ECOSYSTEM-BASED MANAGEMENT OF THE LAKE ERIE ECOSYSTEM: A SURVEY-BASED APPROACH TO ASSESSMENT OF MANAGEMENT NEEDS

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by

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DEDICATION

This work is dedicated

To my wife of 30 years, Annette, without whose love and support I could not have sustained;

To my daughters, Michelle and Laura, with the hope that they will pursue and achieve their dreams; and

To my father and mother, Neil and Lina Wilson, who inspired me to dream big dreams and always encouraged me to pursue my aquatic interests. Through this and spiritual guidance I came to realize my personal mission: “To better understand the environment and work for its preservation.” My hope is that this work will contribute toward that end.

My thanks and deep appreciation to all.

CHAPTER I

INTRODUCTION

Project Background

Ecosystem-based management (EBM) has emerged as an integrated approach to managing ecosystems, including human interactions and impacts. This methodology is being adopted as an approach to environmental management around the globe, including management of the Laurentian Great Lakes. Similarly, an ecosystem approach (EA) has currently been adopted for management of the Lake Erie ecosystem. The purpose of this project is to examine whether EBM can be implemented on a voluntary basis for effective management of the Lake Erie ecosystem, or whether legislative mandates will be required for success. The present project begins with a review of the general attributes of an EBM model to develop a framework for analysis. It then reviews EBM in practice in selected reference aquatic ecosystems including Chesapeake Bay, Puget Sound, Tampa Bay and Baltic Sea, including a comparison of relevant characteristics. The current management model of Lake Erie is analyzed relative to an EBM framework. The question of whether EBM can be implemented effectively on a voluntary basis or whether a legislative mandate is required is asked of all systems, and then recommendations are made for EBM implementation in Lake Erie. Differing attitudes by diverse ecosystem stakeholders on this matter are also characterized. This will be useful

input to the governments of the United States and Canada, the primary audiences, as they continue negotiations on an updated version of the governing Great Lakes Water Quality Agreement (GLWQA).

Toward Ecosystem-Based Management: A Brief History

Pre-1980s

Environmental management has evolved through the years. Traditional land-based systems, such as those managed by the U.S. Fish and Wildlife Service (USFWS), have depended upon the time-tested single species approach (Clark 1999). There has been trust in that approach due to its dependence upon finite scientific data and multiple successes through time in terms of recovering selected populations or bringing back critically endangered species from the brink of extinction. With this approach the desired end is clearly defined and measurable: the stabilization of the target species' population. However, many other related aspects of the ecosystem are not considered nor factored into management strategies under this approach.

The environmental movement of the 1960s and 1970s triggered an abundance of federal statutes, state laws and local ordinances to deal with the effects of industrializetion in the U.S. over the previous century. Many of these laws and regulations had a single-species or single-issue focus, as was typical in the earlier days of environmental management. Nevertheless, these new regulations were often burdensome, unwieldy and left many critical interrelationships of the ecosystem unaddressed.

Interestingly, much earlier work by ecologists and ecological organizations on land-based systems in the 1930s and 1940s planted the seeds and advocated for many specific elements of what later became the contemporary ecosystem discussion. For example, the 1932 work of the Ecological Society of America's Committee for the Study of Plant and Animal Communities recognized that a comprehensive U.S. nature sanctuary system must protect ecosystems as well as particular species of concern, represent a wide range of ecosystem types, manage for ecological "fluctuations" and employ a core reserve/buffer zone approach (Shelford 1933). The Committee also emphasized the value of interagency cooperation for success and the need for ecologists to educate the public as to the value of the sanctuaries. However, these early attempts to ground resource management better in ecology and landscape-level concerns were not successful.

From a political science standpoint, policy analyst Lynton Caldwell (1970) published a forward-thinking article in 1970 that advocated using ecosystems as the basis for public land policy. He recognized that this would require substantial political rethinking and, indeed, the blossoming of the environmental movement in the 1970s was not strong enough to overcome the inertia to bring this to fruition. Similar forward thinking relative to the aquatic environment of the Great Lakes was expressed with the seminal 1978 document prepared by the Great Lakes Research Advisory Board for the International Joint Commission entitled: "The Ecosystem Approach - Scope and Implications of an Ecosystem Approach to Transboundary Problems in the Great Lakes Basin" (GLRAB 1978).

Two biologists, Frank and John Craighead, are often credited with focusing current attention on ecosystem management. Their research with grizzly bears in

Yellowstone National Park showed that the bears' needs could not be met solely within the park (Craighead 1979) and thus set the stage for defining greater ecosystems. William Newmark's (1985) work comparing biotic and legal boundaries of reserves in western North America reinforced these conclusions.

1980s

By the 1980s there was strong criticism due to the shortcomings of many of the previously instituted regulations. Key negative attributes cited were top-down decision-making which ignored local conditions, lack of acknowledgement of interrelationships among components of the natural systems and a preponderance of inflexible mandates which did not allow for adjustments to changing ecosystem circumstances.

Among the promising new approaches to dealing with the previous shortcomings of managing the environment was Ecosystem Management (EM), the approach utilizing a broad-scale approach to managing for ecological integrity and considering social as well as scientific data in management decisions. Nomenclature later transitioned more commonly to EA as well as to the Ecosystem Approach to Management (EAM), referring to extending existing management foci to include additional considerations consistent with ecosystem management characteristics (Murawski 2007). Today this integrated, holistic approach to managing the environment, including human impacts, is predominantly referred to as EBM, although EA is used interchangeably in many venues. (The term EM is sometimes still used today, but many prefer the terms EA or EBM as these terms emphasize that it is not the ecosystem being managed per se, but the human

interactions with the ecosystem.) Although many formal definitions of EBM were offered by scholars, most agree that at a minimum EBM involves collaborative, landscape-scale planning and implementation that is flexible and adaptive (Cortner and Moote 1999, Grumbine 1994). EBM shares attributes with several other environmental problem-solving approaches that emerged in the 1980s and later, particularly its emphasis on a holistic approach, collaboration, decentralization and flexibility. However, the attribute that sets it apart is the scale at which problems are addressed (Cestero 1999) and the nature of government involvement (Koontz et al. 2004). EBM initiatives span large landscapes that may encompass marine or other aquatic ecosystems, publicly and privately owned land and urban as well as rural areas (Layzer 2008). Thus, by the late 1980s, EBM had emerged as a holistic approach to managing ecosystems that were recognized to include interdependent plant, animal and human communities and interactions with their physical environment. EBM was seen as useful to address perceived deficiencies in the environmental policymaking system created in earlier years and to enable addressing of more complex ecological problems over time. By the late 1980s, an ecosystem approach to land management was being supported by many scientists, managers and others.

1990s

Because of the broad appeal of EBM and its potential positive impact on sustainability, several nongovernmental organizations, professional societies, federal agencies and state officials endorsed ecosystem-based approaches to land-use and natural

resource policy-making (Beattie 1996, Dombeck 1996, Western Governors' Association 1998). It gained broader applicability in the aquatic environment as well. For example, Canada enacted the *Oceans Act* in 1997. This Act outlined a new approach to managing oceans and their resources based on the premise that oceans must be managed as a collaborative effort amongst all stakeholders that use the oceans, and that new management tools and approaches were required (O'Boyle and Jamieson 2006). The Act changed the legislative basis for management, requiring consideration of the impacts of all human activities on Canada's ecosystems in marine resource management plans.

2000s

In the 2000s, scientists, managers and advocates aggressively promoted EBM for marine systems. In 2005, more than two hundred academic scientists and policy experts from U.S. institutions agreed by consensus on the following definition of EBM for the oceans:

> Ecosystem-based management is an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors. (McLeod et al. 2005).

The above definition of EBM has been adopted for use in this project, and the criteria "to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need" will be used to benchmark EBM implementation success.

Interestingly however, despite widespread enthusiasm for EBM, scholars have not provided systematic evidence of its efficacy in practice – until recently, few initiatives had existed long enough for evaluators to assess their substantive benefits, and of those few, their complexity and heterogeneity made evaluation particularly challenging (Layzer 2008). Nevertheless, in recent years scholars have been analyzing aspects of EBM, particularly the effects of stakeholder collaboration on natural resources planning and management. They have observed that watershed collaboratives and other participation-intensive problem-solving efforts do appear to increase social capital in these systems, as well as the level of stakeholder agreement (Beierle and Cayford 2002, Lubell 2005). In addition, it was noted that several of these participatory initiatives have taken concrete steps (e.g. implementing restoration projects, monitoring and outreach programs, etc.) toward achieving their environmental objectives (Huntington and Sommarstrom 2000, Imperial and Hennessey 2000). Importantly, however, scholars have been unable to document a causal relationship between collaboration and improved environmental conditions, despite widespread agreement that the most important measure of success is achievement of on-the-ground environmental benefits beyond what would have occurred anyway (Born and Genskow 1999, O'Leary, Nabatchi, and Bingham 2004). Layzer (2008) notes that, despite the fact that existing empirical work highlights a small number of variables that appear to be correlated with "success," serious gaps remain in understanding of whether, how and under what conditions collaborative governance arrangements yield genuine environmental improvements. Systematic evidence of the

efficacy of landscape-scale planning and flexible, adaptive implementation is even more elusive. The current project aims to shed light on these important issues.

Statement of Problem

My dissertation research program will be focused on answering the following question: What are the important factors for successful implementation of EBM in the Lake Erie ecosystem to maintain it in a healthy, productive and resilient condition so that it can provide the services humans want and need? Thus the focus of this work will be on reviewing aspects of the ecosystem management process regarding implementation success, as opposed to looking at the content of what is managed directly (i.e. phosphorus, invasive species, etc.).

Framework of Study

This project seeks to review an EBM framework and its characteristics, then review its application in selected aquatic ecosystems (Lake Erie, Chesapeake Bay, Puget Sound, Tampa Bay, Baltic Sea) through a survey approach of stakeholders including implementation on a voluntary versus legislatively mandated basis. The current Lake Erie management model is then examined relative to an EBM framework and relative to the four reference ecosystems. Recommendations will be made regarding EBM implementation in Lake Erie on a voluntary versus legislatively mandated basis, and differing viewpoints by diverse ecosystem stakeholders will be noted.

Research Questions

Specifically, the project will address the following research questions:

1. To what extent have EA/EBM criteria been implemented in management of Lake Erie and reference aquatic ecosystems?
2. Which EA/EBM criteria are most important to effective management of these ecosystems?
3. Have legislatively-mandated elements of EA/EBM led to a greater rate of success than voluntary implementation in achieving ecosystem goals?
4. Has EA/EBM implementation been effective in maintaining the ecosystems in a healthy condition or restoring them to same?
5. Does ecosystem size have an impact on EA/EBM effectiveness and ecosystem outcomes?
6. Are there differences in perceptions of management effectiveness by various types of ecosystem managers for LE and reference aquatic ecosystems?
7. What would be the key characteristics for a successful EBM implementation in the Lake Erie ecosystem?

This analysis and model for successful EBM implementation will be useful in optimizing the effectiveness of EA/EBM implementation in the Lake Erie ecosystem, and for optimizing future EBM implementation in other aquatic ecosystems as well.

EBM Criteria

Christensen et al. (1996) note that ecosystem management must include the following:

1) Long-term sustainability as a fundamental value
2) Clear, operational goals
3) Sound ecological models and understanding
4) Understanding complexity and interconnectedness

5) Recognition of the dynamic character of ecosystems
6) Attention to context and scale
7) Acknowledgment of humans as ecosystem components
8) Commitment to adaptability and accountability

Grumbine (1997) outlined ten dominant themes of ecosystem management:

1) Hierarchical context
2) Ecological boundaries
3) Ecological integrity
4) Data collection
5) Monitoring
6) Interagency cooperation
7) Humans embedded in nature
8) Adaptive management
9) Organizational change
10) Values

Koontz and Bodine (2008) note that, although there is no single, agreed-upon definition of ecosystem management, scholars have identified a number of key components:

1) Collaboration with stakeholders
2) Interagency cooperation
3) Integration of scientific information to manage areas holistically across multiple resources and hierarchical levels of ecological systems

4) Integration of social and economic information into management decisions
5) Preservation of ecological processes
6) Adaptive management

Layzer (2008) noted the three primary elements of EBM to be:

1) Landscape-scale focus
2) Collaborative planning to engage all stakeholders
3) Flexible, adaptive implementation of planning goals

McLeod and Leslie (2009) note five basic principles to EBM:

1) Diverse ecosystem service provision
2) Importance of natural boundaries
3) Integrated management
4) Accounting for cumulative impacts and necessary trade-offs among services
5) Making decisions under uncertainty

A composite list of EBM criteria as follows will be adopted for evaluation of the various management models:

1) Collaborative planning to engage all stakeholders (Layzer 2008)
2) Integration of multiple system components and uses (Boesch 2006)
3) Integration of scientific information into management decisions (Koontz and Bodine 2008)
4) Integration of social and economic information into management decisions (Koontz and Bodine 2008)
5) Clear, operational goals (Christiansen 1996)
6) Identifying and striving for sustainable outcomes (Boesch 2006)

7) Precaution in avoiding deleterious actions (Boesch 2006)
8) Adaptive management (Koontz and Bodine 2008)
9) Monitoring (Grumbine 1997)
10) Landscape- or regional-scale focus (Layzer 2008)

This holistic approach to ecosystem management embraces not only science-based ecological elements but also considers socioeconomic and political aspects of the system. Understanding the entire ecosystem, including human impacts, was seen as important to maintaining ecological integrity in a sustainable manner, while satisfying real-world needs of the socioeconomic and political sectors as well.

EBM has been adopted as the desired approach for ecosystem management by several notable agencies and organizations for both terrestrial and aquatic applications. For the aquatic environment, EBM is embodied as a key principle in the landmark report "An Ocean Blueprint for the 21st Century" by the U.S. Commission on Ocean Policy (2004). It was also a defining characteristic in the earlier Pew Ocean Commission summary report (2003) "America's Living Oceans: Creating a Course for Sea Change." Likewise, EBM was a foundational theme in the NOAA Sea Grant (2008) draft blueprint "NOAA National Sea Grant College Program Strategic Plan 2009-2013: Meeting the Challenge." Holistic management of ecosystems through EBM has become a pervasive goal on a global scale.

EBM in Practice

EBM has been adopted as a management strategy in several major aquatic ecosystems, both in the U.S. and abroad. The present project will consider three aquatic ecosystems in the U.S. and one system in Europe for reference in developing the EBM model for Lake Erie. These ecosystems vary greatly in political complexity (Table 1) and are characterized as follows:

1) Chesapeake Bay. As North America's largest and most biologically diverse estuary, the Chesapeake Bay and its tributaries have been an important asset to the mid-Atlantic region's economy and culture. However, this ecosystem has undergone significant degradation over time, and continues to face pressures from population growth and development. In 1983 the states of Virginia, Maryland, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission and the U.S. EPA signed the first agreement to establish the Chesapeake Bay Program partnership to protect and restore the Chesapeake Bay's ecosystem through an EBM approach.

Table 1

Political Complexity of Ecosystems

Ecosystems by Political Complexity	Political Composition
Baltic Sea	Nine Countries
Lake Erie	Four states, one province (two countries)
Chesapeake Bay	Six states, Washington D.C. (one country)
Puget Sound	One state, one province (two countries)
Tampa Bay	One state (one country)

2) Puget Sound. The Puget Sound ecosystem runs from the upland habitats of the Olympic and Cascade mountain ranges to the depths of Puget Sound and out to the Pacific Ocean. It is in trouble due to development and human population growth in the region which have resulted in polluted waterways, loss of species and compromised habitat. In 2007, Washington Governor Christine Gregoire proposed and the Legislature created a new state agency and a public-private partnership, the Puget Sound Partnership, to reverse Puget Sound's decline and restore it to health by 2020. With a substantial commitment of State of Washington and federal funding, a broad-based EBM effort is underway to accomplish this task.
3) Tampa Bay. In the 1970s the Tampa Bay estuary was not attractive. Excess nitrogen released into the bay resulted in smelly algae, a 50% loss of seagrass and

degraded water quality. Local citizens demanded action, and nitrogen controls were initiated in 1980 and have been continued through the present which have resulted in a 60% total nitrogen load reduction compared to the mid-1970s. The Tampa Bay Estuary Program, a consortium of local, state, federal and private partners, was established in 1991 to continue to improve the condition of Tampa Bay through a targeted EBM process. Many of its ecosystem restoration goals are being achieved, including continued restrictions on nitrogen inputs, restoration of seagrass beds and improved water quality.

4) Baltic Sea. The Baltic Sea region is made up of nine countries: Denmark, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland and Germany. Human activities over the past centuries have put considerable pressure on the marine ecosystem particularly in the areas of eutrophication, hazardous substances, maritime traffic and threatened biodiversity (Backer et al. 2009). Thus the ecosystem has experienced a basin-scale shift in state and trophic structure during the 20th century (Boesch et al. 2006). In 1974 the Helsinki Convention was signed as a regional intergovernmental response to these pressures and other relevant issues, governed by the Helsinki Commission (HELCOM). With adoption of the EA, the Baltic countries committed themselves to further steps in this direction. This was strengthened by the parallel European work in implementing the European Union Water Framework Directive (EC 2000) and developing the Marine Strategy Framework Directive (EC 2008). The HELCOM Baltic Sea Action Plan (BSAP) was adopted in Krakow, Poland in 2007 as a multilateral

> Ministerial Declaration in which the HELCOM contracting parties, coastal country Governments and the European Commission commit themselves to carry out specific actions for achieving the agreed Ecological Objectives, and eventually a Baltic Sea in good Environmental Status by 2021 (HELCOM 2007).

To add perspective for comparison purposes, the relative size of the five selected ecosystems is important. For example, as seen in Table 2, the Baltic Sea ecosystem (both basin and water area), the largest system in the study, is two orders of magnitude larger than the Tampa Bay ecosystem, the smallest in the study. The other three ecosystems fall between these two extremes. Chesapeake Bay, the largest ecosystem basin studied in the U.S., is followed by Lake Erie, then Puget Sound, all of which are larger than the Tampa Bay ecosystem. These differences in size must be taken into account as EBM implementation is analyzed. For example, located in the Great Lakes are areas targeted for clean up and remediation, each termed an "area of concern" (AOC). Lake Erie has 12

Table 2.

Relative Size of Ecosystems in Study

Ecosystems	Ecosystem size: basin (sq mi)	Ecosystem size: water area (sq mi)
Baltic Sea	582,088	145,522
Chesapeake Bay	64,299	4,479
Lake Erie	30,140	9,940
Puget Sound	15,993	1,544
Tampa Bay	2,200	400

such AOCs. For comparison in size, Tampa Bay would be somewhat similar to a large AOC in the Great Lakes.

Key EBM-related characteristics of each of the four primary reference systems will be examined, as well as the voluntary versus legislatively mandated basis for implementation. These learnings from the reference ecosystems will inform the management strategy for Lake Erie.

Current EA Model for Management and Governance of the Lake Erie Ecosystem

Regarding the Laurentian Great Lakes, both the U.S. and Canada advocate use of EA methodology in research, planning and management of this resource (Hartig et al., 1998). The U.S.-Canada GLWQA has been a key guiding document in this regard. First introduced in 1972, revised in 1978 and amended by Protocol in 1987, it specified many aspects of water quality management for the open waters of the Great Lakes. Under the GLWQA, a Remedial Action Plan (RAP) program was formalized to identify and implement actions to restore the most polluted areas of the Great Lakes, and an ecosystem management approach was adopted for this purpose. Likewise an EA is being applied to the Lake Erie ecosystem. The Lake Erie Lakewide Management Plan (LaMP) was initially created by the Lake Erie LaMP Work Group which is comprised of multiple organizational stakeholders from both the U.S. and Canada including U.S. EPA, Environment Canada, state agencies from Ohio, Michigan, New York and Pennsylvania, and others. It was first published in 2000 and has been updated biannually (LaMPs exist for the other Great Lakes as well). The LaMP utilizes an EA for management of the Lake

Erie ecosystem, integrating environmental protection and natural resources management (Vincent and Letterhos 2008). Other jurisdictions have also expressed intent to apply EBM to Lake Erie, as expressed by New York State (NYOGLECC 2007).

Governance and management of Lake Erie are complicated by the fact that there are many agencies and organizations at various political levels exerting oversight and/or management activity on the lake ecosystem. These include:

Binational

- International Joint Commission (IJC) – established as a result of the 1909 Boundary Waters Treaty between U.S. and Canada to oversee waters shared by the two countries. This agency had primary oversight responsibility for GLWQA activities until 1987.
- Great Lakes Fishery Commission/Lake Erie Committee – established in 1955 between U.S. and Canada to manage the Great Lakes fisheries.
- Binational Executive Committee (BEC) – resulted from the 1987 Protocol to the GLWQA. BEC now has primary oversight of GLWQA.
- Lake Erie LaMP Management Committee – responsible for oversight of the Lake Erie LaMP process.
- Lake Erie Millennium Network - a collaborative effort to deal with Lake Erie environmental issues by defining and understanding Lake Erie's most pressing problems, propose solutions, and track the changes.

Federal – U.S.

- U.S. EPA – has primary responsibility for GLWQA implementation for U.S.
- Great Lakes Regional Collaboration (GLRC) – established by executive order by President Bush in 2004.

Federal – Canada

- Environment Canada – has primary responsibility for GLWQA implementation for Canada.

State – U.S.

- The four states bordering Lake Erie (MI, OH, PA, NY) all have multiple agencies with various Lake Erie-related responsibilities.

- Ohio Lake Erie Commission – an alliance of state agencies in Ohio whose purpose is restoration of Lake Erie and its watershed.

Provincial – Canada

- The Province of Ontario has various agencies (e.g. Ontario Ministry of Environment) with Lake Erie-related responsibilities. The Canada-Ontario Agreement provides a mechanism for Provincial-Federal coordination to improve the environmental quality of the Great Lakes.

Other

- Municipalities

- Local governments

- Western Lake Erie Basin Partnership – a new (2006) U.S.-based collaboration of organizations seeking to link land use to water quality, support ongoing efforts and identify new opportunities to enhance and improve the watershed.

- Non-Governmental Organizations (NGOs) – e.g. Ducks Unlimited, The Nature Conservancy, etc.

- Businesses – e.g. marinas, commercial fishermen, shipping, tourism.

The Lake Erie LaMP process encompasses some of these groups as partners, particularly at the federal, state and provincial levels, but not all. Other groups, particularly municipalities, local governments, NGOs, fisheries and land use planners, are not part of the Lake Erie LaMP planning or implementation process.

With this level of complexity regarding management and governance, the current project will seek to analyze the current management system for Lake Erie relative to an

EBM framework. Recommendations will then be made regarding a new model for how to optimize how this aquatic ecosystem is managed.

CHAPTER 2

MATERIALS AND METHODS

Chapter Summary

The current chapter reviews the methodology used in this survey research project on management of large aquatic ecosystems. It begins with the selection of Lake Erie and the four reference ecosystems (three in U.S., one in Europe) used for the study. It outlines selection and categorization of survey respondents, then development and implementation of the survey research questionnaire itself. It concludes with a review of the data analysis which was undertaken in three ways: Analysis A involves all five ecosystems together. Analysis B focuses on Lake Erie only, stratifying respondents in two ways: by area of focus (Aquatic, Fisheries, Watershed and Ecosystem), and by type of organization (Government/Regulatory, Business/Industry, Academic and NGO). Analysis C utilizes all five ecosystems together, stratifying respondents in the two ways similar to that undertaken for Lake Erie. Through these comparative analyses, differences in perceptions of respondents in the various ecosystems become evident. Also highlighted by this methodology are differences in perceptions by various types of respondents within both the Lake Erie ecosystem and within all ecosystems viewed collectively. These analyses prove invaluable in understanding ecosystem stakeholders and providing insight into effective management strategies.

Aquatic Ecosystems Selected for Study

The large aquatic ecosystems of interest were identified. The primary focus of the project was on the Lake Erie ecosystem. Reference aquatic ecosystems to which EBM or EA were being applied were then selected. Chesapeake Bay, Tampa Bay and Puget Sound in the U.S. were chosen because of their varied approaches and time of involvement with EBM/EA. The Baltic Sea in Europe was also selected as a reference ecosystem due to its history with EBM and mandated approach to water management. However, due to the fact that nine countries with multiple languages and cultures border the Baltic Sea, this ecosystem was initially seen as optional for comparison due to the potential difficulty of obtaining sufficient data. Ultimately this was not a problem and the Baltic Sea ecosystem was included for reference.

Survey Research Questionnaire

Preliminary Study of Potential Survey Respondents

Before undertaking the survey, background research was done to identify the many types of stakeholders in the Lake Erie ecosystem. These exist at several levels: Binational (U.S., Canada), federal (U.S., Canada), U.S. states (Michigan, Ohio, Pennsylvania, New York), Province of Ontario as well as various municipalities, local governments, businesses and partnership organizations in both the U.S. and Canada. Personal interviews were then done with several leaders and stakeholders of these organizations to gain perspective on the current state of ecosystem management in the Lake Erie basin.

Targeted Survey Respondents/Stratification

For each of the five ecosystems, appropriate respondents were identified, including their email addresses. Five categories of respondents were sought initially:

- Aquatic – aquatic scientists employed primarily by government agencies (all levels), universities and NGOs
- Fisheries – fisheries managers employed primarily by government agencies (all levels) and NGOs
- Watershed – land-based managers in forestry, agriculture, etc. employed primarily by government agencies (all levels) and universities in the watershed
- Business/Industry – business owners and corporate managers in the ecosystem, both water- and land-based, including port managers, charter fishermen, marina owners, etc.
- Non-Governmental Organization (NGO) – managers employed by non-profit environmental organizations at local, regional and national levels

After field testing of survey, additional categories of respondents were added as follows:

- Ecosystem – managers employed primarily by government agencies (all levels) who have broad responsibilities involving the entire ecosystem
- Government/Regulatory – managers employed by government agencies (all levels) and/or who have regulatory responsibilities within the ecosystem
- Academic – university personnel (primarily faculty) involved with the ecosystem

Respondents were identified primarily through Web-based research and conference attendance lists. Total targeted respondents were: Lake Erie 159, Chesapeake 351, Tampa 163, Puget 160 and Baltic 152 for a total of 985.

Survey Research Questionnaire Structure and Implementation

A 30-question survey (see Appendix A) was created to administer to stakeholders in the five aquatic ecosystems to test how they perceive that various EBM criteria are

being implemented in their respective ecosystems. Of particular note was whether key parameters are being implemented on a voluntary versus legislatively-mandated basis and whether the latter would be beneficial to the ecosystem. Note: For purposes of this survey, legislative mandate was defined as referring to a legislative directive, order or law governing implementation of ecosystem management parameters. Implementation on a voluntary basis would be in the absence of such a legislative mandate. In the survey, questions 1-4 identify the respondent relative to ecosystem involvement, nature of their organization and area of focus in the ecosystem. Questions 5-24 inquire about their perceptions on implementation of EBM criteria (e.g. collaborative planning, landscape-scale focus, utilization of scientific input in decision-making, precaution, adaptive management, etc.) in their ecosystem. Questions 5-19 and 21-24 were comprised of a scale ranging from 1 to 11 where 1 indicated strong disagreement and 11 represented strong agreement plus a "don't know" option. Questions 25-28 inquire about which EBM parameters are being implemented on a voluntary basis, whether a legislative mandate exists to implement collaborative ecosystem management, which aspects are based on legislative mandate and which would benefit from such implementation. Questions 25, 27 and 28 are nominal l level items. These items contained the following response options: Collaborative planning; Clear, operational goals; planning with broad landscape-scale focus, including watershed; cross-boundary facilitation, incentives for stakeholder collaboration, integration of multiple ecosystem components and uses; integration of scientific information into management decisions; management for sustainable outcomes; precaution to avoid adverse impacts, adaptive management,

monitoring on a recurring basis, public engagement strategy, transboundary management, funding mechanisms, management for maintenance of a healthy, productive and resilient condition; control of specific pollution sources/polluters; other; none of the above; and don't know. Respondents had the option to specify the most important aspect regarding control of specific pollution sources. In addition, respondents were able to specify the EBM parameter for the "other" response. Question 29 asks whether the ecosystem condition is stable or improving. Question 29 was comprised of a scale ranging from 1 to 11 where 1 indicated strong disagreement and 11 represented strong agreement. Question 30 solicits additional comments and allows the survey respondent to receive a copy of the final results. Each question was also designed to have an open-ended portion in order for respondents to record comments and other observations relevant to each item.

The Kent State University Sociology Department Survey Research Lab (SRL) was engaged to assist with administration of the Web-based survey. The Microsoft Word version of the survey was programmed into SRL's Web survey administration program *Sensus* by SRL staff. Programming of the survey began 2 October 2009 followed by field testing by the author, the author's advisor, the author's dissertation committee, and five selected ecosystem managers and survey experts. After field testing of the survey, a determination was made to refine the self-identification of respondents to two categories: Area of focus (Aquatic, Fisheries, Watershed, entire Ecosystem) and type of organization (Government/Regulatory, Business/Industry, Academic and NGO). This enabled further stratification of respondents on the basis of these two different qualitative parameters.

The survey was launched by SRL staff to the first 100 Chesapeake Bay stakeholders as a pilot test on 10/28/09. It was then launched to the remainder of Chesapeake Bay stakeholders and stakeholders of the other four aquatic ecosystems on 11/2/09. In order to obtain information for each ecosystem as a separate entity, each ecosystem was considered a separate sample with its own survey. An identical survey was deployed six times total to the first 100 Chesapeake Bay stakeholders, the remaining Chesapeake Bay stakeholders, Tampa Bay stakeholders, Puget Sound stakeholders, Lake Erie stakeholders, and Baltic Sea stakeholders. The ecosystem samples were later merged during the data analysis process in order to assess broad scale trends.

Survey completion progress was continually tracked while the survey was in the field. SRL's survey system *Sensus* allowed real-time monitoring of completion (and non-completion) rates for respondents in all five ecosystems. The author tracked the progress on a daily basis using a Web address provided by SRL staff. The Web address directed to a Sensus summary statistics page given exclusively for this survey. The summary statistics page included the number of completed surveys, the number of incompleted surveys, and the minimum and maximum time of survey completion among the respondents as a whole.

Email reminders were sent to targeted respondents who had not yet completed the survey on approximately a weekly basis to encourage them to participate and complete the survey. Up to three of these reminders were sent to encourage survey completion. A notable increase in completed surveys was seen for each ecosystem during the four days following distribution of each reminder. The reminders and rates of increase of

respondents to the survey for the five ecosystems ranged from 61-100% after the first reminder was sent, 12-43% after the second reminder, and 12-42% after the third reminder was distributed. Some emails to respondents in each ecosystem bounced. Research was undertaken to find correct email addresses for these respondents and to resend the survey.

The survey was officially closed and removed from Web access on 12/21/09. It was judged to be successful based on the percent completion rates across the various ecosystems as follows: Lake Erie 47%, Chesapeake Bay 34%, Tampa Bay 36%, Puget Sound 34% and Baltic Sea 23%.

Data Analysis

All Ecosystems

The purpose of this analysis was to make comparisons across all five ecosystems without differentiation in the type of respondents in each ecosystem. This enabled higher-level trends and patterns to be identified.

Questions 5-24 and 29 were analyzed using data from all five ecosystems using one-way Analysis of Variance (ANOVA) and F-test of significance to determine significant differences in the implementation of EBM parameters across the five ecosystems. ANOVA is used to determine the impact a categorical independent variable has on an interval level dependent variable. The independent variables in this analysis are each of the five ecosystems. The dependent variables are each of the scaled items (questions 5-24 and 29). Thus, ANOVA was used to understand the differences in

perceptions of stakeholders from the five ecosystems regarding implementation of each of the EBM parameters. The perception by stakeholders of extent of implementation of the EBM parameters in the various ecosystems was measured using the mean value of the dependent variables. To avoid skewing the mean value for each question, "don't know" responses were considered as missing values and ignored for calculating the means, while retaining the cases. The F-test of significance was used to assess any significant difference between the mean value for each dependent variable across the five ecosystems.

To further analyze higher level trends from questions 5-24 and 29 for all systems, the multivariate analysis method Principal Component Analysis (PCA) was selected. Using these questions as variables, PCA was applied using varimax rotation to identify potential components for further analysis. Ultimately, two components with eigenvalues greater than 1 were identified. These are as follows:

> **Component 1: EBM** (ecosystem-based management parameters)
> Eigenvalue: 5.646
> Percent of variance explained: 47.0
> Derived from grouping the following eight survey questions:
>
> 5. Ecosystem management planning is done on a collaborative basis to engage diverse stakeholder groups.
>
> 6. A comprehensive ecosystem management plan which integrates the needs of diverse stakeholder groups is present for the ecosystem.
>
> 9. A cross-boundary facilitator which aids the diverse stakeholder groups in reaching consensus on issues and resolving conflicts is present.
>
> 11. There is recognition of the interconnectedness between species and the interconnectedness among land, air and aquatic aspects of the ecosystem in the management plan for the ecosystem.

12. There is recognition of the integration of ecological, social, economic and institutional perspectives in the management plan for the ecosystem.

14. Societal and economic information is sought and used as important input for decisions on how the ecosystem is managed.

15. The ecosystem management strategy is to seek sustainable outcomes which will enable the ecosystem to function effectively into the future.

17. Adaptive management is being applied for managing the ecosystem.

Component 2: Positive Outcomes (in the ecosystem)
Eigenvalue: 1.584
Percent of variance explained: 13.2
Derived from grouping the following four survey questions:

21. Funding is adequate and sustainable to effectively manage the ecosystem.

22. Management of the ecosystem has proceeded successfully from planning stages to the implementation phase, and is now resulting in desired outcomes.

24. The ecosystem management strategy has been effective in maintaining the ecosystem in a healthy, productive and resilient condition.

29. According to available monitoring results, the condition of the ecosystem over the past ten years is stable or improving.

Two scales were thus created, for EBM and Positive Outcomes. The EBM scale is comprised of key parameters important to implementation of ecosystem-based management, e.g. collaborative planning, cross-boundary facilitation, adaptive management, etc. The Positive Outcomes scale represents attributes indicating ecosystem management success including successful transition from planning to implementation, stable or improving ecosystem condition, etc. Means were calculated for the two scales as follows: For the EBM scale it involves a summation of responses to the eight questions upon which the scale is based (see above), with the total divided by eight.

Likewise, for the Positive Outcomes scale it involves a summation of responses for the four questions upon which it is based (see above), with the total divided by four. The resulting means were observed to be 7.4695 for the EBM scale and 5.4631 for the Positive Outcomes scale. These values relate to the scale for survey responses which ranged from 1 (strong disagreement) to 11 (strong agreement). Reliability of the EBM and Positive Outcomes scales was tested, with both found to be reliable with Cronbach's Alpha values of .891 and .842, respectively. For scale questions, "don't know" responses were treated as missing values and mean replacement was used to avoid skewing the means. Correlations between key variables (EBM, Positive Outcomes, presence of mandate (Question 26), ecosystem condition (Question 29), etc.) were then determined using data from all systems.

Questions 25, 27 and 28 were analyzed using combined data from all five ecosystems together using crosstabs and chi-square test of significance to determine which ecosystem management parameters were seen to be implemented on a voluntary basis (question 25), on a legislative mandate basis (question 27) and which characteristics would be desirable to have implemented on a legislative mandate basis (question 28). Question 26 asked whether a legislative mandate exists to implement collaborative ecosystem management in each ecosystem so only those who responded "yes" to question 26 answered question 27. The highest three values for each ecosystem were then highlighted on each data table. Crosstabs are used for nominal level variables to calculate counts and percentages for two or more variables. Thus crosstabs were used to assess how each ecosystem – Lake Erie, Chesapeake Bay, Puget Sound, Tampa Bay and Baltic

Sea – responded to the implementation (e.g., voluntary, mandated, or desired mandate) of each EBM parameter. A chi-square test was used to determine if there were any significant differences between the stakeholders of each ecosystem in their responses to the implementation of each EBM parameter, and significance was noted with a Y (yes) or N (no). For questions 25, 27 and 28, a mean percentage of respondents across all parameters for each of the five ecosystems was calculated as an indication of strength of agreement with the given question.

The qualitative responses from the open-ended portion of each question in the survey were summarized for each ecosystem. The resulting themes and patterns were then used to further interpret the quantitative data gathered.

Lake Erie Respondent Stratification

The purpose of this analysis was to make comparisons among respondents from the Lake Erie ecosystem. To accomplish this, respondents were stratified in two ways: by area of focus (Aquatic, Fisheries, Watershed, entire Ecosystem) and by type of organization (Government/Regulatory, Business/Industry, Academic and NGO). The same analytical techniques (ANOVA with F-test of significance, PCA and crosstabs with chi-square test of significance) and qualitative-response supplementation which were used previously with the all ecosystems analysis were applied for this determination.

All Ecosystems Respondent Stratification

The purpose of this analysis was to make comparisons among respondents from all five ecosystems combined. This was accomplished by stratifying them in two ways:

by area of focus (Aquatic, Fisheries, Watershed, entire Ecosystem, Other) and by type of organization (Government/Regulatory, Business/Industry, Academic, NGO, Other). The same analytical techniques (ANOVA with F-test of significance, PCA and crosstabs with chi-square test of significance) and qualitative-response supplementation which were used previously with the all ecosystems analysis were applied for this determination.

CHAPTER 3

RESULTS

Chapter Summary

The current chapter begins with a review of the project's findings regarding relationships between EBM and other key parameters for the ecosystems in the study. The reader is encouraged to review the management survey (Appendix A) utilized in the project to facilitate understanding of results. Overall results from the study are presented in the dashboard summary of key characteristics for all ecosystems from survey results (Table 3 Page 61). To maintain clarity, one must keep in mind the analytical framework used as there are several facets to be considered. To review, data analysis was undertaken in three ways: Analysis A involves a comparison using all five ecosystems together to look at differences in perceptions among respondents. Analysis B focuses on Lake Erie only, stratifying respondents in two ways: by area of focus (Aquatic, Fisheries, Watershed and Ecosystem), and by type of organization (Government/Regulatory, Business/Industry, Academic and NGO) to reveal differences in perceptions. Analysis C utilizes all five ecosystems together, stratifying respondents in the two ways similar to that undertaken for Lake Erie to compare perceptions of respondents. In general, there were positive correlations between the PCA-derived scales for EBM implementation and

Positive Outcomes for all ecosystems collectively and each individually, as well as for stratifications for all ecosystem respondents collectively (stratifications were different for Lake Erie alone). Negative correlations were seen with increasing ecosystem size, and no correlation was seen between presence of a mandate for implementation with Positive Outcomes.

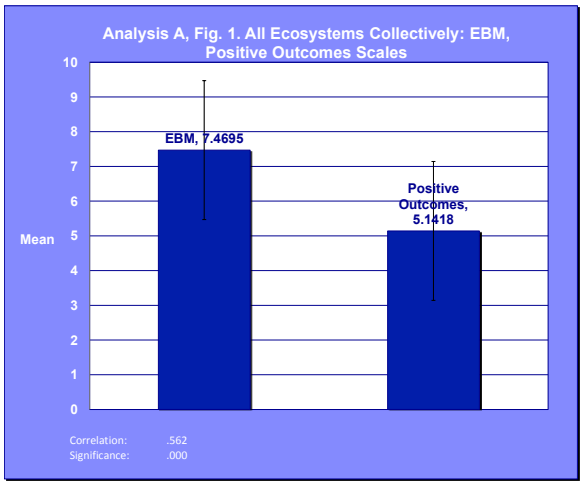
With Lake Erie being the primary focus of the study, a detailed review of results for this ecosystem is then undertaken. For many EBM parameters, Lake Erie had the lowest means of the five ecosystems surveyed (indicating strongest disagreement with successful implementation), second in number only to Chesapeake Bay. This pointed out many opportunities for improvement in management of the ecosystem. Significant contrasts in perceptions by stakeholders were also seen, particularly Aquatic versus Watershed/Ecosystem, and Government/Regulatory versus Academic. These disconnects in understanding of ecosystem management dynamics highlight a key facet of the challenge to effective management of the Lake Erie ecosystem.

