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Development of a Great Lakes-St. Lawrence Ecosystem Model Framework

Council of Great Lakes Research Managers

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COUNCIL OF GREAT LAKES RESEARCH MANAGERS
REPORT TO THE INTERNATIONAL JOINT COMMISSION

International Joint Commission
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Development of a Great Lakes - St. Lawrence Ecosystem Model Framework

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International Joint Commission by

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In 1978, the Governments of Canada and the United States signed a new Great Lakes Water Quality Agreement, in which they agreed to manage uses of the basin using an ecosystem approach. The approach recognizes all possible interactions within the environment that could affect water quality and Great Lakes biota. At first, the ecosystem approach seemed to offer a simplified way to manage the Great Lakes basin, because defining the ecosystem would provide the theory necessary for decision-makers to understand the system. Management decisions thus would be rational and results predictable.

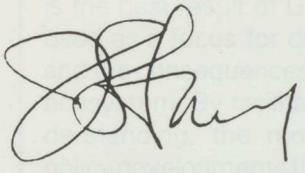
The health of the ecosystem responds to the aggregate of both the anthropogenic and natural influences. Humans are recognized as part of the system, and their economic activity affects and is impacted by water quality. Biota is influenced by nutrients and toxic chemicals, but it also alters fluxes, sedimentation, water quality and chemicals. Banning of toxics such as DDT and PCBs resulted in an initial decline in loadings and burdens in biota. But now, trends in the concentrations have stabilized as a result of long-range transport of contaminants from outside of the Great Lakes basin.

These complex, multivariate ecosystems are simultaneously exposed to a multitude of stresses, mechanisms and cumulative effects, which are poorly understood. Thus, it is unlikely that successful management of the Great Lakes basin, or achieving broad environmental and socio-economic objectives, is possible without substantially broadening the environmental assessment framework to encompass top-down ecosystem management objectives.

The challenge facing the Great Lakes research community is to develop a conceptual framework that includes all components of the ecosystem but which can still be understood. The Council of Great Lakes Research Managers concluded that a single model would not meet both criteria; instead, submodels are required to build the necessary foundation for a conceptual framework.

To make the model understandable and for all pieces to fit, it must include social and natural science specialists who are experts on the various ecosystem components, and thus can provide definitive information. As a group, they can translate the ecosystem model into understandable language for decision-makers to use in and implementing various management strategies for the Great Lakes ecosystem.

The conceptual framework outlined in this workshop report can be developed into an operational network that can provide a logical focus for coordinated analysis of important policy issues spanning many sectors in the basin.



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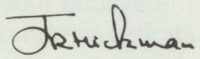

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Canadian Cochair

This report documents the work of a task group formed by the Council of Great Lakes Research Managers under the auspices of the International Joint Commission (IJC) to develop a Great Lakes-St. Lawrence Ecosystem Model (GLSLEM).

The development of an ecosystem model for the Great Lakes basin was one of many recommendations from a futures workshop sponsored by the IJC through the Council (IJC 1990). Although the need for an ecosystem model as a focus for interdisciplinary communication and cooperation was emphasized by workshop participants, there was uncertainty about what type of model should be built. The notion of an ecosystem model conjures up visions of a detailed, complex and comprehensive structure and past experiences with such models have often been disappointing. Alternate forms of the GLSLEM, however, could include a set of models that are tightly integrated, a formal process for model development, or a set of conventions for model development that facilitate later integration.

In spring 1990, the Council formed a steering committee (Appendix II) to:

- develop the concept of a Great Lakes-St. Lawrence Basin Ecosystem Model to a sufficient level of detail for implementation planning to proceed;
- prepare a consensus statement of goals, objectives and intended uses of the model, recognizing that model development and utilization will overlap during the long-term implementation phase; and
- prepare recommendations and an action plan for the Council to implement the model.

The first two objectives were met through a three-day workshop December 4-6, 1990 in Milwaukee, Wisconsin which brought together a variety of experts and decision-makers from across the Great Lakes basin (Appendix IV).

The GLSLEM concept that emerged from the workshop is not a single large model, but a series of "issue based" models. By focusing modelling efforts on selected policy questions, the GLSLEM can be more relevant to policies that promote sustainable development in the basin and more likely to succeed by not attempting to "model the world."

To facilitate development of the GLSLEM, a process to create issue-based models is recommended. Important features of this process include:

- initial scoping of policy questions to include linkages within the ecosystem that extend beyond the traditional bounds of agencies responsible for policy analysis;
- formation of flexible task groups from a consortium of existing agencies and institutions within the Great Lakes basin;
- an emphasis on the use of GLSLEM models as tools for learning by all parties (researchers, policy analysts, decision-makers, the public) concerned with the health of the ecosystem; and
- the use of policy exercise workshops as forums to involve a broad range of participants for mutual learning and discourse.

Learning that results from model development and use is the best result of GLSLEM models, as they can can be used as a focus for dialogue about ecosystem dynamics and the consequences of various human actions within the ecosystem. By facilitating communication and mutual understanding, the models also support a shift toward policy developments that are increasingly based on consensus and participation.

An intriguing use of the GLSLEM framework is its potential to facilitate discourse about human values which, combined with our view of the world, determine human behaviour in the ecosystem. The increased understanding, interdisciplinary/multi-user collaboration and mutual education the GLSLEM initiative provides are essential to implementation of the ecosystem approach.

The authors of this report would like to thank the participants of the Milwaukee workshop, where much of the material in this document was developed. Without their participation and commitment, the ideas expressed in the following pages would not have been formulated. The scholarship, candour and good humour of all who braved a severe winter storm to attend the workshop is acknowledged and appreciated.

We would like to express a special thank you to Peter Seidl and Ken Minns, who organized the workshop and were supportive of our needs and understood our frustrations. Their assistance, guidance and support was invaluable and greatly appreciated. We would also like to thank the members of the Project Technical Advisory Committee for their ideas and contributions to the project.

Finally, we would like to thank Pille Bunnell for her invaluable effort and help in editing this document, and Gwen Eisler and Gillian Kell for their patience and careful control in the production of this report.

1.0 Introduction

In September 1989 the Council of Great Lakes Research Managers (CGLRM) held a Futures Workshop "to establish a framework for future natural and social science research in the Great Lakes basin" (IJC 1990). Among the recommendations that emerged from the meeting was the recognized need to place a greater emphasis on transdisciplinary and interdisciplinary work that address linkages between areas of research that traditionally have proceeded largely in isolation. Establishing linkages between major areas of research (for example between economic, social and ecological components of the Great Lakes Basin Ecosystem) was recognized by workshop participants as essential to develop holistic policy analyses that respond effectively to growing demands on the Great Lakes Basin Ecosystem. Participants thus recommended the development of a Great Lakes-St. Lawrence Ecosystem Model (GLSLEM) at another workshop to scope the building process and develop a detailed implementation plan for consideration and action by the Council.

The Council endorsed the idea of developing a Great Lakes Basin Ecosystem model and established a Steering Committee (see Appendix II) in early 1990 to further develop the concept. Such a model could:

1. help research managers anticipate issues in a binational collaborative manner, to and identify research priorities and data gaps;

2. provide a detailed technical framework to develop and evaluate a broad range of policy options for issues affecting the basin; and

3. implement the ecosystem approach and assess ecosystem integrity in the widest sense.

Several major features of the proposed model also were discussed at the Futures Workshop, for example, it should:

- build from a conceptual base;
- be integrative and issue driven;
- be verifiable;
- provide a much needed structure for organizing data bases;
- make data bases more accessible to the research and decision-making community;
- support state of the environment reporting;
- be capable of tying together submodels that could be revised as new knowledge is gained; and
- be adaptable to address emerging issues.

Participants also felt that model development and the eventual use of the tool(s) developed will serve as a basis for communication and learning among different disciplines, including researchers, research managers, policymakers and the public.

Experienced modellers have little doubt that such a model can be built. However, a variety of opinions there exists on the form the model should take, e.g. whether it should be a single integrated model, a collection of models with a common protocol or framework for integration, or perhaps simply a convention for model development/policy analysis. As the model framework develops it will provide a focus to integrate and synthesize research on all components of the Great Lakes Basin Ecosystem. Many existing suites of models developed to investigate specific components of the Great Lakes basin system also may be adopted either directly or with some modification.

In spring 1990 a Technical Advisory Committee (TAC; see Appendix III) was established to organize the workshop and provide technical insight regarding the process needed to realize the GLSLEM model vision. To prepare for the workshop the TAC circulated a questionnaire to a select group of research managers and policymakers concerned with the Great Lakes-St. Lawrence basin. Information obtained was summarized in a briefing report distributed to all participants prior to the workshop.

One final note as a point of introduction. During the workshop, there was considerable discomfort with the word "model" as the major focus of this exercise. Many felt that "model" commonly refers to a technical *computer exercise* which, although useful, is only part of what is required from this initiative. We also need a model of the *process* required for integration of issues, information and actions. A process that includes stakeholder involvement, communication to a wider constituency, and incorporation of the human dimension in the exercise. Finally, it was agreed that the general use of the word "model" in this context refers to this process, which at some point includes the use of computer models. Thus, in this report the word "model," unless otherwise specified, follows this workshop agreement.

