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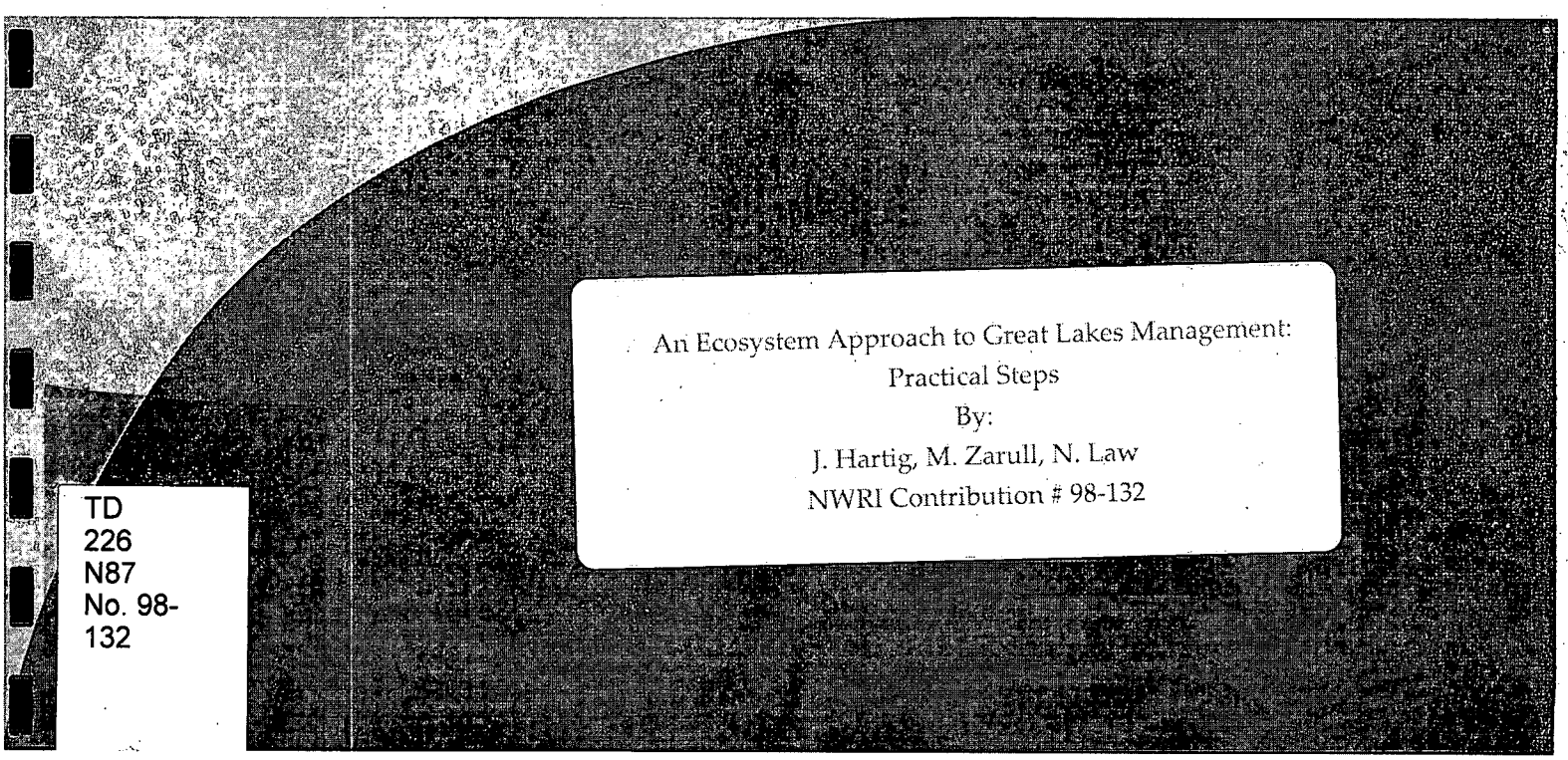

An Ecosystem Approach to Great Lakes Management: Practical Steps

By:

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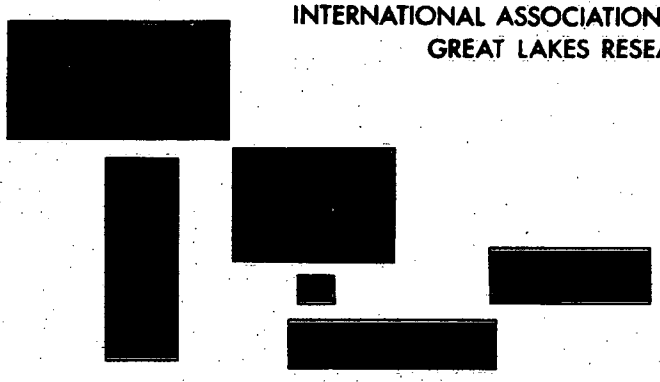