Stakeholder perceptions of ecosystem management attributes are important, but they are not always accurate. Thus, the final portion of this section undertakes an exhaustive review of perceptions (from the survey) versus realities of important ecosystem management characteristics, by ecosystem, including respondent stratifications. Characteristics such as EA/EBM, voluntary versus legislatively-mandated implementation, ecosystem condition, diverse stakeholder perspectives, public engagement and leadership organizations are all examined in detail. Considering alignment (or in some instances, misalignment) between perceptions and realities of

characteristics of these ecosystems provides additional perspective toward creating effective management strategies for these systems.

Relationship of EBM to Positive Outcomes for Large Aquatic Ecosystems

From the current survey research, it is clear that many ecosystem stakeholders believe there is a positive relationship between implementation of EBM and positive outcomes for their respective ecosystems (various correlations shown in Figures 1-8; additional tables in Appendix B). It was shown that there is a significant, strong positive correlation between the EBM and Positive Outcomes scales for all ecosystem stakeholders collectively (Figure 1), and for each ecosystem individually (Figure 3). Similarly, there is a significant, moderate positive correlation between the EBM scale and ecosystem condition (Question 29) for all ecosystem stakeholders collectively (Figure 2), and significant positive correlations for Chesapeake Bay and Tampa Bay when the ecosystems are viewed individually (Figure 4). The correlation between presence of a legislative mandate to implement collaborative ecosystem management and Positive Outcomes using all ecosystems was not significant (Table B26 in Appendix B). It was noted that with increasing ecosystem size, there was a weak negative correlation with effective EBM implementation (Table B28 in Appendix B) as the challenges increase. Similarly, Positive Outcomes (Table B29 in Appendix B) and Ecosystem Condition (Table B30 in Appendix B) were seen to have a moderate negative correlation with ecosystem size as it becomes more difficult to achieve successful restoration and preservation at larger scales.



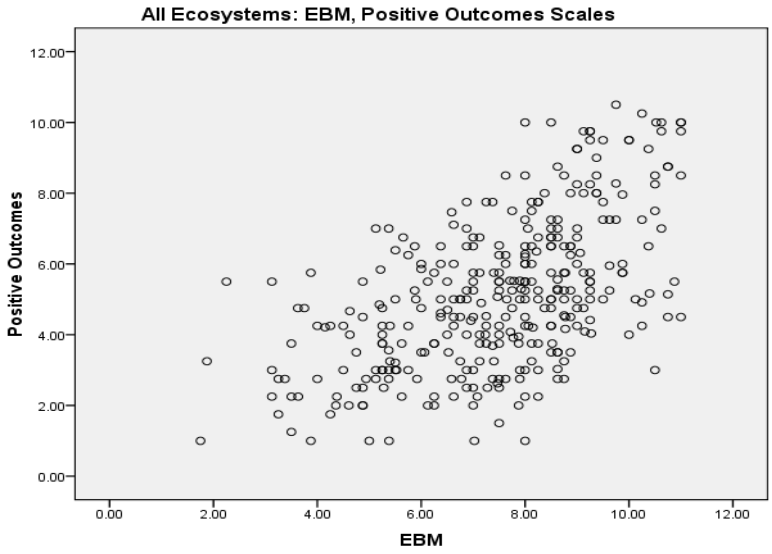


Figure 1. Means for the PCA-derived EBM and positive outcomes scales, correlation between the two and scatterplot representation from a comparison across all ecosystems collectively.

Figure 1. The mean for the EBM scale (7.4695) was higher than that for the Positive Outcomes scale (5.1418), indicating stronger agreement with EBM implementation than with resulting positive outcomes. The correlation coefficient between the EBM and Positive Outcomes scales was significant at the 0.01 level, and indicated a strong positive correlation between the two variables at .562.

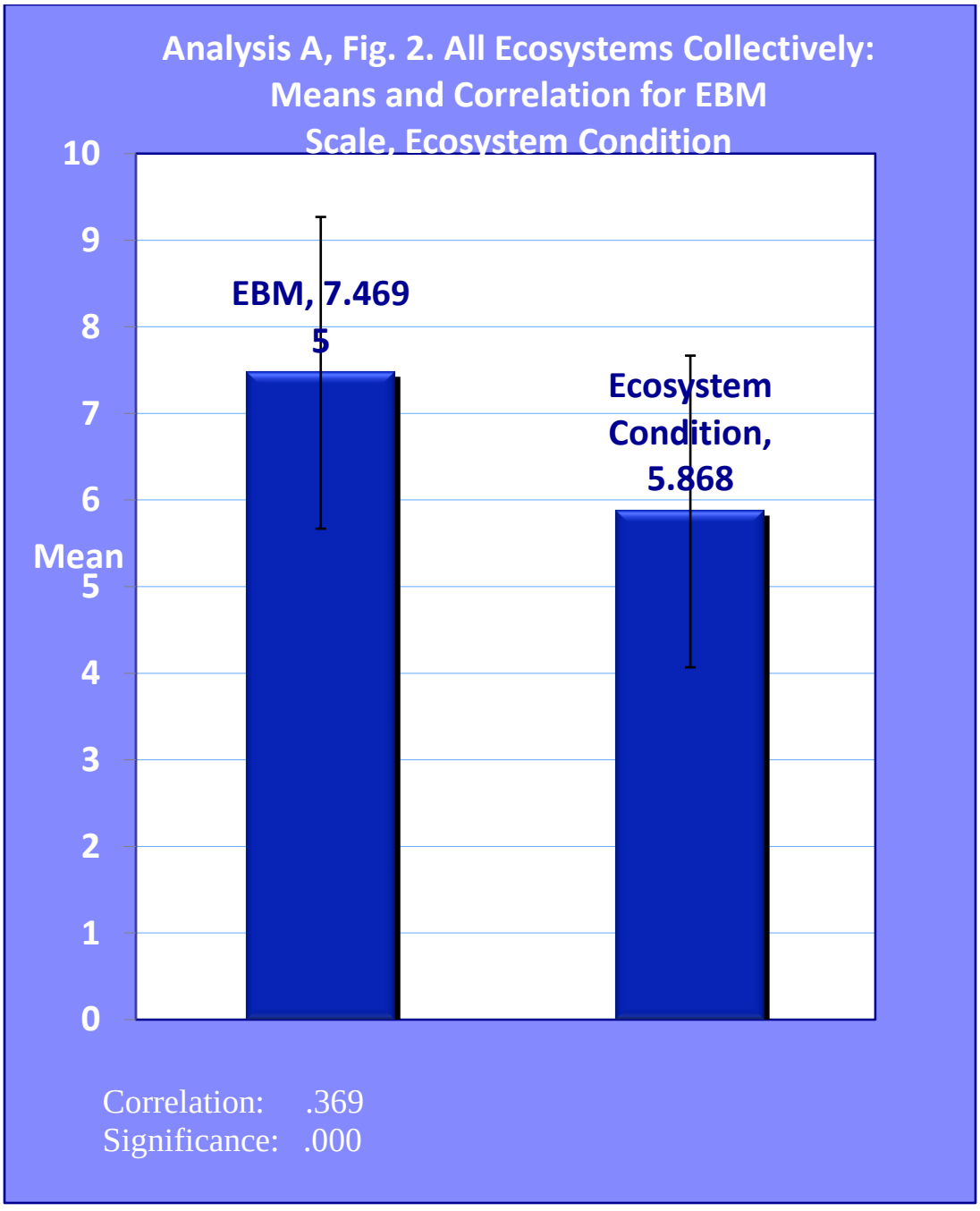


Figure 2. Means for the PCA-derived EBM scale and ecosystem condition parameter and correlation between the two from a comparison across all ecosystems collectively.

Figure 2. The mean for the EBM scale (7.4695) was higher than that for Question 29 regarding whether the ecosystem condition is stable or improving (5.8680), indicating stronger agreement with EBM implementation than with resulting ecosystem condition. The correlation coefficient between the EBM scale and Question 29 regarding whether the ecosystem condition is stable or improving was significant at the 0.01 level, and indicated a moderate positive correlation between the two variables at .369.

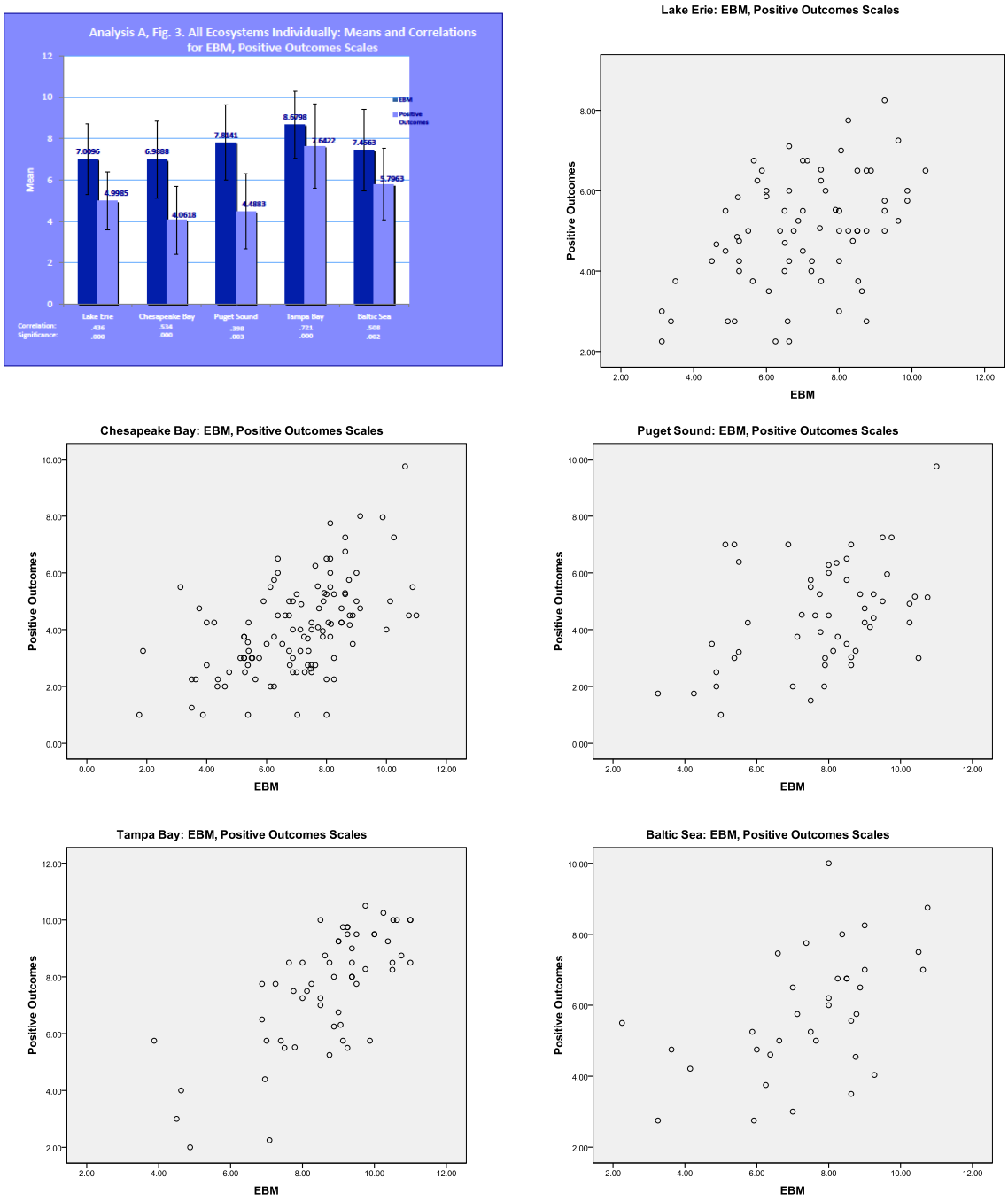


Figure 3. Means for the PCA-derived EBM and positive outcomes scales, correlations between the two and scatterplot representations for each ecosystem individually.

Figure 3. The means for the EBM scale were higher than those for the Positive Outcomes scale for each ecosystem, indicating stronger agreement with EBM implementation than with resulting positive outcomes for each system. For the EBM scale, Tampa Bay (8.6798) had the highest mean and Chesapeake Bay (6.9888) had the lowest mean. Similarly, for the Positive Outcomes scale, Tampa Bay (7.6422) had the highest mean and Chesapeake Bay (4.0618) the lowest mean. The correlation coefficient between the EBM and Positive Outcomes scales was significant at the 0.01 level for each system. Strong positive correlations were shown for Tampa Bay (.721), Chesapeake Bay (.534) and Baltic Sea (.508). Moderate positive correlations were shown for Lake Erie (.436) and Puget Sound (.398).

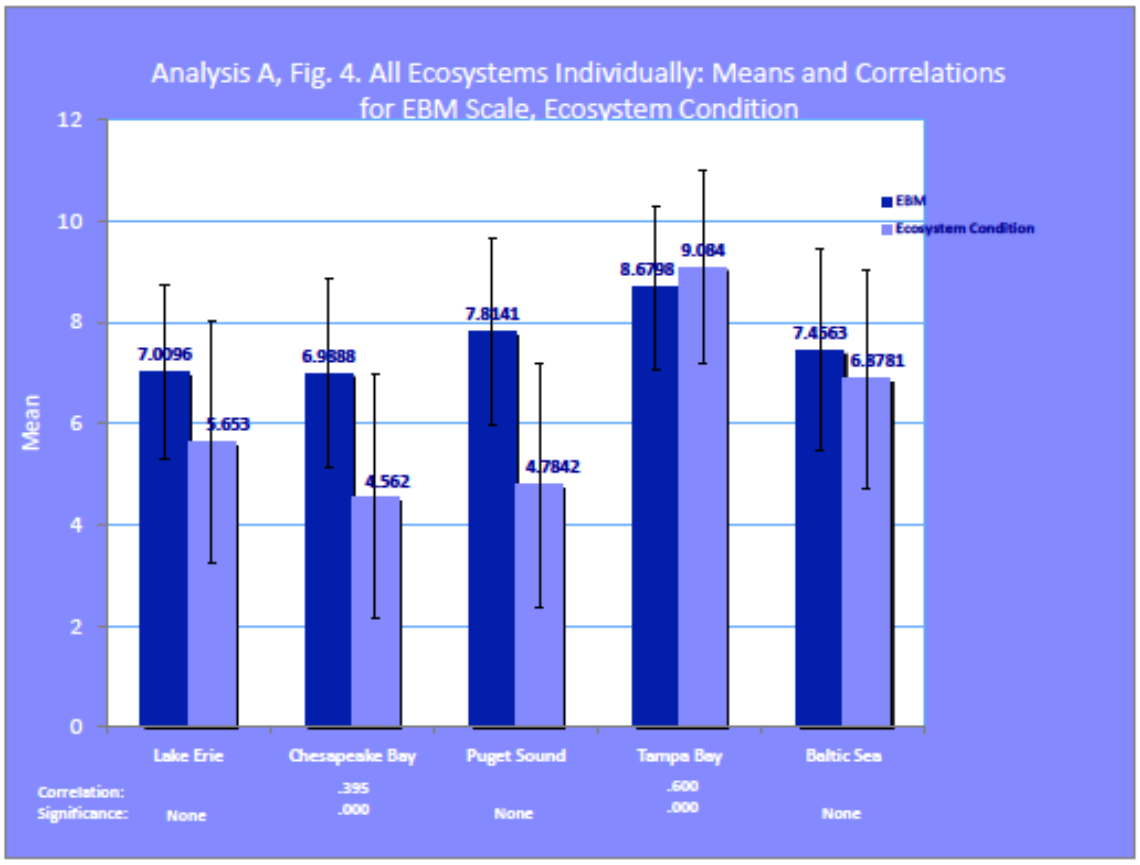


Figure 4. Means for the PCA-derived EBM scale and ecosystem condition parameter and correlation between two, if any, for each ecosystem individually.

Figure 4. The means for the EBM scale were higher than those for Question 29 regarding ecosystem condition is stable or improving for each ecosystem except Tampa Bay, indicating stronger agreement with EBM implementation than with resulting positive ecosystem condition for each system except Tampa Bay. For the EBM scale, Tampa Bay (8.6798) had the highest mean and Chesapeake Bay (6.9888) had the lowest mean. Similarly, for Ecosystem Condition, Tampa Bay (9.0840) had the highest mean and Chesapeake Bay (4.5620) the lowest mean. The correlation coefficient between the EBM scale and Question 29 regarding whether the ecosystem condition is stable or improving was significant for only Tampa Bay and Chesapeake Bay. Tampa Bay showed a strong positive correlation (.600), while Chesapeake Bay had a moderate positive correlation (.395).

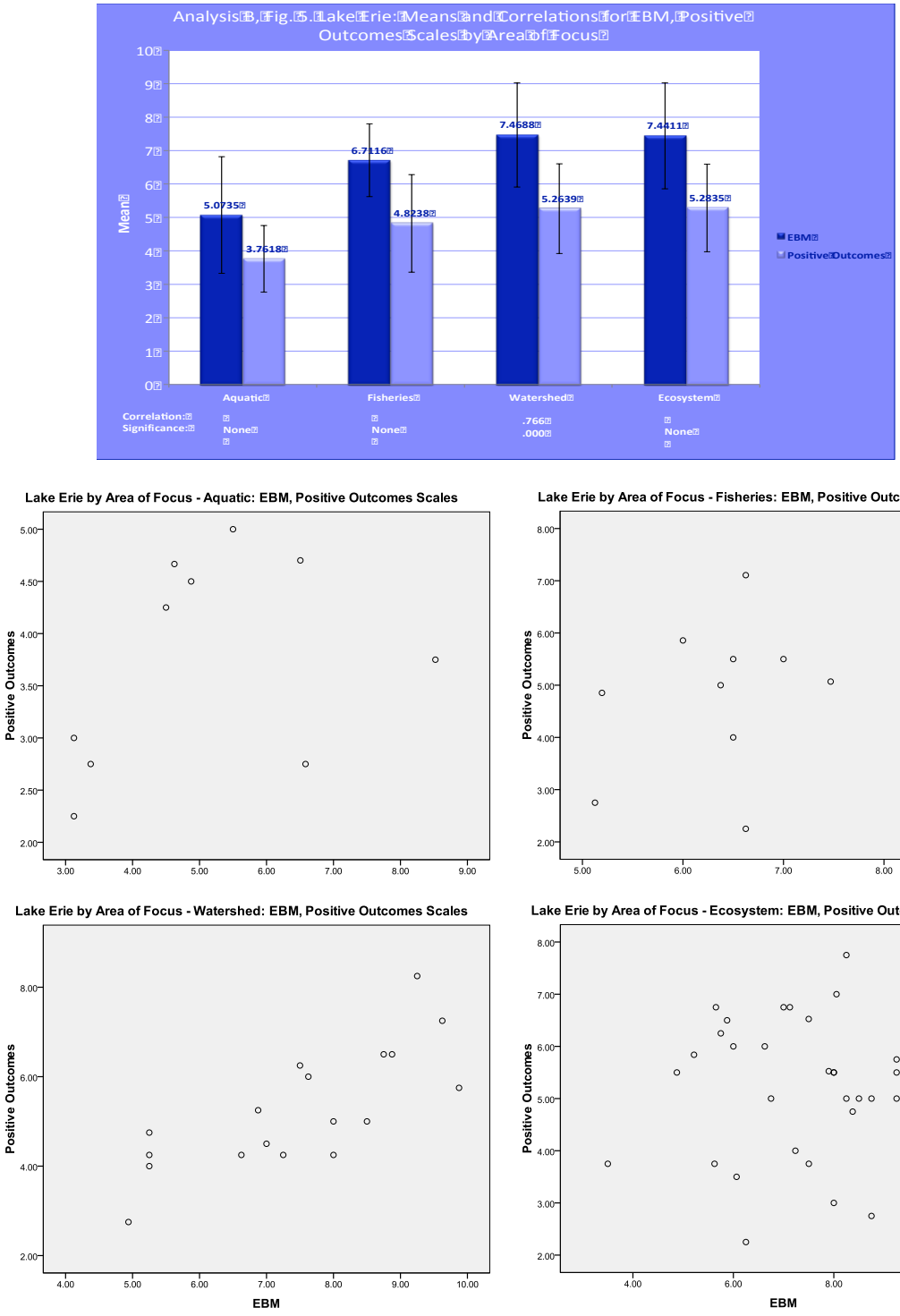
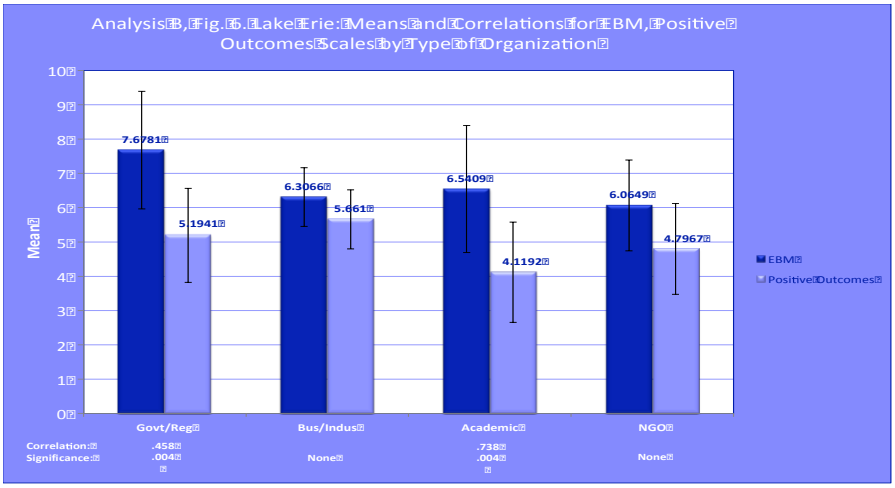


Figure 5. Means for the PCA-derived EBM and positive outcomes scales, correlations between the two, if any, and scatterplot representations for Lake Erie respondents by area of focus.

Figure 5. The means for the EBM scale were higher than those for the Positive Outcomes scale for each area of focus, indicating stronger agreement with EBM implementation than with resulting positive outcomes for each area of focus. For the EBM scale, Ecosystem (7.4411) had the highest mean and Aquatic (5.0735) the lowest mean. Similarly, for the Positive Outcomes scale, Ecosystem (5.2835) had the highest mean and Aquatic (3.7618) the lowest mean. The correlation coefficient between the EBM and Positive Outcomes scales was significant for only Watershed, which showed a strong positive correlation between the two variables at .766.



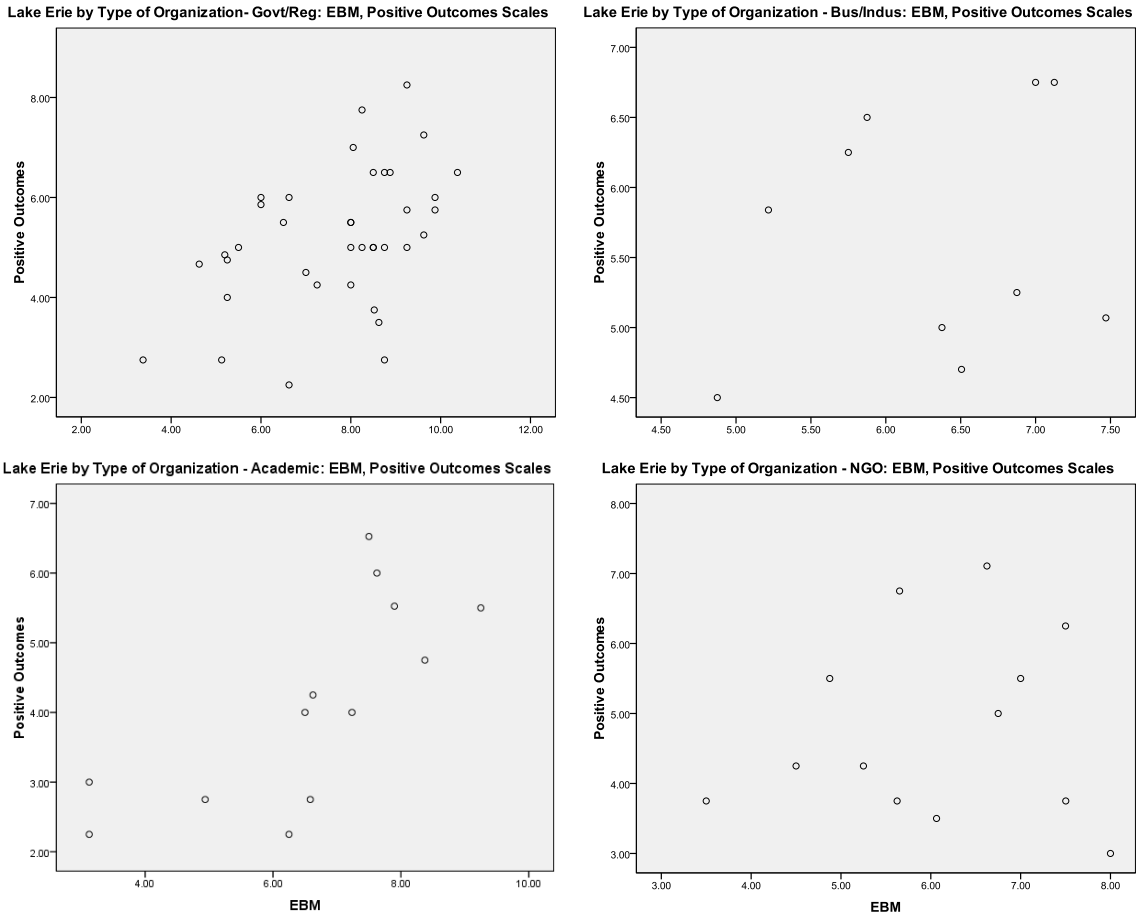


Figure 6. Means for the PCA-derived EBM and positive outcomes scales, correlations between the two, if any, and scatterplot representations for Lake Erie respondents by type of organization.

Figure 6. The means for the EBM scale were higher than those for the Positive Outcomes scale for each type of organization, indicating stronger agreement with EBM implementation than with resulting positive outcomes for each type of organization. For the EBM scale, Government/Regulatory (7.6781) had the highest mean and NGO (6.0649) the lowest mean. For the Positive Outcomes scale, Business/Industry (5.6610) had the highest mean and Academic (4.1192) the lowest mean. The correlation coefficient between the EBM and Positive Outcomes scales was significant for Government/Regulatory and Academic. Academic (.738) showed a strong positive correlation, while Government/Regulatory (.458) showed a moderate positive correlation.

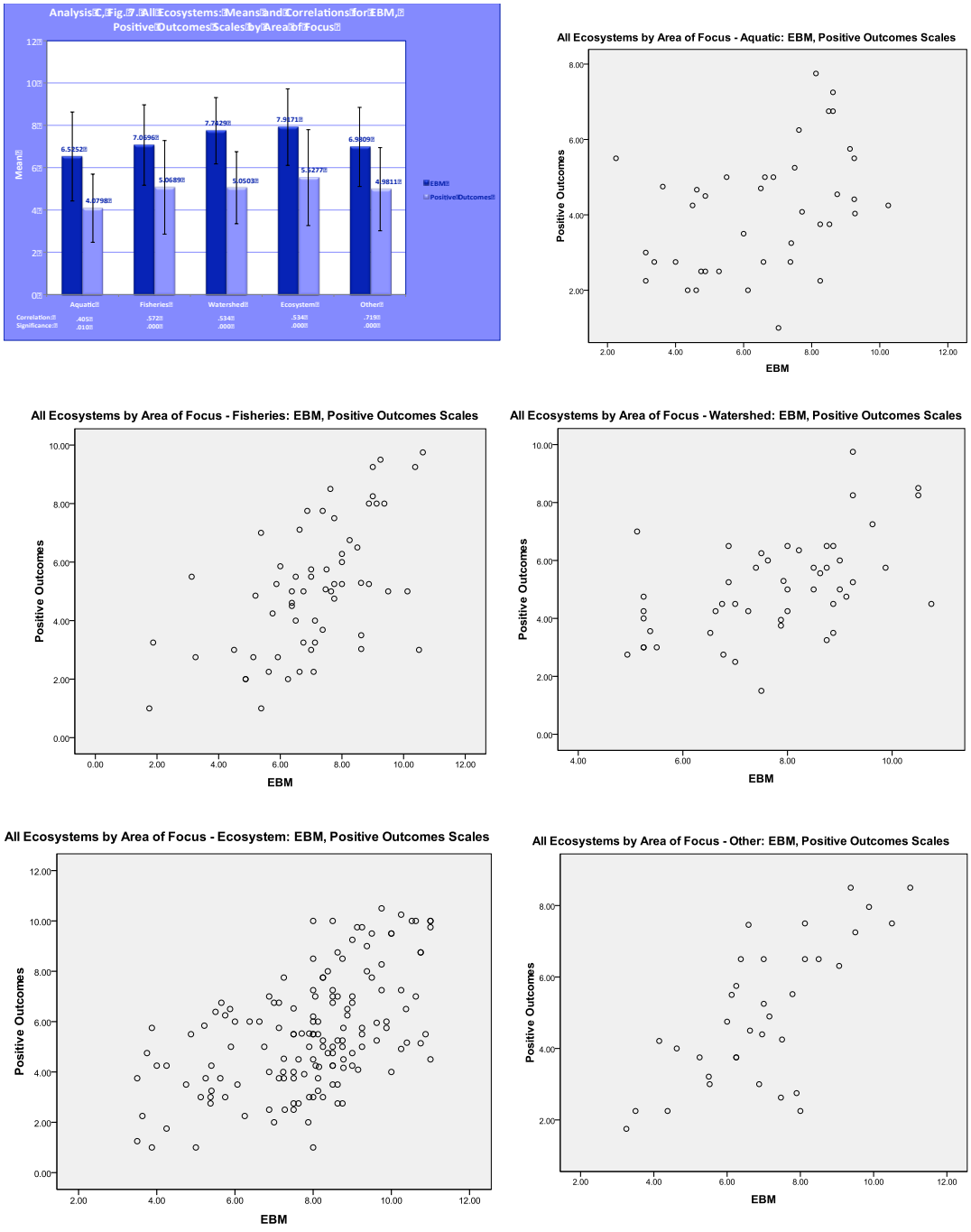


Figure 7. Means for the PCA-derived EBM and positive outcomes scales, correlations between the two, and scatterplot representations for all ecosystem respondents by area of focus.

Figure 7. The means for the EBM scale were higher than those for the Positive Outcomes scale for each area of focus, indicating stronger agreement with EBM implementation than with resulting positive outcomes for each area of focus. For the EBM scale, Ecosystem (7.9171) had the highest mean and Aquatic (6.5254) the lowest mean. Similarly, for the Positive Outcomes scale, Ecosystem (5.5277) had the highest mean and Aquatic (4.0798) the lowest mean. The correlation coefficient between the EBM and Positive Outcomes scales was significant for all areas of focus. All areas of focus had strong positive correlations except Aquatic, which had a moderate positive correlation between the two variables at .405.

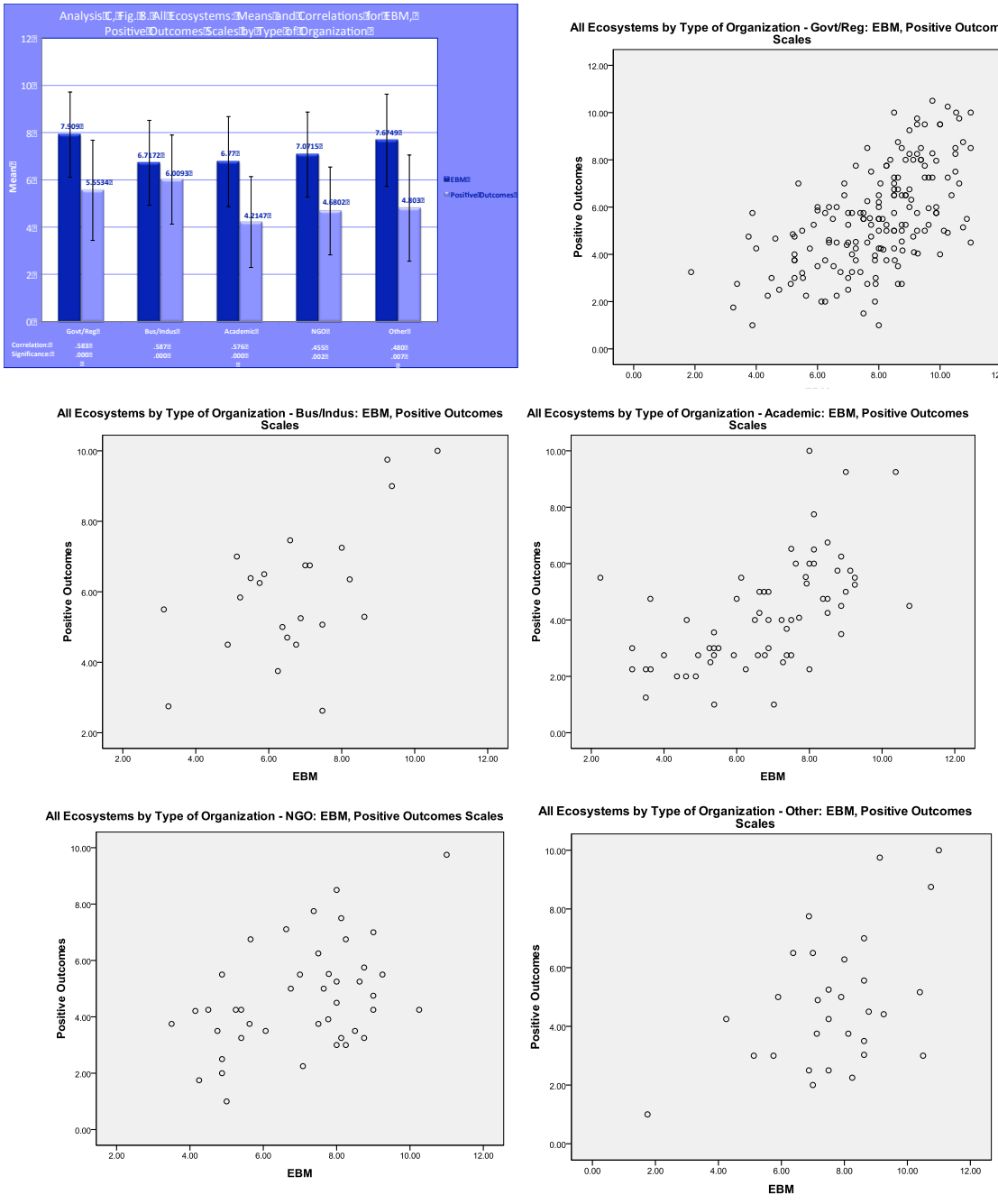


Figure 8. Means for the PCA-derived EBM and positive outcomes scales, correlations between the two, and scatterplot representations for all ecosystem respondents by type of organization.

Figure 8. The means for the EBM scale were higher than those for the Positive Outcomes scale for each type of organization, indicating stronger agreement with EBM implementation than with resulting positive outcomes for each type of organization. For the EBM scale, Government/Regulatory (7.9090) had the highest mean and Business/Industry (6.7172) the lowest mean. For the Positive Outcomes scale, Business/Industry (6.0093) had the highest mean and Academic (4.2147) the lowest mean. The correlation coefficient between the EBM and Positive Outcomes scales was significant for all types of organizations. Business/Industry (.587), Government/Regulatory (.583) and Academic (.576) showed a strong positive correlation, while Other (.480) and NGO (.455) showed a moderate positive correlation.

When viewed on a stratified basis for all ecosystems, the trend of a positive correlation between EBM and Positive Outcomes continues. All ecosystem stakeholders as characterized by area of focus (Figure 7) and type of organization (Figure 8) were seen to have a significant, moderate to strong positive correlation between the EBM and Positive Outcomes scales. Thus there is collectively a positive feeling that implementation of EBM and positive outcomes for the respective ecosystems go hand in hand.

The correlations between EBM and Positive Outcomes for Lake Erie respondents on a stratified basis were not as compelling. When viewed by area of focus (Figure 5), only Watershed was significant, with a strong positive correlation. When viewed by type of organization (Figure 6), only Government/Regulatory and Academic showed significant positive correlations. Thus, although Lake Erie had a significant, moderate positive correlation overall, there does not seem to be uniform confidence that implementation of EBM in the Lake Erie ecosystem will yield the desired positive outcomes. Therefore, key principles to facilitate EBM implementation success in Lake Erie and other large aquatic ecosystems will be put forth.

Summary of Research Findings with Focus on Lake Erie

Lake Erie comprises a complex ecosystem from both a scientific and management standpoint. Regarding the implementation of ecosystem-based management parameters in Lake Erie, survey respondents reflected this complexity and the resulting challenge to successful management of the ecosystem in their survey input. From Analysis A, Table B1 in Appendix B shows second-lowest scores (only to Chesapeake Bay in most cases)

regarding presence of a comprehensive ecosystem management plan, clear goals and objectives present and management plan utilizing a broad landscape-scale focus. This is because there is not one management plan for Lake Erie, but several including the Lake Erie Lakewide Management Plan (LaMP), fishery management plan of the Great Lakes Fishery Commission's Lake Erie Committee, Lake Erie Millennium Network initiative to identify, prioritize and pursue research needs, implementation of the Remedial Action Plans in the 12 Lake Erie areas of concern, implementation of wildlife management plans, etc. Attempts at coordination between the four U.S. states and one Canadian province which border Lake Erie by groups such as Ohio Lake Erie Commission, Ohio Sea Grant, Lake Erie Millennium Network, International Joint Commission, etc. are positive, but the mean score was next to lowest on the cross-boundary facilitator parameter as there is not currently one coordinating organization present for the ecosystem. This attribute of multiple facilitators provided Lake Erie with nearly the lowest score of all ecosystems except Tampa Bay (which is not actually transboundary) on the question of the transboundary nature of the ecosystem making management planning and implementation very difficult, meaning that respondents generally disagreed with this statement. Fortunately, it was agreed broadly (for Lake Erie as well as other ecosystems surveyed) that scientific input is actively sought for ecosystem management decisions. However, Lake Erie had the lowest mean values of the five ecosystems on societal and economic information being used as important input, adaptive management being applied and monitoring being undertaken on a recurring basis so there are important management criteria absent from current decision making. Also, working

against effective collaboration among the multitude of Lake Erie stakeholders, Lake Erie had a low mean value among the five ecosystems on incentives present to encourage collaboration and the lowest value on the presence of an effective public engagement strategy.