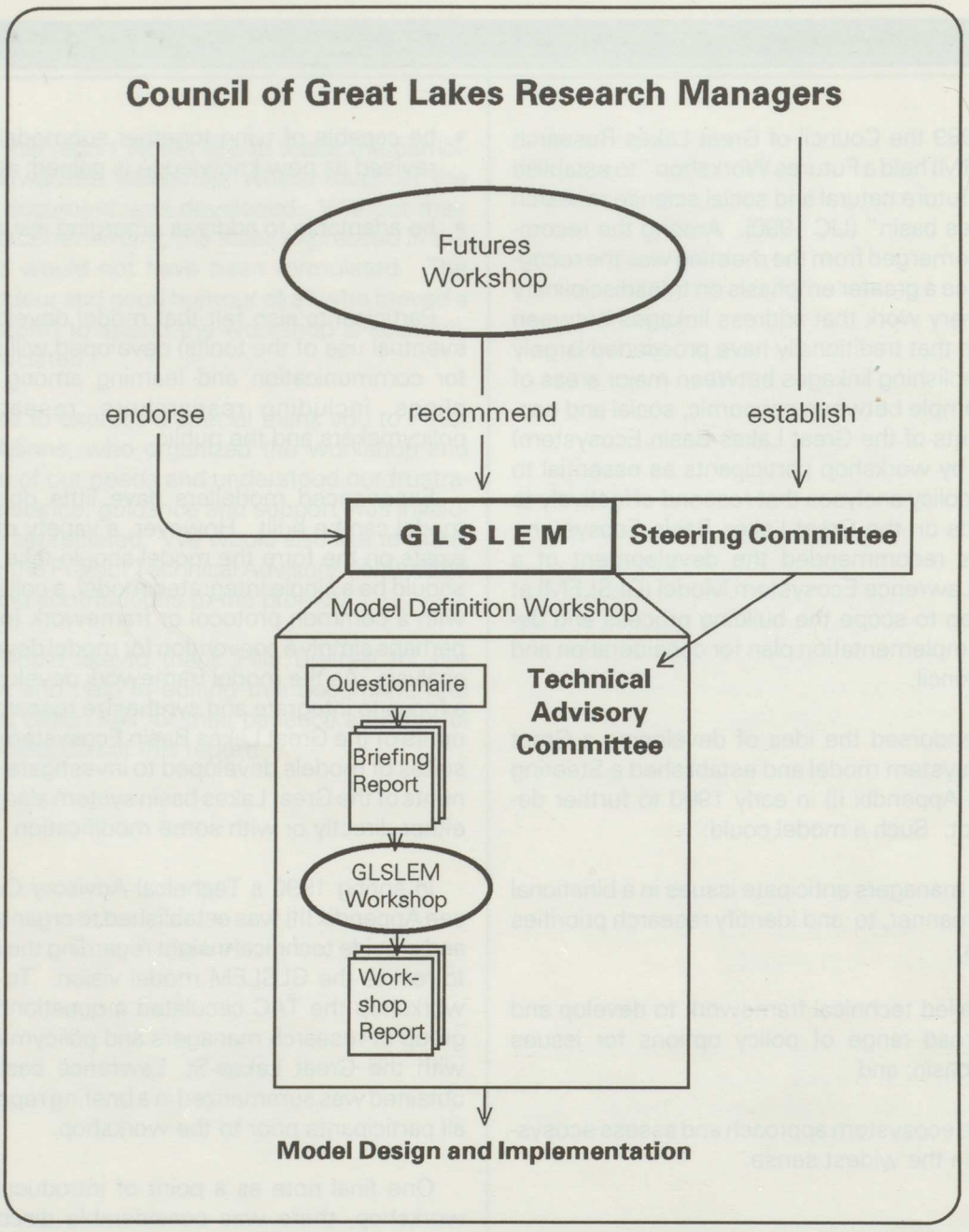


FIGURE 1. Overall organization of GLSLEM development process

2.1 Project Objectives

The objectives of the project are to:

1. Develop the concept of a Great Lakes-St. Lawrence Ecosystem Model (GLSLEM) to a sufficient level of detail for implementation planning to proceed;

2. Prepare a consensus statement of the goals, objectives and intended uses of the model, recognizing that use of the model will begin before development is complete; and

3. Prepare a set of recommendations and an action plan for the Council of Great Lakes Research Managers to implement the model.

The December workshop, on which this report is based, was the primary mechanism for completing the first two objectives. The expectation from the Futures Workshop was that development of the GLSLEM would proceed over the next decade, leading to a working model by the year 2000. Consequently, this report represents only the first steps in development of the GLSLEM framework.

2.2 Approach

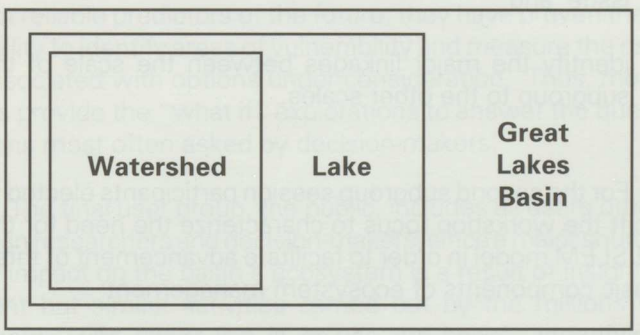
To meet the above objectives, a two-step process was implemented. The first step involved the distribution and completion of a short questionnaire designed to define an initial scope of the GLSLEM model. This questionnaire was prepared and sent by the TAC to experts in the ecological, social and economic aspects of the basin. The questionnaire solicited their thoughts on what issues need to be addressed by the GLSLEM model, the types of analyses the model should support, some detail with respect to the valued ecosystem components, and the spatial and temporal scales that the model should address.

The second step was the three-day workshop. Many respondents to the questionnaire were invited to the workshop, and despite the best efforts of a severe winter snowstorm to delay the opening session, most invitees attended some or all of the workshop. The final workshop agenda evolved from the original design and is summarized in Table 1. The most significant insights and focused debate occurred during the two sessions dedicated to subgroup discussions (Figure 2).

TABLE 1 Workshop agenda

December 4	PM	Opening Statement/Introduction • Review of Conceptual Model Evening Subgroup Session #1 - Issues at selected Partial Scales • Watershed • Great Lakes • Great Lakes/Basinwide
December 5	AM	Subgroup Session #1 (continued)
	PM	Presentations Subgroup Session #2 - Need of Principal Users • Research • Policy • Ethics
December 6	AM	Subgroup Session #2 (continued)
	PM	Subgroup Presentations Workshop Wrapup

Subgroup Session 1: ISSUES



Subgroup Session 2: USERS

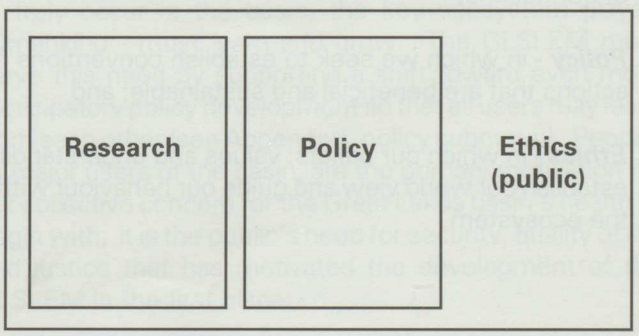


FIGURE 2. Subgroup organization for workshop sessions

The first subgroup session focused on the issues that emerge at one of three spatial scales:

1. ***Watershed Scale*** - issues operating at the scale of an individual river or small lake, which makes up a small part of the Great Lakes basin. Collectively, these hundreds of watersheds compose the Great Lakes basin;

2. ***Great Lake Scale*** - issues operating at the scale of one of the Great Lakes. No single community dramatically affects this scale; rather, this scale is affected by the accumulation of inputs from a large number of communities/watersheds around the Great Lake; and

3. ***Great Lakes Basin scale*** - issues operating at the scale of the Great Lakes basin shared by the Provinces and States in Canada and the United States. This scale encompasses the largest scale concerns faced by a large region of North America.

The major charges to these subgroup discussions were to:

- identify the key issues operating at the relevant scale;
- describe the main indicators to measure the condition of the issue;
- discuss the key actors in the basin for each issue;
- recommend some high priority actions to resolve the issue; and
- identify the major linkages between the scale of the subgroup to the other scales.

For the second subgroup session participants elected to shift the workshop focus to characterize the need for the GLSLEM model in order to facilitate advancement of three basic components of ecosystem management:

1. ***Research*** - in which we seek to better understand ecosystem structure and process, and the consequences of our actions;

2. ***Policy*** - in which we seek to establish conventions for actions that are beneficial and sustainable; and

3. ***Ethics*** - in which our beliefs, values and understanding establish our world view and guide our behaviour within the ecosystem.

As mentioned previously, much of the workshop was spent in subgroup discussions, which are summarized in short reports in Appendix I. This section distills the main ideas from these discussions however, aspects considered important by one or more participants surely have been omitted from this overview. Therefore, we encourage the reader to review the subgroup reports and particularly those from the second subgroup sessions (research, policy and ethics.

The following synthesis is organized under five topics related to the GLSLEM initiative: purpose, users, process, structure, and modelling and ethics.

3.1 Model Purpose

Each organization has a specific set of issues it feels is paramount and in need of attention when developing a model for the Great Lakes region; to expect some as yet unspecified tool to address all issues is a daunting task. However, one common element in all workshop discussions was that the model should help to identify how we, as a society, can obtain sustainable development in the basin. In other words, the primary purpose of the GLSLEM is to help analysts, planners, policymakers and concerned citizens develop ways in which humans can alter their activities to provide a dynamic harmony between those activities and the ecological processes operating in and around the basin.