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COMMENTARY

An Ecosystem Approach to Great Lakes Management: Practical Steps

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MANAGEMENT PERSPECTIVE

Title: An Ecosystem Approach to Great Lakes Management: Practical Steps

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EC Priority/Issue: This work was done as part of the GL2000 Program, for the development and completion of Remedial Action Plans (RAPs) for Areas of Concern (AOCs) and Lakewide Management Plans (LaMPs). It is part of the COA and the federal GL2000 Strategic Plan to Restore Degraded Areas and Conserve and Protect Human and Ecosystem Health. The work began in 1992. A special symposium was held at the 1993 International Association for Great Lakes Research Conference, a follow-up binational workshop was held in November of 1994 and a report produced in 1995.

Current Status: The paper critiques past resource management approaches in the Great Lakes and chronicles the development of an ecosystem approach, contrasting it with the current trend to adopting "Ecosystem Management." Practical steps to implement an ecosystem approach to managing the Great Lakes are described and suggestions for ways to implement these ideas are also presented.

Next Steps: Further exploration of ecosystem management theory and its practical application are being considered.

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ABSTRACT. *Limited success of past approaches to managing the Great Lakes, and mitigating anthropogenically induced stress, necessitates the adoption of a broader, ecosystem approach. This report is an outgrowth of a 1994 binational workshop which was convened by the U. S. Environmental Protection Agency and Environment Canada to identify practical steps that could be taken to implement an ecosystem approach to natural resource management and development in the Great Lakes. An ecosystem approach incorporates the interrelationships among land, air, water, and all living things, including humans, and involves all user groups in comprehensive management. Recent attempts to establish national and international ecosystem-based public policy and management schemes have met with considerable opposition. This opposition is based, in part, on a lack of clarity of terms, theory, and intent in the proposal to apply "ecosystem management." Despite these uncertainties and lack of detailed understanding, there are several, practical steps that can be implemented immediately. This report presents selected examples of these practical steps for implementing an ecosystem approach in eight sectors, which correspond to the breakout sessions used in the workshop. Selected examples include: providing ecological assessments to landowners for protection and enhancement of unique ecological features; incorporating life cycle assessments into all regulatory and incentive-based initiatives to control point sources; and ensuring that all construction and maintenance projects for structures (e.g., breakwalls, piers) address secondary benefits of incidental habitat. Additional practical steps need to be identified and shared at the working level of watershed and environmental management.*

INDEX WORDS: *Ecosystem approach, practical steps, management, workshop.*

INTRODUCTION

The Laurentian Great Lakes represent a significant ecological and economic resource, regionally, nationally and globally. Their vastness and natural resources have enabled the development of wealth and, with it, raised the living standards in both Canada and the United States. As a consequence of this development, knowledge, technology, industrial goods and services, and food have been produced. A further consequence of this development has been extensive transformation of the ecosystem that existed prior to the arrival of western Europeans.

Anthropogenic stresses and impacts were initially local; however, their cumulative effects, along with our ability to cause change over large space and short time-scales, have resulted in many devastating

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and irreversible (on a non-geologic time-scale) alterations to the Great Lakes basin ecosystem. Some ecosystem changes have been as a result of direct actions like clearing of forests for agriculture and urban development, while other changes have been more indirect, for example those impacts resulting from application of pesticides (Christie 1974, Whillans 1979, Colborn *et al.* 1990, Sly 1991, Mills *et al.* 1993, Allan and Zarull 1995).

Although the latter half of the twentieth century has brought with it most of the changes that we tend to identify with environmental degradation, it also brought our first serious attempts to both manage and rehabilitate this ecosystem. Beginning in the early part of this century, a series of actions were taken to provide and protect potable water from the lakes. Somewhat later, actions to manage and protect fish stocks from a variety of pressures were taken; however, it wasn't until the 1970s that basin-wide actions were initiated to restore, maintain, and protect the lakes. The management approaches employed were very much "single issue" focussed (e.g., phosphorus, fish stocking, persistent toxic substances) and while they have demonstrated a certain measure of success, they did not entirely eliminate the problems (GLRAB 1978, NRC and RSC 1985, Sly 1991, Allan *et al.* 1991, United States and Canada 1995, Allan and Zarull 1995).

