL
NEW YORK STATE DEC

50 WOLF RD.
ALBANY, NY 12233-1250

KEVIN MILLS
ENVIRONMENTAL DEFENSE FUND
1875 CONN. AVE. N.W., 10TH FLOOR
WASHINGTON D.C. 20009

PHIL MOY
U.S. ARMY CORPS OF ENGINEERS
111 N. CANAL
CHICAGO, IL 60604-7206

GREG MOOTS
DETROIT CITY PLANNING COMM.
202 CITY-COUNTY BUILDING
DETROIT, MI 48226

STEPHEN NEPSZY
ONTARIO MNR
R.R.#2
WHEATLEY, ONT. N0P 2P0 CANADA

LOIS NEW
NEW YORK STATE DEC
50 WOLF RD.
ALBANY, NY 12233

FRANCINE NORLING
U.S. EPA
77 W. JACKSON BLVD. (WQ-16J)
CHICAGO, IL60604-3590

JEFFREY OLSEN
NEW YORK STATE DOT
1220 WASHINGTON, BLDG. 4, RM. 206
ALBANY, NY 12232-3501

CARMINE PALOMBO
SEMCOG
660 PLAZA DRIVE, STE 1900
DETROIT, MI 48266

ALAN RICHARDSON
TRINITY THEATRE
6 MAIN STREET
TORONTO, ONT. M4E 2V4 CANADA

PAUL RENTSCHLER
HURON RIVER WATERSHED COUNCIL
1100 N. MAIN ST., STE. 210
ANN ARBOR, MI 48104

KARL SCHAFER
CANADA CENTRE FOR INLAND WATERS
867 LAKESHORE RD.
BURLINGTON, ONT. L7R 4A6 CANADA

KEN SCHMIDT
ESSEX REGION CONS. AUTHORITY
360 FAIRVIEW AVE., W.
ESSEX, ONT. N8M 1Y6 CANADA

ROY SCHRAMECK
MICHIGAN DNR
39000 SEVEN MILE RD.
LIVONIA, MI 48152

KURT SEIDEL
WAYNE STATE UNIVERSITY
DEPT. CIVIL & ENV. ENG.
DETROIT, MI 48202

BRUCE SINGBUSH
CITY OF WINDSOR
CITY HALL, ROOM 400
WINDSOR, ONT. N9A 6S1 CANADA

JACK SMILEY
SE MICHIGAN LAND CONSERVANCY
6410 ST. MARYS
DETROIT, MI 48228

FRED SNYDER
OHIO SEA GRANT
CAMP PERRY BLDG. 3, RM. 12
PORT CLINTON, OH 42452

MIKE STIFLER
MICHIGAN DNR
8015 MACKINAW TRAIL
CADILLAC, MI 49601

ROGER THOMA
OHIO EPA
1800 WATERMARK DR.
COLUMBUS, OH 43266-0149

DONALD TILTON
JOHNSON, JOHNSON, & ROY, INC.
110 MILLER
ANN ARBOR, MI 48104

DEAN TOUMARI
DEPARTMENT OF PUBLIC HEALTH
5454 SOUTH VENOY RD.
WAYNE, MI 48184

ROBERT TOWNSEND
NEW YORK STATE DEC
50 WOLF RD.
ALBANY, NY 12233-3502

TONY WAGNER
WATERFRONT REGEN. TRUST
207 QUEEN S QUAY, STE. 580
TORONTO, ONT. M5J 1A7 CANADA

DAVE WEARSCH
MICHIGAN DNR
P.O. BOX 128
ROSCOMMON, MI 48653

ANDREA WEILGAT
761 W. OAKRIDGE
FERNDALE, MI 482202

DICK WOLINSKI
APPLIED SCIENCE AND TECH., INC.
2450 BAKER RD.
DEXTER, MI 48130

MICHAEL ZARULL
NATIONAL WATER RESEARCH INSTITUTE
CCIW, 867 LAKESHORE RD., P.O. BOX 5050
BURLINGTON, ONT. L7R 4A6 CANADA

Appendix 2

Use impairments, listing and delisting guidelines for Great Lakes Areas of Concern, and examples of quantitative objectives and targets for use restoration (Hartig et al. 1994b).