More generally, the GLSLEM should support the development and evaluation of management and policy in the basin. Thus, the model should contribute to the educational and communicational aspects of policy formulation and implementation processes, including the information needs to complete research. Ultimately, the GLSLEM must support learning at all levels: schools, communities, government agencies, industry and politics at all levels, and thus the purpose of the model is to assist society in understanding the need and mechanisms for change.

3.2 Model Users

If we agree that the primary purpose of the model is to support learning, the next question is, "who are the learners?". In a very practical sense, identifying a primary user of the GLSLEM could aid in securing funding and increase commitment to its development by establishing a sense of ownership. However, no single agency or user group emerged from our discussions; rather three major groups emerged as essential users for such a tool: the science community, decision-makers, and the public.

The science community can benefit from a process that helps to determine major areas of uncertainty associated with evaluating or implementing social objectives such as security or quality of life in the basin. In order to create a sustainable society in the Great Lakes basin, science must improve understanding of the key ecological processes that bring about change, and how human activities affect those processes. Development of and experimentation with an ecosystem model is a proven method to identify research and monitoring needs for policy decisions (i.e. wetland habitat, persistent toxic substances input).

In one sense, the term decision-makers encompasses all of us, since we each make decisions every day that ultimately affect some aspect of the quality of life in the basin, albeit in most cases with little consequence. In the context of the GLSLEM, the decision-maker user group refers specifically to those individuals who are responsible for the developing, evaluating and implementing policy in the basin. These individuals range from community to international policymakers in public and private sectors, yet are often seeking answers to similar questions. The relevant scale of concern for these questions may differ among decision-makers depending on their level (e.g. community vs international). In order to answer questions facing decision-makers, a mechanism to experiment with options available to them is needed. Although models are not reliable predictors of the future, they have proven their ability to identify areas of vulnerability and measure the risk associated with options under consideration. Thus, models provide the "what if" explorations to answer the questions most often asked by decision-makers.

The final user group, the public, includes all users other than researchers and decision-makers, since a major source of impact on the basin's ecosystem is a result of insignificant but similar activities carried out by the millions of people who either live in or use the basin. Identifying "people" as major users of the model also recognizes the human dimension of the ecosystem approach; for change to truly occur in the basin, the key ecosystem player, humankind - must learn and grow. The GLSLEM must serve this need by supporting a shift toward even more participatory policy development so that all users may learn from each other (see Appendix I, policy subgroup). People, as major users of the basin, are the primary motivation for our collective concern for the Great Lakes basin's health to begin with; it is the public's need for security, quality of life and justice that has motivated the development of the GLSLEM in the first place.

3.3 Modelling Process

Over the past 20 years, computer modelling has been used for a wide range of resource management problems. Probably the most important lesson that has emerged is that the process of building the model is as important, if not more important, than the model itself. If you want different groups to use the model and its results in their planning, they must contribute to the model building process. One of the most effective means to accomplish this is through the use of workshops, during which expertise and interests from a range of concerned organizations collectively contribute to model articulation and establish mutually acceptable programs to test and refine the model. Interspersed with periods of scientific research to address key uncertainties, this process enables the modelling approach to meet its mandate.

One group that needs to be included in the model development process is the diverse, and often large, constituency of concerned citizens who ultimately must use some results of the analysis. In the past this group has not been included thoroughly, but they can be included through communication techniques such as interactive television, public workshops, questionnaires, videos, newsletters and interviews. Researchers are experimenting with approaches and tools to include such a large and diverse group in processes that encompasses technical and value-laden aspects, and clearly the GLSLEM building process meet this requirement. The development of the GLSLEM, under the umbrella of the IJC, offers an exciting opportunity to design, test and implement effective new methods that build a commitment to environmental excellence and ethics in a large and diverse public.

In the past, modelling experts too often developed the analytic tools and analyses in isolation, and left it up to the policymakers to determine whether the result was relevant to their problems. In the last decade, this exclusive approach has plagued modellers and, as a result, considerable effort has been directed to developing suitable procedures to incorporate the needs and insights of those concerned with policy. One interesting new development is the use of policy exercises, or workshop-style events, at which policymakers, scientists, citizens and communicators work together to integrate a wide range of quantitative and qualitative input into scenarios describing possible rather than predicted futures. By creatively synthesizing model building and analyses with the perspectives of key policymakers, a whole new set of options for change may evolve.

Finally, a necessary condition for ultimate success in the modelling process is the need for continual adaptation. New participants become involved over time, and new information and insight will change the model framework, content and process. Attempts to capture the scientific, social and institutional complexity of the Great Lakes basin will forever deal with the challenge of reaching decisions under great uncertainty since such systems are inherently unpredictable. Recent advances in the study of complex system behaviour (e.g. chaos theory) have demonstrated that the objective of predictability is unreachable. Rather, what is useful is a well-structured and adaptive process that facilitates continual monitoring, research and analysis, interspersed with periods of action, to continually refine current understanding as the model is developed and used. All activities should involve the various users; as understanding of the dynamics of the user community evolves, the model building/use process will also evolve. Hopefully, the process will be resilient so that inevitable surprises are manageable and do not generate catastrophic results. Therefore the modelling process should identify where the system is vulnerable to a set of possible events, rather than attempt to predict the occurrence of the events.

Coordination is needed to initiate and maintain such a process, including defining what steps and responsibilities exist. A conceptual model of the process was identified during the workshop and is illustrated in Figure 3 (see also Appendix I, research subgroup).

This conceptual model recognizes the GLSLEM as a collection of "issue based" models rather than a single, comprehensive model and includes a secretariat to provide a coordinating function in model scoping and development. An explicit objective of the model scoping process is to expand the traditional scope of analysis to include a broad set of ecosystem linkages. Models developed under this process would be designed to support learning and policy development through use in policy exercises that involve a broad spectrum of participants. Public involvement would be especially useful at the scoping and policy exercise steps. Over time, individual models developed through this process could be linked together to provide a more comprehensive overview of ecosystem interactions and result in an extended or generalized or generalized process model that increases participation of all user groups. This process model would form the basis for periodic review and adaptation as referred to previously.

As part of this process, institutional support and constituent responsibilities must be defined. Responsibility for the overall process would be through the formation of a GLSLEM Steering Committee. In the long term, a permanent facility or centre would foster continuity in the model development and use process.

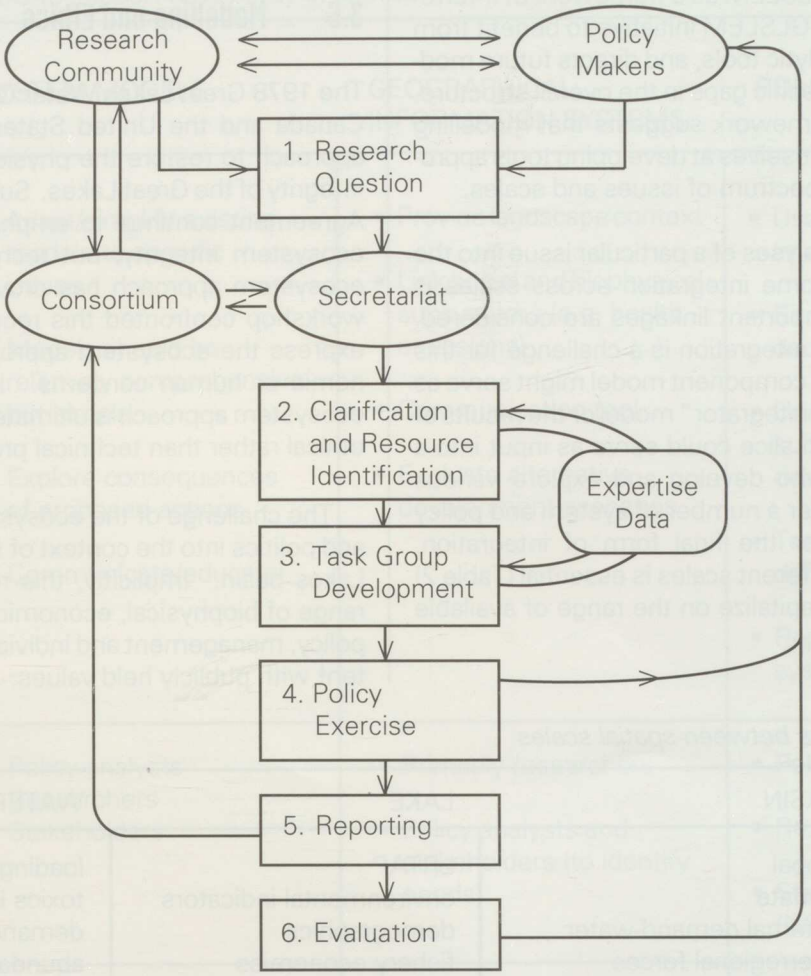


FIGURE 3. A process for developing a GLSLEM

3.4 Model Structure

The Great Lakes basin covers approximately 765,990 km^2 (295,749 mi^2) and is home to almost 40 million people. Issues that affect human and resource health range from local phenomena affecting individuals (e.g. a family living along the shores of a river during a severe flood) to the large-scale, pervasive events that affect large numbers of basin residents (e.g. impacts of climate change on overall agriculture production). Thus, questions asked by residents and users of the ecosystem and the learning required by the same population, operate at a variety of scales. Basinwide management affects local decisions and, in turn, local actions are taken using a basinwide context.