The majority of Lake Erie respondents believe that collaborative planning (66.2%), integration of scientific information (56.8%) and planning with a broad landscape-scale focus (55.4%) are being implemented on a voluntary basis (Table B2 in Appendix B). This coincides with Table B3 in Appendix B which shows Lake Erie as having the second lowest percentage (46.0%) of respondents believing that there is a legislative mandate present to implement collaborative ecosystem management, although almost a quarter (24.3%) of respondents didn't know whether a mandate was present. Each of the five ecosystems studied has some EA/EBM parameters which are being voluntarily implemented and some which are mandated, but there is a predominant operating mode for each. For Lake Erie, the predominant mode is voluntary implementation of EA/EBM parameters. Among those that believe a legislative mandate exists for Lake Erie (Table B4 Appendix B), two of the same parameters that were highest scoring as voluntary, collaborative planning and integration of scientific information, are among the highest-scoring as mandated. That illustrates the importance of these parameters to respondents but lack of agreement on what the factors are driving implementation of these criteria. For example, the Lake Erie LaMP which is a collaborative planning document was called for by the Great Lakes Water Quality Agreement of 1972 (renewed in 1978 and amended by Protocol in 1987) and was to

define the management intervention needed to bring Lake Erie back to chemical, physical and biological integrity, and to further define agency commitments to those actions (Vincent and Letterhos, 2008). Thus the LaMP plan was a mandated initiative. Similarly, the Great Lakes Fisheries Commission put forth a Joint Strategic Plan for Management of Great Lakes Fisheries (1985, revised in 1997) to which all the partner state, provincial, tribal and federal agencies were signatory and pledged their commitment. However, there are other ecosystem management plans for Lake Erie including watershed areas, etc. (e.g. for Western Lake Erie Basin), etc. Most of these are being implemented on a voluntary basis. Even the Lake Erie LaMP plan which was mandated by the GLWQA is not seen as having strength of enforcement, thus compromising its effectiveness and amounting to voluntary implementation. Other examples exist where there are planning initiatives and scientific exchanges but often they are not being done due to legislative mandate nor do they involve effective enforcement and penalties. Thus the characterization that implementation of EA/EBM criteria for Lake Erie is voluntary. When asked what aspects that are not currently mandated would benefit from being mandated for Lake Erie (Table B5 Appendix B), the highest-scoring response for Lake Erie was incentives for stakeholder collaboration (41.9%) (and was among the highest scoring parameters for the other systems except Chesapeake Bay). Scoring second highest for Lake Erie was funding mechanisms (and was in the top three for all other ecosystems as well). Thirdly was integration of social and economic information which was not among the highest three parameters in any other ecosystem. This parameter is important due to the intense use of the Lake Erie ecosystem for commercial (fishing, shipping, port activity),

agricultural, industrial, residential as well as recreational (swimming, fishing, boating) uses.

Viewing Lake Erie respondents on a stratified basis by area of focus (Aquatic, Fisheries, Watershed and entire Ecosystem) and type of organization (Government/ Regulatory, Business/Industry, Academic, NGO) in Analysis B provides additional insights into management of this ecosystem. Viewing responses by area of focus in Appendix B Table B6, most respondents identified with Ecosystem focus, the next highest category being Watershed. In general, Aquatic respondents had the lowest scores on most management parameters. This category also had the lowest score (i.e. disagreed most strongly) that the transboundary nature makes management planning and implementation difficult indicating effective transboundary scientific cooperation. Watershed and Ecosystem respondents had the highest scores related to the various planning parameters, indicating broad participation in the collaborative planning processes. Fisheries respondents generally had scores between the two extremes on most parameters, but the qualitative commentary was quite positive. As summarized by one respondent: “The Great Lakes Fishery Commission (GLFC) is the best example of effective leadership with strong connectivity between vision, goals & objectives, strategic planning, research & monitoring, and use of scientific information as driver of resource management & policy.” Thus the GLFC’s publication “Fish-Community Goals and Objectives for Lake Erie” (Ryan et al. 2003) describes not only fish stock goals and assessments, but has endorsed additional objectives regarding desired ecosystem conditions and a cooperative, inter-jurisdictional approach to fisheries management.

Regarding Table B7 in Appendix B, Watershed had the greatest proportion of respondents (51.4%) regarding believing parameters are voluntarily implemented, whereas Aquatic respondents had the lowest scores. This is reflective of the observation that there is a disconnect between Aquatic and Watershed respondents in the Lake Erie ecosystem. Interestingly, Aquatic also had the lowest score (30.0%) regarding believing there is a legislative mandate to implement collaborative ecosystems management (Table B8 Appendix B). In contrast, Ecosystem respondents had the highest percentage (55.9%) regarding a legislative mandate being present and regarding believing parameters are being implemented via legislative mandate (Table B9 Appendix B). Appendix B Table B10 illustrates that Aquatic respondents had the highest scores regarding believing parameters would benefit from a legislative mandate, with incentives for stakeholder collaboration (60.0%) and clear, operational goals (50.0%) ranking at the top. This again reflects a lack of integration in the overall planning process. In contrast, Fisheries respondents had the least proportion of respondents (13.3%) regarding believing parameters would benefit from a legislative mandate. This contrasts with Aquatic stakeholders and reflects a disconnect between Aquatic and Fisheries respondents. Thus, in the Lake Erie ecosystem, a three-way disconnect between Aquatic, Fisheries and Watershed/Ecosystem stakeholders is evident when viewed by area of focus. This disconnect is supported by the PCA analysis which showed that for Lake Erie, unlike the consolidated profile for all ecosystem stakeholders together, only Watershed respondents had a significant positive correlation between EBM and Positive Outcomes when viewed by area of focus (Figure 5 Page 44).

Viewing responses by type of organization in Appendix B Table B11, most respondents identified with Government/Regulatory organization, with the next highest being Academic and NGO (tied). Business/Industry had the smallest representation in the stratification. In general, Government/Regulatory respondents had higher scores on these parameters (indicating agreement that these were being implemented successfully) than Business/Industry, Academic and NGO respondents. It is seen that Academic respondents had the lowest scores on more parameters than other types of organizations. In contrast, Government/Regulatory had the highest scores on more parameters than other types of organizations. These included key criteria such as collaborative planning, management proceeding from planning to implementation, presence of strong leadership and effective management strategy to maintain a healthy ecosystem. Several contrasting views existed between Business/Industry and Academic respondents indicating their different perceptions on effectiveness of the planning process, funding and ecosystem condition. Government/Regulatory had the greatest proportion of respondents (44.1%) regarding believing parameters are being voluntarily implemented, whereas in contrast NGO had the lowest proportion of respondents (21.6%) believing voluntary implementation is occurring so their perception is quite different (Table B2 in Appendix B). Scores regarding believing there is a legislative mandate to implement collaborative ecosystems management were relatively similar (40.0-47.4%) across the types of organizations (Table B13 in Appendix B). However, 40.0% of Business/Industry respondents indicated they did not know whether a mandate exists, contrasted with only 15.4% of Academic respondents. Of those that believe a legislative mandate exists to implement collaborative

ecosystem management (Table B14 Appendix B), Government/Regulatory had the lowest scores regarding believing parameters are being implemented via mandate (which aligns with this category having the highest scores on voluntary implementation). In contrast, Academic respondents had the highest percentage of respondents believing a legislative mandate exists for implementation, and that additional parameters would benefit from being implemented on this basis (Table B15 Appendix B). In contrast, Business/Industry respondents were least enthusiastic (14.0%) regarding believing that parameters would benefit from being implemented on a legislative mandate basis. This is consistent with their viewpoint that funding is adequate and the condition of the ecosystem is good and improving. Thus there are contrasting opinions among the four types of organizations regarding implementation of the EA/EBM parameters in Lake Erie, with Government/Regulatory being most positive. This resonates with the PCA analysis which showed that for Lake Erie, unlike the consolidated profile for all ecosystem stakeholders together, only Government/ Regulatory and Academic respondents had a significant positive correlation between EBM and Positive Outcomes when viewed by type of organization (Figure 6 Page 46).

Stakeholder Perceptions versus Realities in Lake Erie and Reference Aquatic Ecosystems

The commentary in this section reviews the following key characteristics of all five ecosystems, looking at the perceptions of survey respondents versus realities in each:

1. Ecosystem Approach/Ecosystem-Based Management
2. Voluntary Versus Legislatively Mandated Implementation of EA/EBM Criteria

3. Ecosystem Condition
4. Perspectives of Diverse Ecosystem Stakeholders
5. Public Engagement
6. EA/EBM Leadership Organizations

Each topic above (except 4) includes the following sequence of ecosystems reviewed:

- Lake Erie
- Lake Erie Respondent Stratification (by area of focus, type of organization)
- Chesapeake Bay
- Puget Sound
- Tampa Bay
- Baltic Sea
- All Ecosystems Respondent Stratification (by area of focus, type of organization)

A dashboard summary of key characteristics for all ecosystems from survey results is shown in Table 3 as follows:

Table 3

Dashboard Summary of Key Characteristics for All Ecosystems from Survey Results

Key Characteristics	Ecosystems				
	Lake Erie	Chesapeake Bay	Puget Sound	Tampa Bay	Baltic Sea
1. Ecosystem Approach/ Ecosystem-Based Management	Philosophy adopted: Yes Successfully implemented: No	Philosophy adopted: Yes Successfully implemented: No	Philosophy adopted: Yes Successfully implemented: TBD (new)	Philosophy adopted: Yes Successfully implemented: Yes	Philosophy adopted: Yes Successfully implemented: Yes
2. Predominantly Voluntary versus Legislatively Mandated Implementation	Voluntary	Voluntary	Mandated	Voluntary	Mandated
3. Ecosystem Condition (last 10 years)	Degrading	Degrading	Mixed	Improved	Degraded but improving
4. Perspectives of Diverse Ecosystem Stakeholders	By area of focus: Disconnect between Aquatic, Fisheries and Watershed/ Ecosystem respondents. By type of organization: Disconnect between Government/ Regulatory, Business/ Industry, Academic and NGO respondents				
	By area of focus: Disconnect between Aquatic, Fisheries and Watershed/Ecosystem respondents. By type of organization: Disconnect between Government/Regulatory, Business/Industry, Academic and NGO respondents.				
5. Public Engagement	Weak	Moderate, Uneven	Strong	Strong	Weak
6. EA/EBM Leadership Organizations	Multiple	Chesapeake Bay Program	Puget Sound Partnership	Tampa Bay Estuary Program	HELCOM

The environmental integrity of Lake Erie is dependent not only on various characteristics and stressors within the lake itself, but also on influences from throughout the Lake Erie watershed and beyond. Many factors such as urban sprawl, extensive agriculture, industrial presence, climate change, shoreline development, non-invasive species, alteration of natural lands and presence of contaminants from outside the Lake Erie basin all impact its health. On a broader scale, the International Joint Commission (IJC) has adopted the ecosystem approach in its International Watersheds Initiative (IWI) which focuses on the 5,500 mile border between Canada and the United States, involving more than 300 lakes and rivers including the Great Lakes (IJC 2009). The premise is that water resource issues can be anticipated, prevented or resolved at the local level first, thus avoiding escalation into international issues. This requires an integrated, ecosystem approach which considers interrelationships in the entire watershed and not just the lakes themselves. Emerging environmental, economic and social challenges – often involving conflicting interests – make a broad watershed, or ecosystem, approach very desirable to attain balanced solutions. Hartig, Zarull and Law (1998) argued early on that due to limited success with earlier approaches to managing the Great Lakes that a broader ecosystem approach to management must be adopted. They noted that anthropogenic stresses were initially local. However, their cumulative effects and human impacts over large spatial and short time scales have resulted in many negative and in some cases irreversible alterations to the Great Lakes ecosystem. These same anthropogenic impacts are being seen in Lake Erie. Thus the case for adoption of an ecosystem approach has been compelling.

In contrast, survey respondents from the Lake Erie ecosystem disagreed that many key parameters of EA/EBM were being pursued. For example, Table B1 (Appendix B) in Analysis A shows that when asked whether societal and economic information is sought and used as important input for decisions on how the ecosystem is managed (question 14), Lake Erie respondents disagreed more strongly than respondents from the other four ecosystems. Another key criterion for EA/EBM is the application of adaptive management. The Binational Executive Committee (BEC) overseeing the LaMPs including that for Lake Erie endorsed the application of the concept of adaptive management to the LaMP process. The LaMPs are to employ a dynamic process with iterative elements, such as periodic reporting. Utilizing the adaptive management principle should allow the process to change and build upon lessons learned, successes, new information, changes in the lake and public input. However, when asked about whether adaptive management is being applied for managing the ecosystem, whereby a course of action is undertaken, the results evaluated and the course of action revised on a specific time table to respond to changing ecosystem conditions and attributes (Table B1 Appendix B, question 17), Lake Erie respondents disagreed most strongly of those from the five ecosystems. Monitoring is also an important EA/EBM parameter. The Lake Erie LaMP is said to focus on measuring ecosystem health, sorting out the stressors involved in impairing the lake and evaluating the effectiveness of programs in resolving the stress by continuously monitoring the ecosystem response. However, once again, when Lake Erie respondents were asked whether monitoring of the ecosystem on a recurring basis to detect and track changes in key parameters (e.g. water quality, habitat loss/restoration,

etc.) is occurring (Table B1 Appendix B, question 18) they disagreed most strongly of respondents in all five ecosystems. Similarly, Lake Erie respondents disagreed most strongly of those in the five ecosystems that an effective public engagement strategy is present to inform and involve the general public in the ecosystem management initiative and to enlist their support for this effort (Table B1 Appendix B, question 19). Public engagement is a critical parameter in a successful EA/EBM program to enlist their support and political influence of this holistic management approach. Effective, integrated ecosystem management planning is another key criterion of a broad EA/EBM approach. Lake Erie respondents expressed stronger disagreement than respondents from three of the other four ecosystems that a comprehensive ecosystem management plan which integrates the needs of diverse stakeholder groups is present for the ecosystem (Table B1 Appendix B, question 6), that there are clear goals and objectives present in the management plan used for managing the ecosystem (Table B1 Appendix B, question 7), and that the ecosystem management plan utilizes a broad landscape- or regional-scale focus, including the water body and its watershed (Table B1 Appendix B, question 8).

Lake Erie Respondent Stratification

Viewing Lake Erie respondents on a stratified basis by area of focus (Aquatic, Fisheries, Watershed and entire Ecosystem) and type of organization (Government/ Regulatory, Business/Industry, Academic, NGO) in Analysis B provides additional insights into implementation of EA/EBM parameters in the Lake Erie Ecosystem. When viewed by area of focus, it is seen in Table B6 Appendix B that Aquatic respondents

most strongly disagreed that EA/EBM parameters were being implemented successfully. This respondent category is primarily comprised of scientists who are very familiar with the dynamics of the lake. Watershed and Ecosystem categories agreed most strongly with successful implementation of EA/EBM planning parameters. This aligns with the fact that these categories have broad perspective on overall ecosystem management processes involved for the ecosystem.

As viewed by type of organization for Lake Erie (Table B11 Appendix B), the Academic category most strongly disagreed with successful EA/EBM implementation on more parameters than other organizational respondents. In contrast, Government/ Regulatory stakeholders agreed most strongly with EA/EBM implementation success on more parameters than other types of organizations. This category is in large part held responsible for the management program's success. Conversely, Academic respondents were in the range of stronger disagreement that successful EA/EBM implementation is occurring in Lake Erie.

Thus there are discrepancies between the EA management philosophy officially adopted for Lake Erie and the views of Lake Erie ecosystem stakeholders regarding whether these parameters are being successfully implemented. It is clear that there is a significant gap between the desired EA philosophy and reality.

Chesapeake Bay

EA/EBM has been officially embraced as the preferred management strategy for the Chesapeake Bay ecosystem. In 1983 and 1987, the states of Virginia, Maryland, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission and the U.S.

Environmental Protection Agency representing the federal government signed historic agreements that established the Chesapeake Bay Program partnership to protect and restore the Chesapeake Bay's ecosystem. Chesapeake Bay Program's Chesapeake Bay 2000 agreement commits to several EA/EBM parameters for living resource protection and restoration: To recognize the interconnectedness of the Bay's living resources and the importance of protecting the entire natural system; manage harvest levels with precaution to maintain their health and stability and protect the ecosystem as a whole; conduct actions in an integrated and coordinated manner; continually monitor, evaluate and revise to adjust to the dynamic nature of the Bay (adaptive management); and to advance the ecosystem approach from a single-system perspective to ecosystem functions and shift from single-species to multi-species management (Chesapeake Bay Program 1999). The Chesapeake 2000 agreement goes beyond the original focus of the program on water quality with actions to address habitat, living resources, sound land use within the watershed, and even individual stewardship. A hallmark of this program was the setting of ambitious quantitative goals and timelines (Boesch 2006). Indeed the U.S. Commission on Ocean Policy (2004) pointed to the Chesapeake Bay Program as a model for regional ecosystem-based management.

However, Chesapeake Bay respondents to the survey saw many problems regarding adoption of EA/EBM parameters in reality. In fact, Chesapeake Bay respondents disagreed most strongly on more EA/EBM parameters being present than respondents from any other of the five ecosystems surveyed. This included strongest disagreement that a comprehensive ecosystem management plan which integrates the

needs of diverse stakeholder groups is present for the ecosystem (Table B1 Appendix B, question 6) and that there are clear goals and objectives present in the management plan used for managing the ecosystem (Table B1 Appendix B, question 7). Thus EA/EBM success in the Chesapeake Bay ecosystem is yet to be recognized by respondents in this ecosystem.

Puget Sound

Puget Sound stakeholders have also adopted the EA/EBM management model. In 2007, Governor Christine Gregoire proposed and the Legislature created the Puget Sound Partnership to reverse Puget Sound's decline and restore it to health by 2020. An Action Agenda was released by the Puget Sound Partnership in 2008 which outlined the immediate and long-tem actions to restore and protect Puget Sound. The Puget Sound Action Agenda represented a new way of approaching the management of Puget Sound as compared with previous models. It took an ecosystem approach from the crest of the Cascades and Olympics to the waters of the Strait of Juan de Fuca and Hood Canal (Puget Sound Partnership 2008). It integrated scientific assessment with community priorities and established a set of integrated actions needed to protect and restore Puget Sound. It was intended to form the basis for cooperation and collaboration among implementing partners. It was designed to be adaptable and was intended to be changed over time (adaptive management). Diverse groups from federal and state agencies, tribes, city and county governments and other agencies, businesses, environmental organizations, watershed groups, landowners and citizens stated their support for the

Action Agenda and their willingness to implement their role toward ecosystem restoration.

Relative to the other ecosystems surveyed, there is satisfaction with progress of EA/EBM implementation to date in the Puget Sound ecosystem (understanding that the Action Agenda came into being relatively recently, i.e. within the past two years). This is indicated by mid-range agreement scores (i.e. neither highest nor lowest) on most questions relative to EA/EBM parameter implementation (Table B1 Appendix B).

Tampa Bay

Tampa Bay stakeholders have clearly adopted an EA/EBM framework for holistic management of their ecosystem; however the terms EA and EBM do not appear specifically in their materials. The Tampa Bay Estuary Program (TBEP) was established by Congress in 1991 to assist the region in developing and implementing a comprehensive plan for Bay improvement. TBEP was a partnership of the U.S. Environmental Protection Agency; Florida Department of Environmental Protection; Southwest Florida Water Management District; Hillsborough, Pinellas and Manatee counties; and the cities of Tampa, St. Petersburg and Clearwater. TBEP was successful in developing a Comprehensive Conservation and Management Plan (CCMP) called *Charting the Course* for Tampa Bay. The original CCMP was adopted in 1996 and contained six Action Plans for Bay improvement. The plans were participatively developed and sought input from bay managers, advocates, key industries and citizens from throughout the region with the mindset that a healthy bay is the cornerstone for a prosperous economy (Tampa Bay Estuary Program 2006). The CCMP contains clear

goals and priorities, quantitative targets, priority for monitoring and public engagement and other EA/EBM criteria. In 1998, the original nine partners and six other partners signed a formal Interlocal Agreement, and ancillary agreements, pledging to achieve the goals of the newly-completed CCMP. How those goals were achieved was left largely to individual communities, who could select from among a range of acceptable alternatives enabling flexibility and cost-effective implementation.

In alignment with this integrated, collaborative approach, Tampa Bay survey respondents reflected significantly and consistently higher agreement (i.e. highest agreement scores on all questions except two in Table B1 Appendix B) with effective EA/EBM parameter implementation than respondents from the other ecosystems surveyed. This included all parameters involving planning, scientific input, sustainable management strategy, use of precaution, monitoring, public engagement, successful transition from planning to implementation resulting in desired outcomes and effective leadership, among others. This positive perspective of Tampa Bay respondents led to the highest agreement rating of all ecosystems regarding the ecosystem management strategy having been effective in maintaining the ecosystem in a healthy, productive and resilient condition so it can provide the services humans want and need.

Baltic Sea

Regarding the Baltic Sea, the HELCOM Baltic Sea Action Plan (HELCOM, 2007) fully embraces the principles of EA/EBM. EA is acknowledged from the outset, beginning in the Preamble of the document: “Acknowledging that the ecosystem approach is based on an integrated management of all human activities impacting on the

marine environment and, based on best available scientific knowledge about the ecosystem and its dynamics, identifies and leads to actions improving the health of the marine ecosystem thus supporting sustainable use of ecosystem goods and services. . .” Other parameters of EA/EBM are embedded in the operating principles agreed upon by the contracting parties, including consideration of economic and socio-economic goals for sustainable development, maintenance of biodiversity, monitoring and assessment, quantitative targets, adaptive management and more. As noted by Backer et al. (2009), the Action Plan is a regional intergovernmental program of measures for the protection and management of the marine environment explicitly based on the ecosystem approach. It strongly links Baltic marine environmental concerns to important socio-economic fields such as agriculture and fisheries and promotes cross-sectoral tools including marine spatial planning.

Relative to the other ecosystems surveyed, there is satisfaction with progress of EA/EBM implementation to date in the Baltic Sea ecosystem (understanding that the Action Plan was implemented in 2007). This is indicated by mid-range agreement scores (i.e. neither highest nor lowest) on most questions relative to EA/EBM parameter implementation (Table B1 Appendix B).

All Ecosystems Respondent Stratification

Viewing data on respondents from all five ecosystems combined on a stratified basis by area of focus (Aquatic, Fisheries, Watershed, entire Ecosystem and Other) and type of organization (Government/Regulatory, Business/Industry, Academic, NGO and Other) in Analysis C provides additional insights into implementation of EA/EBM

parameters in these ecosystems. When viewed by area of focus, it is seen in Table B16 (Appendix B) that Aquatic respondents most strongly disagreed that EA/EBM parameters were being implemented successfully. This respondent category is primarily comprised of scientists who are very familiar with the dynamics of the water bodies. Ecosystem category respondents agreed most strongly with successful implementation of EA/EBM planning parameters. This aligns with the fact that these categories have broad perspective on overall ecosystem management processes involved for the ecosystem. Fisheries respondents agreed most strongly of all categories on the parameter of the ecosystem condition is stable or improving. The Other category contained respondents who most strongly disagreed with the parameters of scientific input being sought and that the management strategy was seeking sustainable outcomes. Other respondents most strongly agreed that the transboundary nature of the ecosystem makes management very difficult.

As viewed by type of organization for all ecosystems combined (Table B21 Appendix B), the Business/Industry category most strongly disagreed with successful EA/EBM implementation on more parameters than other organizational respondents, followed closely by Academic respondents. Government/Regulatory stakeholders agreed most strongly with EA/EBM implementation success. These stakeholders are in large part held responsible for the management program's success. Business/Industry stakeholders agreed most strongly on parameters related to funding and ecosystem condition. Other organizational category respondents most strongly agreed with success on several EA/EBM parameters. In general, Government/Regulatory and Other respondents most

strongly agreed regarding success of EA/EBM implementation in these five aquatic ecosystems.

2. Voluntary versus Legislatively Mandated Implementation of EA/EBM Criteria

Lake Erie

As noted earlier, the Lake Erie ecosystem has a mandated EA/EBM planning process as required by the Great Lakes Water Quality Agreement (GLWQA) of 1972 (renewed in 1978 and amended by Protocol in 1987) which has resulted in the Lake Erie LaMP, but implementation of these EA/EBM criteria via the many existing plans in reality is primarily being done on a voluntary basis. This holds true for the fisheries sector. For Lake Erie and the Great Lakes in general, fisheries managers from the U.S., Canada, U.S. tribes, federal agencies in Canada and the U.S. and the binational IJC all have a role in Great Lakes fisheries management. These independent (yet interdependent) fisheries managers work collectively through *A Joint Strategic Plan for Management of the Great Lakes Fisheries*, a voluntary, multi-jurisdictional agreement signed in 1981 (GLFC 2007). Thus, although there are federal (U.S. and Canadian), provincial and state regulations to govern specific aspects of the Lake Erie ecosystem, implementation of the planning process is primarily on a voluntary basis.

In Analysis A, Table B2 in Appendix B shows that Lake Erie respondents most strongly agreed that collaborative planning, integration of scientific information and planning with a broad landscape-scale focus were accomplished on a voluntary basis, which is true. In Table B3 Appendix B, less than half (46%) of respondents indicated a

belief that a legislative mandate exists to implement collaborative ecosystem management. This percentage regarding belief that a legislative mandate exists is second lowest among the five ecosystems. As noted earlier, a mandate exists for planning in Lake Erie vis-à-vis the GLWQA but implementation is primarily being accomplished on a voluntary basis. When asked which parameters which are not currently mandated would benefit from being mandated, the strongest responses were in the categories of incentives for stakeholder collaboration, funding mechanisms and integration of social and economic information. These resonate strongly with the current state of ecosystem management in Lake Erie. One of the strong themes by respondents is that there are many plans and initiatives underway. Stronger incentives for collaboration, if present, could lead to better integration of protection and restoration efforts and more effective management efforts. The interest in mandated funding mechanisms is being addressed by the Obama administration through the Great Lakes Restoration Initiative (this survey project was completed prior to GLRI implementation). As noted earlier, strong interest exists in increased integration of social and economic information into ecosystem management for Lake Erie due to the ecosystem's intense productivity and use for its fisheries, recreational uses and agriculture and industry in the watershed.

Lake Erie Respondent Stratification

When viewed on a stratified basis by area of focus for Lake Erie (Analysis B, Table B7 Appendix B), it is seen that the Watershed respondents agreed most strongly that parameters are being implemented on a voluntary basis. This agrees with the perception expressed in comments by many that agriculture (both animal and plant)

produces significant nonpoint runoff of nutrients which ultimately leads to eutrophication of the lake and is currently being voluntarily managed, an issue which many feel needs to be addressed. Table B8 in Appendix B shows that only for Ecosystem respondents did more than half (55.9%) agree that a legislative mandate exists for implementing EA/EBM parameters. Interesting, Aquatics agreed most strongly that parameters would benefit from mandated implementation (Table B10 Appendix B) as they are "on the ground" dealing with the multiple stressors in the lake due to invasive species, eutrophication from terrestrial runoff, etc.

When viewed on a stratified basis by type of organization for Lake Erie (Table B12 Appendix B), Government/Regulatory respondents agreed most strongly that parameters are being implemented on a voluntary basis. Table B13 in Appendix B shows that in no category of respondents did greater than half agree that a legislative mandate exists. Table B15 Appendix B shows that Academics agreed most strongly that aspects would benefit from implementation via a legislative mandate and included ongoing management (versus planning) parameters such as precaution, adaptive management, integration of social and economic information, etc. Many in this category of respondents are "on the ground" scientists who understand the ecosystem and its intricacies most thoroughly and realize its needs for effective management. In contrast, Business/Industry felt the least need for additional mandated parameters as many of their comments expressed the opinion that too many mandates exist already.

Chesapeake Bay

Chesapeake Bay has historically had a primarily voluntary basis for implementing EA/EBM parameters despite the presence of the Clean Water Act of 1972 and other laws. Lack of ecosystem management success prompted a change. With the issuance on May 12, 2009 of Executive Order 13508 on Chesapeake Bay Protection and Restoration by President Obama, the Chesapeake Bay ecosystem shifted to a more mandated approach. The Executive Order strengthens federal government leadership and intervention by several agencies in the ecosystem management process. It resulted in creation of the *Strategy for Protecting and Restoring the Chesapeake Bay Watershed* (Federal Leadership Committee for the Chesapeake Bay 2009) which outlines federal leadership as well as collaborative work with the many state and local governments, businesses, NGOs and residents in an EBM framework. Being recently implemented (2009), it's effectiveness in ecosystem protection and restoration for Chesapeake Bay will take time to be demonstrated.

In Analysis A, Table B2 (Appendix B) shows that Chesapeake Bay stakeholders agreed most strongly that integration of scientific information, collaborative planning, monitoring and public engagement were being voluntarily implemented. Many attributed this to the actions of the Chesapeake Bay Program which was established in 1983. It has formal but voluntary agreements with its many partners to accomplish ecosystem management objectives. Table B3 in Appendix B indicates that slightly more than half (53.1%) of Chesapeake respondents believe that a mandate exists to implement collaborative ecosystem management. Table B4 in Appendix B indicates that seven

EA/EBM parameters received the three highest scores regarding which criteria were thought to be implemented on a mandated basis by those believing there was a mandate for the ecosystem. This is likely influenced by the Executive Order and resulting plan which strongly endorses all of these parameters. Respondents agreed that the ecosystem would benefit from having funding mechanisms, management for sustainable outcomes and precaution mandated among EA/EBM parameters as well.

Puget Sound

The Puget Sound ecosystem is implementing EA/EBM on primarily a legislatively mandated basis based on state law in Washington. Specifically, at the direction of Governor Christine Gregoire, the Washington State legislature enacted Senate Bill 5372 on April 20, 2007 which triggered the formation of a new state agency and a public-private partnership. The Puget Sound Partnership was created with the goal of restoring Puget Sound to health by the year 2020. This resulted in creation of the collaborative Puget Sound Action Agenda implemented in 2008 which contains four principles and hundreds of specific goals to be met.

In Analysis A, Table B2 (Appendix B) shows that Puget Sound stakeholders agreed that collaborative planning, public engagement and integration of scientific information were the EA/EBM parameters being most strongly implemented on a voluntary basis. However, these values were generally lower than in other U.S. systems for similar parameters indicating a more mandatory influence. Puget Sound had the highest percentage of respondents (74.1%) believing there was a mandate to implement collaborative ecosystem management (Table B3 Appendix B), and generally higher

percentages on more parameters being implemented via mandate (Table B4 Appendix B) than the other ecosystems. This agrees with the mandated basis of the ecosystem. Only funding mechanisms and incentives for stakeholder collaboration were indicated specifically as desired additions for mandated parameters as most others are included in the current mandate for Puget Sound.

Tampa Bay

Tampa Bay stakeholders have implemented EA/EBM on primarily a voluntary basis, but with a strong regulatory backbone of enforced mandates in place. Regulations exist at the federal and state level pertaining to management of the ecosystem. For example, at the federal level there is the Tampa Bay National Estuary Program which implements programs to reduce/eliminate harmful effects including a grass-roots effort to reduce runoff into the bay. Due to pressure from its citizenry, the State of Florida enacted the Grizzle-Figg Act in 1978 to reduce loadings from wastewater treatment plants into Tampa Bay. This led to significant reductions of nitrogen released into the Bay and improvement in water quality and habitat restoration in the ecosystem. However, much of the ecosystem management activity is coordinated by the Tampa Bay Estuary Program formed in 1991 on a voluntary basis. For example, a Nitrogen Management Consortium was established in 1996 to address long-term nitrogen management. The voluntary group, including electric utility, industry and agricultural representatives along with local governments and regulatory agencies, gained national acclaim for its efforts to reduce nitrogen loadings to the bay, above and beyond requirements of individual entities. The process was so effective that it satisfied state and federal requirements for establishing a

Total Maximum Daily Load for the bay, thereby achieving through consensus what otherwise would have required additional mandates. Steps have been taken to step up enforcement of existing environmental laws in the Tampa Bay region to reinforce these positive environmental initiatives, particularly by local governments in the area. In addition, as a potential substitute for law enforcement, there are a growing number of community-driven boater education initiatives, such as those developed by Tampa BayWatch to foster good environmental stewardship among boaters and anglers, while also serving as additional eyes on the water to report violations.

Keeping in mind the voluntary nature of EA/EBM implementation with a regulatory backbone in Tampa Bay, it is seen that these respondents had higher percentage scores on successful implementation of more EA/EBM parameters than in the other ecosystems surveyed (Analysis A, Table B2 Appendix B). Strongest agreement was achieved on the criteria of integration of scientific information, monitoring and collaborative planning. Tampa Bay had the lowest percentage (39.7%) of respondents believing that there was a mandate to implement collaborative ecosystem management of all ecosystems surveyed (Table B3 Appendix B) which is in alignment with primarily voluntary EA/EBM implementation. Likewise, only funding mechanisms and incentives for stakeholder collaboration were specifically suggested as benefitting from implementation on a legislatively mandated basis.

Baltic Sea

The Baltic Sea ecosystem has implemented EA/EBM on primarily a legislatively mandated basis. In fact, there are several legislative mandates which apply to the Baltic

Sea ecosystem. In 2000 the European Union Water Framework Directive (EC 2000) was adopted to meet the increasing demand by citizens and environmental organizations in Europe for cleaner rivers and lakes, groundwater and coastal beaches. It requires that surface freshwater and ground water bodies be ecologically sound by 2015. The goal of the Marine Strategy Framework Directive adopted in 2008 (EC 2008) is in line with the objectives of the WFD of 2000. The Marine Strategy Framework Directive aims to protect more effectively the marine environment across Europe. Its purpose is to achieve good environmental status of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. The Marine Strategy Framework Directive embodies the environmental component of the European Union's future maritime policy, designed to achieve the full economic potential of oceans and seas in harmony with the marine environment. More specific to the Baltic Sea, the Helsinki Commission (HELCOM) Baltic Sea Action Plan which was adopted by the coastal countries of the Baltic Sea and European Union in 2007 is a regional intergovernmental program of measures for the protection and management of the Baltic Sea marine environment. Thus there are several legislative mandates governing the management of the Baltic Sea ecosystem.

This mandated approach was reflected in the survey responses by the Baltic Sea stakeholders. In Analysis A, Table B2 (Appendix B) it is seen that the Baltic Sea had relatively low scores regarding parameters being implemented on a voluntary basis, with only integration of scientific information receiving a relatively high percentage of support. The parameter of collaborative planning, which was among the highest three

scoring parameters in all other ecosystems, received only 20.0% support by Baltic Sea ecosystem stakeholders. In line with the mandated approach, 62.9% of Baltic Sea respondents indicated that a mandate exists for collaborative ecosystem management (Table B3 Appendix B). Their highest three mandated parameters were monitoring, integration of scientific information and control of specific pollution sources (Table B4 Appendix B), reflecting a more mandated approach for the ecosystem. Stakeholders expressed interest in several additional parameters being mandated including clear goals, planning with a landscape-scale focus, collaborative planning and incentives for collaboration (Table B5 Appendix B), indicating a desire for a less compartmentalized, more collaborative approach to management of the ecosystem.

All Ecosystems Respondent Stratification

When viewed on a stratified basis by area of focus for respondents from all ecosystems together (Analysis C, Table B17 Appendix B), it is seen that the Watershed respondents agreed most strongly with most parameters being implemented on a voluntary basis. This agrees with the perception expressed in comments by stakeholders in several of the ecosystems that agriculture particularly produces significant nonpoint runoff of nutrients in the respective watersheds which ultimately leads to eutrophication of these ecosystems and is currently being voluntarily managed in some systems, an issue which many feel needs to be addressed. In contrast, Aquatic had the lowest percentage of respondents agreeing that parameters were being voluntarily implemented as there are many specific water quality targets present for these ecosystems. Table B18 in Appendix B shows that Ecosystem and Watershed categories had the highest percentage of

respondents who agreed that a legislative mandate exists for implementing EA/EBM parameters. Fisheries respondents had the lowest percentage agreeing that a legislative mandate exists, as in some systems fisheries are managed on a voluntary collaborative basis. Interestingly, Aquatic stakeholders agreed most strongly regarding parameters which would benefit from mandated implementation (Table B20 Appendix B), with incentives, clear goals, management for sustainable outcomes and funding mechanisms receiving the highest scores.

When viewed on a stratified basis by type of organization for respondents from all ecosystems together (Table B22 Appendix B), Government/Regulatory respondents agreed most strongly that parameters were being implemented on a voluntary basis. Other had the lowest percentage regarding believing parameters are being implemented on a voluntary basis. Table B23 in Appendix B shows that Government/Regulatory respondents had the highest score regarding agreeing there is a legislative mandate to implement collaborative ecosystem management because this category is primarily responsible for overseeing implementation of these mandates. This was followed by NGO respondents who had the second highest score as this category seeks to promote environmental activism and enforcement of mandates which do exist. Business/Industry had the lowest score for mandated implementation of EA/EBM parameters and, interestingly, this category also had the lowest percentage regarding believing voluntary implementation is occurring. Table B25 Appendix B shows that NGO respondents agreed most strongly that aspects would benefit from implementation via a legislative mandate as they seek to promote environmental activism and enforcement of mandates for

environmental preservation and restoration. In addition to funding mechanisms, incentives for collaboration and integration of social and economic information were their highest priorities for new mandates. Business/Industry had the least proportion of respondents regarding believing parameters would benefit from legislative mandates.

3. Ecosystem Condition

Lake Erie

Lake Erie is a complex ecosystem. Being the shallowest and most productive of the Great Lakes, it has had many challenges through the years. Eutrophication was the predominant environmental issue in Lake Erie during the 1960's and 1970's, toxic contaminants in the 1980's, and invasive species in the 1990's and today. In this new millennium, scientists are recognizing that all of these issues and others, such as habitat loss and degradation, climate change and more, are occurring concurrently (IJC 2004). It is generally recognized that the lake had improved significantly from the days of eutrophication in the 1960's when thick green algal mats floated on the surface of the western basin. Programs created by both the U.S. and Canada in response to the GLWQA led to significant reductions of phosphorus entering Lake Erie during the late 1970s and the 1980s. These programs, especially those involving improved sewage treatment plants and phosphorus-free laundry detergent led to a reversal of the lake's eutrophication and water quality improved significantly. The U.S. and Canadian Governments realized further improvements in subsequent years through a variety of control measures focused on both point and nonpoint sources of pollution. However, in the past decade there has

been observed backsliding of Lake Erie ecosystem condition with respect to eutrophic condition, resulting harmful algal blooms and hypoxia. Invasive species such as zebra mussels have contributed to this system perturbation. The biological, chemical and physical processes of the lake are complex and many interactive mechanisms are not clearly understood.

This reality was expressed by survey respondents in the Lake Erie ecosystem as they relatively strongly disagreed with the statement that, according to available monitoring results, the condition of the ecosystem over the past ten years is stable or improving (Analysis A, Table B1 Appendix B, Question 29). This strength of disagreement was only surpassed on questions related to the ecosystem management strategy being effective in maintaining the ecosystem in a healthy, productive and resilient condition (Question 24), management proceeding successfully from planning to implementation (Question 22) and adequate, sustainable funding (Question 21).

Lake Erie Respondent Stratification

Divergence of perspectives regarding ecosystem condition for Lake Erie was seen in the respondent stratification by area of focus and type of organization. When viewed by area of focus (Analysis B, Table B6 Appendix B, Question 29), Aquatic stakeholders disagreed most strongly that the ecosystem condition over the past decade is stable or improving. Many of these are scientists and others involved directly with the lake that understand and appreciate the complexity of the aquatic ecosystem and the many pressures and challenges it is facing. In contrast, Watershed disagreed least of the four

focus areas that the ecosystem is stable or improving. However, the range of mean values for responses across the ecosystem for Question 29 was not significantly different.

When stratified by type of organization (Analysis B, Table B11 Appendix B, Question 29), Academics disagreed most strongly that the condition of the ecosystem over the past ten years is stable or improving. Again, many of these are scientists who keenly understand that the lake is facing extreme challenges. In contrast, Business/Industry stakeholders expressed relatively strong agreement that the ecosystem condition is stable or improving. This illustrates a disconnect between perceptions in this group and the realities of the lake ecosystem. The range of mean values for these responses across the ecosystem did show a significant difference.

Chesapeake Bay

The Chesapeake Bay ecosystem continues to be under extreme pressure due to population growth, agricultural operations and other stressors in the watershed. The condition of the ecosystem has degraded accordingly. In 2009, water quality in the Bay was extremely poor, meeting only 24 percent of goals established by the Chesapeake Bay Program. Stream quality in the watershed was also degraded, with 52 per cent of the streams having a rating of poor or very poor based on the index of biological integrity (Federal Leadership Committee for the Chesapeake Bay 2009). It has been noted that restoring and protecting the Chesapeake Bay and its watershed is a significant challenge, as the last several decades have shown. The wide range of serious environmental problems affecting it, combined with the sheer size of the Chesapeake Bay and its 64,299-square mile watershed, magnify the challenge.