Use Impairment	**Listing Guideline**	**Delisting Guideline**	**Example of Quantitative Objective/Target for use Restoration**
Restrictions on fish and wildlife consumption	When contaminant levels in fish or wildlife populations exceed current standards, objectives or guidelines, or public health advisories are in effect for human consumption of fish or wildlife.	When contaminant levels in fish and wildlife populations do not exceed current standards, objectives or guidelines, and no public health advisories are in effect for human consumption of fish or wildlife. * Contaminant levels in fish and wildlife must be due to contaminant input from watershed.	Over 159,000 kg of PCBs reside in Kalamazoo River (Michigan) sediments and have resulted in contamination of the fishery. Two levels of cleanup standards apply: • a short-term target based on the U.S. Food and Drug Administration Action Level of 2 mg/kg PCBs in the edible portion of fish; and • a long-term target of 0.05 mg/kg PCBs in fish tissue established to protect human health through Rule 57 of Michigan Water Quality Standards (Waggoner and Creal 1992).
Tainting of fish and wildlife flavor	When ambient water quality standards, objectives, or guidelines, for the anthropogenic substance(s) known to cause tainting, are being exceeded or survey results have identified tainting of fish or wildlife flavor.	When survey results confirm no tainting of fish or wildlife flavor.	In Spanish River (Ontario), 72 hour in situ fish exposure under low flow and subsequent sensory evaluation were used to re-evaluate fish tainting due to mill effluent (upstream control site and downstream effluent plume). A triangle test (three samples to each of eleven panelists; two samples the same and one different) was used to determine a difference (Jardine and Bowman 1992). The number of correct responses must not be significantly different (95% confidence) from chance of guessing odd sample. Based on this approach, a sensory panel could not distinguish tainting in fish exposed to mill effluent.

Degraded fish and wildlife populations	When fish and wildlife management programs have identified degraded fish or wildlife populations due to a cause within the watershed. In addition, this use will be considered impaired when relevant, field validated, fish or wildlife bioassays with appropriate quality assurance/quality controls confirm significant toxicity from water column or sediment contaminants.	When environmental conditions support healthy, self-sustaining communities of desired fish and wildlife at predetermined levels of abundance that would be expected from the amount and quality of suitable physical, chemical and biological habitat present. An effort must be made to ensure that fish and wildlife objectives for Areas of Concern are consistent with Great Lakes ecosystem objectives and Great Lakes Fishery Commission fish community goals. Further, in the absence of community structure data, this use will be considered restored when fish and wildlife bioassays confirm no significant toxicity from water column or sediment contaminants.	In Hamilton Harbor (Lake Ontario), the overall objective is to shift from a fish community indicative of eutrophy, to a self-sustaining community indicative of mesotrophy. Quantitative fishery targets include (Hamilton Harbour Remedial Action Plan Writing Team 1992): • 200-250 kg/ha total biomass of fish in littoral habitats; • 40-60 kg/ha piscivore biomass in littoral habitats; • 70-100 kg/ha specialist biomass in littoral habitats; • 30-90 kg/ha generalist biomass in littoral habitats; • native piscivores representing 20-25% of total biomass; • 80-90% native species; and • a species richness of 6-7 species per survey transect.
Fish tumors or other deformities	When the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or when survey data confirm the presence of neoplastic or preneoplastic liver tumors in bullheads or suckers.	When the incidence rates of fish tumors or other deformities do not exceed rates at unimpacted control sites and when survey data confirm the absence of neoplastic or preneoplastic liver tumors in bullheads or suckers.	In the Black River (Ohio), PAH contamination is known to cause fish tumors. Based on standardized fish survey techniques, two targets apply: no neoplastic liver tumors in a minimum sample of 25 brown bullhead (> two years old); and the incidence rate of skin and lip tumors must be less than the incidence rate at a control site. 150 control site and 130 contaminated site fish would be needed to verify a 5% difference (2% vs 7%; 95% confidence) (Bauman 1992).
Bird or animal deformities or reproductive problems	When wildlife survey data confirm the presence of deformities (e.g. cross-bill syndrome) or other reproductive problems (e.g. egg-shell thinning) in sentinel wildlife species.	When the incidence rates of deformities (e.g. cross-bill syndrome) or reproductive problems (e.g. egg-shell thinning) in sentinel wildlife species do not exceed background levels in inland control populations.	In the Fox River and Green Bay (Wisconsin), historical discharges from the world's largest concentration of pulp and paper mills are believed to be the primary source of 30,000 kg of PCBs that reside in river sediments downstream of Lake Winnebago and up to 15,000 kg of PCBs in Green Bay. Studies have demonstrated avian exposure to contaminants through aquatic food chains. A 1983 study of two colonies of Forster's tern, showed reproductive success of a lower Green Bay colony to be significantly impaired when compared to a relatively clean reference colony on Lake Poygan, upstream from industrial activities on the Fox River. Based on the 1983 study and an additional study in 1988, reproductive success was defined as: a hatching rate of 90% based on mean hatchability of the 1983