Many questions also encompass physical, biological and social concerns. Linkages between the ecological system we wish to protect, the economic system supporting the welfare of the resident human population, and the institutional system structured to facilitate human control over these systems thus must be understood in order to consider the effects of people on the environment and the effects of the environment on people.

These considerations have important implications for the structure of the model or set of models developed to address questions of concern. The model must accommodate a range of scales from short-term and local to long-term and basinwide, it must represent ecological, economic and social issues, and must capture the wide variety of feedbacks between sectors, time and distance in the system.

The GLSLEM cannot become a "white elephant" story, like so many past attempts to build models intended to be all things to all people. Many lessons can be learned from past grand modelling schemes and one is to avoid building a single computer tool that addresses all scales simultaneously. A more effective approach is to develop a number of models, each of which is designed to address a set of problems at a specified scale, and integrate these in an overall framework. The conclusion that the model should not be a single, all-inclusive model but rather a framework of interrelated, issue based models was a consistent theme in workshop discussions (Appendix I). Parts of the GLSLEM may be either or both human and computer based linkages among the set of models.

This concept of the GLSLEM as a framework of interrelated models allows the GLSLEM initiative to benefit from existing models and analytic tools, and directs future modelling efforts to filling specific gaps in the overall structure. Experience with this framework suggests that modelling efforts should direct themselves at developing tools appropriate to addressing a spectrum of issues and scales.

To incorporate the analyses of a particular issue into the GLSLEM framework, some integration across scales is needed to ensure all important linkages are considered. How to accomplish this integration is a challenge for this GLSLEM initiative. Each component model might serve as input into some form of "integrator" model or the results of the analyses within each slice could serve as input into a workshop of experts who develop and explore various "futures" scenarios under a number of system and policy assumptions. Whatever the final form of integration, linkages between the different scales is essential (Table 2) and the process must capitalize on the range of available tools (Table 3).

3.5 Modelling and Ethics

The 1978 Great Lakes Water Quality Agreement between Canada and the United States called for an ecosystem approach to restore the physical, chemical and biological integrity of the Great Lakes. Subsequent extensions of the Agreement continue to emphasize the goal of restoring ecosystem integrity, but technical interpretation of the ecosystem approach has proven illusive. The GLSLEM workshop confronted this recurring issue and sought to express the ecosystem approach in terms of socio-economic or human concerns. It was suggested that the ecosystem approach is ultimately a world view and thus an ethical rather than technical problem.

The challenge of the ecosystem approach is to fit lakes and politics into the context of the ecosystem of the Great Lakes basin. Implicitly, this requires actions on a wide range of biophysical, economic and social issues to make policy, management and individual behaviour more consistent with publicly held values.

TABLE 2 Major linkages between spatial scales

	BASIN	LAKE	WATERSHED
BASIN	global climate external demand-water interregional forces international regulations trade patterns LRTAP - global	LRTAP environmental indicators demographics fishery economics	loadings toxics in other areas demand for land use abundance of land types population growth
LAKE	toxics in Areas of Concern bioaccumulation rates regulations change in land use water consumption	shoreline use	habitat inventory
WATERSHED	Areas of Concern - RAPs toxic-materials generated generated bioaccumulation episodes outbreaks species decline regulations education local agreements industrial infrastructure demographics	point, nonpoint loads/inputs environmental indicators fish quota harvesting	

LRTAP = Long Range Toxic Air Pollutants

TABLE 3 Examples of tools to support new policy initiatives

	SYSTEM MODELS	GEOGRAPHICAL INFORMATION SYSTEMS	POLICY GAMING
APPLICATION	• Adapt/simplify existing models to specific issues • Models should be relatively comprehensive but simple • Explore consequences of proposed actions • Communicate/educate	• Provide landscape context • Link social and biophysical subsystems (e.g. health - emissions) • Communication tool • Evaluate alternative development scenarios	• Uses other tools for support (models, G.I.S.) • Simulate different modes of decision-making • Understand effects of subjectivity in policy development • Test strategies under different scenarios • Represent institutional system dynamics
INVOLVEMENT IN DEVELOPMENT	• Policy analysts • Researchers • Stakeholders	• Primarily researchers • Policy analysts and stakeholders (to identify needs)	• Policy analysts • Researchers • Stakeholders (NGO and industry)
INVOLVEMENT IN USE	• Agency heads • Politicians • Public education • Policy analysts • Researchers • Stakeholders	• Research • Policy analysts • Stakeholders	• Policy analysts • Researchers • Stakeholders (NGO and industry)
RESEARCH NEEDS	• How to communicate uncertainty	• Links to simulation models for use in forecasting effects	• Experimental development through application to current issues

NGO = Non-Government Organization

Viewing the ecosystem approach as an ethical challenge is an advantage in that social and economic aspects of human society may be more easily linked by an examination of fundamental values. If we assume that all individuals residing in the Great Lakes basin ultimately share some core values, would seem reasonable to claim that life in a sustainable ecosystem is the most primitive value and that it is implemented through values of security, quality of life, compassion and justice. Many layers of instrumental values ultimately implement the core values and beliefs about the nature of the world, i.e. world view, and decisions about actions affecting ecosystems derive from an interaction of knowledge and values. Conflicts that arise due to different interpretations of knowledge and values often involve notions such as justice, equity and stewardship, and they may represent fundamental disagreement about the preference for various tradeoffs (Figure 4).

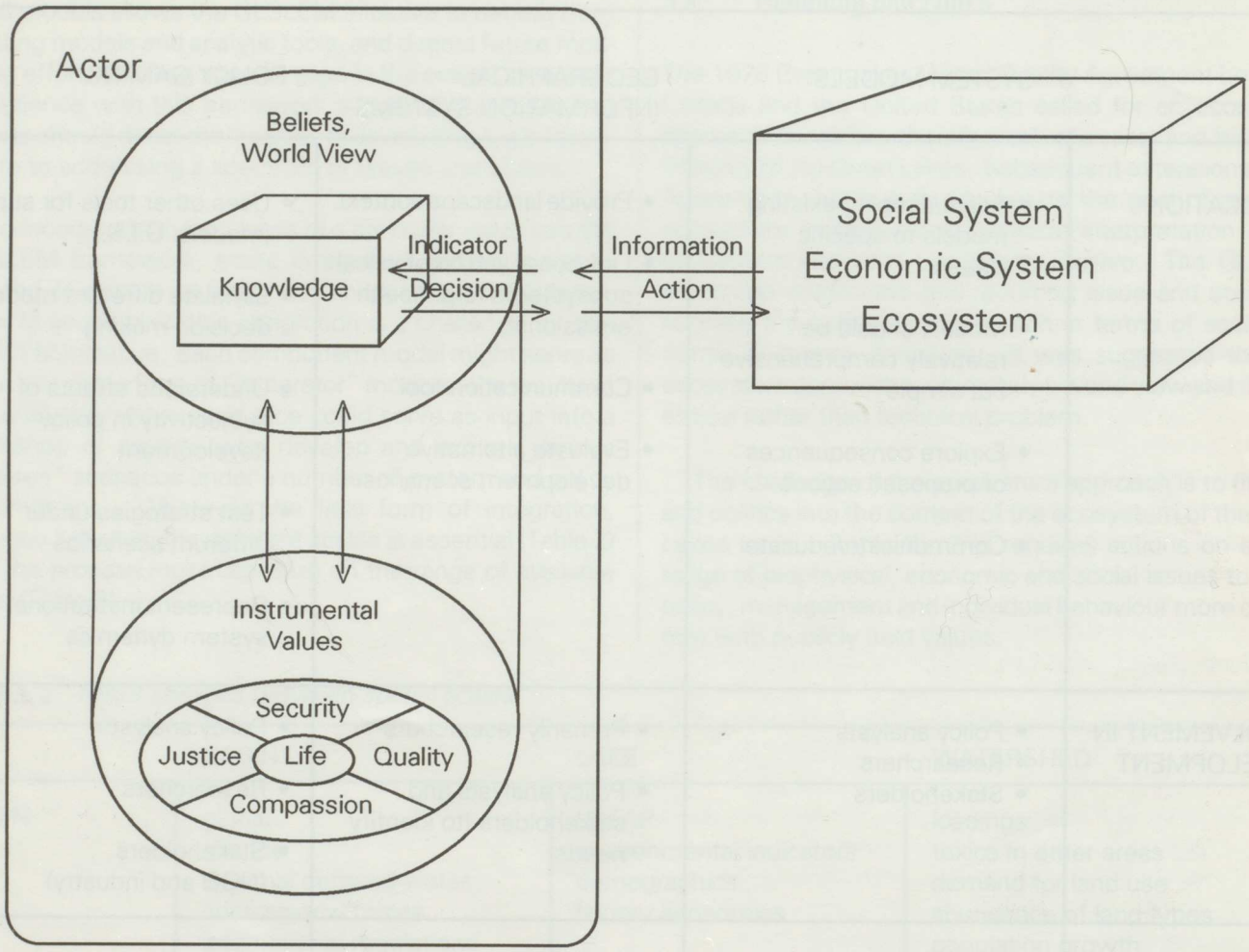


FIGURE 4. Relationships between values, beliefs and knowledge, and the social, economic and ecological systems

Policy choices are always the result of some analysis of tradeoffs in benefits and costs or risks of adverse consequences of decisions. This tradeoff character of decisions is not always formal, but may be nearly universal in making rational choices. Models provide a way to formalize tradeoff analysis and make it more objective. If policy choices are value laden, however, economic and ecological analysis of the consequences of policy choices may not capture fundamental concerns and world views. One way out of this dilemma might be to use models developed within the GLSLEM framework as an aid to discuss values and view the human dimension of the ecosystem approach as a process to learn and clarify values.