Survey respondents agreed with the notion that the Chesapeake Bay is in a much degraded state. They disagreed most strongly of respondents in all five ecosystems with the statement that the condition of the ecosystem over the past decade is stable or improving. They realize that much work needs to be done to restore and protect all aspects of the ecosystem.

Puget Sound

The Puget Sound ecosystem has experienced stress and degradation from human activity for decades. For example, pollution and subsequently restricted marine harvests have reduced ecosystem support for human health and well-being. In addition, concerns about species viability and ongoing habitat alteration illustrate the vulnerability of biological systems in the region. Altered stream flows and water quality are some of the underlying problems in the Puget Sound ecosystem. In its most recent update on the condition of the ecosystem, the Puget Sound Partnership reported that the Puget Sound ecosystem continues to show signs of stress, but progress is being made toward restoring healthy conditions in some areas (Puget Sound Partnership 2010). The report tells of worsening trends in eight of the 20 indicators including fish harvests, orcas, herring and eelgrass. Improvements were noted in seven indicators, including increases in shellfish harvesting areas and runs of threatened salmon species. The remaining five indicators describe other ecosystem aspects, but for which no clear trend is apparent in the existing information.

Puget Sound ecosystem respondents share this perception that the ecosystem is still under considerable stress. Compared with respondents from the other ecosystems

surveyed, they were the group which disagreed second most strongly that the ecosystem condition over the past ten years is stable or improving. However, with the relatively new Puget Sound Partnership in place and some ecosystem improvements becoming evident, many expressed comments of confidence that restoration would continue.

Tampa Bay

The Tampa Bay ecosystem had undergone major changes over the years due to stresses from coastal development, including dredging for maintenance and expansion of its major port facility (the tenth largest in the U.S.). Approximately 44% of the historic emergent coastal wetlands and 81% of the historic submergent seagrass meadows had been lost through 1981 (Lewis et al. 1999). Declines in commercial and recreational fishery harvests and coastal wildlife populations followed similar trends in declines. The citizens of the Tampa Bay region were determined not to let this trend continue. Beginning in the early 1970's, citizen groups began to apply pressure which ultimately resulted in mandates for wastewater treatment and other pollution curbs. This and related citizen initiatives brought about reduced nitrogen and contaminant inputs into the Bay, enabling restoration of seagrass beds and other aquatic habitats in the Tampa Bay ecosystem. These ecosystem improvements were very visible and were embraced by Tampa Bay stakeholders such that a collaborative, voluntary EBM-type management system continues to keep the ecosystem in good condition.

Tampa Bay stakeholders reflected their pride in effective ecosystem management in their survey responses. Thus they were in very strong agreement with the statement that the condition of the ecosystem over the past ten years is stable or improving

(Analysis A, Table B1 Appendix B, Question 29). This was considerably stronger agreement than from respondents of any of the other ecosystems surveyed. Most stakeholders in the Tampa Bay watershed area interact with the Bay and care about it. They could visually see the improvements they were bringing about, giving momentum to their collaborative approach to maintaining its integrity (Greening 2010).

Baltic Sea

Regarding the Baltic Sea, HELCOM completed an Initial Holistic Assessment of the Ecosystem Health of the Baltic Sea 2003-2007 (HELCOM 2010) which showed that the Baltic Sea ecosystem has degraded to such an extent that its capacity to deliver goods and services to humans living in the nine coastal states has been hampered. None of the open basins of the Baltic Sea has an acceptable ecosystem health status. Eutrophication is a major concern in most areas of the Baltic Sea despite a decrease in inputs of nitrogen by 30% and of phosphorus by 45% since 1990 due primarily to natural conditions such as dry years. Thus, upgrading of waste water treatment facilities and active reduction of nutrient inputs from agriculture are recognized as being of utmost importance for ecosystem improvement. There are some positive signals of decreasing trends of certain organic pollutants which have been banned. However, the overall status of most of the Baltic Sea regarding hazardous substances is still impaired. Baltic Sea biodiversity is declining, and the offshore fish community has shifted dominance as a result of combined effects of climate-related fluctuations, overfishing and eutrophication. Thus the Baltic Sea ecosystem is still in a much challenged condition.

Despite the significantly degraded state of the Baltic Sea ecosystem, respondents were mildly positive about its condition. Thus Baltic Sea stakeholders showed the second strongest agreement (behind Tampa Bay respondents) that the condition of the ecosystem over the past ten years is stable or improving (Analysis A, Table B1 Appendix B, Question 29). Several expressed comments that deterioration of the system had been halted and some signs of improvement were present. The more positive responses than current ecosystem condition warrants may also reflect optimism that the HELCOM Baltic Sea Action Plan may indeed provide a roadmap for ecosystem restoration.

All Ecosystems Respondent Stratification

Differences in perspectives regarding ecosystem condition for data from all five ecosystems together were seen in the respondent stratification by area of focus and type of organization, but the trends were similar to those for Lake Erie respondents. When viewed by area of focus (Analysis C, Table B16 Appendix B, Question 29), Aquatic stakeholders disagreed most strongly that the condition of the ecosystems over the past decade were stable or improving. Many of these respondents were scientists and others involved directly with the ecosystem dynamics that understand and appreciate the complexity of the systems and the many pressures and challenges they are facing. In contrast, Fisheries disagreed least of the four focus areas that the ecosystems were stable or improving as they have generally been successful in maintaining the respective fisheries despite the challenges (sometimes including overfishing) being experienced in the ecosystems. However, the range of mean values for responses across the ecosystems was not significantly different.

When stratified by type of organization (Analysis C, Table B21 Appendix B, Question 29), Academics disagreed most strongly that the condition of the ecosystems over the past ten years were stable or improving. Again, many of these were scientists who keenly understand that the ecosystems are facing extreme challenges. In contrast, Business/Industry stakeholders expressed relatively strong agreement that the condition of the respective ecosystems were stable or improving. This illustrates a disconnect between perceptions in this group and the realities of the aquatic ecosystems involved. The range of mean values for these responses across the ecosystems did show a significant difference.

4. Perspectives of Diverse Ecosystem Stakeholders

The holistic nature of EA/EBM, by definition, involves a variety of different types of stakeholders with different views on the ecosystem and its management. One aspect of this project involved stratification of survey responses for Lake Erie and all ecosystems together in two ways: by area of focus (Aquatic, Fisheries, Watershed and Ecosystem) and by type of organization (Government/Regulatory, Business/Industry, Academic and NGO). These stratifications illuminate the differences (and similarities) in perspectives among different ecosystem stakeholders. This is important because, even though the diverse stakeholders come with varying perspectives, they must develop a common understanding of ecosystem parameters and realities through communication to implement collaborative EA/EBM effectively.

In preceding sections of this report, these stratifications have been analyzed thoroughly. The following comments are meant to highlight general trends seen in the stratifications for Lake Erie and from all systems being considered together.

Lake Erie Respondent Stratification

For the Lake Erie ecosystem, a three-way disconnect between Aquatic, Fisheries and Watershed/Ecosystem stakeholders was evident when viewed by area of focus. Aquatic stakeholders were primarily scientists and others who are intimately involved with the lake and have a keen awareness of its many challenges of eutrophication, invasive species, etc. due to their more focused approach. Thus they disagreed most strongly that EA/EBM parameters have been implemented successfully. Through effective scientific collegiality they were least concerned that the transboundary nature of the ecosystem makes management planning and implementation difficulty. However, Aquatic respondents are caught in the multi-management maze without any particular organization in charge and were the group which believed most strongly that mandates would assist in effective management. In contrast, Watershed and Ecosystem respondents had the highest scores related to the various planning parameters, indicating broad perspective and participation in the collaborative planning processes. Watershed also had the greatest proportion of respondents agreeing that EA/EBM parameters were being voluntarily implemented. A third perspective was that of Fisheries respondents who are seen by many to have a very effective planning and management process in place for Lake Erie. This group had high scores in various categories related to cross-boundary facilitation, sustainable strategy, precaution, public engagement strategy, effectiveness in

maintaining a healthy ecosystem and positive condition of ecosystem. This category had the least proportion of respondents agreeing that parameters would benefit from legislative mandates as Fisheries are operating effectively already. Thus, there is a need (and opportunity) to bring Aquatic, Watershed/Ecosystem and Fisheries respondents to a common baseline to improve ecosystem management for Lake Erie.

Viewing stratified responses for Lake Erie by type of organization revealed some interesting contrasts in perceptions also. In general, Government/Regulatory respondents showed stronger agreement on successful implementation of EA/EBM parameters than Business/Industry, Academic and NGO respondents. Business/Industry had highest scores on adequate funding and ecosystem condition. Due to this positive perception, they were least in favor of additional mandates to successfully implement EA/EBM parameters. NGO respondents viewed EA/EBM progress for Lake Erie much differently and had the lowest scores (indicating strongest disagreement regarding successful implementation) on several parameters. NGOs show activism at the grassroots level to correct problems in the ecosystem. Similarly, Academics are primarily scientists who understand the threats and challenges to the Lake Erie ecosystem and do not see the picture as so positive. Thus this group had the strongest disagreement on more parameters than other types of organizations. This group also agreed most strongly that legislative mandates could benefit implementation of these parameters. For effective EA/EBM to take place, all groups need to understand the realities of not only the scientific aspect, but also the economic, social and institutional perspectives of all stakeholders.

All Ecosystems Respondent Stratification

When data from all five ecosystems are combined and stratified, many of the trends (i.e. read "disconnects") between stakeholder groups seen in Lake Erie are noted to be present broadly across the composite ecosystem. When looking at area of focus for the composite data, Aquatic stakeholders disagreed most strongly that EA/EBM parameters were being implemented successfully, and the Ecosystem and Watershed groups agreed most strongly regarding ecosystem management success. When viewed by type of organization, similar to Lake Erie, Government/Regulatory respondents agreed most strongly regarding EA/EBM being implemented successfully, and Business/Industry, Academic and NGO respondents agreed least strongly. Interestingly, in contrast to the Lake Erie analysis, in the all-ecosystems data Business/Industry stakeholders disagreed more strongly regarding success of EA/EBM implementation than did the Business/ Industry stakeholders in the Lake Erie ecosystem. This may indicate more animosity by this group in some of the other ecosystems, indicating an even larger gulf to be bridged for effective collaborative management.

5. Public Engagement

Public engagement can bring about societal and cultural change. It can alter attitudes and perceptions. It can inform and motivate stakeholders who can likewise influence policy makers. In matters involving science such as aquatic ecosystem management, public engagement can have a profound effect on the individuals involved, be they decision-makers, public participants or experts. In addition, as more and more scientists and civil servants gain personal experiences of public dialogue, these activities

contribute to bringing about a wider shift in how the social dimensions of science and technology are addressed (Andersson and Gavelin 2009). Public engagement has gone from being a niche pursuit to become a core element of science governance. These activities can also have 'second order' positive impacts for communities and citizens more generally as citizens and policy makers become more scientifically aware and scientists come to understand public perceptions and concerns to a greater degree. Regarding ecosystem management, everyone wins from being more informed and involved and the ecosystems benefit from more informed decision making.

Lake Erie

Public engagement is understood to be important to management success in the Lake Erie ecosystem. The Lake Erie LaMP planning document (Vincent and Letterhos 2008) devotes an entire section to "Public Involvement." Therein is highlighted an important public engagement mechanism for this binational ecosystem, the Lake Erie Binational Public Forum, created and funded jointly by the U.S. and Canadian governments. This diverse group serves many purposes including providing outreach projects and education regarding Lake Erie issues to the public, as well as input to the LaMP process based on constituent input. Another prominent public engagement organization serving Lake Erie as well as the entire Great Lakes region is the NOAA Sea Grant College Program, specifically the members of the Great Lakes Sea Grant Network. These organizations serve as education and outreach components for the region, disseminating research results and assistance through extension agents and bringing the needs of the public to the attention of program providers. Sea Grant offices are also

initiators of collaborations among Great Lakes organizations which is also a significant challenge. Unfortunately, Sea Grant only exists on the U.S. side of the Great Lakes; there is not a Canadian counterpart organization.

Lake Erie survey respondents seemed to recognize the magnitude of the public engagement challenge. In the comparison across all five ecosystems (Analysis A, Table B1 Appendix B, Question 19), their response to the question of whether an effective public engagement strategy is present to inform and involve the general public in the ecosystem management initiative and to enlist their support for this effort was the strongest disagreement of all the ecosystems. In written survey comments respondents did highlight that there are several groups and forums for public engagement including the State of the Lakes Ecosystem Conference (although not strong media coverage so primarily attendees benefit), International Joint Commission and NGOs. In fact, several indicated that there are too many efforts with too many mixed messages. Others characterized the situation as sporadic but insufficient [public engagement] efforts thus making the strategy ineffective. Thus they do not believe that an effective public engagement strategy is present for Lake Erie, signifying that more must be done to integrate efforts in this area.

Lake Erie Respondent Stratification

On a stratified basis by area of focus, Aquatic respondents for Lake Erie rated public engagement among the three highest scoring criteria to benefit from being implemented on a legislative mandate basis (Analysis B, Table B10 Appendix B). Likewise, when viewed on a stratified basis by type of organization (Analysis B, Table

B15 Appendix B), both Business/Industry and NGO respondents rated public engagement among the three highest scoring criteria to benefit from being implemented on a legislative mandate basis. Thus, even though there are significant public engagement plans and efforts underway in the Lake Erie ecosystem, respondents expressed the perception that there is considerable room for improvement in the current public engagement strategy.

Chesapeake Bay

For the Chesapeake Bay ecosystem, the Chesapeake Bay Program has as one of its six goal strategies in its strategic framework to "Foster Chesapeake Stewardship" in Chesapeake Bay through enhanced public access, education and increased citizen and community engagement. Thus public engagement is prominently featured in the ecosystem management plans. In addition, the Chesapeake Bay Trust provides funding to promote Bay awareness programs, workshops and outreach efforts to advance public support for Bay restoration. Similarly, the Chesapeake Bay Foundation has public education as a priority in its strategic plan. It is apparent that public engagement is a key component of the Chesapeake Bay management strategy.

In general, Chesapeake Bay respondents had an intermediate mean value of the five ecosystems surveyed that an effective public engagement strategy was in place (Analysis A, Table B1 Appendix B, Question 19). Survey respondent comments ranged from "the public is well informed on the problems" to "public engagement is primarily through press releases and newspaper articles" to "average Bay citizen is not sufficiently

informed or motivated to assist in recovery." Thus the public engagement strategy seems to be uneven at best.

Puget Sound

The Puget Sound Partnership has communication, outreach and education firmly embedded as a key component of its Puget Sound Action Agenda (Puget Sound Partnership 2008). In its preamble, the opening letter from the Puget Sound Partnership Leadership Council sets the tone for its public engagement strategy: "We call on all citizens of our region to understand what's going on in Puget Sound and pledge to take the steps, individually and collectively, to protect, restore and maintain our shared place."

This call to action is reflected in the survey responses from Puget Sound stakeholders. As compared with the other ecosystems, stakeholders were second strongest in agreement that an effective public engagement strategy was in place (Analysis A, Table B1 Appendix B, Question 19). Unlike Chesapeake Bay respondents, comments by Puget Sound participants on the public engagement strategy were nearly uniformly positive. They spoke highly of their ECO (Education, Communication and Outreach) Network and Puget Sound Starts Here campaign. Many expressed the viewpoint that they were convinced that public participation and understanding were necessary to meet their protection and restoration objectives. There was clearly a widespread understanding that public outreach and education is critical to Puget Sound recovery. The stakeholders of the Puget Sound ecosystem seemly to clearly "get it" regarding the importance of public engagement to success of their ecosystem management plans.

Tampa Bay

For the Tampa Bay Ecosystem, public engagement has been a cornerstone of its ecosystem management success for decades. Indeed, back in the 1970s Tampa Bay citizens brought political pressure which resulted in nitrogen control regulations and began the process of protecting and restoring Tampa Bay. Public engagement plays a prominent role in the "Charting the Course" (Tampa Bay Estuary Program 2006) planning document for the ecosystem which contains an action plan for public education and involvement. Public involvement also adds synergy to the key strategy of using partnerships broadly to accomplish ecosystem restoration objectives.

Tampa Bay respondents reflected their opinions on the importance of an effective public engagement strategy and success in their ecosystem in that they agreed most strongly of all stakeholders in the five ecosystems that an effective public engagement strategy was in place for Tampa Bay (Analysis A, Table B1 Appendix B, Question 19). According to stakeholder comments, the Tampa Bay Estuary Program receives substantial credit for catalyzing the effective public outreach strategy and getting citizens involved. In the words of one respondent: "The citizens committee has been a part of the process from the start. The programs could reach out to some groups, however the program does use local governments and other partners to do this and it appears to work well." In the Tampa Bay ecosystem, effective public engagement has been a key success factor to activate and focus citizen support and generate strong political will to preserve and restore the ecosystem.

Baltic Sea

The Baltic Sea ecosystem is a geographically, politically and socially complex array of nine bordering countries. Therefore, it is understandable that there is not a strong emphasis on one public engagement strategy for the entire ecosystem. In fact, in the Baltic Sea Action Plan (HELCOM 2007), there is no emphasis on public engagement at all. Rather, focus is placed on each country meeting its respective mandated targets on eutrophication, hazardous substances, environmentally-friendly maritime activities and biodiversity conservation. With this emphasis on each country doing its part to achieve Baltic Sea restoration objectives, it is not surprising that whatever public engagement programs occur are primarily implemented on a country-by-country basis.

Baltic Sea respondents were consistent with this reality in that they were the second strongest group to disagree that an effective public engagement strategy was in place for the ecosystem (Analysis A, Table B1 Appendix B, Question 19). Although there is not one public engagement strategy, comments suggested that HELCOM plays a role in fostering public interaction. Their annual meetings are open for NGOs and other stakeholder organizations, many of which have an active international cooperation across the Baltic Sea ecosystem at an organizational (as opposed to individual) level. Thus public engagement does not appear to be a strategic success factor for ecosystem management in the Baltic Sea ecosystem.

All Ecosystems Respondent Stratification

When viewing data from all five ecosystems on a stratified basis, some additional insight is gleaned. When stratified by area of focus, Ecosystem respondents with broad

perspective on the ecosystem agreed most strongly that an effective public engagement strategy was in place, while Aquatic stakeholders disagreed most strongly although the differences were not significant (Analysis C, Appendix B Table B16, Question 19). There was general agreement on its voluntary nature (Analysis C, Appendix B Table B17), and no group felt strongly that it would benefit from being implemented on a legislative mandate basis (Analysis C, Table B20 Appendix B).

Likewise, when stratified by type of organization, it was seen that Other respondents (who were not able to be categorized more specifically) most strongly agreed that an effective public engagement strategy was in place, and Business/Industry stakeholders disagreed most strongly, with a significant difference shown (Analysis C, Table B21 Appendix B, Question 19). Again, there was general agreement on its voluntary nature (Analysis C, Table B22 Appendix B), and no group expressed strong sentiment that it would benefit from being implemented on a legislative mandate basis (Analysis C, Appendix B Table B25). Therefore, although public engagement can be an important component of a successful ecosystem management strategy, it is seen as a primary voluntary activity and its prominence varies greatly by ecosystem.

6. EA/EBM Leadership Organizations

Strong, effective leadership is required to orchestrate important change. The leader needs to create a vision for the future, and inspire and motivate people towards achieving that vision despite whatever obstacles might lie in the way. All five of the aquatic ecosystems surveyed are striving to orchestrate important change to protect and restore their respective ecosystems. Each has one or more leadership organizations trying

to bring about this change. Below is a review of the leadership organizations bringing about EA/EBM in these ecosystems.

Lake Erie

The Lake Erie ecosystem has multiple leadership organizations working at various levels to bring about EA/EBM, but no one organization is in charge of this effort. Being a binational ecosystem, the Binational Executive Committee has overall responsibility for GLWQA implementation, with the U.S. effort being led by the U.S. EPA and the Canadian initiative led by Environment Canada. The International Joint Commission is an independent binational organization established by the U.S. and Canada under the Boundary Waters Treaty of 1909, but in recent years it has been reduced to an advisory role regarding management of the ecosystem. The Great Lakes Fishery Commission, established in 1955 by the Canadian/U.S. Convention on Great Lakes Fisheries, facilitates cooperative fishery management among the state, provincial, tribal, and federal management agencies. At the state and provincial level, several environmental and natural resource agencies provide leadership. Local organizations such as the Western Lake Erie Basin Partnership are also effective at leading efforts at the local scale. Unfortunately, these ecosystem management efforts for Lake Erie are not integrated and coordinated under any one leadership organization.

Lake Erie stakeholders recognized this lack of leadership integration and, despite several successful leadership initiatives in the ecosystem, were the second most strong to disagree (behind Chesapeake Bay) among all ecosystem respondents that strong, effective leadership is present and has enabled the ecosystem management program to

maximize progress (Analysis A, Table B1 Appendix B, Question 23). Respondent comments reflected this view also: “There is no single leader. Instead, various groups take leadership in various areas. Often progress is localized rather than wide scale.” As one stakeholder summed it up: “Lake Erie needs a champion. There is a lack of leadership and this inhibits progress as much as anything.”

Lake Erie Respondent Stratification

When viewed on a stratified basis by area of focus for Lake Erie respondents (Analysis B, Table B6 Appendix B, Question 23), it was seen that Ecosystem stakeholders agreed most strongly that strong, effective leadership is present. This might be expected as many of these respondents are ultimately responsible for successful management of the ecosystem. Aquatic respondents disagreed most strongly that strong, effective leadership was in place (although the differences across the four area of focus categories were not significant).

When Lake Erie respondents were stratified by type of organization (Analysis B, Table B11 Appendix B, Question 23), it was seen that Government/Regulatory respondents agreed most strongly that strong, effective leadership is present. On the other hand, Business/Industry disagreed most strongly that strong, effective leadership is present, with the differences in responses being significant.

Chesapeake Bay

For the Chesapeake Bay ecosystem, the Chesapeake Bay Program (CBP) is the key leadership organization leading the ecosystem management initiative. It is a unique

regional partnership that has led and directed the efforts to restore Chesapeake Bay since 1983. CBP partners include the states of Maryland, Pennsylvania and Virginia, the District of Columbia, the Chesapeake Bay Commission, U.S. EPA and various citizen advisory bodies. Each partner is affiliated with CBP through formal, voluntary agreements and uses its own resources to fund projects to advance Chesapeake Bay restoration. Unfortunately, restoration success under CBP has been inadequate such that in 2009 under Executive Order 13508 on Chesapeake Bay Protection and Restoration by President Obama, the federal government will step in and take a much stronger role to facilitate restoration progress.

Chesapeake Bay respondents agreed that ecosystem management leadership was falling short, in that they disagreed most strongly of all stakeholders in the five ecosystems that strong, effective leadership is present (Analysis A, Table B1 Appendix B, Question 23). From comments by one respondent: "Lots of action, lots of good talk, many studies, many meetings and conferences, but little actual accomplishments."

Puget Sound

For Puget Sound, the Puget Sound Partnership (PSP) is the entity designated to lead the ecosystem restoration effort. PSP is an agency of the state of Washington established specifically to lead efforts to protect and restore Puget Sound and its diversity of life. It is a community effort of citizens, governments, tribes, scientists and businesses working together to restore and protect the Puget Sound ecosystem. PSP led the effort to create an Action Agenda (Puget Sound Partnership 2008) for science-based action to restore the Puget Sound ecosystem to health. It is governed by a PSP Leadership Council

comprised of seven leading citizens appointed by Governor Gregoire, with its first chair being Bill Ruckelshaus, the first administrator of the U.S. EPA. With this leadership team in place, expectations are high for success by PSP with restoration of the ecosystem.

Citizens for the most part agreed that strong, effective leadership was in place for the Puget Sound ecosystem as survey respondents were the second strongest group of the five ecosystems to agree with that statement (Analysis A, Table B1 Appendix B, Question 23). As observed by one respondent: "Effective leadership is present and has lead to an increased focus and distribution of resources to Puget Sound recovery."

Tampa Bay

For Tampa Bay, the Tampa Bay Estuary Program (TBEP) has the leadership position for ecosystem protection and restoration. It was created in 1991 by Congress to assist the community in restoring and protecting Florida's largest open-water estuary. The mission of the TBEP is to build partnerships to restore and protect Tampa Bay through implementation of a scientifically sound, community-based management plan. With partners such as the Agency on Bay Management, Tampa Bay Regional Planning Council, Florida Department of Environmental Protection and Southwest Florida Water Management District, TBEP has experienced much success in protecting and restoring the Tampa Bay ecosystem.

Survey respondents from Tampa Bay reflected this positive leadership situation by agreeing significantly more strongly than stakeholders from the other ecosystems that strong, effective leadership is in place (Analysis A, Table B1 Appendix B, Question 23). Respondents not only indicated strong endorsement of leadership by TBEP in their

comments, but former TBEP Executive Director Dick Eckenrod and current Executive Director Holly Greening were specifically mentioned repeatedly for their leadership. Clearly TBEP is exhibiting the leadership required for management success in the Tampa Bay ecosystem.

Baltic Sea

For the Baltic Sea ecosystem which includes nine countries, the Helsinki Commission (HELCOM) is the entity leading the protection and restoration effort. It is an international organization governing the convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention). HELCOM works on protection of the Baltic Sea in cooperation with its participating member organizations and serves as an environmental policy maker, focal point, supervisory and coordinating body to ensure environmental objectives are being pursued and achieved by its members.

Although prominently responsible for ecosystem management for the Baltic Sea, HELCOM was not necessarily seen as providing strong leadership in its role. Baltic Sea survey respondents had an intermediate mean value among all ecosystem respondents that strong, effective leadership is present for the ecosystem (Analysis A, Table B1 Appendix B, Question 29). Comments by respondents put the leadership situation in perspective: "HELCOM can be considered as a leader, however in reality is a mediator." Another wrote: "It is less of a leadership issue and more a matter of political consensus and peer pressure. We are talking about sovereign states here, not a small municipality." Thus HELCOM faces a unique and difficult leadership challenge with responsibility for protection and restoration of a multi-country aquatic ecosystem.

All Ecosystems Respondent Stratification

When viewed on a stratified basis by area of focus for all ecosystem respondents together (Analysis C, Table B16 Appendix B, Question 23), the results were similar to those for Lake Erie. It was seen that Ecosystem stakeholders agreed most strongly that strong, effective leadership is present for the respective ecosystems. This might be expected as many of these respondents are ultimately responsible for successful management of these ecosystems. As was the case for Lake Erie, Aquatic respondents disagreed most strongly that strong, effective leadership was in place (and here the differences across the area of focus categories were significant).

When all survey respondents were stratified by type of organization (Analysis C, Table B21 Appendix B, Question 23), it was seen that, as was the case with Lake Erie, Government/Regulatory respondents agreed most strongly that strong, effective leadership is present. On the other hand, Academic respondents disagreed most strongly that strong, effective leadership is present, with the differences in responses being significant.

CHAPTER 4

DISCUSSION

Chapter Summary

Using the survey results and analysis as a basis, the current project is used to inform more effective ecosystem management strategies for the ecosystems in the study, with particular attention to improvements for the Lake Erie system. Ten principles for success in this area are put forth and discussed in detail, with relevant project results and EBM literature cited where appropriate. Incorporation of these principles into the various ecosystem management practices will help overcome some of the obstacles and challenges found from the research to exist. Having an engaged public, effective leadership, a comprehensive plan with clear goals and decisions based on science can get the program started in the proper direction. However, to bridge the diverse perspectives revealed in the survey requires special attention. Incentives for collaboration, effective communication and cross-boundary facilitation are required to ensure that a holistic, integrated effort is actually achieved. Legislative mandates (versus voluntary implementation) can be used as necessary to achieve required standards. If applied in an adaptive management format and funded adequately, long term sustainability of these ecosystems can be achieved.

These and other important parameters are then woven together into a general model of required attributes of successful EBM for large aquatic ecosystems (Table 5 Page 134). The model is then customized for Lake Erie (Table 6 Page 137). It proposes leadership facilitation by the International Joint Commission, primarily mandate-based implementation of parameters (versus the current primarily voluntary approach) and strengthened public engagement. Applying this model would lead to more effective ecosystem protection and restoration for Lake Erie.

The Lake Erie EBM model is then taken one step further by applying it to a current challenge being faced in the lake, that of installing wind turbines to derive wind power in the lake ecosystem (Table 7 Page 155). The current status and issues are discussed, then opportunities and synergistic actions are presented from approaching this initiative in a more integrated, holistic manner. Although in a primarily voluntary implementation mode initially, it is expected that it would be beneficial to shift to more mandated parameters over time to minimize negative impacts on the lake ecosystem while maximizing potential synergy among stakeholders. Also noted was an immediate and significant need for a binational public engagement program to educate the populace and temper the pockets of resistance which are already beginning to form.

This chapter concludes with thoughts on future research. Two areas of further study are noted to be particularly beneficial. Since ecosystem protection and restoration is a long-term endeavor, a longitudinal study to follow how attitudes about and conditions in these ecosystems change over time would be informative. In addition, multi-faceted

socioeconomic analysis of the diverse stakeholders to understand why such varied perceptions exist would be useful. This is critical if efficient and effective implementation of EBM is to be achieved.

Ten Principles for Successful EBM Implementation in Large Aquatic Ecosystems

From the results of the current survey research initiative, supported by relevant EBM literature, important principles for successful EBM implementation can be delineated. Ten of the most important of these principles are summarized as follows:

1. **People are not inclined to preserve what they don't appreciate so public engagement is critical to educate and foster appreciation of the ecosystem.**
2. **Leadership is required for successful ecosystem protection and restoration.**
3. **Communication is important because diverse ecosystem stakeholders all see the ecosystem somewhat differently and have different interests/goals for it.**
4. **Incentives are needed to encourage collaboration.**
5. **Cross-boundary facilitators are necessary for success to bridge diverse stakeholder perspectives and facilitate integration and consensus.**
6. **There must be a comprehensive ecosystem management plan with clear, measurable goals for ecosystem preservation and restoration.**
7. **Ecosystem decisions must be grounded in science.**
8. **Some EBM parameters can be implemented successfully on a voluntary basis, others require legislative mandates to set minimum standards for EBM/ecosystem restoration. Voluntary versus legislatively-mandated implementation of parameters varies by ecosystem.**
9. **Ecosystem restoration progress must be monitored and evaluated to quantify effort and impact to implement adaptive management.**

10. **Ecosystem protection/restoration for <u>sustainability</u> is a <u>long-term goal</u> and must be <u>funded accordingly</u>.**

Due to the importance of these ten principles to the success of EBM implementation in large aquatic ecosystems, they warrant elaboration to highlight relevant factors which make each one critical. Lack of emphasis of some of these principles has led to suboptimal if not unsuccessful implementation efforts in some aquatic ecosystems.

1. **People are not inclined to preserve what they don't appreciate so <u>public engagement</u> is critical to educate and foster appreciation of the ecosystem.**

Environmental appreciation is a precursor to protection and restoration. If the stakeholders of a given aquatic ecosystem do not have a personal appreciation of that water body and its importance, they will not be nearly as motivated to support its protection. This is true whether the stakeholder comprises an elected official, business leader, scientist or member of the general public. As used in this study, public engagement enables stakeholders to become educated about the ecosystem and connected directly with it. As noted by Vigmostad et al. (2005), they were struck by the deeply personal ways people came to be committed to restoring an ecosystem, no matter their role or organization. Each person's interest, enjoyment and commitment focused on a particular ecosystem stemming from a unique personal history. Most of the commitments grew out of experiential involvement with the ecosystem through study or recreation. Gaining these stakeholder commitments and their involvement with the ecosystem of interest is critical, as involvement of a broad base of stakeholders is a central foundation

to EBM (NYOGLECC 2007). Incorporating a process for robust, sustained stakeholder involvement to develop and implement EBM is a key to ensuring that decisions affecting ecological systems are made with transparency and a full consideration of the public's perspectives. Stakeholders' early involvement and ongoing participation is necessary for identifying the functions of the ecosystem that provide human value, such as recreation, commercial fishing or other marketable products. Recognizing and including local knowledge to build a richer understanding of the relationship between the ecosystem and humans in a defined place is the goal for a good stakeholder process. The United Nations Environment Programme (Olsen 2006) asserts that stakeholders must be involved in all steps and at all levels in these ecosystem preservation processes. "In terms of outcomes this translates into generating constituencies that understand and actively support the program. Constituencies are essential at the local level within the groups that will be most affected by implementation of a program. If such support is absent the task of imposing the implementation of new policies, regulations and decision-making procedures on an unwilling or uninformed society is likely to prove unworkable. Constituencies are also essential at higher levels in the governance hierarchy - typically at the state (province) and/or national level. Depending upon the scope of the program and the significance of its actions, constituencies may also need to be built among the general public." Similarly, managers in the Great Barrier Reef Marine Park Authority (GBRMPA) clearly recognize the potentially significant ecosystem benefits that arise from involving stakeholders in identifying and adopting strategies to achieve ecosystem goals (Ruckelshaus et al. 2008).

This is very significant in that the GBRMPA is the current gold standard for EBM in the oceans, and its success thus far in applying EBM principles is in large part because of its equal attention to both the human and natural systems parts of the ecosystem management. Commitments to ecosystem protection and restoration built through personal experience with the ecosystem and public engagement in the process are powerful forces. Indeed, in the Puget Sound ecosystem, extensive, structured stakeholder engagement led to formal creation of the state agency [Puget Sound Partnership], its governance structure and a legislative mandate to restore the ecosystem (Tallis et al. 2010). Similarly, in the Tampa Bay ecosystem, public engagement and the resulting political pressure brought about created a turning point in condition of the ecosystem when, in the 1970s, Tampa Bay citizens brought political pressure which resulted in nitrogen control regulations and began the process of protecting and restoring Tampa Bay. Leslie and McLeod (2007) assert that meaningful engagement with stakeholders is needed to create management initiatives that are credible, enforceable and realistic. The form of such engagement varies, but it can be useful to think of stakeholders as agents within dynamic networks that are linked to the environment at multiple spatial scales, rather than as static, well-defined groups (Berkes 2004). Auster et al. (2008) point out that any societal mandate to view conservation and management of marine biological diversity in a holistic sense must come from the larger public. Indeed, "emotive notions of nature's grandeur and beauty and human spiritual connection to untamed wilderness (rather than scientific data or arguments per se) drove the creation of the U.S. national

park system." A public environmental ethic for aquatic ecosystems would enable genuine environmental protection (legislative or otherwise), and this can be achieved through public engagement. The ultimate success in preserving and restoring these aquatic ecosystems depends on a more inclusive ethic for these environments. This more inclusive ethic coupled with stakeholder involvement from the initial planning stages fosters a sense of ownership and commitment in the parties involved and stimulates long-term interest in protected areas. This local support expands the pool of individuals formally and informally overseeing activities in the conservation area (Lundquist and Granek 2005). Thus public engagement can facilitate long-term stewardship of the aquatic ecosystem which is required if protection and restoration efforts are to be successful. This was borne out in the current research, as strong public engagement programs were associated with EBM success as indicated by improved ecosystem condition for Tampa Bay and Puget Sound.

2. **<u>Leadership</u> is required for successful ecosystem protection and restoration.**

As noted earlier, strong, effective leadership is required to orchestrate important change. The leader needs to create a vision for the future, and inspire and motivate people towards achieving that vision despite whatever obstacles might lie in the way. Protecting and restoring large aquatic ecosystems involves orchestrating important change to bring about improved ecosystem conditions.

The value of dynamic political leadership to catalyze this process cannot be overestimated. As noted by Vigmostad et al. (2005), large-scale ecosystem restorations

involve complex and lengthy negotiations among dozens of scientists, government agency staff, and stakeholders. Restoration success depends on achieving consensus and commitment to complex restoration plans and their implementation. Who is brought to the table, and how they are convened can make or break a negotiation. Dynamic political leadership launched from hard-won consensus is the one thing that can amass the resources needed to restore large-scale ecosystems. Thus, successful protection and restoration initiatives have often been led by high-level public officials who were personally involved with the ecosystem throughout long careers in public service. However, personal passion and direct action is the driving force for restoration, regardless of the leader's position or political party affiliation. These champions serve to catalyze the restoration process. Such buy-in and leadership by high-level elected leaders was the key to making restoration easier for the Chesapeake Bay as well as the major rehabilitation underway in the Everglades. Similarly, leadership by Governor Christine Gregoire of Washington catalyzed the restoration effort underway in Puget Sound and led to creation of the Puget Sound Partnership which spearheads this initiative today.

Olem and Duda (1995) note that lessons learned from joint international management of the Baltic Sea, other international projects and efforts by the World Bank provide direction for the way ahead in improving management of these international watercourses. Joint international institutional arrangements should be established with participants from different levels of government and stakeholders in each country to undertake assessments of the problems to be addressed and to formulate strategies for

solving the problems. An impartial commission or high-level steering committee is necessary to oversee this work, which should be based on joint fact-finding to build trust among participants in the processes. This type of leadership in seen in the current research in HELCOM for the Baltic Sea on a large, international scale down to the Tampa Bay Estuary Program for the Tampa Bay ecosystem in Florida.

3. **<u>Communication</u> is important because diverse ecosystem stakeholders all see the ecosystem somewhat differently and have different interests/goals for it.**

The stakeholders of a given ecosystem are a diverse populous with contrasting perspectives and often conflicting priorities for ecosystem preservation and restoration. These stakeholders may include government officials, scientists, business leaders and NGO representatives as well as the general public. As seen in the current research, different perspectives on progress may be held by aquatic scientists versus watershed managers, government officials versus NGO representatives. Some perceptions of ecosystem characteristics and processes may simply be incorrect as was seen with some of the business leader data on ecosystem condition. Berkes and Folke (1998) note that differences in focus, knowledge and terminology among different groups make reaching consensus in EBM difficult. Groups with different interests in ecosystems often talk past each other, hear what they want to hear rather than what is being said (Weeks and Packard 1997), or discount what is being said as lacking credibility or relevance (Cash et al. 2003). These problems of human communication are exacerbated by the complex ecological interactions and cumulative impacts of diverse human activities across a large suite of ecosystem services.

In all cases, however, the challenge to successful EBM implementation is the need to define a common vision, including objectives for aquatic EBM and for the social and ecological states and services that people are most interested in maintaining or restoring (Leslie and McLeod 2007). While the details of a vision will vary with the spatial and temporal scale of a particular effort, in all cases a dialogue is needed among managers, resource users, scientists and other stakeholders to determine what ecosystem services people need or want from the aquatic environment and what components of ecosystem structure and functioning need to be in place in order to provide those services. Dietz et al. (2003) note that sharp differences in power and in values across interested parties make conflict inherent in environmental choices. Indeed, conflict resolution may be as important a motivation for designing resource institutions as is concern with the resources themselves. People bring varying perspectives, interests and fundamental philosophies to problems of environmental governance and their conflicts, if they do not escalate to the point of dysfunction, can spark learning and change. Communication infused with baseline information about the ecosystem can begin to bring about understanding and consensus on goals and direction. Gutrich et al. (2005) assert that stakeholders may have a willingness to cooperate, but hold different mental models of resource management which results in failed communication. Interdisciplinary science-based models can serve as tools to identify areas of potential consensus.

Given the diversity of ecosystem stakeholders and frames of reference, progress and challenges must be communicated in a variety of formats. For example, it must not

all be “science speak” but there must be verbiage in lay terms also. Vigmostad et al. (2005) suggest that progress should be reported in several ways: for scientists, meeting numeric goals; for public officials, complying with the terms of agreements; and for the public, improving the state of the living resources - such as rockfish and oysters in the Chesapeake Bay and wading birds in the Everglades - as well as public health measures.