Just as we are unable to ascribe a single cause to many ecological changes in the basin, we are unable to claim clear victory for any single management action. This is due in part to the number of management actions that have taken place simultaneously—some with different objectives, some with conflicting objectives (e.g., phosphorus control and fish stocking). Further, management success may be limited due to the expression of natural variability found in all ecosystems and which may be exaggerated in the Great Lakes as a result of sustained anthropogenic instability (Leach and Nepszy 1976, Regier 1979, Ryder and Edwards 1985). However, the most serious difficulty of these "single issue" approaches is that they attempt to treat the symptom, rather than the cause. For example, the problems associated with nutrient enrichment have been addressed almost exclusively through building large treatment facilities, rather than controlling population growth and distribution. If these approaches do not provide complete and sustainable solutions, how then should the ecosystem be managed (if it can be managed at all, in the strictest sense of the word)?

Since 1977, the International Joint Commission (IJC), as well as the governments of Canada and the United States, have advocated the use of an ecosystem approach (i.e., accounting for the interrelationships among land, air, water, and all living things, including humans, and involving all user groups in comprehensive management) to manage the Great Lakes (GLRAB 1977 and 1978; United States and Canada 1978). At no time, however, has the concept been sufficiently detailed or defined so that it could be implemented in a simple, step-wise fashion. Neither have the legislative, philosophical, and social changes required to adequately implement it been undertaken (GLRAB 1978). However, a much broader approach to the management of the Great Lakes has evolved from these initial, uncertain beginnings. Indeed, "ecosystem management" or an ecosystem approach to management (these terms have been incorrectly interchanged in their use) is now widely advocated by governments and agencies worldwide (Francis *et al.* 1979, Harris *et al.* 1982, Hartig and Vallentyne 1989, Department of the Interior 1994, Christensen *et al.* 1996, Fitzsimmons 1996). By ecosystem approach we mean an action-based, adaptive planning and management process (as defined by Holling 1978) that accounts for the interrelationships among ecological components (including humans).

Early attempts to implement an ecosystem approach focussed on a scale smaller than the entire Great Lakes (Francis *et al.* 1979). This was followed by the development of ecosystem objectives (Ryder and Edwards 1985, United States and Canada 1987, Edwards and Ryder 1990, Bertram and Reynoldson 1992). More recently, the Remedial Action Plan (RAP) Program has provided the opportunity to implement these concepts (Hartig and Thomas 1988, Hartig and Vallentyne 1989, Hartig and Zarull 1992). However, attempts to establish national and international land and water management policies for the protection and restoration of ecosystems have been met with considerable opposition and implementation problems.

There are several major difficulties to clear articulation and implementation of an ecosystem approach to managing natural resources. These include a vagueness surrounding certain key concepts and terms, some controversy surrounding aspects of both ecological theory and its practical application in management, and the short-term social and economic costs (and possibly hardships) of rigorously adopting such actions (Fitzsimmons 1996, Shrader-Frechette and McCoy 1994, Sagoff 1985, Peters 1991, Rees and Wackernagel 1992,

WCED 1987, Christensen *et al.* 1996). These difficulties and challenges, while not insurmountable, provide several large impediments to the adoption of a broader management approach that is essential for adequate protection and restoration of the Great Lakes. However, it is possible to implement certain actions, based both on accepted theory and practical experience, that further the use of an ecosystem approach in the Great Lakes.

In November 1994, a binational workshop was convened by the U.S. Environmental Protection Agency and Environment Canada, in cooperation with the IJC and Wayne State University (Detroit, Michigan), to identify practical steps that could be taken to implement an ecosystem approach to natural resource management and development in the Great Lakes. Practical steps to implement an ecosystem approach were defined as "those pragmatic actions that: can be taken in the near term (3-5 years) that 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." This paper presents selected examples of these practical steps for implementing an ecosystem approach in eight sectors, which correspond to the breakout sessions used in the workshop. Additional practical steps can be found in U.S. Environmental Protection Agency and Environment Canada (1995).

PRACTICAL STEPS

Land-Use Planning Within a Watershed

Through separate legislation, regulations, and government bodies, the ability of local government to participate in ecosystem-based management of a watershed has been limited due to restricted geographical scope and prescribed regulatory responsibilities (Cox 1989). Land-use planning should by viewed 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. An overall goal to help ensure that land-use planning encompasses an ecosystem approach would be 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 space 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 1 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 can be implemented in a step-wise fashion to help facilitate transition to ecosystem-based 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;

TABLE 1 . Selected examples of practical steps to implement an ecosystem approach in eight different sectors.