4.0 Council of Great Lakes Research Managers Recommendations

The following recommendations are a result of workshop discussions and subgroup reports.

4.1 Model Purpose and Users

Policy and Management Support

Design GLSLEM analysis to help decision-makers assess the implications of policy and management changes being considered in the basin.

Build Model Process to Expand Policy Analysis

Building the systems models for major basin issues should facilitate policy analysis and analyze initiatives according to their effect on the ecosystem.

Interdisciplinary and Intersector Research

The GLSLEM analysis and process must stress the need for interdisciplinary research to develop new working relationships among all the relevant disciplines and sectors.

4.2 Developing and Supporting GLSLEM

Short Term: IJC and CGLRM Cooperative Framework

Initiatives from the GLSLEM project can be pursued through a cooperative research/development framework that stresses the connections between research and decision-making and fosters the ecosystem approach to studying and managing uses of the basin system.

Immediate Pilot Application

A systems model approach should be applied as soon as possible to at least one major issue in the basin to test and evaluate the concept.

4.3 Framework Structure

Ecosystem Approach

The ecosystem approach should be explicit in the GLSLEM structure and should integrate all relevant disciplines.

Integrated Modelling

The GLSLEM framework should be developed as an integrated set of relatively simple, issue-based models that incorporate dominant ecological processes and link subsystems of the Great Lakes Basin Ecosystem. This set of models must address issues at the watershed, Great Lake and basin spatial scales.

Innovative Use of Existing Data and Models

The process must foster more innovative and efficient use of existing data and models. Much data and expertise to address some of the pressing issues is already in place; a commitment to cooperation and integration is needed.

4.4 Modelling and Ethics

The process should include examination of social and economic effects, socio-economic resilience and vulnerability, and should support learning and educational outreach initiatives.

5.0 Reference Cited

International Joint Commission, 1990. *Great Lakes 2000: Building a Vision.* The report of the Council of Great Lakes Research Managers Futures Workshop. September 20-22, 1989, Niagara-on-the-Lake. Prepared by the Rawson Academy of Aquatic Science, Ottawa, Ontario.

FIRST SUBGROUP SESSIONS

1. Watershed Scale
2. Great Lake Scale
3. Great Lake Basin Scale

SECOND SUBGROUP SESSIONS

1. Research Users
2. Policy Users
3. People and Ethics

First Subgroup 1: Watershed Scale

Focus

The watershed group considered how a Great Lakes-St. Lawrence Ecosystem Model (GLSLEM) could be used to assess ecological issues at the scale of an individual watershed, or what is the most appropriate model to support analysis at this scale.

Issues

All ecological issues within the Great Lakes Basin Ecosystem are important at the watershed scale of resolution. Most important, however, are those ecological problems observed primarily at this scale (e.g. pollution, resource depletion). If unchecked, such problems may become issues at larger scales. Ecological issues at the watershed scale include:

- availability and quality of physical resources (water, air, soil);
- resilience and productivity of biotic resources (terrestrial and aquatic);
- effects of human activities on ecosystem components and processes;
- constraints and effects on humans in the watershed arising from ecosystem deterioration; and
- uncertainty about the effects of large scale processes (eg. changes in lake levels, population growth/movement, climate change) on ecosystem processes at the watershed scale.

At a watershed scale, issues associated with distribution of ecosystem components (chemicals, biota) become explicit and significant. Pollution that has led to the development of remedial action plans for locally degraded areas is a prime example while these efforts are site specific, common issues for many Areas of Concern include air and water quality, resource depletion, impaired use of resources and an inability for the local environment to repair itself.

Two key and highly interconnected issues become apparent at this scale:

1. Upstream/downstream equity, or the negative effects of ecologically damaging actions taken in one place may be exported downstream to be dealt with by other inhabitant, and
2. Insufficient local control of ecosystem degradation, due to inputs from other areas.

Thus, there appears to be a separation between the creation of a problem (effective control of inputs) and the responsibility for its resolution. This arises in part because agencies responsible for ecosystem protection often do not have interconnected policies and controls beyond their respective jurisdictions.

Actors

All levels of government (municipal, regional, state/province and federal) are involved in policies that affect the ecosystem at the watershed scale. As noted above, however, a key issue at this scale is the effectiveness of environmental policies formulated at larger spatial scales. Specific examples discussed by the group include policies concerning water quality, air quality, land use and ecosystem health. In essence, the problem is formulating policies that apply to large areas but for which effects are significantly different depending on local conditions (e.g. population density, rates of industrial activity). Examples include:

Water Quality

- regulation over large areas is the responsibility of state/provincial governments
- significant loadings internal to a watershed from municipal or point sources may require specific local management
- inputs from "upstream" may limit the effectiveness of local action

Air Quality

- essentially the same situation exists for air quality as for water quality except that external sources are often relatively more important and more difficult to assign cause

Land Use

- in the U.S. regulation is at the county level; in Canada, the province sets the overall rules which are then interpreted/implemented by municipalities
- problems arise from local market conditions/developers' initiatives in local areas that may be missed at the scale of provincial or county regulation

Ecosystem Health

- responsibility lies with state/provincial and federal governments
- Greater control might be achieved at the municipal level with the direct involvement of locally affected people who both cause and must live with the problems created

Linkages

The major linkages to other spatial scales needed to understand ecosystem issues at the watershed scale arise for three reasons:

1. To characterize inputs to or outputs from the watershed. Since the ecosystem is not "closed," information on watershed inputs is needed to understand the total loading of different stressors to the environment. For example, water quality data on inputs from nonlocal sources is needed from both the lake and basin scale to describe the mass balance of pollutants within the watershed.

2. To provide a context for interpretation. Information on the resource status (concentrations, rates of change) elsewhere in the basin may determine the significance of resource status within a local area. For example, assessing the significance of different patterns of land use within one watershed may depend on knowledge of the availability of different types of land types over a larger area.

3. To provide information on how larger scale processes may affect ecosystem dynamics at the watershed scale. Some processes such as climate change and lake level variations operate on larger spatial scales. Such processes, which may affect ecosystem dynamics within the watershed, reflect the cumulative effects of inputs or activities over large areas. Therefore, understanding potential changes in the ecosystem at the watershed scale requires information on the state of physical and biotic resources that operate at these larger scales.

Recommendations

Since problems with the quality and availability of physical resources are inherently site-specific, we concluded that a Great Lakes Basin Ecosystem model must address issues at this scale.

Watershed or site models that address specific issues and include key linkages to larger scale processes (e.g. lake levels, climate change, population growth) would be most useful. Preliminary examples of this type of model may be provided by work in support of various remedial action plans in the basin. Developing a "generic" watershed or RAP scale model that encapsulates the research process from different RAP areas could provide a valuable education and communications tool. Developing such a model also would provide a specific and focused opportunity to explore linkages between different spatial scales in the basin.

The utility of a Great Lakes-St. Lawrence basin scale model was also considered. To be useful, the model must simulate the state of resources at the watershed scale, and include an explicit spatial structure. The model must be linked to a geographic information system that could provide spatial detail for both modelling and presentation of results. Development of such a comprehensive model was considered infeasible at the present time.

First Subgroup 2: Great Lake Scale

Focus

This spatial scale includes a single Great Lake and its drainage basin. While the broad definition includes all aquatic and terrestrial areas and human activity in the drainage basin, group discussions generally focused on the Great Lake itself.

The charge to the subgroup was to identify important policy issues of a Great Lake basin, and to identify the following for each issue:

1. interested and affected individuals and institutions (actors);

2. information needs, focusing on information required from other spatial scales; and

3. actions/activities and indicators.

The actors include those who cause a particular issue, are involved in regulation or are affected by the issue. The information needs represent the interdependencies of the different scales of the Great Lakes-St. Lawrence basin. Actions/activities include what people do to create or resolve an issue and indicators show the response of the system to those actions or activities.

The discussions began with the identification of ecological goals for a Great Lake basin. The goals are not meant to be exhaustive, but rather to provide perspective on the issues of the basins of the Great Lakes, and to develop a Great Lakes-St. Lawrence ecosystem model or model framework (GLSLEM). The goals are as follows:

1. Restore and maintain of self-sustaining populations of healthy fish stocks suitable for unrestricted consumption by all members of the ecosystem.

2. Great Lakes that are drinkable, swimmable and accessible to humans.

3. Stable and balanced foods webs.

4. Maintained and sufficient habitat to sustain diversity in natural populations.

5. Fulfillment of the Great Lakes Water Quality Agreement goals and objectives (1987).

Issues

Nine issues were identified for a Great Lake basin that should be addressed by a GLSLEM:

1. Toxic contaminants
2. Indicators of ecosystem health
3. Environmental change
4. Exotic species
5. Goals of management
6. Fishing mortality
7. Impacts of energy options
8. Response of food webs to disturbance
9. Hydrology-climate change

Table 1 summarizes the issues identified at this scale and includes key actors, information needs, actions/activities, and indicators for each issue.