4. **<u>Incentives</u> are needed to encourage collaboration.**

Given the diversity of stakeholders in the various aquatic ecosystems and the wide range of perceptions and interests in those systems, it is no surprise that collaboration among them is an unnatural act. However, if EBM is to be successful, collaboration among stakeholders is a requirement. Incentives for collaboration can facilitate this process. These can come through the structural organization of the project. As noted by Granek et al. (2009), a common set of objectives and, in some cases, new governance structures will be necessary to support an effective participatory process and provide an incentive for governmental groups to work together. As in ecosystem-scale management elsewhere, integration of diverse information and views can be challenging at the land-aquatic interface because of the lack of an integrated institutional framework and the overlap of multiple political jurisdictions and economic sectors. Once collaboration among diverse stakeholders is underway, incentives are needed to encourage perseverance in the process, particularly for voluntary efforts, for the pathway is often complicated and arduous. Evans and Klinger (2008) highlight that collaborative management processes are most effective when a range of participants are actively

involved in developing a joint understanding of the facts, defining the problems, and developing creative solutions together. However, the sheer number and complexity of the factors that must be considered under an ecosystem approach - even when using a surrogate-scheme shortcut - may exceed the participants' interest and expertise in interpreting large amounts of detailed technical information. This may overwhelm the willingness and ability of bottom-up efforts to bear those costs, particularly in the case of community-based efforts.

In the current research, respondents from most ecosystems disagreed relatively strongly with the statement that incentives are present which encourage the diverse stakeholder groups to collaborate for effective ecosystem management. However, they recognized the value of having incentives for collaboration present, as in all ecosystems except Chesapeake Bay the respondents ranked incentives for stakeholder collaboration as one of their top three parameters which would benefit from being implemented on a legislative mandate basis.

Often these incentives are equated to funding, which indeed can be a powerful stimulus to collaboration in voluntary EBM programs. (Respondents from all ecosystems disagreed strongly that funding is adequate and sustainable to effectively manage their respective ecosystems, and all ranked funding mechanisms among the top three parameters which would benefit from being implemented on a legislative mandate basis.) Dietz et al. (2003) note that in voluntary programs, success appears to depend on the existence of incentives that benefit leaders in volunteering over laggards and on the

simultaneous use of other strategies, particularly ones that create incentives for compliance. In addition to outright funding, other financial tools can provide incentives for collaboration as well as compliance under regulatory regimes. It was noted that financial instruments such as tradeable environmental allowances (TEAs) can provide incentives to achieve compliance with environmental rules in collaboration with other organizations. TEAs define a limit to environmental withdrawals or emissions and permit free trade of allocated allowances under those limits and have become quite popular (Tietenberg 2002).

5. **Cross-boundary facilitators are necessary for success to bridge diverse stakeholder perspectives and facilitate integration and consensus.**

Despite effective leadership, succinct communication and other positive factors, it is still difficult to maintain effective cooperation among diverse ecosystem stakeholders toward achieving good ecosystem governance. Roux et al. (2008) noted several barriers to effective cooperation from their research: the more people that are involved, the higher the chance of opposition; benefits to all parties are not always explicit; most people operate at maximum work capacity without the additional burden of having to make cooperation or cooperative activities work; there is no explicit reward system for effective cooperation; proper understanding of another party's issues requires deep engagement and prolonged interaction between people (requiring individuals to spend more time on such activities than would normally be planned); few people are used to bidirectional communications, especially the listening part; turf protection is rife at all levels; continuity in relationships tends to break down due to high rates of staff turnover;

and incompatibility of databases maintained by different organizations hampers data sharing.

There are also various levels of interaction possible among cross-sector ecosystem stakeholders as they work toward an EBM outcome. These types of interstakeholder behavior are characterized by Kinnaman and Bleich (2004) as toleration, coordination, cooperation and collaboration. Commonly, it is agreed that cooperation is a reasonable goal to strive for because different parties will have to actively work together for mutual benefit while retaining their respective identities (working cultures, professional disciplines and operational contexts).

Given the diversity of backgrounds and frames of reference that exist among these ecosystem stakeholders, it is clear that a "boundary-spanning function" (Cash et al. 2003) is necessary to ensure effective cross-sector engagement. In general, "boundary spanners" broker ties among different groups. This function is performed by individuals who may be affiliated with organizations that play an intermediary role between the science and policy domains and who facilitate perceptions of salience, credibility and legitimacy, as well as the trade-offs among them (Roux et a. 2008). A skilled, independent, boundary-spanning agent is invaluable for creating a relatively risk-free space within which the formal organizations explore and negotiate cooperative policy options. Brown et al. (2002) note that creating the institutional spaces for such conversations is difficult, but possible, as is initiating the processes of consensus-building and compromise that follow. A cornerstone of the cooperation-building process is to get all stakeholders on a common

baseline of scientific understanding of the ecosystem. Leslie and McLeod (2007) reinforce that often scientific understanding among decision makers, managers and communities of stakeholders are facilitated through boundary organizations. These organizations work at the interface of science and politics, translating knowledge and actively mediating conflicts between different groups. They are able to do this effectively in part because they are responsive and accountable to multiple communities (Cash et al. 2003).

As a practical matter, having significant professional experience as a cross-boundary facilitator myself, I can attest that it is not always an easy task. It requires a unique set of interpersonal and professional skills to listen, strategize, influence, mediate and ultimately lead the process to a successful conclusion. As noted by Vigmostad et al. (2005), "facilitators with a sophisticated understanding of the ecosystem, superb group process skills and a commitment to consider all viewpoints are worth their weight in gold."

6. **There must be a <u>comprehensive ecosystem management plan with clear, measurable goals</u> for ecosystem preservation and restoration.**

All of the ecosystems studied in the current project had a primary management plan for the ecosystem, but the presence of clear, measurable goals in each plan varied by plan. The importance of such goals has been emphasized by several authors as they are key to measuring ecosystem restoration progress. Vigmostad et al. (2005) observed from their work with large-scale ecosystem restoration projects that aggressive, measurable goals with dates are crucial. They noted that to be effective, these goals need to be

performance-based (i.e. produce measurable change in ecosystem outcomes) as well as understandable. They did note, however, that speed of accomplishment can become an issue. A nagging problem which was experienced was the tension between those who wanted to take a fast road to those goals and those who wanted to go slow. One approach to dealing with this issue is to move ahead with interim ecological goals that allow the project to gather, refine and discuss data while taking early restorative actions.

Since EBM takes a holistic view of the ecosystem and interconnectedness of its components and considers socioeconomic as well as ecological targets, goals in the ecosystem plan must reflect this broader view. Olsen et al. (2006) reinforce this broader perspective, noting that program goals need to appeal to the values of society as well as reflect a solid understanding of the ecosystem and institutional process that must be orchestrated to achieve them. Thus collaborative planning among the diverse ecosystem stakeholder groups to arrive at the management plan and its goals can facilitate a collective, realistic perspective. Since it is difficult to manage what one cannot measure, without clear goals it is difficult or impossible to assess the long-term impacts of a program. These goals, then, should define both the environmental and social conditions that, when achieved, would constitute success. To be useful, specific targets should be set that define how much and by when.

As noted earlier, the present project illustrates that not only are there varying perceptions on the presence of a management plan with clear, measurable goals across the ecosystems surveyed, but perceptions within each ecosystem vary by stakeholder. For

Lake Erie, managers at the Ecosystem level were much more positive that there were clear goals and objectives present in the management plan for the ecosystem than Aquatic stakeholders. Likewise, Government/Regulatory representatives felt much more strongly that these were present than Business/Industry stakeholders. Similar trends persisted in the stratification data across all ecosystems, with Academic disagreeing most strongly among organizations. Thus perceptions and the management and influencing thereof are a very important part of the EBM process.

Managing stakeholder perceptions and expectations on project goals and outcomes is extremely important because it affects their level of engagement and support of the project. Clark et al. (2002) noted that a weakness of marine conservation projects has been the failure to accurately define the problem, resulting in an inability to effectively address objectives and leading to perceived failures or loss of support from certain stakeholder groups. Jones (2002) lists 10 potential objectives with which to select marine protected areas and judge their effectiveness: 1) protect rare and vulnerable habitats and species, 2) conserve a representative set of habitat types, 3) maintain and restore ecological function, 4) promote research and education, 5) establish harvest refugia, 6) control tourism and recreation, 7) promote integrated coastal management, 8) maintain aesthetic values, 9) maintain traditional values, and 10) preserve cultural symbolic value of protected areas. Each objective could be accompanied by a set of measurable goals to judge effectiveness in meeting the objective. Thus clearly defined and shared objectives are valuable for defining expected outcomes, for ensuring that

expectations are realistic and aligned, and for guiding the relative importance of socioeconomic, political and biological criteria in the decision-making process.

Success of the ecosystem management plan, then, may be defined by a multitude of social, economic, political, cultural or ecological criteria but should be explicitly linked to the project's objectives, goals and specific activities (Conservation Measures Partnership 2004). To evaluate success, more comprehensive and case-specific information on how conservation decisions are made is needed (Saterson et al. 2004). Ideally, such documentation would include information on project objectives and outcomes, the decision-making process and measures of success (Kleiman et al. 2000).

7. **Ecosystem decisions must be grounded in <u>science</u>.**

There was nearly universal agreement among ecosystem stakeholders in the current project that scientific input was being actively sought from scientists engaged in studying the respective ecosystems and was being used as important input for decisions on how the ecosystems were being managed. Indeed, science is fundamental to EBM, as EBM is a science-based approach that relies on understanding the interconnections and complexities of ecological systems (NYOGLECC 2007). Although a participatory process may be necessary for successful EBM, credible scientific information is also required (Granek et al. 2009). However, there are varying opinions on the role and level of dominance science should play in the planning process. Some proponents suggest a process-oriented approach where science informs site selection and educates stakeholders such that they support protection and restoration of ecologically relevant sites (Roberts

2003). Others believe in a consensus-based approach where science should be weighed equally with socioeconomic, cultural and other values (Jones 2002). Regardless, scientific input is critical to successful EBM implementation. It is also critical that scientists agree with one another for a successful EBM process. As reported by Vigmostad et al. (2005), participants stressed the vital need for consensus among scientists and said it is critical to gain consensus among scientists before stakeholders. One stakeholder in their study noted that "when scientists start dueling, you are dead." Scientists need to agree or politicians will use this to stall the restoration. Areas of needed agreement include identifying the problems and their sources, solutions and measures. Once scientists agree, effective integration of scientific input in cooperative ecosystem management depends on the role of science, the stakeholders and decision-makers involved and the common language utilized to compare tradeoffs (Gutrich et al. 2005). Stakeholders bring diverse preferences for ecosystem goods and services to the process of deliberation regarding environmental management strategies (Keystone Center 1996). Gutrich et al. (2005) note that the public process of ecosystem management can be viewed generally in four phases, with stakeholders: 1) arriving at the table with held beliefs and values concerning environmental resources, 2) deliberating to identify a common goal and to formulate a management plan, 3) implementing the plan and monitoring success of the plan and 4) seeking funding and other sustaining support for the agreed management activities. Science can be utilized at each stage of this process to inform decision-making, prioritize actions, justify actions undertaken, support requests

for funding for environmental protection, generate better policy and increase public awareness to mobilize support for environmental protection. The National Research Council indicates that effective incorporation of science into the public process requires a recursive integration of scientific analysis and political deliberation whereby analysis is used to inform deliberation and deliberation is used to frame analysis (Stern and Fineberg 1996). Science can serve as a communication device by informing stakeholders and articulating stakeholder values of ecosystems in an understandable, common language. Yet, socio-cultural context greatly influences the success of incorporating scientific approaches and determines the extent to which science can be utilized to build consensus.

Often ecosystem management decisions come down to the money required to bring about protection and restoration of the system. Scientific approaches can also offer the opportunity to address tradeoffs in a common language beyond monetary terms. Scientists can aid in the development and assessment of environmental "umbrella" indicators, still quantifiable and scalable, that can be utilized to monitor the status of a resource (Salzman and Ruhl 2001). Stakeholders can agree to base success criteria on environmental or socio-cultural indicators eliminating the need for an assessment of economic efficiency. Examples include physical and ecological indicators, social indicators and functional use values (Wainger 2001). By developing non-monetary indicators, science can contribute to the development and consideration of quantifiable tradeoffs while building trust through the respect shown for cultural values. And trust is a key ingredient for consensus building in the public EBM process. Therefore, integration

of scientific input must be transparent and inclusive of public feedback. Trust can be conceptualized as a willingness to defer to the competence and discretion of others in the public process of ecosystem management (Focht and Trachtenberg 2005). Many times decision making on environmental issues is complicated by system complexity, scientific uncertainty, public controversy and social distrust (Rhoads et al. 1999). Too often the introduction of science into the public process has attempted to substitute quantifiable values and optimization strategies for messy and unpredictable political deliberations (Chee 2004). Scientific quantification may provide novel information and common metrics for analysis, but if distrust exists among the stakeholders, the scientific information may never be considered. The situation becomes particularly problematic if some scientists are perceived as members of a coalition (such as an environmental coalition) rather than a third party providing scientific input. In such cases, their analysis will be heavily discounted by members of opposing coalitions (Sabatier and Zafonte 2002).

Thus science, delivered and accepted in a spirit of trust, is critical to the public process of EBM. However, sound science is necessary for commons governance, but not sufficient argue Dietz et al. (2003). They contend that too many strategies for governance of local commons are designed in capital cities or by donor agencies in ignorance of the state of the science and local conditions. The results are often tragic, but at least those tragedies are local. As the impact of humans on the Earth increases, humanity will be

challenged to develop and implement understanding of large-scale commons governance quickly enough to avoid the large-scale tragedies that will otherwise ensue.

8. **Some EBM parameters can be implemented successfully on a voluntary basis, others require legislative mandates to set minimum standards for EBM/ecosystem restoration. Voluntary versus legislatively-mandated implementation of parameters varies by ecosystem.**

Most large aquatic ecosystems in the current study have some combination of voluntary and legislatively mandated parameters for EBM implementation, although a predominant mode (voluntary or mandated) was seen to be present for each. These ecosystems, varying greatly by size, have also experienced varying degrees of success with EA/EBM implementation (Table 4). Analysis of survey data shows no significant

Table 4

EA/EBM Implementation Success Vis-à-vis Ecosystem Size

Ecosystems, by Size	Ecosystem Basin Size (Sq Mi)	Predominant EA/EBM Implementation Basis	Ecosystem Condition	EA/EBM Implementation Effective to Date?
Baltic Sea	582,088	Mandated	Degraded but improving	Yes
Chesapeake Bay	64,299	Voluntary	Degrading	No
Lake Erie	30,140	Voluntary	Degrading	No
Puget Sound	8,764	Mandated	Mixed	TBD (new)
Tampa Bay	2,200	Voluntary	Improved	Yes

correlation between presence of a legislative mandate to implement collaborative ecosystem management and positive outcomes for either all ecosystems collectively

(Table B26 Appendix B) or individually (Table B27 Appendix B). The smallest ecosystem of those studied, Tampa Bay, had excellent EBM success with voluntary implementation. On the other hand, Puget Sound, the second smallest of the ecosystems studied, has had mixed ecosystem condition results with its relatively new EBM program under a mandated regime. The larger Chesapeake Bay and Lake Erie ecosystems have both struggled utilizing a voluntary approach. At the apex of size in the current study, the Baltic Sea ecosystem is beginning to turn around its ecosystem condition through a mandated approach. Thus it is observed that there is a role for both predominantly voluntary and mandated approaches. As pointed out earlier, in reality all systems have a combination of voluntary and mandated EBM parameters being implemented. With the results from the current study as a baseline, it would be interesting to do a longitudinal study on these ecosystems to see if correlations between presence of a mandate and positive outcomes emerge, as well as additional correlations based on ecosystem size.

Vigmostad et al. (2005) reported that criticisms of the slow rate of water quality improvement in the Chesapeake Bay have focused attention on the voluntary nature of the program's agreements. Some have called for a more regulatory approach to ensure that agreements and commitments are met because with a voluntary approach, if deadlines are missed there are no penalties. In contrast, legal action, especially in the federal arena, imposes requirements and deadlines that force parties to work together to address ecosystem damage. Federal laws can also serve as a backup, to set the floor for ecosystem protection and restoration. Thus federal laws are sometimes seen as necessary

for restorations at the large ecosystem scale. Vigmostad et al. (2005) go on to suggest that restoration actions should be spread along a continuum ranging from voluntary to mandatory. Initiatives should be prepared to transform voluntary measures into mandatory regulations after a predetermined length of time if voluntary efforts prove to be insufficient. Initiatives also should assess the adequacy of compliance and enforcement tools and, if needed, consider litigation.

Granek et al. (2009) amplify the message that EBM is most effective if there are existing institutions (e.g. laws, regulations as well as social norms) that facilitate integrated management. Overlapping governance structures and interacting social and ecological processes can inhibit clear allocation of responsibility. The different and sometimes conflicting objectives of agencies with mandates to manage different sectors also present challenges for coordinated ecosystem-scale decision making. If voluntary measures fail, a clear mandate to sustain the delivery of ecosystem services and an overarching policy framework for quantifying trade-offs among them can provide a foundation for coordinated management.

The U.S. in general is showing forward movement in legislating aspects of EBM such as in the reauthorization of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act passed at the close of 2006 (Leslie and McLeod 2007). A number of states, including Massachusetts, New Jersey, New York and California, have passed legislation or taken other actions to introduce more ecosystem-based approaches into their coastal and ocean management efforts. In New York, for example,

legislation was introduced in 2006 to formally create a New York State EBM initiative (Carroll 2007). It was ultimately signed into law to become Article XIV of the New York State Environmental Conservation Law. One of its requirements was preparation of a report to the Governor and State Legislature recommending actions New York State should initiate to address the mandate of the act implementing an EBM approach to coastal ecosystems and the Great Lakes. In general, the U.S. can do more to strengthen its legislatively-mandated framework for EBM implementation where voluntary approaches are ineffective. Browman and Stergiou (2005) highlight that both Canada (via the Oceans Act) and Australia (via the Oceans Policy) have governance frameworks in place that mandate integrated and comprehensive management of human impacts on coastal and ocean ecosystems This is a direction in which the US can move to reinforce effective implementation of EBM if voluntary measures prove inadequate.

9. **Ecosystem restoration progress must be <u>monitored</u> and evaluated to quantify effort and impact to implement <u>adaptive management</u>.**

Adaptive management is essential for long-term success of EBM. It is built on the foundation of three principal elements: monitor, evaluate and adapt (NYOGLECC 2007). Thus monitoring, evaluation and adaptive management are inextricably linked. Along with the other elements noted, these form a feedback loop for all aspects of EBM. Information from monitoring of ecological, economic and social conditions, coupled with evaluation to quantify effort and impact, help gauge the success of accomplishing EBM objectives. Given the complexity of ecosystems, it is challenging to predict with certainty whether a particular course of action will achieve stated objectives and meet goals.

Adaptive management allows for learning and requires applying knowledge in decisions to provide for continuous adjustments to accomplish goals.

Thus an effective monitoring program is a cornerstone to evaluating and measuring ecosystem restoration success against objectives and to applying adaptive management. Vigmostad et al. (2005) reinforce this point by urging the acquisition of adequate funds for monitoring on an ongoing basis, for without data there is no way to evaluate projects and assess progress. Monitoring can also contribute to maintaining interest and support of stakeholder groups by demonstrating short- and long-term successes (Lundquist and Granek 2005). For monitoring to be effective, it requires the development of a full suite of ecological, economic, social and institutional indicators so that one has a comprehensive view of how a system is changing through time in response to different disturbances and management strategies (Leslie and McLeod 2007).

Developing these comprehensive indicators for a large-scale ecosystem and implementing them via a rigorous monitoring and evaluation program is both challenging and expensive. From the current research, room for improvement in this area was noted for the Lake Erie ecosystem as respondents were the least positive of those surveyed in the five ecosystems that monitoring of the ecosystem on a recurring basis to detect and track changes in key parameters was occurring. Likewise, Lake Erie respondents were the least positive of those from the five ecosystems surveyed that adaptive management was being applied for managing the ecosystem.

Change in these ecosystems over time is inevitable. These changes can be monitored in the respective systems, evaluated and managed through adaptive management strategies. However, not only will there be changes in the ecosystems, there must be flexibility for adaptive change in the governance organizations themselves. Institutions must be designed to allow for adaptation because some current understanding is likely to be wrong, the required scale of organization can shift and biophysical and social systems change. This is a principal lesson of adaptive management research (Gunderson and Holling 2001).

10. **Ecosystem protection/restoration for <u>sustainability</u> is a <u>long-term goal</u> and must be <u>funded accordingly</u>.**

A common denominator theme which extended across stakeholders of all five ecosystems surveyed: Not enough money was available for effective ecosystem management. Specifically, there were serious concerns in all systems surveyed about funding being adequate and sustainable to effectively manage the respective systems. Funding mechanisms was also the only EBM parameter ranked among the top three in all ecosystems as one which would benefit from being implemented on a legislative mandate basis. [Note: This survey research was completed prior to funding of the Great Lakes Restoration Initiative by the Obama administration which committed an initial $475 million in the 2010 budget to Great Lakes restoration projects.]

Vigmostad et al. (2005) suggest that since restoration of large-scale ecosystems is a "game of billions," one must secure a mix of state, private and federal financial support. Obtaining an adequate funding base for ecosystem protection and restoration is a critical

part of implementation, and must extend over a prolonged period since rehabilitation of these systems often takes years if not decades. Those needed billions of dollars can be aggregated from federal and state governments as well as local governments and the private sector, including philanthropic organizations. Cost sharing between state and federal governments is crucial. However, even when adequate authorizations are in place, achieving appropriations can be difficult, especially in these days of mounting federal deficits and rising costs of defense and homeland security. In addition, because restorations need adequate and committed resources over long periods of time, working within annual budget cycles can deem long-term projects uncertain.

The nature of large-scale ecosystem protection and restoration requires long-term commitment of key individuals to the process as well as funding (Roux et al. 2008). Building more effective knowledge systems that span disciplinary, research, policy and operational domains takes time (much more than is usually planned or budgeted for) and requires patient persistence. Strategies to promote such systems require a sufficiently long-term perspective that takes into account the generally slow impact of ideas (and new scientific information) in practice (Cash et al. 2003).

Required Attributes of Successful EBM Model for Large Aquatic Ecosystems

From the current survey research initiative and relevant EBM literature, and taking into account the ten principles for successful EBM implementation outlined earlier, a general model of required attributes for successful EBM in large aquatic

ecosystems can be developed (Table 5). Although most of these characteristics have been discussed in various contexts previously, a brief overview of the consolidated model will prove beneficial.

Table 5

Required Attributes of Successful Ecosystem-Based Management Model for Large Aquatic Ecosystems

Characteristic	Description
EBM Leadership Organization	One organization which can act as both leader for EBM initiative and cross-boundary facilitator to facilitate collaboration among diverse ecosystem stakeholders
Voluntary Versus Legislative Mandate-Based Implementation of EBM Parameters	Combination of voluntary and mandated EBM parameters. Optimum to build on voluntary or mandated parameters already in existence which model EBM attributes in a given ecosystem, then expand. EBM parameters to address: Collaborative Planning Clear, Operational Goals. Minimum ecosystem quality standards must be specified. Planning with Broad Landscape-Scale Focus Cross-Boundary Facilitation Incentives for Stakeholder Collaboration Integration of Multiple Components Integration of Scientific Information Integration of Social, Economic Information Management for Sustainable Outcomes Precaution to Avoid Adverse Impacts Adaptive Management Monitoring on a Recurring Basis Public Engagement Strategy Transboundary Management Funding Mechanisms
Public Engagement to Involve Diverse Stakeholders	A critical factor. Effective public engagement of ecosystem stakeholders will enhance environmental appreciation, generate political pressure for preservation/restoration support and facilitate common understanding of ecosystem characteristics, dynamics and challenges among diverse stakeholders
Effect on Ecosystem Condition	Effective EBM strategy and implementation process can enable stabilization and ultimately improvement in ecosystem condition over time

An extremely important characteristic of any initiative is who is leading it. Thus the EBM leadership organization is an important parameter. In most EA/EBM efforts in large aquatic ecosystems there are many organizations involved at several levels (local, state, provincial, federal, etc.). However, for effectiveness there should be an ultimate leading organization which can provide not only coordination across groups, but act as a cross-boundary facilitator to bridge differing stakeholder perspectives and facilitate integration and consensus.

Several EBM parameters were tested in the current survey regarding stakeholder perceptions of effective implementation: collaborative planning; clear, operational goals; planning with broad landscape-scale focus; cross-boundary facilitation; etc. It was found that a combination of voluntary and mandate-based implementation of these parameters was present in most systems. However, a predominant approach (voluntary or mandated) was present for each ecosystem. It was observed that mandates on some characteristics were necessary to enable effective implementation, although which particular parameters were mandated versus voluntarily implemented varied by ecosystem. Whether on a voluntary or mandated basis, it is seen as critical to implement all of these EBM parameters effectively for successful restoration/protection of the ecosystem of interest.

Although it is one of the previous EBM characteristics surveyed, public engagement is so pivotal to a successful EBM program that it is highlighted and magnified here. As noted in the ten important principles, people are not inclined to preserve an asset that they don't appreciate. It is not the same to tell someone about the

Chesapeake Bay or Lake Erie as it is for them to experience those water bodies firsthand. Environmental appreciation leads to support for protection and restoration, and this can be greatly facilitated by an effective public engagement program. Public engagement can also help build common understanding and trust among diverse ecosystem stakeholders, as well as generate political pressure for preservation efforts.

The goal of an EBM program, as noted earlier, is most often to protect, preserve and/or restore these unique and invaluable large aquatic ecosystems. With today's intense pressures of urbanization, agriculture, industrial utilization and more, society needs to come to an understanding that this is a precarious balancing act to utilize these ecosystems while maintaining their biological diversity and ecosystem integrity on a sustainable basis into the future. An EBM methodology, if applied systematically, can be effective in stabilizing and ultimately improving the condition of these ecosystems over time.

Envisioning a Successful EBM Implementation in the Lake Erie Ecosystem

The general model of required attributes of successful EBM for large aquatic ecosystems can be applied to Lake Erie, the primary system of interest. For the Lake Erie ecosystem to successfully adopt and implement an EBM operating mode, some fundamental changes and adjustments are required. Following is a presentation and discussion of recommendations which, if implemented, would create a new model to enable maximum progress toward ecosystem protection and restoration for Lake Erie.

The characteristics of this recommended model for EBM implementation in the Lake Erie ecosystem are summarized in Table 6 as follows:

Table 6

Recommended Ecosystem-Based Management Model for Lake Erie Ecosystem

Characteristic	Description		
EBM Leadership Organization	International Joint Commission (or Similar)		
		Voluntary	Mandated
Implementation of EBM Parameters	Collaborative Planning		X
	Clear, Operational Goals		X
	Planning with Broad Landscape-Scale Focus		X
	Cross-Boundary Facilitation	X	
	Incentives for Stakeholder Collaboration		X
	Integration of Multiple Components		X
	Integration of Scientific Information	X	
	Integration of Social, Economic Information		X
	Management for Sustainable Outcomes		X
	Precaution to Avoid Adverse Impacts		X
	Adaptive Management		X
	Monitoring on a Recurring Basis		X
	Public Engagement Strategy		X
	Transboundary Management		X
	Funding Mechanisms		
Voluntary Versus Legislative Mandate-Based Implementation	Combination of Voluntary and Mandated EBM Parameters		
Public Engagement to Involve Diverse Stakeholders	Binational Public Engagement Program, Coordinated by IJC (or Similar), Funded at Substantial 10% of Budget Level		
Effect on Ecosystem Condition	Integrated, Effective Management Strategy Can Enable Improvement in Condition of Lake Ecosystem		

EBM Leadership Organization: International Joint Commission (or Similar)

For effective leadership and consistent governance, the Lake Erie ecosystem would ideally have one binational organization with funding ability, political support, enforcement authority and cross-boundary facilitation capability to oversee the ecosystem. However, the governing document for the Great Lakes, the GLWQA, is a binational agreement between the U.S. and Canada which is implemented bilaterally by each country. The organization charged by the federal governments with responsibility for implementation in the binational Great Lakes ecosystem is the Binational Executive Committee (BEC). However, one of the organizations well positioned to catalyze and provide general oversight for the process is the International Joint Commission (IJC), through implementation of the International Watersheds Initiative (IWI) in the Great Lakes, particularly Lake Erie. (There are other existing organizations which could assume this binational role, or a new organization could be created for this EBM leadership purpose.) The IWI, coupled with the Cooperative Science and Monitoring Initiative (CSMI) started in 2006 (Richardson et al. 2010) and the LaMP planning process underway in the Great Lakes, provide the needed infrastructure for the IJC to successfully implement EBM. Specifically, the governments should give a reference to IJC to identify the obstacles and opportunities to overcome them in implementing a more robust EBM in the Great Lakes, using Lake Erie and the Lake Erie LaMP coupled with CSMI as the model.

To elaborate, the IWI is an innovative initiative developed by the IJC to help fulfill its mission under the Boundary Waters Treaty of 1909 in assisting the Canadian and U.S. governments with transborder issues involving the more than 300 lakes and rivers in the 5,500 mile binational border. Integral to the IWI is an integrated, ecosystem approach that looks at complex interrelationships in the entire watershed, and not just at water quantity or quality within border lakes and rivers taken in isolation (IJC 2009). The IJC developed and has begun implementing the IWI during the past decade, supported by special funding from the two federal governments. It is being successfully implemented by some of the IJC control boards on rivers that traverse the international border from coast to coast, but not in the Great Lakes. Therein lies the opportunity for the Great Lakes and thus Lake Erie.

To complement the IWI in this management effort, the CSMI is a plan to binationally coordinate science and monitoring on the Great Lakes. The plan builds upon the pre-established Cooperative Monitoring five-year cycle which focuses on a different Great Lake each year. This research, monitoring and evaluation process provides critical input to the LaMP planning activities for each lake. The CSMI intensive lake surveys can identify the water and ecosystem quality problems in the lakes. Management actions that need to be taken will likely extend up the tributaries and into the watershed sources of these issues. Thus CSMI will invoke the EA to management of these lake ecosystems (as officially embraced by the LaMPs). It will also provide a baseline for adaptive management to be successfully implemented in the Great Lakes.

The new model hereby proposed for implementation of EBM in Lake Erie would be to require, by mandate, implementation of the IWI in the Great Lakes, in conjunction with current CSMI efforts, with guidance, cross-boundary facilitation and assessment of progress provided by the IJC. This mandate could be incorporated into the renegotiation of the GLWQA underway at present. This would create one effective oversight organization for implementation of EBM in the Lake Erie ecosystem, jointly authorized and funded by the U.S. and Canadian governments, and would enable more coordinated management and unified governance of this ecosystem. It would enable the Lake Erie LaMP to be enhanced with more elements of EBM and implemented successfully with IJC oversight. Through evaluation of progress by the governments and leading public consultation, the IJC would help ensure binational accountability and success of the EBM implementation program.

Implementation of EBM Parameters

Following is a review of key EBM parameters tested in the survey, with recommendations on implementation via a voluntary or mandated basis in the Lake Erie ecosystem. Some of these are being implemented already; plans should be made to implement the remainder of these EBM parameters.

- **Collaborative planning**. Mandated. This is occurring on a voluntary basis on different levels, but will be more effective when mandated. As noted earlier, ultimate responsibility resides with the BEC. However, in its report to the governments in 2006, the IJC recommended that the current GLWQLA be

replaced with a more action-oriented Agreement, including a commitment to developing a Binational Action Plan (BAP) (IJC 2006). The BAP would be a mechanism to connect the watershed plans, Remedial Action Plans for Areas of Concern and LaMPs in a more integrated EBM framework. Specific measures of accountability (objectives, timetables and costs) by those responsible for carrying out the activities of the BAP would be included. A further step to ensure accountability, recommended here, is to have the various levels of governments and agencies responsible be signatory to the BAP. The IJC can ensure that all key stakeholder groups participate, including those that are being left out of the planning process currently. The IJC can also help ensure that the LaMP planning document, which formally embraces EA also, makes the transition into an implementation blueprint, a criticism often cited today.

- **Clear, operational goals**. Mandated. The ecosystem management plan must include specific, measurable quantitative targets for nutrient limits, habitat restoration and other parameters with timelines for achievement. These have not been present in the Lake Erie LaMP in the past. However, current efforts to develop a Binational Nutrient Management Strategy with new nutrient targets for the lake, and the forthcoming Binational Biodiversity Conservation Strategy are steps in the right direction which can inform the Lake Erie LaMP in the future.
- **Planning with broad landscape-scale focus**. Mandated. There is increasing recognition at several levels that what happens on the land affects what happens

in the water. For example, the impact of agricultural fertilizer runoff and its role in stimulating algal blooms in Lake Erie is receiving increasing attention. However, the Lake Erie LaMP has traditionally not had a broad landscape-scale focus, but rather has concentrated on the water body itself. This must change formally and informally in LaMP planning and implementation, as the lake is inseparable from its watershed and they must be managed as an integrated whole. In addition to biological, chemical and ecological considerations, the LaMP's scope must be broadened to include sociological and economic factors as well. This holistic, integrated view of the ecosystem and the effects of people on it is the essence of EBM.

- **Cross-boundary facilitation**. Voluntary. There are a number of cross-boundary facilitating organizations (e.g. Lake Erie Millennium Network, Great Lakes Binational Executive Committee, etc.) in place to facilitate collaboration across both geopolitical boundaries as well as to bridge divides among diverse stakeholders groups. This challenge will be facilitated by having one organization (IJC) responsible for binational ecosystem management. In its strengthened role, IJC can foster even stronger international communication and cooperation between organizations in the U.S. and Canada as well as continue its cross-boundary facilitation role among organizations on both sides of the border.

Additional integrative expertise for cross-boundary facilitation must be developed on an individual (as well as organizational) level as well. That is, more

individuals who can serve as cross-boundary translators and collaboration brokers must be developed/acquired and utilized. They have unique multi-disciplinary backgrounds (in government, business, legal and scientific/technical fields) and experience brokering multi-organizational partnerships and collaborations. This talent in successfully bringing together diverse groups with different interests but common goals is critically important to creating a common baseline of understanding of ecosystem dynamics and issues among the diverse stakeholders to facilitate more effective collaborative partnerships and decision making.

- **Incentives for stakeholder collaboration**. Mandated. Federal funding (provided by U.S. and Canada) can be leveraged through actions of the IJC to create strengthened incentives for bilateral collaboration among stakeholders for research, protection and restoration efforts for the Lake Erie ecosystem. Use of a cost-sharing strategy between federal and non-federal funds is especially effective to induce collaboration between parties. This funding, although provided as an incentive at the federal level, will stimulate collaboration at the provincial, state and local/municipal level as well. This is important as many of the on-the-ground initiatives are implemented at non-federal levels.

As noted earlier, effective cross-boundary facilitation can also serve as an incentive for collaboration. When the process for partnership formation becomes easier and more mutually rewarding, an increasing number of stakeholder groups will find it worthwhile to work together to achieve common ecosystem objectives.

- **Integration of multiple components**. Mandated. This is occurring to some extent in the planning process with the adoption of an ecosystem approach, but efforts in this area need to be increased. This perspective involves the interconnectedness between the air, land, water and biota, and human impacts on these, including climate change over extended time frames. Lake Erie survey respondents saw much room for improvement in this area as exemplified in the Lake Erie LaMP. The LaMP officially embraces EA, but its focus has traditionally been on offshore areas of the lake. It has also been seen as a planning document and not an implementation tool. As discussed earlier, the IWI and CSMI processes will help connect the lake (both offshore and nearshore) to related watershed influences and thus enable water and habitat problems in the lake to be addressed. The driving factors of ecosystem health, through the monitoring and evaluation process, can be tracked and used to form the basis of an effective adaptive management strategy to manage the ecosystem. This informational input will enable the LaMP to transition from being simply a planning document to becoming a relevant vehicle for EBM implementation in Lake Erie. In addition, integrating the perspectives of diverse Lake Erie ecosystem stakeholders (e.g. Business/Industry, Government/Regulatory and Academic) through effective cross-boundary facilitation will also enable further integration of multiple ecosystem components.
- **Integration of scientific information**. Voluntary. This parameter is well recognized as being critical to successful ecosystem protection and restoration,

not only in Lake Erie but in all aquatic ecosystems surveyed. For Lake Erie, when respondents were viewed on a stratified basis both by area of focus and type of organization, all classes of stakeholders indicated strong agreement that scientific input was being used as important input for decisions on how the ecosystem is managed. The best science is being sought (to the extent it can be funded) and incorporated in the management plans and decisions for the Lake Erie ecosystem. One initiative contributing significantly to success in this area is the Lake Erie Millennium Network (LEMN). LEMN, through a series of events dealing with Lake Erie environmental issues, seeks to summarize current status of the lake, document research and management needs and develop a responsive binational research agenda to address those needs. In addition, as discussed earlier, the CSMI provides scientific input to the LaMP which can be used as a science-based blueprint for implementation of EBM in Lake Erie. Also, the IJC Council of Great Lakes Research Managers assists in this process by conducting workshops in advance of CSMI intensive surveys and recommends research and monitoring priorities. Thus scientific information is heavily integrated into management decisions for Lake Erie. The utilization of additional research-to-application expertise could make the process of moving research to application for the benefit of the ecosystem and society more efficient.

- **Integration of social, economic information**. Mandated. Among all ecosystems surveyed, Lake Erie respondents showed weakest agreement that this type of

information is used as important input for ecosystem management decisions. This is a notable shortcoming, as the lake is an extremely important economic engine for bordering states in the U.S. and the Province of Ontario in Canada. In Ohio alone, invasive species, algal blooms, chemical runoff and climate change all have the potential to stagger the economic engine that generates thousands of jobs in the state in industries from tourism to recreational fishing to shipping. The Lake Erie fishery is extremely important also. Dr. Jeffrey Reutter (2010) explains what he calls the "50-and-two rule": Lake Superior has 50 percent of the water in the Great Lakes, but only 2 percent of the fish. Lake Erie has only 2 percent of the water, but more than 50 percent of all the fish in the Great Lakes. These potential economic and societal impacts must be dollarized and considered explicitly in the environmental management equation for the lake.

Viewing Lake Erie stakeholders on a stratified basis, survey results showed that Government/Regulatory stakeholders at the Ecosystem level felt societal and economic information were being incorporated for effective ecosystem management, but most other stakeholder groups did not. Consistently including this information across all stakeholder categories would ensure that a holistic, integrated approach to management of the ecosystem is being taken. This would bring Business/Industry, an important stakeholder group, and others to the table and ensure that societal concerns are addressed. These are key to achieving a satisfactory, workable plan for effective ecosystem management.

- **Management for sustainable outcomes**. Mandated. It is critical that the Lake Erie ecosystem (i.e. both the water body and watershed) be managed with a long-term view (i.e. minimum twenty-year perspective) to ensure that solutions to problems being addressed today do not cause larger problems for the lake longer term. From the survey, Ecosystem stakeholders were more confident that this was taking place than Aquatic scientists. Likewise, Government/Regulatory representatives were more confident that a sustainable management strategy was being followed than were NGO respondents. These varying perspectives and realities must be reconciled through communication and cross-boundary facilitation such that stakeholders agree (and in reality it is true) that a sustainable strategy is being implemented for Lake Erie. Management decisions should enable the lake to function effectively and satisfy stakeholder needs today without compromising the ability of future generations to enjoy and derive benefits from the lake ecosystem.
- **Precaution to avoid adverse impacts**. Mandated. There is room for improvement in the implementation of this parameter in the Lake Erie ecosystem, as evidenced by comparison with respondents from other ecosystems surveyed (Lake Erie showed second most strong disagreement, although the differences were not significant). The precautionary approach is buttressed by the fact that a scientific basis is sought to understand potential risks and outcomes for most management decisions for the lake ecosystem. However, it is not currently

articulated as a management principle for the Great Lakes. It would be beneficial to formally incorporate the precautionary principle as an important EBM parameter into the GLWQA during the current negotiations.