			reference colony at Lake Poygan (Kubiak et al. 1989) and mean hatchability of 155 populations of 113 avian species (Koenig 1982); a mean fledging rate of between 1.0 chick/pair judged necessary to sustain the Forster's tern population (Trick 1982) and 1.55 chicks/pair measured at the 1983 reference colony; an average incubation time of 23 days; and a normal growth rate of chicks (body weight and length of wing, tarsus, bill and head) based on 1988 data for chicks known to have successfully fledged from the Green Bay colony (Harris et al. 1993).
Degradation of Benthos	When benthic macroinvertebrate community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when toxicity (as defined by relevant, field-validated, bioassays with appropriate quality assurance/quality controls) of sediment-associated contaminants at a site is significantly higher than controls.	When benthic macroinvertebrate community structure does not significantly diverge from unimpacted control sites of comparable physical and chemical characteristics. Further, in the absence of community structure data, this use will be considered restored when toxicity of sediment-associated contaminants is not significantly higher than controls.	In Canada, site-specific guidelines for benthos are being established from a reference site data base (i.e. biological attributes and environmental variables) using multivariate techniques, such as cluster and ordination analysis (Reynoldson and Zarull 1993). Reference site benthic communities are grouped using cluster analysis. The site environmental variables, which are not affected or minimally affected by anthropogenic activity, are then used as predictors to group the sites into the appropriate biological clusters. The benthic community structure and the same nine environmental variables (depth, NO3, silt, aluminum, calcium, loss on ignition, alkalinity, sodium, pH) are measured at the test sites. Using the environmental predictors and the discriminant model (derived from the reference site data base), each site is assigned to a biological cluster. The benthic invertebrate data are then similarly analyzed. If the site in the Area of Concern lies outside the reference site cluster, then that site is judged to be impaired. In the Great Lakes, 335 sites have been sampled and the multivariate "model" developed from this data base correctly predicts benthic invertebrate communities with 90% accuracy (Reynoldson et al. 1995). In addition, acute and chronic measures of "toxicity" (including growth and reproduction) performed at these same sites provide measures of background performance for the appropriate, indigenous organisms that are to be used in assessing sediment toxicity (see below).
Restrictions on dredging activities	When contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on	When contaminants in sediments do not exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities.	Great Lakes dredging guidelines were developed to provide protection against the short and long-term impacts associated with the disposal of dredged sediments. These guidelines employ bulk chemistry measurements for a few parameters that are

	dredging or disposal activities.		assessed using either water quality equivalent standards or background concentration classifications (Zarull and Reynoldson 1992; IJC 1982). More recently, the Ontario Ministry of Environment and Energy has released a biologically-based, sediment contaminant concentration guidelines for use in assessing bottom sediments in Areas of Concern and for use in assessing dredged material disposal. These chemical concentration guidelines are also supported through the use of site-specific bioassays (OMOE 1992). In many areas outside the Great Lakes, the Sediment Quality Triad Approach (i.e. chemistry, benthos community structure, and bioassays) is being used to assess sediment problems and recommend remedial actions (Chapman 1990). A similar method has been recommended for use in the Great Lakes (IJC 1987, 1988; Zarull and Reynoldson 1992). Endpoints for benthos community structure are being established as described above, using reference sites throughout the nearshore Great Lakes. Sediment bioassays, an essential adjunct, provide confirmation that sediment is the source of the impact, rather than the water column or other factors, which are integrated by the benthos. As with community structure, a reference site (bioassay) data base has been established (Reynoldson et al. 1995). Examples of quantitative endpoints for standard sediment bioassays performed at "clean" sites (based on the value at the 5th percentile on the normal distribution curve below which toxicity is indicated) include: • Chironomus riparius 10-day bioassay: 68% survival in all sediments and growth of 0.22 mg dry weight per individual; Hexagenia limbata 21-day bioassay: 84% survival in all sediments, growth of 0.38 mg dry weight per individual in unfed organisms and growth of 0.58 mg dry weight in fed organisms; • Hyallella azteca 28-day bioassay: 75% survival and growth of 0.22 mg dry weight in all sediments; and • Tubifex tubifex 28-day bioassay: 24 cocoons and 21 young per adult in unfed and 31 cocoons or 35 young per adult in fed.