Recommendations

A model or modelling framework that addresses issues at the scale of a Great Lake basin needs to capture activities operating at the smaller spatial scales. It should also capture the interactions between each Great Lake. The ecosystem approach should be explicit in a GLSLEM and should integrate the different disciplines. It is expected and desired that a GLSLEM should trade off some detail and resolution for interdisciplinary breadth.

A model or modelling framework for the Great Lakes-St. Lawrence ecosystem should be used to integrate policy and research, and should provide policymakers with information to effectively assess policy options. The GLSLEM should be used to assess the implications for all disciplines and sectors in the basin, of a change in policy concerning an issue of the Great Lakes-St. Lawrence basin.

TABLE 1 Important issues at the scale of a single Great Lake
Included for each issue are major affected groups and institutions (actors), information needs, actions/activities and indicators.

ISSUE	ACTORS	LINKAGES	ACTION/ACTIVITY	INDICATORS
TOXIC CONTAMINANTS	• Consumers • Contaminators • Policymakers	• Point and nonpoint source loadings in watershed • Inplace contaminants in watershed	• Technology • Dredging • Effluent treatment	• Dissolved oxygen • pH • Body burdens • Potable water
INDICATORS OF ECOSYSTEM HEALTH	• Policymakers • Research community • Public • Nongovernmental organizations	• Indicators of health at all scales	• Development of indicators	• Human health • Sale of bottled water • Animal and plant diversity • Recreation
ENVIRONMENTAL CHANGE	• Research community • Policymakers • Public • Nongovernmental organizations	• Climate (global) • Demographics at all scales	• Legislation • Education	• Temperature • Air and water quality • Energy use • Human health
EXOTIC SPECIES	• Fisheries management • Utilities • Resource users	• Distribution and rate of spread at all scales • Global implications • Economic implications of introduction at all scales	• Shipping activity/ regulations • Diversions	• Change in trophic levels • Treatment costs • Change in species assemblage
FISHING MORTALITY	• Tourism • Recreation • Fisheries management • Aquaculture industry	• Economic development in basin • Commercial quotas in watershed • Harvest	• Allocation • Marketing • Harvesting • Stocking	• Catch per Unit Effort • Recruitment
IMPACTS OF ENERGY OPTIONS	• Utilities • Research and development • Industry • Public transportation	• Transportation demand • Climate (regional) • Demographics in whole basin • Water consumption	• Conservation strategies • Transportation • Recycling	• Global air quality • Energy development in watershed
RESPONSE OF FOOD WEB TO DISTURBANCE	• Ecologists • Nongovernmental organizations • Fisheries managers • Research community	• Pollution loadings at all scales • Harvesting at all scales	• Harvesting • Nutrient loading • Introduction of exotics • Habitat protection	• Predator/prey ratios • Diversity • Age structure • Production
HYDROLOGY/ CLIMATE CHANGE	• Transportation • Shoreline property owners • Utilities • Wetland research	• Records of lake levels and flows • Storm frequency • Climate (global)	• Diversions • Fossil fuel combustion • Impoundments	• Water levels • Air quality • Temperature
GOALS OF MANAGEMENT	• Resource users • Managers • Policymakers	• Lakewide management plans • RAPs	• Harvest restrictions • Enforcement • Effluent standards	• State of resources • State of human and ecosystem health

First Subgroup 3: Great Lakes Basin Scale

Focus

The charge to this subgroup was to examine issues at the scale of the Great Lakes basin. The subgroup set the spatial limits of the basin to include the surface water drainage basin of the Great Lakes and St. Lawrence River down to the freshwater/salt water interface near Quebec City. The subgroup discussed issues relevant to this spatial scale and for each issue examined who is most concerned about this issue, what valued ecosystem components were affected, what actions or measures required consideration for management or remediation, what information was required from other spatial scales to act on the issues, and what timeframe was appropriate for the issue.

During discussion, participants in the subgroup recognized that all of the following issues shared common driving variables and some key actors who share interest in the issues. Common external drivers for these issues include: global economic forces, global climate change, global and regional political change, immigration policy, and learning. Key actors common to all issues discussed were elected and appointed officials, shoreline users, members of the research community, members of the information community, indigenous peoples, and women's groups.

Issues

Issues discussed by participants fell into three major areas: physical and biological issues, economic issues, and social issues. The following is a summary of the main points of discussion for each area including identification of specific groups for whom the issue is important (key actors), important indicators to recognize problems and judge possible solutions, major activities affecting the issue, and linkage to other spatial scales (Table 2).

Physical and Biological Issues

1. Changes in water amount and water level fluctuations in the Great Lakes basin

2. Effects of toxic contaminants on human health through changes in air and water quality

3. The overall health and integrity of the Great Lakes ecosystem

4. Introduction of exotic species into the Great Lakes basin

Social Issues

1. Coordination of multi-institutional governance in the Great Lakes basin

2. Need for change in human values

Economic Issues

1. Shifts in industrial base in the Great Lakes basin and introduction of new technologies and new resources

2. Land use changes in the Great Lakes basin and overall loss of productive capacity

Recommendations

No specific recommendations emerged from the subgroup discussions.

TABLE 2 Important issues at the scale of Great Lakes-St. Lawrence basin
Included for each issue are major affected groups and institutions (actors), information needs,actions/activities and indicators.

ISSUE	ACTORS	LINKAGES	ACTION/ACTIVITY	INDICATORS
WATER AMOUNT AND LEVELS	• User coalitions • Management authorities • Planning agencies •Global climate	• Local consumptive use of water • Demand for diversion of water outside the basin fluctuations	• Climate change • Demographic change • Economic growth • Regulation of water levels and • Planning agencies	• Economic loss due to change of mean water level • Consumptive use of water in basin
TOXIC CONTAMINANTS' EFFECT ON HUMAN HEALTH	• Health professionals • Resource managers • Industrial sector nonpoint source questions • Local heritage and protected sites	• Local Areas of Concern RAPs • Local point and residents in basin in fish and wildlife • Contaminant loading rates	• Manufacture and use of chemicals • Lifestyle of • Contaminant levels	• Water quality related to human health
HEALTH OF ECOSYSTEM	• Scientific community • Management agencies • General public and nongovernmental organizations	• Local Areas of Concern • Local episodes of problems • Long-range transport of toxic materials	• Industrial base and waste loading • Public perceptions of risk • Regulation and remediation of invasion of exotic species	• Foodweb structure and biodiversity • Health of constituent species • Limits on human use of Great Lakes resources
COORDINATION OF INSTITUTIONS	• Governmental agencies • Nongovernmental organizations • International agencies • New partnerships	• National and institutional legislation, agreements and regulations • Local agreements and implementation stresses	• Historical institut-ional conflict/ isolation of levels • Jurisdictional limits of government agencies • Social and economic	Litigation • Agreements and coalitions • Indicators of public conflict
EXOTIC SPECIES	• Shipping industry • Biotechnology and agricultural interests • Governmental agencies	• Local and global remediation efforts and regulation • Governmental regulation • Global trade patterns	• Distribution manage-ment authority • Economic growth • Climate change	• Foodweb effects • Cost of remediation and control • Changes in species composition
CHANGE IN HUMAN VALUES	• Environmental activists • Educators • Media	• Local education • Median approaches • Public participation in local initiatives	• Frequency of extreme events • Globalization and recognition of limits • Rising public concern • Spirituality	• Demographic issues • Attitudinal measures and perceptions of public beliefs • Measure of consumption • Political preferences
SHIFT IN INDUSTRIAL BASE AND TECHNOLOGY	• Business and industrial develop-ment associations • Banks • Unions	• Local industrial infrastructure • Local demographic trends • Global and regional economic trends	• Technology development • Energy and resource limits • World and regional market competition	• Economic measures • Migration patterns and other demographic trends • Tax and revenue flows
LAND USE CHANGES	• Developers • User coalitions • Industry	• Local economics • Local quality of life • Local demographic trends	• Economic growth • Population growth and regulation • Variability of lake levels	• Status of wetlands • Agricultural land • Shoreline degradatiom

Second Subgroup 1: Research Users

Focus

The research subgroup was to identify research needs and information gaps surrounding issues facing policymakers of the Great Lakes-St. Lawrence basin, and to identify the tools, data and institutional processes required to address these information needs. The initial focus of discussion was on the efficacy of current research protocols to address past and future policy needs in the basin. Subsequent discussion focused on the role and structure of a model or modelling framework to increase researchers' ability to provide useful information to policymakers in the basin.

Rationale

Research in the Great Lakes-St. Lawrence basin should not continue along the path of isolated deterministic research. The research community is relatively rich in data and the abundance of data and models that now exist should be used more effectively to begin to resolve basinwide issues.

Questions facing policymakers on such issues as toxic contamination, lake levels, nutrient inputs, exotic species and climate change cannot be answered with conventional research protocols. Rather, they are second order questions that examine the linkages and integrating mechanisms within the ecosystem. The necessary work is multidisciplinary in nature, and requires cooperative research among the various disciplines and sectors operating in the basin. Data and models from the economic, social and environmental disciplines must be identified and pooled to enable easy integration before any significant advance can occur to resolve the basin's various policy issues.

Conventional research is limited because it focuses on relatively smallscale, easily answerable questions that are well defined within a particular discipline. Investigators generally shy away from tackling second order, multidiscipline questions. A major impediment to conducting interdisciplinary research is the lack of contact and cohesion among different disciplines. Thus, the institutional framework to support and foster interdisciplinary research in the region does not exist.

After some discussion, the group reached consensus on the following points with respect to research needs for the issues facing policymakers in the Great Lakes-St. Lawrence basin.