- **Adaptive management**. Mandated. Significant opportunity for improvement exists in implementing an adaptive management strategy for Lake Erie. Respondents from this ecosystem were least positive of respondents from all ecosystems surveyed that adaptive management was being applied for managing the ecosystem. There was also significant disagreement among Lake Erie stakeholders (e.g. Aquatic versus Watershed, Academic versus Government/Regulatory) regarding application of this strategy. There is an attempt to implement adaptive management via the Lake Erie LaMP, but efforts to implement this parameter effectively must be increased. As outlined in the IJC 2007-2009 nearshore framework report (IJC 2009), an adaptive-management framework must be embedded in the Lakewide Management Plans (LaMPs) for the Great Lakes. Adaptive management is critical to successful implementation of EBM for Lake Erie. The Lake Erie ecosystem is complex and undergoes constant stress and change. As discussed earlier, the CSMI lake surveys will identify water and ecosystem quality problems in the lake for which management actions, often traced to source problems in the watershed, can be taken. Continued monitoring and evaluation after these management actions are taken is necessary to see if the lake responded favorably. If not, management actions must be adjusted and

monitored and evaluated again as ecosystem conditions and attributes warrant. Thus an adaptive-management process is necessary for EBM implementation success in Lake Erie.

- **Monitoring on a recurring basis**. Mandated. This parameter must be implemented more rigorously and consistently to support effect adaptive management (described previously). Lake Erie survey respondents disagreed most strongly of respondents from all ecosystems that monitoring on a recurring basis to detect and track changes in key parameters is occurring. The CSMI is a critical component to ensuring that this EBM parameter is implemented effectively. Through planning and pooling of available binational resources, CSMI intensive lake surveys are carried out with a focus on each Great Lake every five years. To assist with implementation, each country may offer competitive grants to aid in the process. For example, the U.S. EPA funds the Lake Erie Coordinated Science and Monitoring initiative (U.S. EPA 2008). This grant program of 2008-9 involves making several awards to improve scientific understanding and monitoring effectiveness in the lake. It is recommended that data from the CSMI comprehensive monitoring efforts should be kept in one integrated, binational database which would be readily available to stakeholders of both countries. Current monitoring efforts are neither consistent nor coordinated on a broad basis and are not aligned with planning activities. More consistent, thorough monitoring of nearshore areas is particularly important.

- **Public engagement strategy**. Mandated. Once again, Lake Erie came up lacking on this parameter with respondents disagreeing most strongly of all ecosystems about an effective public engagement strategy being present. However, it is not that there are no public engagement initiatives present for the Lake Erie ecosystem; several are underway. The issue here is fragmentation, with the challenge being to create an integrated, impactful public engagement strategy for the entire ecosystem. Public engagement is often undertaken as a "nice-to-do" activity and funded accordingly, but it is extremely important to create understanding and action among key stakeholder groups. Public engagement often results in public pressure which can trigger legislative action and funding support for protection and restoration activities. An integrated, binational public engagement strategy must be implemented for effectiveness in gaining public understanding and support for protection and restoration of the ecosystem. The IJC (or similar organization), as part of its binational coordination charter, is best positioned to undertake and oversee this and should be given a reference by the governments to do so.
- **Transboundary management**. Mandated. Relative to the other ecosystems surveyed, Lake Erie respondents in general did not feel that the transboundary nature of the ecosystem posed a substantial impediment to management planning and implementation. Binational oversight of the Lake Erie ecosystem provided by

the BEC with implementation coordination by the IJC or similar organization (discussed earlier) will further improve the effectiveness of this parameter.

- **Funding mechanisms**. Mandated. This was one parameter nearly universally agreed upon by all respondents in all ecosystems, in that few think that funding is adequate and sustainable to effectively manage their ecosystem. This was true with Lake Erie as well. One issue for Lake Erie is that there is a different funding structure in the U.S. and Canada for Great Lakes protection and restoration. Whereas the U.S. federal government has committed a first allocation of $475 million in FY 2010 to a broad Great Lakes Restoration Initiative, the Canadian federal government in partnership with the Province of Ontario through the Canada-Ontario Agreement has committed a much smaller amount ($40 million) focused primarily on specific Areas of Concern. Under the proposed model, some of the funding provided through the IWI, as well as existing efforts by the IJC advisory boards, would be channeled by IJC to provide guidance, cross-boundary facilitation and assessment of progress to the binational EBM implementation effort.

Voluntary versus Legislative Mandate-Based Implementation

As is seen, in addition to various pollution controls and other regulations currently in place for the Lake Erie ecosystem, it is recommended that several EBM parameters related to the process of managing the ecosystem be mandated as well (discussed above). Other aspects of EBM implementation will remain on a voluntary basis. This will

increase the effectiveness of EBM application in the ecosystem by ensuring that all important parameters are implemented. As was seen in the survey data, the Chesapeake Bay and Lake Erie ecosystems, both voluntarily managed, have struggled the most to attain and maintain ecosystem management objectives. The two systems governed primarily by a legislative mandate, Puget Sound and Baltic Sea, have generally fared better. The Tampa Bay ecosystem, which had the most positive performance regarding ecosystem protection and restoration, had an interesting mix of voluntary management reinforced by a strictly enforced regulatory backbone. The approach recommended for Lake Erie provides a more structured EBM framework but enables key voluntary parameters which are working effectively to continue to do so. If the regulatory framework and mandates currently in place for the lake ecosystem are strictly enforced, they will encourage more diligent participation in the EBM process by all stakeholders and thereby lead to a more successful ecosystem restoration and maintenance program.

Public Engagement to Involve Diverse Stakeholders

As noted earlier, an effective public engagement strategy is critical to a successful EBM program. If the public does not have interaction with and appreciation of the Lake Erie ecosystem, they will not understand the ramifications of their actions (particularly in the watershed) and will not be motivated to fight for the restoration and preservation of the ecosystem. Likewise, key stakeholders may hold misperceptions about this valuable resource and misunderstandings about how it is being managed and the part they can play to make it better. Public engagement can not only provide education to inform the public

of current developments regarding the lake, but can make them more science-savvy stewards such they can help translate new science-based approaches into application in their communities and businesses. An informed and motivated public constituency can be very powerful in persuading their legislators to act in an informed way to supply the resources and mandates (if needed) to protect and restore the ecosystem. As discussed earlier, this was the case with informed and engaged Tampa Bay stakeholders who brought legislative pressure to bear on their nitrogen management and contaminants problem, beginning the turnaround of their ecosystem in the 1970s. Therefore, it is recommended that a binational public engagement program be put in place, coordinated by the IJC (or similar) and funded at a substantial 10% of budget level by the respective federal governments. This can be implemented by the Sea Grant College Program, for example, in the US. Unfortunately, there is currently no parallel organization for Canadian implementation. It is therefore recommended that the Conservation Authorities consider taking on this public engagement responsibility in Canada. Public forums currently held for the LaMP process and by similar groups for the Areas of Concern/Remedial Action Plan will be included also. With overall coordination provided by the IJC, a more integrated, comprehensive public engagement program for the U.S. and Canada will emerge. This will significantly facilitate effective EBM adoption for the Lake Erie ecosystem.

Effect on Ecosystem Condition

Implementation of the recommended EBM program for Lake Erie will result in a more integrated, effective management strategy and, ultimately, improvement in the condition of the lake ecosystem. Through unified binational coordination (IJC or similar), improved collaboration and communication with the GLFC in an ecosystem context, implementation of EBM parameters on a combined voluntary and mandated basis and an effective public engagement initiative, informed decisions will be made on an ongoing basis, results monitored and evaluated and decisions revised as needed to ensure ecosystem success. Lake Erie had undergone dramatic improvement since the 1960s, until the last decade during which eutrophication, invasive species and other factors have caused backsliding in ecosystem condition. Through the recommended EBM strategy based on an integrated, science-based approach and an informed, engaged public, there is no reason that a turnaround in ecosystem condition cannot occur such that protection and restoration of the Lake Erie ecosystem can continue effectively.

Example of Lake Erie EBM Model in Practice: Wind Energy in the Lake

The above model for successful EBM implementation in Lake Erie can not only be applied for managing the ecosystem as a whole, the general framework can be adapted to deal with specific issues faced in the lake. A current issue confronting Lake Erie managers is how to implement wind power in the lake ecosystem. This challenge will be discussed below in the context of utilizing an EBM framework to maximize the

opportunity while minimizing the negative impact of this initiative on the Lake Erie ecosystem. The characteristics of this recommended model for wind energy implementation in the Lake Erie ecosystem are summarized in Table 7. Many government officials and economic developers on both sides of the border are excited

Table 7

Example of Lake Erie EBM Model in Practice: Wind Energy

Characteristic	Description		
EBM Leadership Organization	International Joint Commission (or Similar)		
		Voluntary	Mandated
Implementation of EBM Parameters	Collaborative Planning	X	
	Clear, Operational Goals	X	
	Planning with Broad Landscape-Scale Focus	X	
	Cross-Boundary Facilitation	X	
	Incentives for Stakeholder Collaboration	X	
	Integration of Multiple Components	X	
	Integration of Scientific Information		X
	Integration of Social, Economic Information	X	
	Management for Sustainable Outcomes	X	
	Precaution to Avoid Adverse Impacts	X	
	Adaptive Management	X	
	Monitoring on a Recurring Basis	X	
	Public Engagement Strategy	X	
	Transboundary Management	X	
	Funding Mechanisms	X	
Voluntary Versus Legislative Mandate-Based Implementation	Primarily Voluntary Initially, to More Mandated Over Time		
Public Engagement to Involve Diverse Stakeholders	Binational Public Engagement Program, Coordinated by IJC (or Similar), Needed Immediately		
Effect on Ecosystem Condition	Minimize Negative Impacts on Lake Ecosystem, Realize Synergy from Holistic Approach		

about the prospect of bringing wind power to Lake Erie due to the promise of jobs and clean energy for their local economies. The plans to build and install turbines to bring the wind energy into being are big in every way. Not only are the turbines themselves extremely large in proportion, the four U.S. states and Province of Ontario have aggressive plans to install wind farms with turbines numbering from a few initially into the hundreds. For example, Northeast Ohio, through the Lake Erie Energy Development Corporation (LEEDCo), has its sights set on becoming the first fresh water off-shore wind project in North America (PRNewswire 2010). Plans call for a five-turbine, 20 megawatt (MW) wind farm off Cleveland initially, with 1,000 MW of wind-generating capacity in the lake by 2020. This opportunity has not gone unnoticed by the state of New York. The New York Power Authority has commissioned a wind power study for the Great Lakes of New York (AWS Truewind 2010). Their estimates show the potential for a 120-500 MW offshore wind project, most of which will be sited in Lake Erie. Canada similarly has big plans. SouthPoint Wind has proposed 15 wind turbines off Kingsville and Leamington in Lake Erie (Windfair.net 2010). If successful, it has proposed a 1,400 MW project with 13 wind farms, 10 of which would be located in Lake Erie with 55 turbines in each for a total of 550 turbines in the lake! Additional wind energy projects for Lake Erie are being scoped and considered in Pennsylvania and Michigan also.

Each of the four U.S. states and the Province of Ontario are operating independently in deciding how wind power should be implemented in Lake Erie. But one must ask: Since this is one ecosystem, should there not be a larger view taken of the lake

to ensure that its overall integrity is not harmed or degraded further by these disparate economic development efforts? And, if viewed on a more holistic basis, are there synergistic opportunities and economies of scale which could be realized from working together that could actually bring more benefit and less harm than from each jurisdiction working separately?

Adopting an EBM approach for the implementation of wind power in Lake Erie could provide the types of invaluable insights which are needed. Following is a description of how the parameters of an EBM framework could be successfully applied to the lake ecosystem to make this process more rational.

- **EBM leadership organization.** Voluntary. As the primary binational coordinator for the Lake Erie ecosystem, the International Joint Commission (IJC, or similar organization) would serve as the convener and facilitator of the process to bring together the four U.S. states and the Province of Ontario, as well as other interested parties, to discuss the wind energy opportunity and its inherent challenges. The IJC would not have direct authority over these political entities or their private developers, but could facilitate a collaborative process to take a more holistic view at the ecosystem level to arrive at a more integrated, rational approach. Pertinent topics which could be discussed and decided upon at this level include distance from shore for placement of wind turbines; the possibility of purchasing shared equipment for transport, installation and maintenance of wind turbines (thereby saving cost for each installation); macro-environmental

studies on overall impact of wind installations in the lake with costs shared among parties; intralake shipping considerations; fishing allowances around turbines; minimum safety standards and underwater grid configuration for minimum disruption to lake bottom and to minimize anchoring hazards. This latter topic could also include the opportunity of a shared electrical grid which could ultimately span the lake to the benefit of both countries, with costs shared proportionately. The IJC, as the binational EBM coordinator for Lake Erie, would be ideally positioned to facilitate these discussions.

- **Collaborative planning.** Voluntary. Once convened by the IJC (or similar organization), the political jurisdictions and interested parties could undertake collective discussion of the wind energy opportunity and its challenges, addressing the issues and opportunities noted earlier as well as others. This collaborative planning exercise would result in a more uniform approach as to how the overall Lake Erie ecosystem would be impacted and managed, and would result in a plan and potentially standards for how wind energy would be implemented in the lake. This would serve to inform and enhance the Lake Erie LaMP and its management strategy for the lake.
- **Clear, operational goals.** Voluntary. As an outcome of the collaborative planning exercise noted above, the overall wind energy plan for Lake Erie would contain clear goals and preferentially minimum standards for implementation of wind turbines and the underwater energy grid in the lake, as well as connectivity

to the land-based grid in the watershed. These goals and standards would be accompanied by agreed-upon timelines for implementation to enable a coordinated, integrated blueprint.

- **Planning with a broad landscape-scale focus.** Voluntary. As noted earlier, this collaborative planning exercise would be accomplished on a holistic basis involving the entire lake and its watershed as one ecosystem, in contrast to the state-by-state and provincial planning currently underway. The current approach will likely result in disjoint solutions and suboptimal implementation of placing wind turbines and infrastructure in Lake Erie, not to mention lost opportunity regarding economic savings which could be realized through economies of scale if the various governments and energy developers were to collaborate.
- **Cross-boundary facilitation.** Voluntary. The IJC would be the primary facilitator of this multi-party dialogue at all levels including federal (U.S. and Canada), state, provincial and municipal. It would also be the boundary-spanning agent which could reach across the divide seen in the current research between Aquatic, Fisheries and Watershed stewards. Similarly, the IJC could raise the level of communication between Government/Regulatory, Business/Industry, Academic and NGO managers to bring more accurate, complete understanding of the problems and opportunities inherent in the wind power initiative. As there would likely be tensions and disagreements over some issues, the IJC would serve

as a neutral cross-boundary facilitator which would mediate these discussions and look for win-win solutions.

- **Incentives for stakeholder collaboration.** Voluntary. The incentives for collaboration would be primarily economic, but hold other potential advantages as well. As noted earlier, energy developers would have the potential for expanded market share and reduced costs from collaboration across borders which would accrue to the benefit of their respective governments as well. Scientists could share data from different wind feasibility projects around the lake which could be compiled and accessed in a central database which would make collaboration attractive. Similarly, fisheries managers would be motivated to work together on the big picture for fishing opportunities around the turbines and the grid and to develop safe procedures for doing so. These groups could be incentivized further by infusion of matching funds (from the U.S. and Canadian federal governments) as they develop the operating norms for the ecosystem with wind power being implemented.
- **Integration of multiple components.** Voluntary. As outlined earlier, this perspective involves the interconnectedness between the air, land, water and biota, and human impacts on these, including climate change over extended time frames. The introduction of wind power generation into the Lake Erie ecosystem encompasses all of these parameters and thus would benefit from an EBM approach. The fauna of the air and water are intimately involved as well as the

land under the lake and in the watershed for interconnections with the existing electrical grid. Industrial, governmental, scientific and general public interests all must be served. The introduction of wind turbines and underwater infrastructure deserve a holistic approach to track and predict their impact over time, as they will be affected by short-term weather conditions (gales, ice, etc.) as well as longer term climatic and potentially wind pattern alterations. These parameters must be managed through an integrated framework which is the essence of EBM.

- **Integration of scientific information.** Mandated. Informed implementation of wind power on Lake Erie is dependent upon not only economic drivers, but scientific input as well. Questions alluded to previously including impact on local fisheries, other biota, lake bottom, seismic risk, etc. should be considered, including probable changes over time. Thus integration of scientific information is critical. As suggested previously, if this information from individual wind feasibility studies is collected in a central repository, it can be shared among parties and used to create an overall composite of probable impact on the lake ecosystem.
- **Integration of social, economic impact.** Voluntary. Similar to treatment of scientific information, collection and integration of economic information and potential impacts on society from the introduction of wind turbines in the lake should be undertaken. This would be useful in helping to address a range of issues, from the visual impact of wind turbines on shoreline views by the public to

economies of scale which could be realized by wind power developers working together to share equipment, environmental data, etc. As asserted earlier, if there is not overall coordination in this way, solutions are likely to be disjoint and suboptimal for the lake ecosystem and potential synergies of implementation are likely to go unrealized.

- **Management for sustainable outcomes.** Voluntary. In this "gold rush" to put wind turbines in the lake, the primary motivation in the context of clean energy has been economic including the promise of new jobs and revitalized economies. Many elected officials are hoping Lake Erie wind power will create an economic stimulus for their respective economies in the short term. However, introducing wind power into the lake ecosystem is a long term initiative with impacts that will be felt for decades. We must consider this view also and remember that management decisions should enable the lake to function effectively and satisfy stakeholder needs today without compromising the ability of future generations to enjoy and derive benefits from the lake ecosystem.
- **Precaution to avoid adverse impacts.** Voluntary. In general, precaution has been exercised and science has been utilized for most past management decisions affecting Lake Erie. The fact that scientific data do not yet exist regarding many probable impacts of wind turbines in the lake should not detract from precaution being exercised in these and future management decisions affecting wind power. Utilizing this approach will be difficult given that the freight train of putting wind

turbines in the lake has left the station and momentum is building daily, but precaution must be exercised to enable a sustainable future for the ecosystem.

- **Adaptive management.** Voluntary. Since implementing wind turbines in this freshwater ecosystem will be a global "first," it will be especially important to monitor and evaluate changes in the ecosystem (particularly physical and biological) and adapt the management strategy accordingly over time. Survey results showed that adaptive management has not traditionally been a strength for Lake Erie, but it will be especially important in this case.
- **Monitoring on a recurring basis.** Voluntary. Consistent monitoring of changes in the ecosystem due to introduction of wind turbines and associated infrastructure will be key to a successful adaptive management program (discussed above). Effective and recurrent monitoring will be particularly important since these wind farms with tens if not hundreds of wind turbines will be installed in the important and vulnerable nearshore areas of the lake. Having these monitoring data deposited in a central database overseen by the IJC and accessible to all parties from both U.S. and Canada would be invaluable in supporting a comprehensive adaptive management program for the Lake Erie ecosystem.
- **Public engagement strategy.** Voluntary. This is a critical but often undervalued component of a successful EBM strategy. When it comes to a potentially controversial topic like introducing wind power into Lake Erie, engaging the

public early in the process becomes extremely important. The alternative in not involving and consulting with the general public on this matter is not desirable for, as the old adage goes, "if they are not in on it, and not up on it, they will be down on it" (Cutinella 2000). An integrated, binational public engagement strategy coordinated by the IJC (or similar) needs to be launched immediately, for public resistance is already building due to lack of involvement. Erie, PA writer Peter Panepento (2008) wrote that "If you think the debate over plans to build a tires-to-energy plant on the Lake Erie shore has been intense, brace yourself for what could be an even more caustic battle over the possibility of wind farms on the Great Lakes." Similar public resistance is building in Canada over the prospect of putting wind turbines in Lake Erie. As noted by Larry Cornies (2010), there is a divide between the champions and detractors of Ontario's turbulent green energy industry. Some think it points the way forward, positioning the province to stake its claim to an industry still in its wild-west phase. Others see it as regressive and illogical, its projects as ugly as they are intrusive and impractical. This is where an effective public engagement strategy can be helpful, in creating effective two-way communication where the realities of the wind power project can be understood and public concerns heard and dealt with to bring the two sides closer together. If the public's concerns are not addressed, there could be trouble ahead for the wind power initiative. Cornies (2010) goes on to state that signs proclaiming "No wind turbines in our lake" have dotted the

landscape along the shore of Lake Erie's Pigeon Bay, adjacent to Point Pelee National Park, and on Pelee Island for many months – a campaign directed primarily against South Point Wind which wants to build turbines in the shallow waters along the ecologically sensitive coastline. If the public does feel that it is being heard, it can go on to generate legislative support for its concerns as was seen in the Tampa Bay case with the current research. In Ontario, protesters have presented a petition against the project and their own government, which caused the government to impose new rules that will require offshore projects to be set at least five kilometers from shore, ratcheting up the cost. Thus the time and energy spent in engaging the public early in these potentially controversial initiatives is well worth the effort to prevent potentially show-stopping problems downstream.

- **Transboundary management.** Voluntary. As noted earlier, the IJC (or similar) can serve as a "neutral broker" for management discussions and public engagement in the Lake Erie ecosystem in general. Related to the wind energy initiative, the IJC can create the much-needed binational dialogue to work out issues and realize potential synergy from the different governments and wind power firms working together to come up with common approaches and shared resources. This will be helpful in ensuring that some of the stakeholders who are sometimes left out of the conversation (e.g. NGOs, Fisheries, Watershed representatives) are included as well.

- **Funding mechanisms.** Voluntary. The wind power initiative in Lake Erie is primarily a private-sector led effort, with strong support being shown by many state and provincial governments. Thus private funds (with governmental tax breaks in many cases) would be the primary resources utilized. However, as noted earlier, funds from both the U.S. and Canadian federal governments could be used to incentivize collaboration through matching funds in such areas as shared environmental studies and fisheries information, creation of a shared database of results, and incentives to get state, provincial and municipal entities to work together on these projects.
- **Voluntary versus legislative mandate-based implementation.** None of the EBM parameters, with the exception of the integration of scientific information in environmental studies, is currently mandated as related to the wind energy initiative on Lake Erie. Thus it is a strongly voluntarily-based EBM framework at present. As was seen in the current research, this approach met with limited success in ecosystems as complex as Lake Erie. Thus it can be anticipated that, for effective EBM for wind energy in the Lake Erie ecosystem in the future, some mandates will be necessary to set minimum standards and operating norms. In the meantime, the IJC can promote the utilization of the EBM framework on a voluntary basis. Over time, those parameters which would be most effective through mandate-based implementation will become evident and should thereby be acted upon to make them mandated.

- **Effect on ecosystem condition.** One might ask: "How much impact can a wind turbine in Lake Erie have anyway?" The apparent (though perhaps inaccurate) answer may be "not much." However, when one considers that there may be wind turbines numbering in the hundreds, along with associated infrastructure and network grid (extending into the watershed), placed in important nearshore ecosystem areas all around the lake, the potential impact on the ecosystem is much greater. Thus, to minimize negative impact on the ecosystem, it must be considered in a holistic manner as the course is charted for wind power in Lake Erie to ensure a sustainable future for all.

Thoughts on Future Research

Longitudinal Study

The current study is cross-sectional in that it looks at the status of the five ecosystems at a given time. While proving very useful in understanding the different perceptions of ecosystem stakeholders and the conditions of the various ecosystems, it is nevertheless a snapshot in time.

A longitudinal study of these same ecosystems and stakeholders over time would reveal how attitudes about and conditions in these ecosystems change. This is extremely important because, as was pointed out earlier, the nature of large-scale ecosystem protection and restoration is a long-term process involving decades and requires long-term resource commitment to achieve success. A longitudinal study is also important

because the subject ecosystems are at different stages of progression in their adoption of EA/EBM. Chesapeake Bay, Lake Erie and Tampa Bay all adopted this holistic ecosystem management approach many years ago, while Puget Sound and the Baltic Sea have both implemented this approach within the past five years. A temporal view of these ecosystems and the stakeholders involved would illuminate trends and correlations involving EBM, voluntary versus mandatory implementation, ecosystem size and positive outcomes/ecosystem condition over time. This would be very useful in informing adaptive management of these systems.

Better Understanding of Ecosystem Stakeholders

To assist with the challenging process of effectively implementing EBM in these various ecosystems, study needs to be done to better understand the question of "Why do perspectives of diverse ecosystem stakeholders vary?" This type of multi-faceted socioeconomic analysis is particularly important to understand stakeholders whose perceptions are at the extremes of divergence in the stratified portion of the survey. That is, for Lake Erie, why Aquatic and Watershed/Ecosystem stakeholders saw the situation for EBM implementation and success so differently; likewise why Government/Regulatory stakeholders were so much more positive than the other categories of respondents. Quite similar extremes were seen in the stratification of stakeholders from all ecosystems together. Better understanding the reasons for these different perceptions would be useful in the EBM implementation process to help achieve a common understanding of the EBM challenge among stakeholders for each ecosystem,

as well as informing the optimum communication and cross-boundary facilitation techniques to use in each. This is critical if efficient and effective implementation of EBM is to be achieved.

APPENDICES

APPENDIX A

MANAGEMENT SURVEY FOR LARGE AQUATIC ECOSYSTEMS

APPENDIX A

MANAGEMENT SURVEY FOR LARGE AQUATIC ECOSYSTEMS

This is a brief survey examining aspects of how large aquatic ecosystems are managed and the effectiveness in maintaining those ecosystems in a healthy, productive and resilient condition so they can provide the services humans want and need. Your participation in the survey is appreciated.

Your responses will be kept confidential and will be used only in the aggregate. You will also be given the opportunity to provide brief additional comments and these will be summarized without attribution.

This project has been approved by the Kent State University Institutional Review Board. If you have questions about KSU's rules for research, please call Dr. John West, Vice President for Research at 330.672.3012. If you have questions about the survey, please feel free to contact Gregory Wilson, Doctoral Candidate, at greg.wilson@kent.edu or 330.672.0704.

1. Which aquatic ecosystem are you primarily involved with?

   _____ Lake Erie
   _____ Chesapeake Bay
   _____ Puget Sound
   _____ Tampa Bay
   _____ Baltic Sea
   _____ Other Please specify: _____

2. How long have you been working with this ecosystem?

   _____ Less than one year
   _____ One to three years
   _____ Three to five years
   _____ Five to ten years
   _____ More than ten years

3. Which one of the following best describes the type of organization you are employed by/affiliated with relative to the ecosystem?

_____ Government/regulatory
_____ Business/industry
_____ Academic
_____ Non-governmental organization (NGO)
_____ Other Please specify: _____

4. Which of the following best describes your primary area of focus relative to the ecosystem?

_____ Aquatic (limnological)
_____ Fisheries
_____ Watershed (land) based
_____ Entire ecosystem (including watershed)
_____ Other Please specify: _____

Unless otherwise indicated, for the following statements please indicate your level of agreement or disagreement using the following:

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree
Don't know (DK)

5. Ecosystem management planning is done on a collaborative basis to engage diverse stakeholder groups (governmental, business, non-governmental organizations, etc.) involved with the ecosystem.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

6. A comprehensive ecosystem management plan which integrates the needs of diverse stakeholder groups (governmental, business, non-governmental organizations, etc.) is present for the ecosystem.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

7. There are clear goals and objectives present in the management plan used for managing the ecosystem.

   Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

   Comments:

8. The ecosystem management plan utilizes a broad landscape- or regional-scale focus, including the water body and its watershed.

   Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

   Comments:

9. A cross-boundary facilitator (person or organization) which aids the diverse stakeholder groups (governmental, business, non-governmental organizations, etc.) in reaching consensus on issues and resolving conflicts is present and is an important part of the ecosystem management process.

   Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

   Name of cross-boundary facilitator, if present: _____

   Comments:

10. Incentives are present which encourage the diverse stakeholder groups (governmental, business, non-governmental organizations, etc.) to collaborate for effective ecosystem management.

    Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

    List key incentives, if present: _____

    Comments:

11. There is recognition of the interconnectedness between species and the interconnectedness among land, air and aquatic aspects of the ecosystem in the management plan for the ecosystem.

    Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

    Comments:

12. There is recognition of the integration of ecological, social, economic and institutional perspectives in the management plan for the ecosystem.

    Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

    Comments:

13. Scientific input is actively sought from scientists engaged in studying the ecosystem and is used as important input for decisions on how the ecosystem is managed.

    Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

    Comments:

14. Societal and economic information is sought and used as important input for decisions on how the ecosystem is managed.

    Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

    Comments:

15. The ecosystem management strategy is to seek sustainable outcomes which will enable the ecosystem to function effectively into the future, i.e. satisfying present needs without compromising the ability of future generations to meet their own needs.

    Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

    Comments:

16. Precaution is exercised to avoid actions which might result in adverse impacts to the ecosystem, i.e. the level of scientific uncertainty and potential risk of damage are considered as part of every management action.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

17. Adaptive management is being applied for managing the ecosystem, whereby a course of action is undertaken, the results evaluated and the course of action revised on a specific timetable to respond to changing ecosystem conditions and attributes.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

18. Monitoring of the ecosystem on a recurring basis to detect and track changes in key parameters (e.g. water quality, habitat loss/restoration, etc.) is occurring.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

19. An effective public engagement strategy is present to inform and involve the general public in the ecosystem management initiative and to enlist their support for this effort.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

20. Is the aquatic ecosystem with which you are working multistate and/or multinational (including its respective watershed)?

Yes
No

20a. The transboundary nature of the ecosystem makes management planning and implementation very difficult.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

21. Funding is adequate and sustainable to effectively manage the ecosystem.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

22. Management of the ecosystem has proceeded successfully from planning stages to the implementation phase, and is now resulting in desired outcomes.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Primary factor responsible for success or lack thereof: _____

Comments:

23. Strong, effective leadership is present and has enabled the ecosystem management program to maximize progress.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Identify provider of strong, effective leadership, if present:

Comments:

24. The ecosystem management strategy has been effective in maintaining the ecosystem in a healthy, productive and resilient condition so it can provide the services humans want and need.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Primary factor responsible for success or lack thereof: _____

Comments:

25. Based on your knowledge and experience, please indicate which of the following aspects for managing the ecosystem are being implemented on a voluntary basis (i.e. not based on legislative mandate) in the ecosystem with which you are involved. Select all that apply.

_____ Collaborative planning
_____ Clear, operational goals
_____ Planning with broad landscape-scale focus, including watershed
_____ Cross-boundary facilitation
_____ Incentives for stakeholder collaboration
_____ Integration of multiple ecosystem components and uses
_____ Integration of scientific information into management decisions
_____ Integration of social and economic information into management decisions
_____ Management for sustainable outcomes
_____ Precaution to avoid adverse impacts
_____ Adaptive management
_____ Monitoring on a recurring basis
_____ Public engagement strategy
_____ Transboundary management
_____ Funding mechanisms
_____ Management for maintenance of a healthy, productive and resilient condition
_____ Control of specific pollution sources/polluters, the most important being
_____ Other Please specify: _____
_____ None of the above
_____ Don't know

26. Is there a legislative mandate to implement collaborative ecosystem management (or ecosystem approach to management or ecosystem-based management) in the ecosystem with which you are involved?

_____ Yes, Source of the mandate (federal, state, etc.)
Please specify: _____
_____ No
_____ Don't know

27. Based on your knowledge and experience, please indicate which of the following aspects for managing the ecosystem are being implemented based on legislative mandate in the ecosystem with which you are involved. Select all that apply.

_____ Collaborative planning
_____ Clear, operational goals
_____ Planning with broad landscape-scale focus, including watershed
_____ Cross-boundary facilitation
_____ Incentives for stakeholder collaboration
_____ Integration of multiple ecosystem components and uses
_____ Integration of scientific information into management decisions
_____ Integration of social and economic information into management decisions
_____ Management for sustainable outcomes
_____ Precaution to avoid adverse impacts
_____ Adaptive management
_____ Monitoring on a recurring basis
_____ Public engagement strategy
_____ Transboundary management
_____ Funding mechanisms
_____ Management for maintenance of a healthy, productive and resilient condition
_____ Control of specific pollution sources/polluters, the most important being
_____ Other Please specify: _____
_____ None of the above
_____ Don't know

28. Based on your knowledge and experience, please indicate which of the following aspects that are not currently being implemented based on legislative mandate would benefit from being implemented based on legislative mandate to be most effective in managing the ecosystem with which you are involved. Select all that apply.

_____ Collaborative planning
_____ Clear, operational goals
_____ Planning with broad landscape-scale focus, including watershed
_____ Cross-boundary facilitation
_____ Incentives for stakeholder collaboration
_____ Integration of multiple ecosystem components and uses
_____ Integration of scientific information into management decisions
_____ Integration of social and economic information into management decisions
_____ Management for sustainable outcomes
_____ Precaution to avoid adverse impacts
_____ Adaptive management
_____ Monitoring on a recurring basis
_____ Public engagement strategy
_____ Transboundary management
_____ Funding mechanisms
_____ Management for maintenance of a healthy, productive and resilient condition
_____ Control of specific pollution sources/polluters, the most important being
_____ Other Please specify: _____
_____ None of the above
_____ Don't know

29. According to available monitoring results, the condition of the ecosystem over the past ten years is stable or improving.

Strongly disagree = 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 – 9 – 10 -11 = Strongly agree DK

Comments:

30. Any additional comments:

Would you like to receive a copy of the final results?

_____ Yes
_____ No

APPENDIX B

RESULTS TABLES

Table B1

Mean Values for EBM Questions 5-24, 29 Using All Ecosystems (Analysis A)

Ques		Lake Erie	Ches Bay	Puget Sound	Tampa Bay	Balti c Sea	Total	F-Test	Signif Value	Sig
5	Ecosystem management planning is done on a collaborative basis to engage diverse stakeholder groups involved with the ecosystem.	7.99	7.62	8.28	9.19	7.69	8.09	4.711	0.001	Y
6	A comprehensive ecosystem management plan which integrates the needs of diverse stakeholder groups is present for the ecosystem.	6.56	6.06	7.37	8.54	7.00	6.92	8.862	0.000	Y
7	There are clear goals and objectives present in the management plan used for managing the ecosystem.	6.97	6.72	7.10	9.04	7.51	7.33	7.666	0.000	Y
8	The ecosystem management plan utilizes a broad landscape- or regional-scale focus, including the water body and its watershed.	7.53	8.11	8.65	8.89	7.37	8.13	3.392	0.010	Y
9	A cross-boundary facilitator (person or organization) which aids the diverse stakeholder groups in reaching consensus on issues and resolving conflicts is present and is an important part of the ecosystem management process.	6.88	6.27	6.96	9.35	7.26	7.19	10.190	0.000	Y
10	Incentives are present which encourage the diverse stakeholder groups to collaborate for effective ecosystem management.	5.67	5.63	5.62	6.96	6.48	5.97	3.270	0.012	Y
11	There is recognition of the interconnectedness between species and the interconnectedness among land, air and aquatic aspects of the ecosystem in the management plan for the ecosystem.	7.36	7.68	8.72	9.13	7.82	8.06	5.891	0.000	Y
12	There is recognition of the integration of ecological, social, economic and institutional perspectives in the management plan for the ecosystem.	6.78	6.92	8.09	8.51	7.82	7.45	6.232	0.000	Y
13	Scientific input is actively sought from scientists engaged in studying the ecosystem and is used as important input for decisions on how the ecosystem is managed.	8.61	8.08	8.54	9.53	8.09	8.52	4.531	0.001	Y
14	Societal and economic information is sought and used as important input for decisions on how the ecosystem is managed.	6.36	6.96	7.62	7.77	6.71	7.02	3.376	0.010	Y

Table B1 Continued

Mean Values for EBM Questions 5-24, 29 Using All Ecosystems (Analysis A)

Ques		Lake Erie	Ches Bay	Puget Sound	Tampa Bay	Baltic Sea	Total	F-Test	Signif Value	Sig
15	The ecosystem management strategy is to seek sustainable outcomes which will enable the ecosystem to function effectively into the future, i.e. satisfying present needs without compromising the ability of future generations to meet their own needs.	7.37	7.26	8.11	9.00	8.32	7.85	5.968	0.000	Y
16	Precaution is exercised to avoid actions which might result in adverse impacts to the ecosystem, i.e. the level of scientific uncertainty and potential risk of damage are considered as part of every management action.	6.64	6.58	7.06	7.91	7.14	6.97	3.181	0.014	N
17	Adaptive management is being applied for managing the ecosystem, whereby a course of action is undertaken, the results evaluated and the course of action revised on a specific timetable to respond to changing ecosystem conditions and attributes.	6.46	6.82	7.62	8.60	7.03	7.18	5.379	0.000	Y
18	Monitoring of the ecosystem on a recurring basis to detect and track changes in key parameters (e.g. water quality, habitat loss/restoration, etc.) is occurring.	7.17	8.34	7.65	9.50	8.89	8.24	10.375	0.000	Y
19	An effective public engagement strategy is present to inform and involve the general public in the ecosystem management initiative and to enlist their support for this effort.	6.27	6.75	7.09	8.21	6.41	6.93	5.436	0.000	Y
20a	The transboundary nature of the ecosystem makes management planning and implementation very difficult.	7.99	9.33	7.98	7.86	8.40	8.59	5.711	0.000	Y
21	Funding is adequate and sustainable to effectively manage the ecosystem.	4.03	3.71	3.42	5.63	5.69	4.36	10.240	0.000	Y
22	Management of the ecosystem has proceeded successfully from planning stages to the implementation phase, and is now resulting in desired outcomes.	5.01	4.04	4.55	8.14	5.59	5.23	30.757	0.000	Y
23	Strong, effective leadership is present and has enabled the ecosystem management program to maximize progress.	5.78	5.10	6.73	8.96	5.85	6.28	25.459	0.000	Y
24	The ecosystem management strategy has been effective in maintaining the ecosystem in a healthy, productive and resilient condition so it can provide the services humans want and need.	5.32	3.81	4.49	8.09	5.29	5.15	38.583	0.000	Y
29	According to available monitoring results, the condition of the ecosystem over the past ten years is stable or improving.	5.64	4.51	4.67	9.14	6.94	5.87	41.929	0.000	Y

Response range for each question: Strongly disagree=1 to Strongly agree=11

Highest scores

Lowest scores

Table B2

Percentage Values for Question 25 Regarding EBM Implementation on Voluntary Basis Using all Ecosystems (Analysis A)