			If the community criteria (CC) and the bioassay criteria (BC) are met, then open water disposal of sediment is acceptable. If neither CC nor BC are met, then confinement and/or treatment are necessary. If CC are not met, but all BC are, then open water disposal is possible since community problem is not likely sediment related. If CC are not met, but some BC are, then open water disposal is dependent upon the degree of acceptable risk. If CC are met, but some BC are not, then a careful reassessment of methods/procedures is required (this could also be a result of a highly adapted indigenous community).
Eutrophication or undesirable algae	When there are persistent water quality problems (e.g. dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity, etc.) attributed to cultural eutrophication.	When there are no persistent water quality problems (e.g. dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity, etc.) attributed to cultural eutrophication.	In Saginaw Bay, Lake Huron, modelling phosphorous loading-phosphorous concentration-threshold odor value relationships has led to establishment of a 15 mg/L total phosphorous (TP) concentration for the inner bay (Bierman et al. 1983). The TP loading target is 440 tonnes/yr, which will result in threshold odor values < 3 and a TP concentration of 15 mg/L. In Green Bay, Lake Michigan, regression analysis has been used to model the relationships among TP loading, TP concentration, total suspended solids, chlorophyll a, and water clarity. Based on a 0.7 m Secchi depth (summer average) necessary to restore submerged aquatic vegetation (McAllister 1991), trophic state objectives were established as follows: 90 ug/L summer average TP, 25 ug/L summer average chlorophyll a, and 10 mg/L total suspended solids. These values correspond to an annual TP load of about 350 tonnes/yr, or a 50% reduction in current loading (WDNR 1993).
Restrictions on drinking water consumption or taste or odor problems	When treated drinking water supplies are impacted to the extent that: 1) densities of disease causing organisms or concentrations of hazardous/toxic chemicals or radioactive substances exceed human health standards, objectives or guidelines; 2) taste and odor problems are present; or 3) treatment needed to make raw water suitable for drinking is beyond	For treated drinking water supplies: 1) when densities of disease causing organisms or concentrations of hazardous/toxic chemicals or radioactive substances do not exceed human health standards, objectives or guidelines; 2) when taste and odor problems are absent; and 3) when treatment needed to make raw water suitable for drinking does not exceed standard treatment as defined above.	In the Maumee River Area of Concern in southwestern Lake Erie, nitrate levels have increased above 10 mg/L during spring and fall in some municipal water supplies. When this occurs, drinking water consumption warnings are issued because elevated levels of nitrate have been found to be harmful to certain groups of people (e.g. excessive nitrate causes methemoglobinemia in infants). Drinking water consumption warnings are removed by the municipalities when nitrate levels fall below 10 mg/L for two consecutive days based on standardized sampling and analytical techniques. In Saginaw Bay, Lake Huron, taste and odor problems associated with blue-green algae

	the standard treatment used in comparable portions of the Great Lakes which are not degraded (i.e. settling, coagulation, disinfection).		have been identified in the municipal water supplies. Threshold odor is quantitatively measured and ranked on a scale from one to ten based on the dilution necessary to ensure that taste and odor are bearly detectable, with a value of three being the U.S. Public Health Service Threshold Standard (Bierman et al. 1983). Threshold odor is measured daily and biweekly averages are calculated to determine compliance with the U.S. Public Health Service Standard of three.
Beach closings	When waters, which are commonly used for total body-contact or partial body-contact recreation, exceed standards, objectives, or guidelines for such use.	When waters, which are commonly used for total body-contact or partial body-contact recreation, do not exceed standards, objectives, or guidelines for such use.	Along the Metropolitan Toronto Waterfront (Lake Ontario), numerous beaches are posted unsafe for swimming as a result of high bacterial counts from stormwater runoff and combined sewer overflows. The Ontario Ministry Health Standard is 100 colonies Escherichia coli/100 ml. Beaches are considered safe for swimming when the daily geometric mean of a minimum of five samples collected from different sites within the beach area is less than 100 colonies/100 ml based on standardized sampling protocols (Ontario Ministry of Health 1992). In Wisconsin, both narrative and numerical standards are set for public swimming beaches. Waters must be free of chemical substances capable of creating toxic reactions or irritations to skin/membranes, must achieve numerical bacterial standards, and must achieve a 4 m Secchi Disc water clarity standard for safety reasons (Wisconsin Adm. Rule HSS 171).
Degradation of aesthetics	When any substance in water produces a persistent objectionable deposit, unnatural color or turbidity, or unnatural odor (e.g. oil slick, surface scum).	When the waters are devoid of any substance which produces a persistent objectionable deposit, unnatural color or turbidity, or unnatural odor (e.g. oil slick, surface scum).	In New York, narrative standards for suspended sediment and color are set at "none" that would adversely affect the waters for their best use (New York State 1991). For turbidity, the standard is no increase that would cause a visible contrast from natural conditions and, for oil and floating substances, it is no residue that would be visible. If conditions are attributable to unnatural causes and sources, New York ambient water quality standards are used to establish reduction targets in order to make a determination. Examples of quantitative targets that have been established for dischargers causing such conditions include: 3.0 mg/L for suspended solids; and 15 mg/L for oil and floating substances.
Added costs to agriculture or industry	When there are additional costs required to treat the water prior to use for agricultural purposes (i.e. including	When there are no additional costs required to treat the water prior to use for agricultural or industrial purposes (as defined above).	In the St. Clair River Area of Concern, "added costs to agriculture or industry" has been identified as an impaired beneficial use. Food processing industries in Ontario and a salt processes facility in Michigan had to