1. There is a pressing need to focus research efforts on second order (large scale, integrating) questions. Existing data and models should be used more effectively toward this end.
2. Development of interdisciplinary research programs should be a goal.
3. Closer and more productive networks of institutions and disciplines are required.
4. Efforts should be directed to integrate research and policy, and increase the utility of information that research provides policymakers on risk and uncertainty.
5. An institutional framework is needed to encourage development and investigation of the large-scale questions necessary to deal with Great Lakes basin issues.

Results - Overview

A GLSLEM modelling framework is needed to foster interdisciplinary research programs to address multidisciplinary issues in the basin. The framework should include a process that identifies and develops appropriate questions to be answered by the research community and to provide information to policymakers. Thus, the framework could serve as a focal point for policy analysis and research on Great Lake basin issues and would serve as an interface between the research community and policymakers.

The main purpose of the modelling process is to facilitate multidisciplinary policy analysis and to ensure that research on the ecosystem does not occur in isolation by developing links between the different disciplines and sectors in the basin. The GLSLEM modelling framework would provide access to existing models and data from all disciplines, and would provide the mechanism needed to address the second order questions that are essential to dealing with basinwide issues.

A consortium of agencies and institutions are needed to develop and oversee the modelling framework process. The consortium would consist Canadian and American members, whose involvement would be flexible and determined by the required expertise. A central secretariat of one or two people would coordinate GLSLEM modelling framework activities.

The consortium would:

1. provide information on available expertise and existing data to a policy analysis proposal;
2. evaluate and recast research questions to maximize integration of available expertise and information into a proposed study plan; and
3. ensure that policymakers are kept apprised of analytical initiatives in the basin.

The modelling framework and consortium together would provide a home for ecosystemic research in the Great Lakes-St. Lawrence basin. Figure 1 sketches the process of the proposed organizing framework.

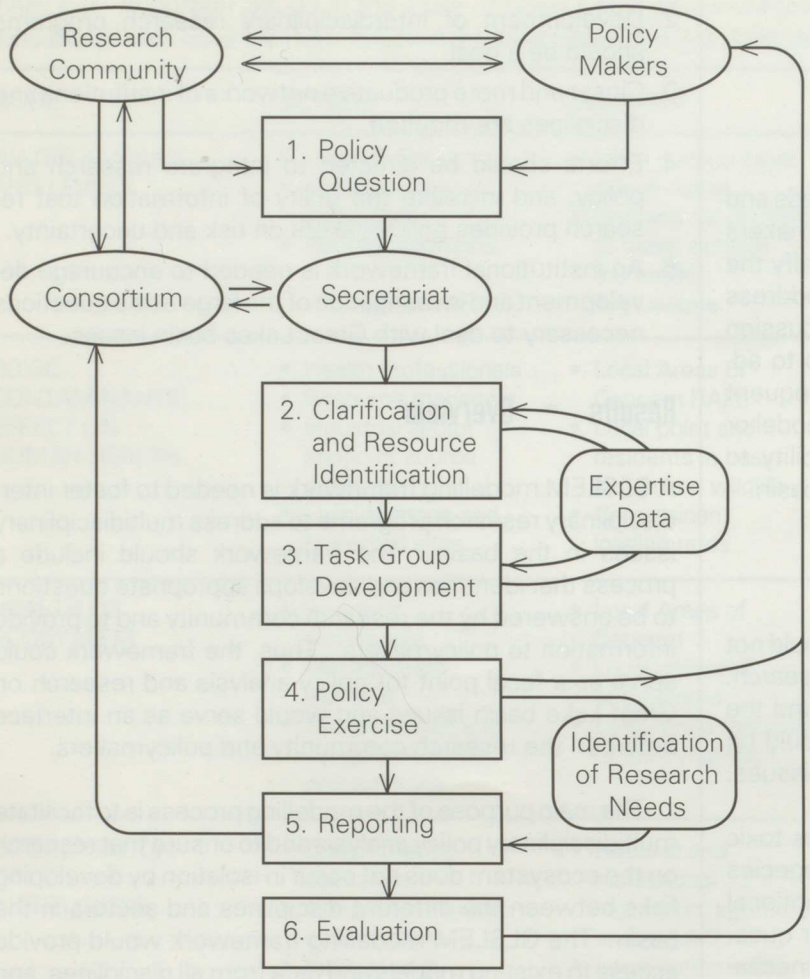


FIGURE 1. Approach for developing GLSLEM models

An Organizing Framework for Ecosystem Analysis

The following represents the proposed steps of the GLSLEM modelling framework (Figure 1).

1. Policy Question

A policy question or proposal for study is submitted to the secretariat who begin the process by notifying consortium members with expertise in the area of proposed analysis. The secretariat identifies available information and expertise relevant to the policy question. Proposals for analyses can be submitted by university, government or the private sector.

2. Clarification and Resource Identification

The policy question is evaluated by experts in the field of study to ensure efforts are not being duplicated and that the proponent is aware of all information and expertise germane to the proposed project. All relevant models, information, data and expertise helpful to the proposed analysis are identified, and to the greatest extent possible, made available to the proponent. Co-operation and collaboration is encouraged. An explicit objective of this step is to expand the scope of analysis to include additional ecosystem linkages not previously included.

3. Task Group Development

After the project is tuned, a team is struck to develop the methodology for the project and to conduct the project. Innovation with respect to the use of existing models and methodologies will be stressed. The methodology will be iterative and flexible to permit adjustments throughout analysis, as information is generated. The methodology will specify a schedule for in-progress and post-project evaluation. The task group will include proponent, members of the consortium, and outside experts.

4. Policy Exercise

The implications of the policy question are evaluated, and analysis of policy options and assessment of uncertainties begins. Part of the task group will be involved in the policy exercise, which is crucial to maintain close links between ecosystemic research and policy. New directions and considerations for policy should emanate from the policy exercise. In addition, research needs will emerge as important knowledge gaps are identified.

5. Reporting

The proponent must provide a report to the consortium on the analysis. The consortium should publish the activities of the modelling framework and subsequent research, which would help generate awareness of the modelling framework and maintain the support of the basin's research community.

6. Evaluation

After the project has been completed, an external review of its overall success should be conducted by the IJC. Actions that occur as a result of the project also should be reviewed by the IJC.

Initiation of the GLSLEM Process

The Council of Great Lakes Research Managers, under the auspices of the IJC, should take the lead to develop the GLSLEM process. The Council should provide the initial funding for startup costs (i.e. the secretariat) and should initiate the process with a few relatively short-term projects (18-24 months). A few successful executions of the process will help to secure its acceptance, and subsequent funding for the modelling framework will come from the proponent and other collaborators.

The success of a modelling framework to enhance analysis in the basin is dependent on the interest and support of the consortium members, and of the research community. Serving the interests of everyone involved in a particular project is the goal, in addition to doing a better job at managing the Great Lakes -St. Lawrence ecosystem.

The benefits of the modelling framework are numerous. It will assist the Council of Great Lakes Research Managers in their "top-down" research efforts, provide a necessary interface between research and decision-making, and result in more efficient use of research funds. The modelling framework will foster the use of the ecosystem approach to studying and managing the Great Lakes-St. Lawrence ecosystem.

Conclusions and Recommendations

A new way of doing business in the Great Lakes-St. Lawrence basin is required. The difficulties managers, researchers and policymakers in the Great Lakes-St. Lawrence basin face in coming to grips with pressing issues of pollution, resource degradation, and climate change is due to the shortcomings of conventional research in the basin. While perfectly adequate for small-scale research questions, conventional research protocols do not of adequately address the broader issues facing the Great Lakes-St. Lawrence Basin. The issues are multidisciplinary, and policymakers require information derived from interdisciplinary research for effective management.

Generating new lists of research needs for the Great Lakes-St. Lawrence basin in the traditional format is strongly discouraged. Rather, efforts should be directed at developing new working relationships among disciplines and sectors, and more innovative and effective uses of existing data and models must be fostered. In most cases, the information and expertise required to properly address the issues of ecosystem health in the Great Lakes-St. Lawrence basin are all ready in place, but need to be reorganized.

Second Subgroup 2: Policy Users

Focus

The charge to the policy subgroup was to consider the range of available policy development options that could lead to sustainable development in the Great Lakes basin. In particular, the group considered:

- how different types of tools might be used to establish policies that foster sustainable development;
- what processes are beneficial in contributing to ecologically sustainable policies; and
- what databases are needed to support policy development.

As outlined in the following sections, the discussions of the group focused primarily on the first two areas.

Approach

The concept of sustainable development stems from the human perspective of achieving a pattern of human-environment interactions which, in the long term, ensures continued beneficial use of the biosphere. While the concept is elegantly simple (i.e. a pattern of use of the biosphere that does not deplete ecological capital for future generations), it does not explicitly specify the attributes of an ecological system consistent with sustainable long-term use by humans. In addition, no one agency or policy group can reasonably be responsible for the establishment of sustainable development.

In the Great Lakes basin, as elsewhere, several agencies are responsible for the protection and management of ecosystem components (e.g. water, air, biotic resources). Numerous other agencies are responsible for significant policies that implicitly have a major effect on human interactions with the biosphere (e.g. transportation, energy, industrial economic policies, etc.) and which seek to meet a multiplicity of objectives. In this environment, it is not likely to be sufficient to develop policy initiatives aimed at sustainable development. Instead, it is necessary to create a policy development environment that supports and encourages broad policy analysis beyond the traditional considerations of agencies responsible for developing different policies.