Sector	Practical	Step (s)		
Land-Use Planning Within a Watershed	Develop partnership agreement for watershed planning and management	Identify and empower an "umbrella" watershed organization for coordination	Compile inventory of ecosystem features and incorporate into geographical information system for decision-making	Develop policies and ordinances to preserve and enhance ecosystem features
Point Source Pollution	Perform internal full cost accounting on all products, processes, and services	Ensure multi-media assessment of loadings and impacts	Establish multi-media permitting for facilities	Incorporate Life Cycle Assessment (LCA) into all regulatory and incentive-based initiatives to control point sources
Nonpoint Source Pollution Associated with the Land-Water Interface	Provide ecological assessments to landowners for protection and enhancement of unique ecological features	Use ecological inventory to prioritize nonpoint source control actions throughout the watershed	Develop whole farm plans to reduce nonpoint source pollution, enhance habitat, maintain hydrology, and enhance economic viability	Develop and implement an illicit connection program for sewer systems in urban areas
Transportation	Ensure democratic transportation planning processes with ecosystem education component	Achieve greater multi-modal balance within bioregions	Ensure bioregional coordination of transportation plans	Utilize economic and market incentives to ensure full cost accounting in transportation planning
Fisheries and Wildlife Management	Establish clear, measurable fish and wildlife management objectives and ensure that all management actions and research projects address them	Ensure that fish stocking rates are determined after consideration of all trophic level interactions	Ensure that individuals with fishery and wildlife expertise get involved up-front in project planning for waterfront redevelopment, shoreline modification, sediment remediation, navigational structures, etc. to adequately address fish and wildlife enhancement opportunities and ensure adequate assessment and monitoring	Ensure that agencies like provincial, state, and local transportation departments, departments of public works, and others incorporate ecological techniques which enhance fish and wildlife (e.g., bioengineering, incidental habitat enhancement of physical structures, willow posts, set backs) into operating manuals and day-to-day operations
Habitat	Incorporate habitat protection into master, land-use, and watershed plans, zoning ordinances, etc.	Seek permanent protection of ecologically significant habitats by purchasing land, establishing easements, etc.	Establish citizen stewardship program to help inventory habitat and work with landowners and agency people to enhance habitat	Ensure that all construction and maintenance projects for structures (e.g., breakwalls, piers) address secondary benefits of incidental habitat
Economic Development for Sustainability	Establish watershed as unit for visioning, planning, and management for environmentally-sustainable economic development	Ensure full costs and benefits are assessed for each project in watershed	Ensure best management plan manuals incorporate economic and non-economic benefits and costs for affected parties	Governments should make greater use of economic instruments to achieve win-win solutions for environment and economy
Human Resource Development and Education	Perform strategic analysis of ecosystem messages and audience	Ensure strategic development of shared actions, with appropriate communications, evaluation, and follow-up	Ensure adequate education and human resource development on practical application of an ecosystem approach within governments	Use governmental outreach programs to show how an ecosystem approach can be used to establish a stewardship ethic among stakeholders

- 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. Review and feedback are also necessary to ensure progress, allow for mid-course corrections, and foster continuous learning.

In general, there is a need "to get on with the job" of watershed planning and management, and a pragmatic approach may be to start small (i.e., subwatershed level). 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. This should ensure that the ecological requirements of indigenous wildlife are being met. 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 or authorities in site planning and management. Once success has been achieved, that positive experience can serve as the building block to further successes.

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. Further 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, which do not always factor in the assimilative capacity or sensitivity of the environment or the ecosystem surrounding each facility, are imposed on the regulated community. 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.

An 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.

Table 1 presents examples of selected practical steps to implement an ecosystem approach for point source pollution. 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 of LCA results in both environmental improvements and economic benefits for industries (Richards and Forsch 1994).

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 (Allenby and Cooper 1994). 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 Associated with the Land-Water Interface

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.

In general, an overall nonpoint source goal would be 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. An essential step in the process is to adopt the watershed or catchment as the primary unit for planning and management (Table 1). 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 among 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 (Table 1). 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.

Transportation

The goal of transportation management is to meet the needs of all community members for affordable and efficient mobility and a clean environment. Overdependence on automobiles as the predominant mode of transportation, continually fuelled 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 modes 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.

In general, society is being impacted by the effects of poor and/or unduly narrow planning. Major problems include: a lack of transportation options (i.e., limited transportation modes); congestion; expansion and urban sprawl; oversubsidization of the automobile, fuel, roads, *etc.*, and deficit financing; threats to national security that result from an 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.*,); 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.