	but not limited to, livestock watering, irrigation and crop-spraying) or industrial purposes (i.e. intended for commercial or industrial applications and noncontact food processing).		temporarily shut down their intakes due to upstream spills in 1990 and 1989, respectively (Ontario Ministry of the Environment and Michigan Department of Natural Resources 1991). In both instances, added costs to these industries were approximately $2,000/hour during the spill events. This use is considered restored when there are no added costs to treat the water prior to use in industrial or agricultural processes.
Degradation of phytoplankton and zooplankton populations	When phytoplankton or zooplankton community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when relevant, field-validated, phytoplankton or zooplankton bioassays (e.g. Ceriodaphnia; algal fractionation bioassays) with appropriate quality assurance/quality controls confirm toxicity in ambient waters.	When phytoplankton or zooplankton community structure does not significantly diverge from unimpacted control sites of comparable physical and chemical characteristics. Further, in the absence of community structure data, this use is considered restored when plankton bioassays confirm no toxicity in ambient waters.	Limited attempts have been made to quantify objectives based on zooplankton and phytoplankton community structure due to the expensive and time-consuming nature of plankton enumeration and quantification. Bioassay endpoints are more frequently used. Degraded zooplankton populations were identified as an impaired use in the Cuyahoga River due to chronic toxicity of ambient waters below the Akron Wastewater Treatment Plant. Toxicity was measured by the seven-day, three brood Ceriodaphnia test. Ceriodaphnia are easily cultured, found in the Great Lakes, sensitive to toxic substances, and have a short maturation time. Based on standard Ceriodaphnia bioassay protocols (IJC 1987), zooplankton populations were considered not impaired when there was no significant difference in survival and number of young per female relative to controls ($P < 0.05$).
Loss of fish and wildlife habitat	When fish and wildlife management goals have not been met as a result of loss of fish and wildlife habitat due to a perturbation in the physical, chemical or biological integrity of the Boundary Waters, including wetlands.	When the amount of physical, chemical and biological habitat required to meet fish and wildlife management goals has been achieved and protected.	Approximately 80% of the wetlands in Hamilton Harbour, Lake Ontario have been lost to development. The water use goal for the fishery is "that water quality and fish habitat should be improved to permit an edible, naturally-reproducing fishery for warmwater species, and water and habitat conditions in Hamilton Harbour should not limit natural reproduction and the edibility of cold water species." This water use goal has been translated into the following targets for fish habitat (Hamilton Harbour Remedial Action Plan Writing Team 1992): increase the quantity of emergent and submergent aquatic plants in the Hamilton Harbor, Cootes Paradise, Grindstone Creek Delta, and Grindstone Creek Marshes to approximately 500 ha in accordance with the Fish and Wildlife Habitat Restoration Project; rehabilitate 344 ha of littoral fish habitat; rehabilitate 39 ha of pike spawning marsh and nursery habitat; provide additional 10 km of littoral shore by creating 5 km of narrow islands; and achieve water clarity as measured by Secchi Disc during the summer

			season of 3.0 m in the harbor and 1.0 m in Cootes Paradise and Grindstone Creek.

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