A significant challenge to attaining toward sustainable development is to determine whether a particular initiative is "sustainable." To assist policy analysts in making such determinations the group felt that it was useful to identify attributes of a Great Lakes Basin Ecosystem that is consistent with sustainable development.

The group considered how sustainable development might be expressed in terms of ecosystem characteristics that agencies responsible for policy development could work toward. Next, the group focused on the type of policy environment needed to bring about a comprehensive policy shift toward sustainable development. This then provided a general background to consider what tools would be most appropriate to support such policy development initiatives.

Results

The attributes of a Great Lakes Basin Ecosystem that would be consistent with achieving sustainable development may be best described as resilience. While some policies that are conserve our use of resources within the Great Lakes basin reflect a sustainable development ethic, the controls on development are frequently indirect and the cumulative effects of unenlightened human activity often negate attempts to attain a sustainable pattern of interactions with the biosphere. Managing for resiliency of the Great Lakes Basin Ecosystem means developing policies that explicitly and implicitly lead to key attributes of the biophysical and human subsystems. Important attributes of these two systems include:

Biophysical Subsystem	Human Subsystem
diversity	flexibility
integrity	sustainability
productivity	designed for surprise

In view of the large number of agencies and concerns involved, no single policy initiative will achieve this. Instead, the real gains will come by creating a policy development environment that supports and progressively promotes evolution of a broad range of policies to achieve a resilient Great Lakes Basin Ecosystem.

Developing policies that lead to ecosystem resilience will require a broad perspective in policy analysis. Two key elements of this perspective are:

1. involvement of stakeholders with a wide range of potential concerns to identify and anticipate possible effects of proposed policies; and

2. a policy development environment that facilitates and encourages multi-stakeholder policy analysis of potential linkages between systems and issues.

The group indicated that development of such a policy analysis framework was a major priority. This framework should permit and encourage a change in the policy development system, which could be characterized as shifting the policy development process as follows:

Needed Shift in Policy Framework

FROM	TO
Point individual analysis	Analysis of cumulative effects
Short timeframe	Long timeframe
Competitive	Cooperative
Negotiated	Consensual
Consultative	Partnerships
Direct involvement of few	Direct involvement of many
Distrust	Based on trust

While a wide variety of tools may be used to support policy analysis, the primary need identified by the subgroup is for tools to support the needed shift in the policy development environment. Key attributes of these tools are that they be accessible and usable by a wide variety of stakeholders and they support exploration of linkages between subsystems of the Great Lakes Basin Ecosystem. The group explicitly considered three types of tools as summarized in Table 3.

Conclusions

Three major conclusions were reached by the subgroup.

1. A single Great Lakes Basin Ecosystem model that attempts to represent the full complexity of ecosystem processes (including human interactions) would be inappropriate.

   Conversely, relatively simple, issue based models are needed that incorporate dominant ecological processes and represent major linkages between subsystems of the Great Lakes Basin Ecosystem. Building such systems models of major issues/problems within the basin should expand the scope of policy analysis and foster exploration of the significance of different initiatives in terms of their effect on ecosystem resiliency.

2. Experimental development and adaptive application of techniques are needed, such as policy gaming/policy exercise to facilitate multi-stakeholder, consensus-based policy development.

3. The above initiatives should be pursued through immediate application to at least one major issue within the basin. Candidate issues suggested as possible starting points include:

   - effects of climate change on the basin (especially in terms of potential effects on future lake levels);
   - effects of exotic species invasions; and/or
   - toxic chemicals (fate and effects).

TABLE 3 Examples of tools to support new policy initiatives

	SYSTEM MODELS	GEOGRAPHICAL INFORMATION SYSTEMS	POLICY GAMING
APPLICATION	• Adapt/simplify existing models to specific issues • Models should be relatively comprehensive but simple • Explore consequences of proposed actions • Communicate/educate	• Provide landscape context • Link social and biophysical subsystems (e.g. health emissions) • Communication tool • Evaluate alternative	• Uses other tools for support (models, G.I.S.) • Simulate different modes of decision-making • Understand effects of subjectivity in policy development
INVOLVE IN DEVELOPMENT	• Policy analysts • Researchers • Stakeholders	• Primarily researchers • Policy analysts and stakeholders (to help identify needs)	• Policy analysts • Researchers • Stakeholders (NGO and industry)
INVOLVE IN USE	• Agency heads • Politicians • Public education • Policy analysts • Researchers • Stakeholders	• Research • Policy analysts • Stakeholders	• Policy analysts • Researchers • Stakeholders (NGO and Industry)
RESEARCH NEEDS	• How to communicate uncertainty	• Links to simulation models for use in forecasting effects	• Experimental development through application to current issues

NGO = Non-governmental organizations
GIS = Geographical Information Systems

It was noted that, in the short term, the recommended initiatives could be pursued through a cooperative research/development network fostered by the IJC through the Council of Great Lakes Research Managers. In the longer term, a permanent facility or centre to support continued development and application of such policy development tools may be needed. This could be one role for the Great Lakes Centre recommended by the Vision 2000 futures workshop, previously sponsored by the Council (IJC 1990).

Second Subgroup 3: Public and Ethics

Focus

The 1978 Great Lakes Water Quality Agreement between Canada and the U.S. calls for an ecosystem approach to restore the physical, chemical and biological integrity of the Great Lakes. Subsequent extensions of the Agreement have continued to emphasize the goal of restoring ecosystem integrity, but technical interpretation of the ecosystem approach has proven illusive. The GLSLEM workshop confronted this recurring issue, and in frustration sought to express this concept in terms of socio-economic concerns, i.e. the human dimension of the ecosystem approach. Several participants suggested that the ecosystem approach was ultimately a world view and thus an ethical rather than a technical problem. A subgroup was thus charged with the task of understanding the ethical implications of the ecosystem approach in its widest sense.

Issues

The 1978 Agreement places politics in an ecosystem context. The challenge of the ecosystem approach is thus to fit lakes and politics into the context of the ecosystem of the Great Lakes basin. Implicitly, this requires actions on a wide range of biophysical, economic and social issues to make policy, management and individual behaviour consistent with publicly held values. Because so many issues discussed in the first phase of subgroups were relevant to this focus, the subgroup began its discussion with a review of fundamental conflicts that arise from the tension between stewardship for ecosystems and concerns for justice and equity in resource use of the Great Lakes basin. Some sample conflict situations include:

1. allocation of wetlands for development or maintenance of ecosystem integrity;

2. zoning or other regulation to limit population size in the Great Lakes basin;

3. fragmentation of knowledge and management authority for the natural resources of the Great Lakes; and

4. distribution of the consequences (costs and risks) of actions in the Great Lakes basin.

Results

Viewing the ecosystem approach as an ethical problem allows for social and economic aspects of human society to be more easily linked by examining fundamental values. The subgroup attempted to sketch out the consequences of this view as illustrated in Figure 4, page 10.

It was argued that all individuals residing in the Great Lakes Basin ultimately share some set of core values. Life in a sustainable ecosystem was considered the most primitive value and is reflected in values of security, quality of life, compassion and justice. Many layers of instrumental values ultimately implement these core values.

Beliefs about the nature of the world (i.e. world view) derive from these layers of instrumental values. Decisions about actions affecting ecosystems result from the combined interaction of knowledge (technical, political, etc.) and values.

Conflicts that arise due to different interpretations of knowledge and values often involve notions such as justice, equity and stewardship, and they may represent fundamental disagreement about the preference for various tradeoffs.

Conclusion and Recommendations

Policy choices are the result of some analysis of tradeoffs between benefits and the costs or risks of adverse consequences of decisions. This tradeoff element may not always be formal, but may be nearly universal in rational choice making. Models provide a way to formalize tradeoff analysis and thus make it more objective. If policy choices are value laden, however, economic and ecological analysis of consequences of policy choices may not capture fundamental concerns and world views. One way out of this dilemma might be to use models as an aid to discuss values. Thus, the subgroup considered it necessary to view the human dimension of the ecosystem approach as a process of learning and value clarification.

To pursue this view of the human dimension of the ecosystem approach, the subgroup developed a series of recommendations.

1. The IJC, through the Council, should take steps to improve knowledge application and adaptability of society. Identification of "carrying capacities" of various life styles is key to linking values and their social and economic manifestations. Specifically, research should be directed toward:

   Consolidation and coordination of existing understanding of the consequences of lifestyle choices, and

   Definition of critical processes and structures of healthy ecosystems affected by lifestyle choices.

2. From the perspective of core values, the Council should launch a new dialogue about resilience and vulnerability characteristics of socio-economic sectors. A task group, workshop and conference would be a useful sequence to follow.

3. The Council should recognize that serious progress will require a major increment in the coordination of ongoing initiatives. The Council should thus foster coordination of "audits" of various historical and current efforts to manage Great Lakes resources.

4. To facilitate discourse about values, the Council should support learning initiatives, such as those presently pursued by the IJC Science Advisory Board, that reinforce clarification of values related to the ecosystem approach. These could include feature films, gaming for children, and other educational outreach initiatives.

5. Given the importance of value clarification, the Council should move rapidly to develop a prototype of the GLSLEM framework. This may involve parallel initiatives, but a simple focus on use conflicts associated with water level fluctuations would add relevance and urgency to the development.

APPENDIX II: Steering Committee

Steering Committee

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