The result 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 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, 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 to automobile dependancy include a balanced intermodal mix of walking, biking and public transit. 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. Practical steps to implement an ecosystem approach in the transportation sector will range from strategic efforts that provide a comprehensive and systematic approach, to short-term pragmatic actions that modify and improve existing transportation systems, which benefit the environment (Table 1). One method of moving forward on urban transportation issues is 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 that identifies 3-4 elements, which affect the average person and can be relatively easily implemented 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 Management

In the Great Lakes basin ecosystem there is a long history of managing a salmon and trout recreational fishery with estimated annual economic benefits of $2 to 4 billion (Talhelm 1988). Despite this long history, a number of challenges remain. These include: achieving self-sustaining populations; restoring native species; addressing species invasions; reducing toxic substances contamination; and rehabilitating habitat.

Selected examples of practical steps to implement an ecosystem approach in fishery management are presented in Table 1. Issues that should be addressed in conjunction with implementing these practical steps 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.

Applying an ecosystem approach in fishery management will require extensive linkages among different programs and sectors. 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 pre-

sented above. Specifically, the GLFC (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 GLFC and the 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, lakewide management plans (LAMPs), and RAPs necessary to achieve ecosystem-based management and help implement some of the practical steps (Table 1).

Habitat Management

One of the major challenges in the area of habitat management is finding it an acceptable "home." Physical habitat rarely receives 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 fish and wildlife 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, in some instances it can also translate into a lost 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.

In general, higher priority should be given to soft engineering alternatives to achieve better outcomes for habitat and economic development and, to maximize future options.

Greater emphasis needs to be placed on "piggy backing" habitat protection and rehabilitation with other local planning and development initiatives; for example, communities can capitalize on the opportunity of waterfront redevelopment to ensure that habitat gets incorporated into master plans. 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). Practical steps to implement an ecosystem approach in the area of habitat management (Table 1), 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).

The current challenge is how to achieve environmentally sustainable economic development in a practical and meaningful way. Certain short-term actions can be taken to help link explicitly environment and economy, and to achieve win-win outcomes (Table 1). 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.

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 that nurtures multiple perspectives. 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.

Resources must be devoted to both develop a strong stewardship ethic throughout society and to develop the human resources, in all sectoral planning and management initiatives, to better understand and use an ecosystem approach (Table 1). The

key message is to achieve communication and education by involving stakeholders, since no one person or agency 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).

CONCLUDING REMARKS

An ecosystem approach is not a new concept, however, its application in management is. An ecosystem approach is not only a way of doing things, but also a way of thinking. 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. At present, narrow agency mandates continue to be a major obstacle to implementing ecosystem-based management. Further progress in ecosystem-based management and its goal of sustainability will require providing clear authority, building of "true partnerships," and implementing practical steps in a continuous improvement fashion (Hartig *et al.* 1998). Table 2 presents a list of critical elements to help managers incorporate an ecosystem approach in management.

Some people have argued that an ecosystem approach provides an excuse to consider everything and solve nothing. Because an ecosystem approach should account for the interrelationships among land, air, water, and all living things, and integrate societal, economic, and environmental concerns, there may be a tendency to be too broad and not focus specifically on obvious, high priority, envi-

TABLE 2. A list of critical elements to help managers guide efforts toward incorporating an ecosystem approach in management (U.S. Environmental Protection Agency and Environment Canada 1995).

- Adopt watershed/bioregion as primary unit for management
- Develop partnership agreement or other mechanism for cooperative, multi-stakeholder management and ensure commitment of leaders
- Identify and empower an "umbrella" watershed organization for coordination
- Develop long-term vision, goals, and quantitative targets for "desired future state" of ecosystem
- Reach agreement on a set of principles to guide decision-making process
- Ensure all planning processes in watershed acknowledge vision, goals, quantitative targets, and principles
- Establish geographical information system (GIS) and decision support system capability in watershed organization
- Compile data and information for input into GIS and ensure strong commitment to research and monitoring to understand 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 (i.e., economic, societal, environmental) are assessed for each project in watershed
- Consolidate capital budgets and pool resources, as necessary, 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, state-of-the-environment and economy reporting every 2-5 years to measure and celebrate progress, and to measure stakeholder satisfaction
- Ensure commitment to broad-based, ecosystem education and human resource development throughout process

ronmental problems. In addition, application of ecosystem-based management has been resisted as a result of vagueness surrounding terms and concepts in ecological theory, as well as an inability to articulate specific action steps, in an incremental fashion. Despite these problems, there are numerous practical steps that can be taken immediately to implement an ecosystem approach in Great Lakes management (Table 1). Additional practical steps need to be identified and continued emphasis should be placed on learning from different experiences in implementing ecosystem approaches. The 42 locally-designed ecosystem approaches being used in Great Lakes RAPs and the lake-specific ecosystem approaches being used in LAMPs serve as laboratories for practical application of 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).

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