		-Ecosystem													
		Lake Erie		Chesapeake Bay		Puget Sound		Tampa Bay		Baltic Sea		Total		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	49	66.2	55	48.7	26	48.1	40	69.0	7	20.0	177	53.0	0.000	Y
b.	Clear, operational goals	24	32.4	19	16.8	9	16.7	33	56.9	7	20.0	92	27.5	0.000	Y
c.	Planning with broad landscape-scale focus	41	55.4	49	43.4	19	35.2	36	62.1	6	17.1	151	45.2	0.000	Y
d.	Cross-boundary facilitation	35	47.3	45	39.8	18	33.3	32	55.2	7	20.0	137	41.0	0.008	Y
e.	Incentives for stakeholder collaboration	25	33.8	25	22.1	8	14.8	21	36.2	9	25.7	88	26.3	0.045	Y
f.	Integration of multiple components	31	41.9	42	37.2	13	24.1	32	55.2	6	17.1	124	37.1	0.001	Y
g.	Integration of scientific information	42	56.8	57	50.4	22	40.7	42	72.4	14	40.0	177	53.0	0.004	Y
h.	Integration of social, economic information	28	37.8	36	31.9	10	18.5	22	37.9	7	20.0	103	30.8	0.064	N
i.	Management for sustainable outcomes	25	33.8	22	19.5	14	25.9	29	50.0	5	14.3	95	28.4	0.000	Y
j.	Precaution to avoid adverse impacts	26	35.1	28	24.8	14	25.9	27	46.6	8	22.9	103	30.8	0.027	Y
k.	Adaptive management	27	36.5	31	27.4	17	31.5	32	55.2	5	14.3	112	33.5	0.000	Y
l.	Monitoring on a recurring basis	34	45.9	51	45.1	18	33.3	41	70.7	9	25.7	153	45.0	0.000	Y
m.	Public engagement strategy	36	46.8	51	45.1	24	44.4	32	55.2	6	17.1	149	44.6	0.008	Y
n.	Transboundary management	23	31.1	28	24.8	11	20.4	14	24.1	6	17.1	82	24.6	0.516	N
o.	Funding mechanisms	23	31.1	30	26.5	11	20.4	21	36.2	7	20.0	92	27.5	0.278	N
p.	Management for healthy condition	21	28.4	18	15.9	11	20.4	26	44.8	1	2.9	77	23.1	0.000	Y
q.	Control of specific pollution sources	23	31.1	28	24.8	8	14.8	23	39.7	4	11.4	86	25.7	0.007	Y
r.	Other	5	6.8	5	4.4	3	5.6	6	10.3	0	0.0	19	5.7	0.292	N
s.	None of the above	4	5.4	7	6.2	3	5.6	1	1.7	6	17.6	21	6.3	0.056	N
t.	Don't know	8	10.8	23	20.4	6	11.1	8	13.8	4	11.4	49	14.7	0.323	N
		Highest three													

Table B3

Percentage Values for Question 26 Regarding Legislative Mandate to Implement Collaborative Ecosystem Mgt Using all Ecosystems (Analysis A)

	Ecosystem													
	Lake Erie		Chesapeake Bay		Puget Sound		Tampa Bay		Baltic Sea		Total		ChiSq	Sig
	n	%	n	%	n	%	n	%	n	%	n	%		
Yes	34	46.0	60	53.1	40	74.1	23	39.7	22.0	62.9	179	53.6	0.001	Y
No	22	29.7	14	12.4	3	5.6	16	27.6	6.0	17.1	61	18.3		
Don't know	18	24.3	39	34.5	11	20.3	19	32.7	7.0	20.0	94	28.1		

Table B4

Percentage Values for Question 27 Regarding EBM Aspects Being Implemented on Legislative Mandate Basis Using All Ecosystems (Analysis A)

		Ecosystes													
		Lake Erie		Chesapeake Bay		Puget Sound		Tampa Bay		Baltic Sea		Total		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	24	70.6	34	56.7	27	67.5	10	43.5	10	45.5	105	58.7	0.128	N
b.	Clear, operational goals	11	32.4	29	48.3	24	60.0	6	26.1	9	40.9	79	44.1	0.049	Y
c.	Planning with broad landscape-scale focus	14	41.2	33	55.0	32	80.0	9	39.1	7	31.8	95	53.1	0.001	Y
d.	Cross-boundary facilitation	23	67.6	35	58.3	11	27.5	6	26.1	12	54.5	87	48.6	0.001	Y
e.	Incentives for stakeholder collaboration	4	11.8	17	28.3	16	40.0	4	17.4	6	27.3	47	26.3	0.070	N
f.	Integration of multiple components	14	41.2	22	36.7	27	67.5	6	26.1	9	40.9	78	43.6	0.009	Y
g.	Integration of scientific information	16	47.1	34	56.7	28	70.0	8	34.8	13	59.1	99	55.3	0.074	N
h.	Integration of social, economic information	12	35.3	24	40.0	21	52.5	4	17.4	7	31.8	68	38.0	0.082	N
i.	Management for sustainable outcomes	9	26.5	20	33.3	20	50.0	6	26.1	7	31.8	62	34.6	0.196	N
j.	Precaution to avoid adverse impacts	10	29.4	17	28.3	16	40.0	3	13.0	8	36.4	54	30.2	0.236	N
k.	Adaptive management	6	17.6	17	28.3	26	65.0	4	17.4	8	36.4	61	34.1	0.000	Y
l.	Monitoring on a recurring basis	12	35.3	33	55.0	22	55.0	10	43.5	17	77.3	94	52.5	0.033	Y
m.	Public engagement strategy	13	38.2	28	46.7	26	65.0	5	21.7	5	22.7	77	43.0	0.002	Y
n.	Transboundary management	16	47.1	30	50.0	7	17.5	3	13.0	9	40.9	65	36.3	0.001	Y
o.	Funding mechanisms	12	35.3	34	56.7	17	42.5	8	34.8	7	31.8	78	43.6	0.130	N
p.	Management for healthy condition	9	26.5	23	38.3	16	40.0	5	21.7	7	31.8	60	33.5	0.463	N
q.	Control of specific pollution sources	12	35.3	35	58.3	14	35.0	9	39.1	12	54.5	82	45.8	0.082	N
r.	Other	0	0.0	3	5.0	4	10.0	3	13.0	1	4.5	11	6.1	0.250	N
s.	None of the above	1	2.9	1	1.7	0	0.0	0	0.0	0	0.0	2	1.1	0.709	N
t.	Don't know	1	2.9	6	10.0	4	10.0	2	8.7	1	4.5	14	7.8	0.711	N
		Highest three													

Table B5

Percentage for Question 28 Regarding EBM Aspects to Implement on Legislative Basis Using all Ecosystems (Analysis A)

		Ecosystem													
		Lake Erie		Chesapeake Bay		Puget Sound		Tampa Bay		Baltic Sea		Total		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	13	17.6	16	14.2	3	5.6	6	10.3	10	28.6	48	14.4	0.032	Y
b.	Clear, operational goals	21	28.4	25	22.1	12	22.2	9	15.5	14	40.0	81	24.3	0.084	N
c.	Planning with broad landscape-scale focus	18	24.3	18	15.9	6	11.1	9	15.5	12	34.3	63	18.9	0.039	Y
d.	Cross-boundary facilitation	15	20.3	19	16.8	8	14.8	6	10.3	7	20.0	55	16.5	0.593	N
e.	Incentives for stakeholder collaboration	31	41.9	31	27.4	15	27.8	14	24.1	10	28.6	101	30.3	0.171	N
f.	Integration of multiple components	15	20.3	21	18.6	7	13.0	9	15.5	5	14.3	57	17.1	0.799	N
g.	Integration of scientific information	18	24.3	20	17.6	7	13.0	8	13.8	3	8.6	56	16.8	0.222	N
h.	Integration of social, economic information	25	33.8	23	20.4	13	24.1	8	13.8	5	14.3	74	22.2	0.045	Y
i.	Management for sustainable outcomes	22	29.7	34	30.1	12	22.2	9	15.5	5	14.3	82	24.6	0.105	N
j.	Precaution to avoid adverse impacts	18	24.3	33	29.2	12	22.2	7	12.1	6	17.1	76	22.8	0.127	N
k.	Adaptive management	20	27.0	30	26.5	8	14.8	7	12.1	8	22.9	73	21.9	0.114	N
l.	Monitoring on a recurring basis	23	31.1	21	18.6	13	24.1	7	12.1	4	11.4	68	20.4	0.039	Y
m.	Public engagement strategy	19	25.7	12	10.6	5	9.3	4	6.9	7	20.0	47	14.1	0.008	Y
n.	Transboundary management	16	21.6	18	15.9	10	18.5	9	15.5	7	20.0	60	18.0	0.855	N
o.	Funding mechanisms	29	39.2	36	31.9	18	33.3	25	43.1	10	28.6	118	35.3	0.492	N
p.	Management for healthy condition	17	23.0	21	18.6	8	14.8	5	8.6	5	14.3	56	16.8	0.251	N
q.	Control of specific pollution sources	11	14.9	29	25.7	9	16.7	10	17.2	5	14.3	64	19.2	0.302	N
r.	Other	5	6.8	9	8.0	4	7.4	3	5.2	0	0.0	21	6.3	0.533	N
s.	None of the above	5	6.8	6	5.3	4	7.4	3	5.2	2	5.7	20	6.0	0.979	N
t.	Don't know	12	16.2	30	26.5	16	29.6	20	34.5	5	14.3	83	24.9	0.067	N
		Highest three													

Table B6

Mean Values for EBM Questions 5-24, 29 Using Lake Erie by Area of Focus (Analysis B)

		Mean Values by Area of Focus							
Ques		Aq	Fish	Wsh	Eco	Total	F-Test	Signif Value	Sig
5	Ecosystem management planning is done on a collaborative basis to engage diverse stakeholder groups involved with the ecosystem.	5.78	7.73	8.61	8.32	7.99	3.820	0.014	Y
6	A comprehensive ecosystem management plan which integrates the needs of diverse stakeholder groups is present for the ecosystem.	4.60	6.27	6.83	7.89	6.56	2.871	0.043	Y
7	There are clear goals and objectives present in the management plan used for managing the ecosystem.	4.10	6.73	7.50	7.64	6.97	7.579	0.000	Y
8	The ecosystem management plan utilizes a broad landscape- or regional-scale focus, including the water body and its watershed.	5.40	6.18	9.06	7.79	7.53	6.998	0.000	Y
9	A cross-boundary facilitator (person or organization) which aids the diverse stakeholder groups in reaching consensus on issues and resolving conflicts is present and is an important part of the ecosystem management process.	3.89	7.30	8.00	6.97	6.88	5.027	0.003	Y
10	Incentives are present which encourage the diverse stakeholder groups to collaborate for effective ecosystem management.	3.22	4.89	6.82	5.97	5.67	4.789	0.005	Y
11	There is recognition of the interconnectedness between species and the interconnectedness among land, air and aquatic aspects of the ecosystem in the management plan for the ecosystem.	5.44	5.80	8.29	7.93	7.36	5.946	0.001	Y
12	There is recognition of the integration of ecological, social, economic and institutional perspectives in the management plan for the ecosystem.	4.56	5.70	7.29	7.48	6.78	4.621	0.006	Y
13	Scientific input is actively sought from scientists engaged in studying the ecosystem and is used as important input for decisions on how the ecosystem is managed.	8.38	8.27	9.17	8.47	8.61	0.684	0.565	N
14	Societal and economic information is sought and used as important input for decisions on how the ecosystem is managed.	4.75	6.18	6.17	6.91	6.36	1.644	0.188	N
15	The ecosystem management strategy is to seek sustainable outcomes which will enable the ecosystem to function effectively into the future, i.e. satisfying present needs without compromising the ability of future generations to meet their own needs.	5.88	7.60	7.39	7.66	7.37	1.272	0.291	N
16	Precaution is exercised to avoid actions which might result in adverse impacts to the ecosystem, i.e. the level of scientific uncertainty and potential risk of damage are considered as part of every management action.	5.14	6.91	6.94	6.71	6.64	1.461	0.234	N

Table B6 Continued

Mean Values for EBM Questions 5-24, 29 Using Lake Erie by Area of Focus (Analysis B)

		Mean Values by Area of Focus							
Ques		Aq	Fish	Wsh	Eco	Total	F-Test	Signif Value	Sig
17	Adaptive management is being applied for managing the ecosystem, whereby a course of action is undertaken, the results evaluated and the course of action revised on a specific timetable to respond to changing ecosystem conditions and attributes.	2.88	6.18	7.17	7.10	6.46	8.106	0.000	Y
18	Monitoring of the ecosystem on a recurring basis to detect and track changes in key parameters (e.g. water quality, habitat loss/restoration, etc.) is occurring.	7.00	7.55	8.00	6.64	7.17	1.150	0.335	N
19	An effective public engagement strategy is present to inform and involve the general public in the ecosystem management initiative and to enlist their support for this effort.	6.00	6.45	5.94	6.45	6.27	0.201	0.896	N
20a	The transboundary nature of the ecosystem makes management planning and implementation very difficult.	6.56	8.09	8.33	8.33	7.99	1.294	0.284	N
21	Funding is adequate and sustainable to effectively manage the ecosystem.	3.30	3.12	3.72	4.64	4.03	3.058	0.034	Y
22	Management of the ecosystem has proceeded successfully from planning stages to the implementation phase, and is now resulting in desired outcomes.	4.00	4.36	5.56	5.21	5.01	1.841	0.148	N
23	Strong, effective leadership is present and has enabled the ecosystem management program to maximize progress.	4.25	5.09	6.00	6.28	5.78	2.290	0.087	N
24	The ecosystem management strategy has been effective in maintaining the ecosystem in a healthy, productive and resilient condition so it can provide the services humans want and need.	3.89	5.30	5.50	5.62	5.32	2.371	1.178	N
29	According to available monitoring results, the condition of the ecosystem over the past ten years is stable or improving.	3.62	6.09	6.28	5.62	5.64	2.437	0.073	N
		Response range for each question: Strongly disagree=1 to Strongly agree=11							
		Highest scores							
		Lowest scores							

Table B7

Percentage Values for Question 25 Regarding EBM Implementation on Voluntary Basis Using Lake Erie by Area of Focus (Analysis B)

		By Area of Focus											
		Aq		Fish		Wsh		Eco		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	4	40.0	5	41.7	15	83.3	25	73.5	49	66.2	0.024	Y
b.	Clear, operational goals	0	0.0	4	33.3	9	50.0	11	32.4	24	32.4	0.062	N
c.	Planning with broad landscape-scale focus	3	30.0	5	41.7	13	72.2	20	58.8	41	55.4	0.124	N
d.	Cross-boundary facilitation	3	30.0	5	41.7	14	77.8	13	38.2	35	47.3	0.027	Y
e.	Incentives for stakeholder collaboration	0	0.0	3	25.0	9	50.0	13	38.2	25	33.8	0.047	Y
f.	Integration of multiple components	0	0.0	4	33.3	14	77.8	13	38.2	31	41.9	0.001	Y
g.	Integration of scientific information	3	30.0	5	41.7	15	83.3	19	55.9	42	56.8	0.026	Y
h.	Integration of social, economic information	0	0.0	4	33.3	11	61.1	13	38.2	28	37.8	0.016	Y
i.	Management for sustainable outcomes	0	0.0	4	33.3	9	50.0	12	35.3	25	33.8	0.064	N
j.	Precaution to avoid adverse impacts	1	10.0	4	33.3	10	55.6	11	32.4	26	35.1	0.102	N
k.	Adaptive management	1	10.0	5	41.7	9	50.0	12	35.3	27	36.5	0.203	N
l.	Monitoring on a recurring basis	4	40.0	5	41.7	11	61.1	14	41.2	34	45.9	0.530	N
m.	Public engagement strategy	3	30.0	6	50.0	13	72.2	14	41.2	36	48.6	0.104	N
n.	Transboundary management	0	0.0	5	41.7	7	38.9	11	32.4	23	31.1	0.129	N
o.	Funding mechanisms	2	20.0	3	25.0	9	50.0	9	26.5	23	31.1	0.248	N
p.	Management for healthy condition	0	0.0	3	25.0	8	44.4	10	29.4	21	28.4	0.096	N
q.	Control of specific pollution sources	3	30.0	2	16.7	9	50.0	9	26.5	23	31.1	0.211	N
r.	Other	1	10.0	1	8.3	0	0.0	3	8.8	5	6.8	0.626	N
S.	None of the above	1	10.0	2	16.7	0	0.0	1	2.9	4	5.4	0.185	N
t.	Don't know	3	30.0	2	16.7	0	0.0	3	8.8	8	10.8	0.087	N
		Highest three											

Table B8

Percentage Values for Question 26 Regarding Legislative Mandate to Implement Collaborative Ecosystem Mgt Using Lake Erie by Area of Focus (Analysis B)

	By Area of Focus											
	Aq		Fish		Wsh		Eco		Tot		ChiSq	Sig
	n	%	n	%	n	%	n	%	n	%		
Yes	3	30.0	4	33.3	8	44.4	19	55.9	34	46.0	0.599	N
No	3	30.0	4	33.3	5	27.8	10	29.4	22	29.7		
Don't know	4	40.0	4	33.3	5	27.8	5	14.7	18	24.3		

Table B9

Percentage Values for Question 27 Regarding Implemented on Legislative Mandate Basis Using Lake Erie by Area of Focus (Analysis B)

		By Area of Focus											
		Aq		Fish		Wsh		Eco		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	2	66.7	3	75.0	6	75.0	13	68.4	24	70.6	0.981	N
b.	Clear, operational goals	1	33.3	0	0.0	3	37.5	7	38.6	11	32.4	0.535	N
c.	Planning with broad landscape-scale focus	0	0.0	1	25.0	2	25.0	11	57.9	14	41.2	0.133	N
d.	Cross-boundary facilitation	2	66.7	2	50.0	6	75.0	13	68.4	23	67.6	0.856	N
e.	Incentives for stakeholder collaboration	0	0.0	0	0.0	0	0.0	4	21.1	4	11.8	0.311	N
f.	Integration of multiple components	0	0.0	1	25.0	3	37.5	10	52.6	14	41.2	0.307	N
g.	Integration of scientific information	1	33.3	2	50.0	3	37.5	10	52.6	16	47.1	0.856	N
h.	Integration of social, economic information	0	0.0	0	0.0	2	25.0	10	52.6	12	35.3	0.082	N
i.	Management for sustainable outcomes	0	0.0	1	25.0	1	12.5	7	36.8	9	26.5	0.401	N
j.	Precaution to avoid adverse impacts	0	0.0	0	0.0	2	25.0	8	42.1	10	29.4	0.215	N
k.	Adaptive management	0	0.0	0	0.0	1	12.5	5	26.3	6	17.6	0.453	N
l.	Monitoring on a recurring basis	1	33.3	1	25.0	5	62.5	5	26.3	12	35.3	0.327	N
m.	Public engagement strategy	0	0.0	1	25.0	3	37.5	9	47.4	13	38.2	0.419	N
n.	Transboundary management	1	33.3	0	0.0	5	62.5	10	52.6	16	47.1	0.188	N
o.	Funding mechanisms	0	0.0	0	0.0	2	25.0	10	52.6	12	35.3	0.082	N
p.	Management for healthy condition	0	0.0	1	25.0	2	25.0	6	31.6	9	26.5	0.718	N
q.	Control of specific pollution sources	0	0.0	0	0.0	3	37.5	9	47.4	12	35.3	0.168	N
r.	Other	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	N/A	
s.	None of the above	0	0.0	0	0.0	0	0.0	1	5.3	1	2.9	0.846	N
t.	Don't know	0	0.0	0	0.0	0	0.0	1	5.3	1	2.9	0.846	N
		Highest three											

Table B10

Percentage Values for Question 28 Regarding Aspects to Implement on Legislative Mandate Basis Using Lake Erie by Area of Focus (Analysis B)

		By Area of Focus											
		Aq		Fish		Wsh		Eco		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	3	30.0	2	16.7	2	11.1	6	17.6	13	17.6	0.661	N
b.	Clear, operational goals	5	50.0	3	25.0	5	27.8	8	23.5	21	28.4	0.429	N
c.	Planning with broad landscape-scale focus	4	40.0	3	25.0	4	22.2	7	20.6	18	24.3	0.651	N
d.	Cross-boundary facilitation	3	30.0	2	16.7	3	16.7	7	20.6	15	20.3	0.843	N
e.	Incentives for stakeholder collaboration	6	60.0	2	16.7	7	38.9	16	47.1	31	41.9	0.177	N
f.	Integration of multiple components	2	20.0	1	8.3	4	22.2	8	23.5	15	20.3	0.723	N
g.	Integration of scientific information	3	30.0	1	8.3	4	22.2	10	29.4	18	24.3	0.501	N
h.	Integration of social, economic information	4	40.0	2	16.7	7	38.9	12	35.3	25	33.8	0.575	N
i.	Management for sustainable outcomes	4	40.0	1	8.3	5	27.8	12	35.3	22	29.7	0.299	N
j.	Precaution to avoid adverse impacts	3	30.0	0	0.0	5	27.8	10	29.4	18	24.3	0.201	N
k.	Adaptive management	4	40.0	0	0.0	4	22.2	12	35.3	20	27.0	0.083	N
l.	Monitoring on a recurring basis	2	20.0	1	8.3	6	33.3	14	41.2	23	31.1	0.162	N
m.	Public engagement strategy	4	40.0	2	16.7	3	16.7	10	29.4	19	25.7	0.458	N
n.	Transboundary management	4	40.0	1	8.3	3	16.7	8	23.5	16	21.6	0.311	N
o.	Funding mechanisms	4	40.0	4	33.3	4	50.0	12	35.3	29	39.2	0.735	N
p.	Management for healthy condition	3	30.0	1	8.3	3	16.7	10	29.4	17	23.0	0.402	N
q.	Control of specific pollution sources	3	30.0	0	0.0	4	22.2	4	11.8	11	14.9	0.177	N
r.	Other	2	20.0	0	0.0	1	5.6	2	5.9	5	6.8	0.291	N
s.	None of the above	0	0.0	1	8.3	3	16.7	1	2.9	5	6.8	0.225	N
t.	Don't know	2	20.0	5	41.7	1	5.6	4	11.8	12	16.2	0.050	Y
			Highest three										

Table B11

Mean Values for EBM Questions 5-24, 29 Using Lake Erie by Type of Organization (Analysis B)

		Mean Values by Type of Organization							
Ques		Gov/ Reg	Bus/ Ind	Acad	NGO	Total	F-Test	Signif Value	Sig
5	Ecosystem management planning is done on a collaborative basis to engage diverse stakeholder groups involved with the ecosystem.	8.42	7.44	7.08	7.92	7.99	1.220	0.309	N
6	A comprehensive ecosystem management plan which integrates the needs of diverse stakeholder groups is present for the ecosystem.	6.89	6.33	5.85	6.46	6.56	0.599	0.618	N
7	There are clear goals and objectives present in the management plan used for managing the ecosystem.	7.55	5.75	6.23	6.77	6.97	1.947	0.130	N
8	The ecosystem management plan utilizes a broad landscape- or regional-scale focus, including the water body and its watershed.	7.89	7.35	6.92	7.23	7.53	0.583	0.628	N
9	A cross-boundary facilitator (person or organization) which aids the diverse stakeholder groups in reaching consensus on issues and resolving conflicts is present and is an important part of the ecosystem management process.	7.97	5.00	6.10	5.50	6.88	4.738	0.005	Y
10	Incentives are present which encourage the diverse stakeholder groups to collaborate for effective ecosystem management.	6.60	4.13	4.64	4.92	5.67	3.668	0.017	Y
11	There is recognition of the interconnectedness between species and the interconnectedness among land, air and aquatic aspects of the ecosystem in the management plan for the ecosystem.	8.06	6.00	8.10	5.58	7.36	5.354	0.002	Y
12	There is recognition of the integration of ecological, social, economic and institutional perspectives in the management plan for the ecosystem.	7.65	5.50	6.60	5.08	6.78	4.610	0.006	Y
13	Scientific input is actively sought from scientists engaged in studying the ecosystem and is used as important input for decisions on how the ecosystem is managed.	8.87	7.33	8.75	8.31	8.61	1.217	0.311	N
14	Societal and economic information is sought and used as important input for decisions on how the ecosystem is managed.	7.05	4.25	6.33	5.58	6.36	3.403	0.023	Y
15	The ecosystem management strategy is to seek sustainable outcomes which will enable the ecosystem to function effectively into the future, i.e. satisfying present needs without compromising the ability of future generations to meet their own needs.	7.92	7.43	6.58	6.42	7.37	1.828	0.151	N
16	Precaution is exercised to avoid actions which might result in adverse impacts to the ecosystem, i.e. the level of scientific uncertainty and potential risk of damage are considered as part of every management action.	7.44	7.14	5.18	5.25	6.64	7.271	0.000	Y

Table B11 Continued

Mean Values for EBM Questions 5-24, 29 Using Lake Erie by Type of Organization (Analysis B)

Ques		Mean Values by Type of Organization					F-Test	Signif Value	Sig
		Gov/ Reg	Bus/ Ind	Acad	NGO	Total			
17	Adaptive management is being applied for managing the ecosystem, whereby a course of action is undertaken, the results evaluated and the course of action revised on a specific timetable to respond to changing ecosystem conditions and attributes.	7.53	6.14	4.83	5.08	6.46	5.735	0.002	Y
18	Monitoring of the ecosystem on a recurring basis to detect and track changes in key parameters (e.g. water quality, habitat loss/restoration, etc.) is occurring.	8.03	7.29	6.15	5.62	7.17	3.974	0.011	Y
19	An effective public engagement strategy is present to inform and involve the general public in the ecosystem management initiative and to enlist their support for this effort.	6.95	5.75	5.69	5.17	6.27	2.071	0.112	N
20a	The transboundary nature of the ecosystem makes management planning and implementation very difficult.	7.51	7.57	8.46	9.08	7.99	1.727	0.170	N
21	Funding is adequate and sustainable to effectively manage the ecosystem.	4.06	5.25	3.08	4.17	4.03	2.822	0.046	Y
22	Management of the ecosystem has proceeded successfully from planning stages to the implementation phase, and is now resulting in desired outcomes.	5.18	5.00	4.62	4.92	5.01	0.275	0.843	N
23	Strong, effective leadership is present and has enabled the ecosystem management program to maximize progress.	6.63	4.57	5.00	4.62	5.78	4.778	0.005	Y
24	The ecosystem management strategy has been effective in maintaining the ecosystem in a healthy, productive and resilient condition so it can provide the services humans want and need.	5.68	5.25	5.15	4.54	5.32	1.343	1.268	N
29	According to available monitoring results, the condition of the ecosystem over the past ten years is stable or improving.	5.89	8.00	3.18	5.54	5.64	8.132	0.000	Y

Response range for each question: Strongly disagree=1 to Strongly agree=11

Highest scores

Lowest scores

Table B12

Percentage Values for Question 25 Regarding EBM Implementation on Voluntary Basis Using Lake Erie by Type of Organization (Analysis B)

		By Type of Organization											
		Gov/Reg		Bus/Ind		Acad		NGO		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	31	81.6	4	40.0	8	61.5	6	46.2	49	66.2	0.023	Y
b.	Clear, operational goals	17	44.7	1	10.0	4	30.8	2	15.4	24	32.4	0.083	N
c.	Planning with broad landscape-scale focus	26	68.4	3	30.0	7	53.8	5	38.5	41	55.4	0.081	N
d.	Cross-boundary facilitation	23	60.5	3	30.0	5	38.5	4	30.8	35	47.3	0.127	N
e.	Incentives for stakeholder collaboration	15	39.5	2	20.0	6	46.2	2	15.4	25	33.8	0.235	N
f.	Integration of multiple components	21	55.3	4	40.0	5	38.5	1	7.7	31	41.9	0.028	Y
g.	Integration of scientific information	27	71.1	4	40.0	7	53.8	4	30.8	42	56.8	0.047	Y
h.	Integration of social, economic information	17	44.7	2	20.0	6	46.2	3	23.1	28	37.8	0.295	N
i.	Management for sustainable outcomes	18	47.4	2	20.0	5	38.5	0	0.0	25	33.8	0.013	Y
j.	Precaution to avoid adverse impacts	18	47.4	2	20.0	3	23.1	3	23.1	26	35.1	0.161	N
k.	Adaptive management	19	50.0	2	20.0	3	23.1	3	23.1	27	36.5	0.103	N
l.	Monitoring on a recurring basis	19	50.0	3	30.0	6	46.2	6	46.2	34	45.9	0.735	N
m.	Public engagement strategy	23	60.5	2	20.0	7	53.8	4	30.8	36	48.6	0.065	N
n.	Transboundary management	16	42.1	1	10.0	4	30.8	2	15.4	23	31.1	0.126	N
o.	Funding mechanisms	12	31.6	3	30.0	4	30.8	4	30.8	23	31.1	1.000	N
p.	Management for healthy condition	15	39.5	2	20.0	3	23.1	1	7.7	21	28.4	0.135	N
q.	Control of specific pollution sources	12	31.6	4	40.0	3	23.1	4	30.8	23	31.1	0.858	N
r.	Other	2	5.3	3	30.0	0	0.0	0	0.0	5	6.8	0.014	Y
s.	None of the above	1	2.6	1	10.0	1	7.7	1	7.7	4	5.4	0.741	N
t.	Don't know	3	7.9	3	30.0	1	7.7	1	7.7	8	10.8	0.220	N

Highest three

Table B13

Percentage Values for Question 26 Regarding Legislative Mandate to Implement Collaborative Ecosystem Mgt Using Lake Erie by Type of Organization (Analysis B)

	By Type of Organization											
	Gov/Reg		Bus/Ind		Acad		NGO		Tot		ChiSq	Sig
	n	%	n	%	n	%	n	%	n	%		
Yes	18	47.4	4	40.0	6	46.2	6	46.2	34	46.0	0.832	N
No	12	31.6	2	20.0	5	38.5	3	23.1	22	29.7		
Don't know	8	21.1	4	40.0	2	15.4	4	30.8	18	24.3		

Table B14

Percentage Values for Question 27 Regarding Aspects Implemented on Legislative Mandate Basis Using Lake Erie by Type of Organization (Analysis B)

		By Type of Organization											
		Gov/Reg		Bus/Ind		Acad		NGO		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	12	66.7	3	75.0	5	83.3	4	66.7	24	70.6	0.877	N
b.	Clear, operational goals	7	38.9	2	50.0	0	0.0	2	33.3	11	32.4	0.285	N
c.	Planning with broad landscape-scale focus	4	22.2	1	25.0	4	66.7	5	83.3	14	41.2	0.028	Y
d.	Cross-boundary facilitation	9	50.0	3	75.0	6	100.0	5	83.3	23	67.6	0.102	N
e.	Incentives for stakeholder collaboration	2	11.1	1	25.0	0	0.0	1	16.7	4	11.8	0.655	N
f.	Integration of multiple components	4	22.2	2	50.0	4	66.7	4	66.7	14	41.2	0.111	N
g.	Integration of scientific information	7	58.9	2	50.0	4	66.7	3	50.0	16	47.1	0.646	N
h.	Integration of social, economic information	4	22.2	1	25.0	5	83.3	2	33.3	12	35.3	0.055	N
i.	Management for sustainable outcomes	6	33.3	2	50.0	1	16.7	0	0.0	9	26.5	0.258	N
j.	Precaution to avoid adverse impacts	5	27.8	3	75.0	1	16.7	1	16.7	10	29.4	0.174	N
k.	Adaptive management	4	22.2	1	25.0	1	16.7	0	0.0	6.0	17.6	0.637	N
l.	Monitoring on a recurring basis	7	38.9	2	50.0	2	33.3	1	16.7	12	35.3	0.705	N
m.	Public engagement strategy	7	38.9	2	50.0	4	66.7	0	0.0	13	38.2	0.111	N
n.	Transboundary management	6	33.3	3	75.0	5	83.3	2	33.3	16	47.1	0.101	N
o.	Funding mechanisms	4	22.2	1	25.0	4	66.7	3	50.0	12	35.3	0.196	N
p.	Management for healthy condition	5	27.8	1	25.0	3	50.0	0	0.0	9	26.5	0.274	N
q.	Control of specific pollution sources	6	33.3	2	50.0	4	66.7	0	0.0	12	35.3	0.099	N
r.	Other	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	N/A	
s.	None of the above	0	0.0	0	0.0	0	0.0	1	16.7	1	2.9	0.186	N
t.	Don't know	1	5.6	0	0.0	0	0.0	0	0.0	1	2.9	0.822	N
		Highest three											

Table B15

Percentage Values for Question 28 Regarding Aspects to Implement on Legislative Mandate Basis Using Lake Erie by Type of Organization (Analysis B)

		By Type of Organization											
		Gov/Reg		Bus/Ind		Acad		NGO		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	4	10.5	2	20.0	4	30.8	3	23.1	13	17.6	0.365	N
b.	Clear, operational goals	8	21.1	4	40.0	5	38.5	4	30.8	21	28.4	0.502	N
c.	Planning with broad landscape-scale focus	9	23.7	1	10.0	5	38.5	3	23.1	18	24.3	0.467	N
d.	Cross-boundary facilitation	6	15.8	1	10.0	4	30.8	4	30.8	15	20.3	0.408	N
e.	Incentives for stakeholder collaboration	13	34.2	2	20.0	7	53.8	9	60.2	31	41.9	0.054	N
f.	Integration of multiple components	8	21.1	0	0.0	3	23.1	4	30.8	15	20.3	0.320	N
g.	Integration of scientific information	8	21.1	1	10.0	6	46.2	3	23.1	18	24.3	0.194	N
h.	Integration of social, economic information	7	18.4	4	40.0	8	61.5	6	46.2	25	33.8	0.023	Y
i.	Management for sustainable outcomes	10	26.3	1	10.0	7	53.8	4	30.8	22	29.7	0.127	N
j.	Precaution to avoid adverse impacts	6	15.8	1	10.0	9	69.2	2	15.4	18	24.3	0.001	Y
k.	Adaptive management	5	13.2	0	0.0	9	69.2	6	46.2	20	27.0	0.000	Y
l.	Monitoring on a recurring basis	11	28.9	0	0.0	7	53.8	5	38.5	23	31.1	0.045	Y
m.	Public engagement strategy	4	10.5	3	30.0	5	38.5	7	53.8	19	25.7	0.011	Y
n.	Transboundary management	6	15.8	1	10.0	5	38.5	4	30.8	16	21.6	0.224	N
o.	Funding mechanisms	15	39.5	1	10.0	6	46.2	7	53.8	29	39.2	0.171	N
p.	Management for healthy condition	6	15.8	1	10.0	5	38.5	5	38.5	17	23.0	0.134	N
q.	Control of specific pollution sources	4	10.5	0	0.0	3	23.1	4	30.8	11	14.9	0.133	N
r.	Other	2	5.3	2	20.0	1	7.7	0	0.0	5	6.8	0.275	N
s.	None of the above	3	7.9	1	10.0	1	7.7	0	0.0	5	6.8	0.752	N
t.	Don't know	8	21.1	2	20.0	1	7.7	1	7.7	12	16.2	0.542	N
		Highest three											

Table B16

Mean Values for EBM Questions 5-24, 29 Using All Ecosystems by Area of Focus (Analysis C)

		Mean Values by Area of Focus								
Ques		Aq	Fish	Wsh	Eco	Other	Total	F-Test	Signif Value	Sig
5	Ecosystem management planning is done on a collaborative basis to engage diverse stakeholder groups involved with the ecosystem.	7.11	7.82	8.65	8.49	7.12	8.09	5.110	0.001	Y
6	A comprehensive ecosystem management plan which integrates the needs of diverse stakeholder groups is present for the ecosystem.	5.82	6.29	7.15	7.53	6.27	6.92	4.885	0.001	Y
7	There are clear goals and objectives present in the management plan used for managing the ecosystem.	6.24	6.48	7.49	7.94	7.12	7.33	4.941	0.001	Y
8	The ecosystem management plan utilizes a broad landscape- or regional-scale focus, including the water body and its watershed.	7.05	7.09	8.73	8.73	7.65	8.13	6.998	0.000	Y
9	A cross-boundary facilitator (person or organization) which aids the diverse stakeholder groups in reaching consensus on issues and resolving conflicts is present and is an important part of the ecosystem management process.	6.03	6.86	7.87	7.58	6.50	7.19	2.951	0.020	Y
10	Incentives are present which encourage the diverse stakeholder groups to collaborate for effective ecosystem management.	4.97	5.54	6.52	6.37	5.21	5.97	3.708	0.006	Y
11	There is recognition of the interconnectedness between species and the interconnectedness among land, air and aquatic aspects of the ecosystem in the management plan for the ecosystem.	6.61	7.48	8.36	8.68	7.59	8.06	7.308	0.000	Y
12	There is recognition of the integration of ecological, social, economic and institutional perspectives in the management plan for the ecosystem.	6.37	7.07	7.60	7.88	7.32	7.45	3.255	0.012	Y
13	Scientific input is actively sought from scientists engaged in studying the ecosystem and is used as important input for decisions on how the ecosystem is managed.	7.84	8.28	8.87	8.90	7.56	8.52	4.075	0.003	Y
14	Societal and economic information is sought and used as important input for decisions on how the ecosystem is managed.	6.56	6.70	7.06	7.32	6.74	7.02	1.281	0.277	N
15	The ecosystem management strategy is to seek sustainable outcomes which will enable the ecosystem to function effectively into the future, i.e. satisfying present needs without compromising the ability of future generations to meet their own needs.	7.26	7.36	8.04	8.26	7.22	7.85	2.716	0.030	Y
16	Precaution is exercised to avoid actions which might result in adverse impacts to the ecosystem, i.e. the level of scientific uncertainty and potential risk of damage are considered as part of every management action.	6.11	6.97	7.23	7.36	5.84	6.97	3.936	0.004	Y

Table B16 Continued

Mean Values for EBM Questions 5-24, 29 Using All Ecosystems by Area of Focus (Analysis C)

		Mean Values by Area of Focus								
Ques		Aq	Fish	Wsh	Eco	Other	Total	F-Test	Signif Value	Sig
17	Adaptive management is being applied for managing the ecosystem, whereby a course of action is undertaken, the results evaluated and the course of action revised on a specific timetable to respond to changing ecosystem conditions and attributes.	5.86	6.78	7.33	7.73	6.66	7.18	4.767	0.001	Y
18	Monitoring of the ecosystem on a recurring basis to detect and track changes in key parameters (e.g. water quality, habitat loss/restoration, etc.) is occurring.	7.90	8.10	8.55	8.29	8.24	8.24	0.489	0.744	N
19	An effective public engagement strategy is present to inform and involve the general public in the ecosystem management initiative and to enlist their support for this effort.	6.50	6.55	6.81	7.27	6.80	6.93	1.239	0.294	N
20a	The transboundary nature of the ecosystem makes management planning and implementation very difficult.	8.59	8.30	8.51	8.67	8.09	8.59	0.361	0.836	N
21	Funding is adequate and sustainable to effectively manage the ecosystem.	3.51	4.43	4.24	4.55	4.50	4.36	1.467	0.212	N
22	Management of the ecosystem has proceeded successfully from planning stages to the implementation phase, and is now resulting in desired outcomes.	4.17	4.75	5.17	5.01	4.84	5.23	3.750	0.005	Y
23	Strong, effective leadership is present and has enabled the ecosystem management program to maximize progress.	5.14	5.72	6.15	6.07	5.69	6.28	5.038	0.001	Y
24	The ecosystem management strategy has been effective in maintaining the ecosystem in a healthy, productive and resilient condition so it can provide the services humans want and need.	3.97	4.98	5.00	5.65	4.74	5.15	3.693	0.006	Y
29	According to available monitoring results, the condition of the ecosystem over the past ten years is stable or improving.	4.67	6.12	5.79	6.10	5.84	5.87	1.925	0.106	N

Response range for each question: Strongly disagree=1 to Strongly agree=11

Highest scores

Lowest scores

Table B17

Percentage Values for Question 25 Regarding Aspects Implemented on Voluntary Basis Using All Ecosystems by Area of Focus (Analysis C)

		By Area of Focus													
		Aq		Fish		Wsh		Eco		Other		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	11	27.5	29	46.8	34	69.4	85	57.4	18	51.4	177	53.0	0.001	Y
b.	Clear, operational goals	5	12.5	16	28.5	15	30.6	47	31.8	9	25.7	92	27.5	0.182	N
c.	Planning with broad landscape-scale focus	10	25.0	24	38.7	27	55.1	76	51.4	14	40.0	151	45.2	0.016	Y
d.	Cross-boundary facilitation	9	22.5	27	43.5	29	59.2	59	39.9	13	37.1	137	41.0	0.012	Y
e.	Incentives for stakeholder collaboration	6	15.0	15	24.2	9	38.8	43	29.1	5	14.3	88	26.3	0.042	Y
f.	Integration of multiple components	7	17.5	18	29.0	26	53.1	60	40.5	13	37.1	124	37.1	0.006	Y
g.	Integration of scientific information	16	40.0	27	43.5	29	59.2	88	59.5	17	48.6	177	53.0	0.077	N
h.	Integration of social, economic information	7	17.5	14	22.6	20	40.8	50	33.8	12	34.3	103	30.8	0.078	N
i.	Management for sustainable outcomes	3	7.5	16	25.8	20	40.8	47	31.8	9	25.7	95	28.4	0.009	Y
j.	Precaution to avoid adverse impacts	6	15.0	20	32.3	17	34.7	51	34.5	9	25.7	103	30.8	0.168	N
k.	Adaptive management	8	20.0	21	33.9	17	34.7	58	39.2	8	22.9	112	33.5	0.124	N
l.	Monitoring on a recurring basis	14	35.0	27	43.5	23	46.9	70	47.3	19	54.3	153	45.8	0.528	N
m.	Public engagement strategy	12	30.0	22	35.5	30	61.2	69	46.6	16	45.7	149	44.6	0.024	Y
n.	Transboundary management	3	7.5	18	29.0	17	34.7	34	23.0	10	28.6	82	24.6	0.038	Y
o.	Funding mechanisms	8	20.0	13	21.0	16	32.7	43	29.1	12	34.3	92	27.5	0.394	N
p.	Management for healthy condition	2	5.0	12	19.4	15	30.6	43	29.1	5	14.3	77	23.1	0.008	Y
q.	Control of specific pollution sources	9	22.5	13	21.0	15	30.6	39	26.4	10	28.6	86	25.7	0.783	N
r.	Other	1	2.5	3	4.8	0	0.0	13	8.8	2	5.7	19	5.7	0.169	N
s.	None of the above	2	5.0	6	9.7	2	4.1	9	6.1	2	5.7	21	6.3	0.780	N
t.	Don't know	11	27.5	12	19.4	7	14.3	14	9.5	5	14.3	49	14.7	0.048	Y
		Highest three													

Table B18

Percentage Values for Question 26 Regarding Legislative Mandate to Implement Collaborative Ecosystem Mgt Using All Ecosystems by Area of Focus (Analysis C)

	By Area of Focus														
	Aq		Fish		Wsh		Eco		Other		Tot		ChiSq	Sig
	n	%	n	%	n	%	n	%	n	%	n	%		
Yes	16	40.0	24	38.7	27	55.1	94	63.5	18	51.4	179	53.6	0.001	Y
No	5	12.5	15	24.2	11	22.4	27	18.2	3	8.6	61	18.3		
Don't know	19	47.5	23	37.1	11	22.4	27	18.2	14	40.0	94	28.1		

Table B19

Percentage Values for Question 27 Regarding Aspects Implemented on Legislative Mandate Basis Using All Ecosystems by Area of Focus (Analysis C)

		By Area of Focus													
		Aq		Fish		Wsh		Eco		Other		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	7	43.8	14	58.3	16	59.3	58	61.7	10	55.6	105	58.7	0.754	N
b.	Clear, operational goals	6	37.5	7	29.2	11	40.7	45	47.9	10	55.6	79	44.1	0.396	N
c.	Planning with broad landscape-scale focus	6	37.5	9	37.5	13	48.1	56	59.6	11	61.1	95	53.1	0.183	N
d.	Cross-boundary facilitation	6	37.5	10	41.7	16	59.2	46	48.9	9	50.0	87	48.6	0.645	N
e.	Incentives for stakeholder collaboration	3	18.8	5	20.8	4	14.8	28	29.8	7	38.9	47	26.3	0.315	N
f.	Integration of multiple components	4	25.0	8	33.3	12	44.4	46	48.9	8	44.4	78	43.6	0.357	N
g.	Integration of scientific information	7	43.8	14	58.3	11	40.7	57	60.6	10	55.6	99	55.3	0.360	N
h.	Integration of social, economic information	3	18.8	7	29.2	11	40.7	39	41.5	8	44.4	68	38.0	0.379	N
i.	Management for sustainable outcomes	4	25.0	10	41.7	10	37.0	30	31.0	8	44.4	62	34.6	0.677	N
j.	Precaution to avoid adverse impacts	3	18.8	6	25.0	9	33.3	31	33.0	5	27.8	54	30.2	0.768	N
k.	Adaptive management	5	31.2	5	20.8	6	22.2	39	41.5	6	33.3	61	34.1	0.205	N
l.	Monitoring on a recurring basis	7	43.8	8	33.3	16	59.3	50	53.2	13	72.2	94	52.5	0.119	N
m.	Public engagement strategy	5	31.3	6	25.0	11	40.7	46	48.9	9	50.0	77	43.0	0.211	N
n.	Transboundary management	6	37.5	6	25.0	11	40.7	33	35.1	9	50.0	65	36.3	0.544	N
o.	Funding mechanisms	5	31.3	9	37.5	9	33.3	45	47.9	10	55.6	78	43.6	0.372	N
p.	Management for healthy condition	5	31.3	6	25.0	9	33.3	31	33.0	9	50.0	60	33.5	0.554	N
q.	Control of specific pollution sources	7	43.8	7	29.2	9	33.3	47	50.0	12	66.7	82	45.8	0.084	N
r.	Other	1	6.3	0	0.0	1	3.7	8	8.5	1	5.6	11	6.1	0.596	N
s.	None of the above	0	0.0	0	0.0	0	0.0	1	1.1	1	5.6	2	1.1	0.410	N
t.	Don't know	4	25.0	2	8.3	2	7.4	6	6.4	0	0.0	14	7.8	0.079	N
		Highest three													

Table B20

Percentage Values for Question 28 Regarding Aspects to Implement on Legislative Mandate Basis Using All Ecosystems by Area of Focus (Analysis C)

		By Area of Focus													
		Aq		Fish		Wsh		Eco		Other		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	8	20.0	9	14.5	6	12.2	21	14.2	4	11.4	48	14.4	0.833	N
b.	Clear, operational goals	14	35.0	20	32.3	11	22.4	29	19.6	9	20.0	81	24.3	0.144	N
c.	Planning with broad landscape-scale focus	9	22.5	12	19.4	6	12.2	30	20.3	6	17.1	63	18.9	0.733	N
d.	Cross-boundary facilitation	7	17.5	14	22.6	6	12.2	23	15.5	5	14.3	55	16.5	0.633	N
e.	Incentives for stakeholder collaboration	15	37.5	19	30.6	12	24.5	50	33.8	5	14.3	101	30.2	0.143	N
f.	Integration of multiple components	6	15.0	10	16.1	9	18.4	30	20.3	2	5.7	57	17.1	0.345	N
g.	Integration of scientific information	10	25.0	7	11.3	6	12.2	28	18.9	5	14.3	56	16.8	0.326	N
h.	Integration of social, economic information	8	20.0	12	19.4	14	28.6	35	23.6	5	14.3	74	22.2	0.557	N
i.	Management for sustainable outcomes	11	27.5	11	17.7	10	20.4	44	29.7	6	17.1	82	24.6	0.251	N
j.	Precaution to avoid adverse impacts	8	20.0	11	17.7	12	24.5	41	27.7	4	11.4	76	22.8	0.218	N
k.	Adaptive management	9	22.5	13	21.0	13	26.5	32	21.6	6	17.1	73	21.9	0.890	N
l.	Monitoring on a recurring basis	8	20.0	7	11.3	11	22.4	37	25.0	5	14.3	68	20.4	0.196	N
m.	Public engagement strategy	7	17.5	9	14.5	5	10.2	23	15.5	3	8.6	47	14.1	0.709	N
n.	Transboundary management	9	22.5	12	19.4	5	10.2	30	20.3	4	11.4	60	18.0	0.381	N
o.	Funding mechanisms	11	27.5	21	33.9	18	36.7	61	41.2	7	20.0	118	35.2	0.135	N
p.	Management for healthy condition	6	15.0	11	17.7	7	14.3	27	18.2	5	14.3	56	16.8	0.947	N
q.	Control of specific pollution sources	10	25.0	13	21.0	9	18.4	26	17.6	6	17.1	64	19.2	0.850	N
r.	Other	3	7.5	3	4.8	2	4.1	10	6.8	3	8.6	21	6.3	0.896	N
s.	None of the above	0	0.0	3	4.8	6	12.2	9	6.1	2	5.7	20	6.0	0.191	N
t.	Don't know	10	25.0	19	30.6	12	24.5	28	18.9	14	40.0	83	24.9	0.084	N
		Highest three													

Table B21

Mean Values for EBM Questions 5-24, 29 Using All Ecosystems by Type of Organization (Analysis C)

		Mean Values by Type of Organization								
Ques		Gov/ Reg	Bus/ Ind	Acad	NGO	Other	Total	F-Test	Signif Value	Sig
5	Ecosystem management planning is done on a collaborative basis to engage diverse stakeholder groups involved with the ecosystem.	8.53	7.14	7.54	7.71	7.93	8.09	3.602	0.007	Y
6	A comprehensive ecosystem management plan which integrates the needs of diverse stakeholder groups is present for the ecosystem.	7.36	6.33	5.83	6.81	7.33	6.92	4.138	0.003	Y
7	There are clear goals and objectives present in the management plan used for managing the ecosystem.	7.90	6.47	6.09	7.02	7.72	7.33	6.082	0.000	Y
8	The ecosystem management plan utilizes a broad landscape- or regional-scale focus, including the water body and its watershed.	8.44	7.10	7.44	7.90	8.60	8.13	3.051	0.017	Y
9	A cross-boundary facilitator (person or organization) which aids the diverse stakeholder groups in reaching consensus on issues and resolving conflicts is present and is an important part of the ecosystem management process.	7.88	5.68	6.29	6.51	7.11	7.19	5.119	0.001	Y
10	Incentives are present which encourage the diverse stakeholder groups to collaborate for effective ecosystem management.	6.50	4.75	5.33	5.28	6.12	5.97	4.445	0.002	Y
11	There is recognition of the interconnectedness between species and the interconnectedness among land, air and aquatic aspects of the ecosystem in the management plan for the ecosystem.	8.35	7.58	7.55	7.49	8.53	8.06	2.232	0.066	N
12	There is recognition of the integration of ecological, social, economic and institutional perspectives in the management plan for the ecosystem.	7.89	6.58	6.69	6.88	7.93	7.45	4.171	0.003	Y
13	Scientific input is actively sought from scientists engaged in studying the ecosystem and is used as important input for decisions on how the ecosystem is managed.	8.73	7.65	7.91	8.49	9.28	8.52	3.184	0.014	Y
14	Societal and economic information is sought and used as important input for decisions on how the ecosystem is managed.	7.30	5.63	6.59	6.95	7.21	7.02	2.877	0.023	Y
15	The ecosystem management strategy is to seek sustainable outcomes which will enable the ecosystem to function effectively into the future, i.e. satisfying present needs without compromising the ability of future generations to meet their own needs.	8.22	7.28	7.30	7.39	7.86	7.85	2.316	0.057	N
16	Precaution is exercised to avoid actions which might result in adverse impacts to the ecosystem, i.e. the level of scientific uncertainty and potential risk of damage are considered as part of every management action.	7.31	7.11	6.34	6.25	7.25	6.97	2.864	0.024	Y

Table B21

Mean Values for EBM Questions 5-24, 29 Using All Ecosystems by Type of Organization (Analysis C)

		Mean Values by Type of Organization								
Ques		Gov/ Reg	Bus/ Ind	Acad	NGO	Other	Total	F-Test	Signif Value	Sig
17	Adaptive management is being applied for managing the ecosystem, whereby a course of action is undertaken, the results evaluated and the course of action revised on a specific timetable to respond to changing ecosystem conditions and attributes.	7.07	6.06	5.92	6.59	7.41	7.18	8.454	0.000	Y
18	Monitoring of the ecosystem on a recurring basis to detect and track changes in key parameters (e.g. water quality, habitat loss/restoration, etc.) is occurring.	8.50	8.00	7.92	7.33	9.04	8.24	3.353	0.010	Y
19	An effective public engagement strategy is present to inform and involve the general public in the ecosystem management initiative and to enlist their support for this effort.	7.36	5.70	6.40	6.26	7.39	6.93	3.984	0.004	Y
20a	The transboundary nature of the ecosystem makes management planning and implementation very difficult.	8.23	8.60	9.07	8.83	8.96	8.59	1.818	0.126	N
21	Funding is adequate and sustainable to effectively manage the ecosystem.	4.55	5.39	3.69	4.15	4.36	4.36	2.513	0.042	Y
22	Management of the ecosystem has proceeded successfully from planning stages to the implementation phase, and is now resulting in desired outcomes.	5.67	5.53	4.29	4.83	5.14	5.23	3.392	0.010	Y
23	Strong, effective leadership is present and has enabled the ecosystem management program to maximize progress.	6.72	5.95	5.49	5.85	6.28	6.28	2.724	0.030	Y
24	The ecosystem management strategy has been effective in maintaining the ecosystem in a healthy, productive and resilient condition so it can provide the services humans want and need.	5.78	5.75	4.22	4.46	4.26	5.15	6.855	0.000	Y
29	According to available monitoring results, the condition of the ecosystem over the past ten years is stable or improving.	6.30	8.24	4.60	5.23	5.43	5.87	8.945	0.000	Y

Response range for each question: Strongly disagree=1 to Strongly agree=11

Highest scores

Lowest scores

Table B22

Percentage Values for Question 25 Regarding Aspects Implemented on Voluntary Basis Using All Ecosystems by Type of Organization (Analysis C)

		By Type of Organization													
		Gov/Reg		Bus/Ind		Acad		NGO		Other		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	107	62.6	10	41.7	27	40.9	21	48.8	12	40.0	177	53.0	0.008	Y
b.	Clear, operational goals	61	35.7	7	29.2	10	15.2	9	20.9	5	16.7	92	27.5	0.009	Y
c.	Planning with broad landscape-scale focus	91	53.2	6	25.0	27	40..9	15	34.9	12	40.0	151	45.2	0.026	Y
d.	Cross-boundary facilitation	85	49.7	6	25.0	21	31.8	15	34.9	10	33.3	137	41.0	0.021	Y
e.	Incentives for stakeholder collaboration	54	31.6	5	20.8	14	21.2	10	23.3	5	16.7	88	26.3	0.254	N
f.	Integration of multiple components	71	41.5	8	33.3	22	33.3	12	27.9	11	36.7	124	37.1	0.472	N
g.	Integration of scientific information	100	58.5	9	37.5	38	57.6	17	39.5	13	43.3	177	53.0	0.057	N
h.	Integration of social, economic information	55	32.2	5	20.8	23	34.8	11	25.6	9	30.0	103	30.8	0.675	N
i.	Management for sustainable outcomes	60	35.1	6	25.0	15	22.7	8	18.6	6	20.0	95	28.4	0.091	N
j.	Precaution to avoid adverse impacts	62	36.3	6	25.0	16	24.2	13	30.2	6	20.0	103	30.8	0.219	N
k.	Adaptive management	78	45.6	4	16.7	12	18.2	13	30.2	5	16.7	112	33.5	0.000	Y
l.	Monitoring on a recurring basis	79	46.2	11	45.8	32	48.5	17	39.5	14	46.7	153	45.8	0.926	N
m.	Public engagement strategy	84	49.1	9	37.5	26	39.4	19	44.2	11	36.7	149	44.6	0.494	N
n.	Transboundary management	46	26.9	2	8.3	18	27.3	11	25.6	5	16.7	82	24.6	0.266	N
o.	Funding mechanisms	52	30.4	6	25.0	16	24.2	12	27.9	6	20.0	92	27.5	0.736	N
p.	Management for healthy condition	50	29.2	5	20.8	9	13.6	8	18.6	5	16.7	77	23.1	0.084	N
q.	Control of specific pollution sources	45	26.3	9	37.5	15	22.7	10	23.3	7	23.3	86	25.7	0.679	N
r.	Other	12	7.0	3	12.5	1	1.5	2	4.7	1	3.3	19	5.7	0.270	N
s.	None of the above	7	4.1	2	8.3	6	9.1	3	7.0	3	10.0	21	6.3	0.527	N
t.	Don't know	22	12.9	4	16.7	11	16.7	8	18.6	4	13.3	49	14.7	0.860	N

Highest three

Table B23

Percentage Values for Question 26 Regarding Legislative Mandate to Implement Collaborative Ecosystem Mgt Using all Ecosystems by Type of Organization (Analysis C)

	By Area of Focus													
	Gov/Reg		Bus/Ind		Acad		NGO		Other		Tot		ChiSq	Sig
	n	%	n	%	n	%	n	%	n	%	n	%		
Yes	102	59.6	9	37.5	29	43.9	23	53.5	16	53.3	179	53.6	0.120	N
No	32	18.4	7	29.2	13	19.7	8	18.6	2	6.7	61	18.3		
Don't know	38	22.2	8	33.3	24	36.4	12	27.9	12	40.0	94	28.1		

Table B24

Percentage Values for Question 27 Regarding Aspects Implemented on Legislative Mandate Basis Using All Ecosystems by Type of Organization (Analysis C)

		By Type of Organization													
		Gov/Reg		Bus/Ind		Acad		NGO		Other		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	63	61.8	5	55.6	17	58.6	15	65.2	5	31.3	105	58.7	0.214	N
b.	Clear, operational goals	47	46.1	3	33.3	10	34.5	11	47.8	8	50.0	79	44.1	0.731	N
c.	Planning with broad landscape-scale focus	55	53.9	2	22.2	15	51.7	14	60.9	9	56.3	95	53.1	0.391	N
d.	Cross-boundary facilitation	46	45.1	5	55.6	19	65.5	13	56.5	4	25.0	87	48.6	0.086	N
e.	Incentives for stakeholder collaboration	30	29.4	1	11.1	5	17.2	6	26.1	5	31.3	47	26.3	0.555	N
f.	Integration of multiple components	43	42.2	3	33.3	16	55.2	12	52.2	4	25.0	78	43.6	0.288	N
g.	Integration of scientific information	59	57.8	4	44.4	14	48.3	13	56.5	9	56.3	99	55.3	0.862	N
h.	Integration of social, economic information	38	37.3	2	22.2	12	41.4	10	41.5	6	37.5	68	38.0	0.842	N
i.	Management for sustainable outcomes	35	34.3	3	33.3	12	4.4	8	34.8	4	25.0	62	34.6	0.870	N
j.	Precaution to avoid adverse impacts	28	27.5	5	55.6	8	27.6	8	34.8	5	31.3	54	30.2	0.486	N
k.	Adaptive management	34	33.3	1	11.1	9	31.0	8	34.8	9	56.3	61	34.1	0.217	N
l.	Monitoring on a recurring basis	56	54.9	5	55.6	16	55.2	8	34.8	9	56.3	94	52.5	0.503	N
m.	Public engagement strategy	47	46.1	4	44.4	13	44.8	9	39.1	4	25.0	77	43.0	0.610	N
n.	Transboundary management	32	31.4	5	55.6	17	58.6	8	34.8	3	18.8	65	36.3	0.028	Y
o.	Funding mechanisms	43	42.2	4	44.4	15	51.7	9	39.1	7	43.8	78	43.6	0.901	N
p.	Management for healthy condition	37	36.3	3	33.3	10	34.5	7	30.4	3	18.8	60	33.5	0.731	N
q.	Control of specific pollution sources	49	48.0	3	33.3	16	55.2	6	26.1	8	50.0	82	45.8	0.239	N
r.	Other	7	6.9	0	0.0	2	6.9	1	4.3	1	6.3	11	6.1	0.933	N
s.	None of the above	1	1.0	0	0.0	0	0.0	1	4.3	0	0.0	2	1.1	0.592	N
t.	Don't know	6	5.9	1	11.1	2	6.9	3	13.0	2	12.5	14	7.8	0.725	N
		Highest three													

Table B25

Percentage Values for Question 28 Regarding Aspects to Implement on Legislative Mandate Basis Using All Ecosystems by Type of Organization (Analysis C)

		By Type of Organization													
		Gov/Reg		Bus/Ind		Acad		NGO		Other		Tot		ChiSq	Sig
		n	%	n	%	n	%	n	%	n	%	n	%		
a.	Collaborative planning	18	10.5	4	16.7	13	19.7	8	18.6	5	16.7	48	14.4	0.351	N
b.	Clear, operational goals	32	18.7	9	37.5	21	31.8	13	30.2	6	20.0	81	24.3	0.080	N
c.	Planning with broad landscape-scale focus	30	17.5	2	8.3	16	24.2	10	23.3	5	16.7	63	18.9	0.431	N
d.	Cross-boundary facilitation	27	15.8	5	20.8	8	12.1	10	23.3	5	16.7	55	16.5	0.603	N
e.	Incentives for stakeholder collaboration	47	27.5	4	16.7	21	31.8	19	44.2	10	33.3	101	30.2	0.142	N
f.	Integration of multiple components	26	15.2	2	8.3	13	19.7	10	23.3	6	20.0	57	17.1	0.496	N
g.	Integration of scientific information	25	14.6	2	8.3	13	19.7	9	20.9	7	23.3	56	16.8	0.455	N
h.	Integration of social, economic information	27	15.8	7	29.2	19	28.8	14	32.6	7	23.3	74	22.2	0.058	N
i.	Management for sustainable outcomes	45	26.3	3	12.5	18	27.3	12	27.9	4	13.3	82	24.6	0.316	N
j.	Precaution to avoid adverse impacts	35	20.5	3	12.5	22	33.3	11	25.6	5	16.7	76	22.8	0.137	N
k.	Adaptive management	34	19.9	1	4.2	22	33.3	11	25.6	5	16.7	73	21.9	0.030	Y
l.	Monitoring on a recurring basis	33	19.3	3	12.5	17	25.8	11	25.6	4	13.3	68	20.4	0.426	N
m.	Public engagement strategy	14	8.2	5	20.8	10	15.2	13	30.2	5	16.7	47	14.1	0.004	Y
n.	Transboundary management	30	17.5	4	16.7	10	15.2	10	23.3	6	20.0	60	18.0	0.861	N
o.	Funding mechanisms	63	36.8	4	16.7	23	34.8	20	46.5	8	26.7	118	35.3	0.127	N
p.	Management for healthy condition	244	14.0	5	20.8	12	18.2	12	27.9	3	10.0	56	16.8	0.192	N
q.	Control of specific pollution sources	27	15.8	4	16.7	12	18.2	13	30.2	8	26.7	64	19.2	0.208	N
r.	Other	10	5.8	4	16.7	4	6.1	1	2.3	2	6.7	21	6.3	0.231	N
s.	None of the above	14	8.2	1	4.2	3	4.5	1	2.3	1	3.3	20	6.0	0.516	N
t.	Don't know	43	25.1	7	29.2	13	19.7	10	23.3	10	33.3	83	24.9	0.663	N
		Highest three													

Table B26

Correlations between Mandate, Positive Outcomes Scale Using All Ecosystems (Analysis A)

		Positive Outcomes	Legislative Mandate to Implement Collaborative Ecosystem Management Present (Question 26)
Positive Outcomes	Pearson Correlation	1	.016
	Significance (2-tailed)		.805
Legislative Mandate to Implement Collaborative Ecosystem Management Present (Question 26)	Pearson Correlation	.016	1
	Significance (2-tailed)	.805	

Bold=significant correlation

Table B27

Correlations between Mandate, Positive Outcomes Scale by Ecosystem (Analysis A)

			Positive Outcomes	Legislative Mandate to Implement Collaborative Ecosystem Management Present (Question 26)
Lake Erie	Positive Outcomes	Pearson Correlation	1	-.114
		Significance (2-tailed)		.404
	Legislative Mandate to Implement Collaborative Ecosystem Management Present (Question 26)	Pearson Correlation	-.114	1
		Significance (2-tailed)	.404	
Chesapeake Bay	Positive Outcomes	Pearson Correlation	1	-.189
		Significance (2-tailed)		.106
	Legislative Mandate to Implement Collaborative Ecosystem Management Present (Question 26)	Pearson Correlation	-.189	1
		Significance (2-tailed)	.106	
Puget Sound	Positive Outcomes	Pearson Correlation	1	-.108
	Legislative Mandate to Implement Collaborative Ecosystem Management Present (Question 26)	Pearson Correlation	-.108	1
		Significance (2-tailed)	.490	
Tampa Bay	Positive Outcomes	Pearson Correlation	1	-.024
		Significance (2-tailed)		.884
	Legislative Mandate to Implement Collaborative Ecosystem Management Present (Question 26)	Pearson Correlation	-.024	1
		Significance (2-tailed)	.884	
Baltic Sea	Positive Outcomes	Pearson Correlation	1	-.331
		Significance (2-tailed)		.085
	Legislative Mandate to Implement Collaborative Ecosystem Management Present (Question 26)	Pearson Correlation	-.331	1
		Significance (2-tailed)	.085	

Bold=significant correlation

Table B28

Correlations between Ecosystem Size, EBM Scale Using All Ecosystems (Analysis A)

		Ecosystem Size	EBM
Ecosystem Size	Pearson Correlation	1	**-.267**
	Significance (2-tailed)		.000
EBM	Pearson Correlation	**-.267**	1
	Significance (2-tailed)	.000	
		Bold=significant correlation	

Table B29

Correlations between Ecosystem Size, Positive Outcomes Scale Using All Ecosystems (Analysis A)

		Ecosystem Size	Positive Outcomes
Ecosystem Size	Pearson Correlation	1	**-.369**
	Significance (2-tailed)		.000
Positive Outcomes	Pearson Correlation	**-.369**	1
	Significance (2-tailed)	.000	
		Bold=significant correlation	

Table B30

Correlations between Ecosystem Size, Ecosystem Condition Using All Ecosystems (Analysis A)

		Ecosystem Size	Ecosystem Condition is Stable or Improving (Question 29)
Ecosystem Size	Pearson Correlation	1	**-.335**
	Significance (2-tailed)		.000
Ecosystem Condition is Stable or Improving (Question 29)	Pearson Correlation	**-.335**	1
	Significance (2-tailed)	.000	
		Bold=significant correlation	

APPENDIX C

DESCRIPTIONS OF RESULTS TABLES IN APPENDIX B

ANALYSIS A. OBSERVATIONS FROM COMPARISON ACROSS ALL ECOSYSTEMS

A1. Observations from All Ecosystems ANOVAs Regarding Lake Erie EA/EBM Implementation

Table B1. Lake Erie had the lowest mean value on the following: Recognition of interconnectedness in management plan; recognition of integration of ecological, social, economic and institutional perspectives in plan; societal and economic information is sought and used as important input; adaptive management is being applied; monitoring on a recurring basis is occurring and effective public engagement strategy is present. In addition, Lake Erie had the second lowest mean value on comprehensive ecosystem management plan present, clear goals and objectives present and management plan utilizes broad landscape-scale focus. However, Lake Erie scored the second highest on the following two EBM parameters: Scientific input is actively sought, and the ecosystem management strategy has been effective in maintaining the ecosystem in a healthy, productive and resilient condition.

A2. Observations from All Ecosystems ANOVAs Regarding Other Ecosystems EA/EBM Implementation

Table B1. Tampa Bay had the highest mean values on most parameters such as collaborative planning, clear goals and objectives present and incentives are present. Chesapeake Bay scored highest on transboundary nature makes management planning

and implementation difficult. Chesapeake Bay scored lowest on more parameters than any other ecosystem including on comprehensive ecosystem management plan and clear goals and objectives present. All ecosystems except Tampa Bay scored low on ecosystem management strategy has been effective in maintaining healthy ecosystem. Lake Erie, Chesapeake Bay and Puget Sound all scored low on condition of ecosystem is stable or improving.

A3. Observations from All Ecosystems Crosstabs Regarding Lake Erie Voluntary versus Mandatory Implementation

Table B2. The highest scoring parameters regarding being implemented on a voluntary basis for Lake Erie were collaborative planning (66.2%), integration of scientific information (56.8%) and planning with broad landscape-scale focus (55.4%).

Table B3. Lake Erie had the second lowest score (46.0%) regarding whether respondents believe a mandate exists to implement collaborative ecosystem management.

Table B4. For those that believe that a legislative mandate exists to implement collaborative ecosystem management in Lake Erie, the highest-ranking aspects being mandated are collaborative planning (70.6%), cross-boundary facilitation (67.6%), integration of scientific information (47.1%) and transboundary management (47.1%).

Table B5. For Lake Erie the parameters that were ranked highest as those that would benefit most from being implemented on a legislative mandate basis were incentives for stakeholder collaboration (41.9%), funding mechanisms (39.2%) and integration of social and economic information (33.8%).

A4. Observations from All Ecosystems Crosstabs Regarding Other Ecosystems Voluntary versus Mandatory Implementation

Table B2. The highest-scoring aspects for voluntary implementation across all ecosystems were integration of scientific information (53.0%, among the top three in all five ecosystems), collaborative planning (53.0%, among the top three in all ecosystems except Baltic Sea), monitoring on a recurring basis (45.8%) and planning with broad landscape-scale focus (45.2%).

Table B3. The highest proportion believing a legislative mandate exists for collaborative ecosystem management were Puget Sound (74.1%) and Baltic Sea (62.9%). 28.1% of respondents did not know whether a legislative mandate exists in their ecosystem.

Table B4. For those that believe that a legislative mandate exists to implement collaborative ecosystem management the top two parameters were collaborative planning (58.7%) and integration of scientific information (55.3%). These were the same top two parameters as were see for voluntary implementation (Table 2).

Table B5. The parameters that were ranked highest as those that would benefit most from being implemented on a legislative mandate basis were funding mechanisms (35.3%) and incentives for stakeholder collaboration (30.2%). 24.9% of respondents indicated that they didn't know.

A5. Observations from All Ecosystems Regarding Correlations between Key Parameters

Table B26. The correlation coefficient between the Positive Outcomes scale and Question 26 regarding whether a legislative mandate to implement collaborative ecosystem management is present was not significant.

Table B27. The correlation coefficient between the Positive Outcomes scale and Question 26 regarding whether a legislative mandate to implement collaborative ecosystem management is present was not significant for any ecosystem.

Table B28. Each ecosystem was given a linear value for size, with Tampa Bay (smallest)=1, Puget Sound=2, Lake Erie=3, Chesapeake Bay=4 and Baltic Sea (largest)=5. The correlation coefficient between Ecosystem Size and the EBM scale was significant at the 0.01 level, and indicated a weak negative correlation at -.267.

Table B29. Each ecosystem was given a linear value for size as noted earlier. The correlation coefficient between Ecosystem Size and the Positive Outcomes scale was significant at the 0.01 level, and indicated a moderate negative correlation at -.369.

Table B30. Each ecosystem was given a linear value for size as noted earlier. The correlation between Ecosystem Size and Question 29 regarding whether the ecosystem condition is stable or improving was significant at the 0.01 level, and indicated a moderate negative correlation between the two variables at -.335.

ANALYSIS B. OBSERVATIONS FROM LAKE ERIE RESPONDENT STRATIFICATION

B1. Observations from Lake Erie Respondent Stratification ANOVAs by Area of Focus Regarding EA/EBM Implementation

Table B6. Most respondents identified with Ecosystem focus, next highest category was Watershed. Aquatic had the lowest mean values on most parameters, including collaborative planning, incentives present and application of adaptive management. Aquatic also had the lowest mean value (i.e. disagreed most strongly) that transboundary

nature of the ecosystem makes management planning and implementation difficult. In contrast, Watershed and Ecosystem had highest scores related to various planning parameters. Fisheries had the highest score indicating they agreed most strongly related to effective public engagement strategy.

B2. Observations from Lake Erie Respondent Stratification Crosstabs by Area of Focus Regarding Voluntary Versus Mandatory Implementation

Table B7. Watershed had highest scores (i.e. greatest proportion of respondents, 51.4%) regarding believing parameters are being voluntarily implemented. In contrast, Aquatic had lowest scores (i.e. least proportion of respondents, 16.0%) regarding believing parameters are being voluntarily implemented.

Table B8. Highest score regarding believing there is a legislative mandate to implement collaborative ecosystems management is Ecosystem (55.9%). The lowest score regarding believing there is a legislative mandate to implement collaborative ecosystems management is Aquatic (30.0%). 24.3% of all respondents didn't know whether a legislative mandate exists.

Table B9. For those that believe that a legislative mandate exists to implement collaborative ecosystem management, Ecosystem had highest scores (i.e. greatest proportion of respondents, 39.3%) regarding believing parameters are being implemented via legislative mandate. Among those that believe that a legislative mandate exists to implement collaborative ecosystem management, Aquatic had lowest scores (i.e. lowest proportion of respondents, 13.3%) regarding believing parameters are being implemented via legislative mandate.

Table B10. Aquatic had highest scores (i.e. greatest proportion of respondents, 32.5%) regarding believing parameters would benefit from being implemented on a legislative mandate basis. Fisheries had lowest scores (i.e. least proportion of respondents, 13.3%) regarding believing parameters would benefit from being implemented on a legislative mandate basis.

B3. Observations from Lake Erie Respondent Stratification ANOVAs by Type of Organization Regarding EA/EBM Implementation

Table B11. Most respondents identified with Government/Regulatory organization, next highest were Academic and NGO (tied). Business/Industry had the smallest representation. In general, Government/Regulatory had the highest mean values on these parameters than the other three types of organizations. Business/Industry had the highest mean values on funding being adequate and sustainable, as well as that the condition of the ecosystem is stable or improving. However, Business/Industry disagreed most strongly that a cross-boundary facilitator is present, that incentives for collaboration are present and that societal and economic information is used for ecosystem management decisions. Likewise, Academic respondents disagreed most strongly that precaution is exercised, adaptive management is being applied and funding is adequate. NGO respondents disagreed most strongly that there is recognition of interconnectedness between ecosystem elements; integration of ecological, social, economic and institutional perspectives in the management plan; and that the ecosystem management strategy has been effective. Government/Regulatory had lowest score (i.e. disagreed most strongly) that transboundary nature makes management planning and implementation difficult.

B4. Observations from Lake Erie Respondent Stratification Crosstabs by Type of Organization Regarding Voluntary Versus Mandatory Implementation

Table B12. Government/Regulatory had highest scores (i.e. greatest proportion of respondents, 44.1%) regarding believing parameters are being voluntarily implemented. In contrast, NGO had lowest scores (i.e. least proportion of respondents, 21.6%) regarding believing parameters are being voluntarily implemented.

Table B13. Scores regarding believing there is a legislative mandate to implement collaborative ecosystems management were relatively similar (range 40.0-47.4%) across the types of organizations.

Table B14. For those that believe that a legislative mandate exists to implement collaborative ecosystem management, Academic had highest scores (i.e. greatest proportion of respondents, 44.2%) regarding believing parameters are being implemented via legislative mandate. In contrast, for those that believe that a legislative mandate exists to implement collaborative ecosystem management, Government/Regulatory had lowest scores (i.e. lowest proportion of respondents, 25.8%) regarding believing parameters are being implemented via legislative mandate.

Table B15. Academic had highest scores (i.e. greatest proportion of respondents, 38.8%) regarding believing parameters would benefit from being implemented on a legislative mandate basis. Business/Industry had lowest scores (i.e. least proportion of respondents, 14.0%) regarding believing parameters would benefit from being implemented on a legislative mandate basis.

ANALYSIS C. OBSERVATIONS FROM ALL ECOSYSTEMS RESPONDENT STRATIFICATION

C1. Observations from All Ecosystems Respondent Stratification ANOVAs by Area of Focus Regarding EA/EBM Implementation

Table B16. Most respondents identified with Ecosystem focus, next highest category Fisheries. As noted, a significant Other category was present when all ecosystems were combined. Ecosystem had the greatest number of highest mean values on parameters including clear goals and objectives, recognition of interconnectedness in management plan and scientific input is actively sought. Fisheries had the highest mean value on ecosystem condition is stable or improving. Other had the highest score on transboundary nature of ecosystem making management difficult. Aquatic had the lowest mean values on most parameters including collaborative planning, whether ecosystem management has proceeded successfully from planning to implementation, effectiveness of management strategy in maintaining healthy ecosystem and whether ecosystem is stable or improving. Other had the lowest scores on scientific input is actively sought and management strategy seeking sustainable outcomes.

C2. Observations from All Ecosystems Respondent Stratification Crosstabs by Area of Focus Regarding Voluntary Versus Mandatory Implementation

Table B17. Watershed had highest scores (i.e. greatest proportion of respondents, 38.6%) regarding believing parameters are being voluntarily implemented. In contrast, Aquatic had lowest scores (i.e. least proportion of respondents, 18.8%) regarding believing parameters are being voluntarily implemented.

Table B18. Highest score regarding believing there is a legislative mandate to implement collaborative ecosystems management is Ecosystem (63.5%). In contrast, lowest score regarding believing there is a legislative mandate to implement collaborative ecosystems management is Fisheries (38.7%). 28.1% of all respondents didn't know whether a legislative mandate exists.

Table B19. For those that believe that a legislative mandate exists to implement collaborative ecosystem management, Other had highest scores (i.e. greatest proportion of respondents, 43.3%) regarding believing parameters are being implemented via legislative mandate. In contrast, for those that believe that a legislative mandate exists to implement collaborative ecosystem management, Fisheries had lowest scores (i.e. lowest proportion of respondents, 29.0%) regarding believing parameters are being implemented via legislative mandate.

Table B20. Aquatic had highest scores (i.e. greatest proportion of respondents, 21.1%) regarding believing parameters would benefit from being implemented on a legislative mandate basis. In contrast, Other had lowest scores (i.e. least proportion of respondents, 14.8%) regarding believing parameters would benefit from being implemented on a legislative mandate basis.

C3. Observations from All Ecosystems Respondent Stratification ANOVAs by Type of Organization Regarding EA/EBM Implementation

Table B21. Most respondents identified with Government/Regulatory organization, next highest was Academic. Business/Industry had smallest representation. In general, Government/Regulatory and Other had higher mean values on these parameters than

Business/Industry, Academic and NGO. Government/Regulatory had highest scores on planning and collaboration parameters as well as positive ecosystem outcomes. Other had highest scores on seven parameters including plan with landscape-scale focus, recognition of interconnectedness, scientific input sought, societal and economic information sought, monitoring and public engagement strategy. Business/Industry had the lowest scores on more parameters than other types of organizations including collaborative planning, plan with broad landscape-scale focus, presence of cross-boundary facilitator, presence of incentives for collaboration, societal and economic information used in management decisions and public engagement strategy. This was followed closely by Academic which had the lowest scores on several parameters including clear goals and objectives present, adaptive management is being applied, funding is adequate and several positive outcome parameters.

C4. Observations from All Ecosystems Respondent Stratification Crosstabs by Type of Organization Regarding Voluntary Versus Mandatory Implementation

Table B22. Government/Regulatory had highest scores (i.e. greatest proportion of respondents, 35.7%) regarding believing parameters are being voluntarily implemented. In contrast, Other had lowest scores (i.e. least proportion of respondents, 25.0%) regarding believing parameters are being voluntarily implemented.

Table B23. Highest score regarding believing there is a legislative mandate to implement collaborative ecosystems management is Government/Regulatory (59.6%). In contrast, lowest score regarding believing there is a legislative mandate to implement collaborative ecosystems management is Business/Industry (37.5%).

Table B24. For those that believe that a legislative mandate exists to implement collaborative ecosystem management, Academic had highest scores (i.e. greatest proportion of respondents, 37.5%) regarding believing parameters are being implemented via legislative mandate. In contrast, for those that believe that a legislative mandate exists to implement collaborative ecosystem management, Business/Industry had lowest scores (i.e. lowest proportion of respondents, 32.8%) regarding believing parameters are being implemented via legislative mandate.

Table B25. NGO had highest scores (i.e. greatest proportion of respondents, 25.6%) regarding believing parameters would benefit from being implemented on a legislative mandate basis. In contrast, Business/Industry had lowest scores (i.e. least proportion of respondents, 16.5%) regarding believing parameters would benefit from being implemented on a legislative mandate basis.

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