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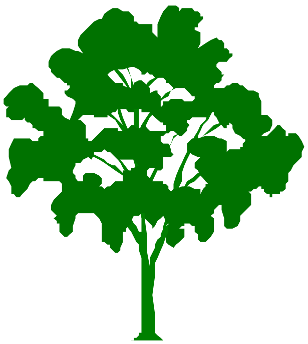


Executive Summary

This report on environmental value creation through investment (EVCI) builds on the recent experience of U.S. financial markets where the idea of "socially responsible investment" (SRI) has come to be accepted as an investment strategy offering fully competitive returns. The Great Lakes Protection Fund and the Center for Sustainable Systems Studies at Miami University have been interested in the possibility of developing an equivalent investment rating based on a company's environmental performance. This report summarizes results from two workshops sponsored by the Fund during the summer and fall of 2001 that sought to consider the potential for creating value in the Great Lakes basin by investing in firms whose environmental performance protects ecosystem function in the region.

A key finding in recent environmental and financial reports is that, as business models changed in recent years, responsible environmental performance has become both relatively common and profitable, other considerations being equal. The benefits to society, however, are distributed to everyone, or to every region supplying resources or using the products of such companies. What is missing, and could be developed within the Great Lakes basin community, is the potential for value creation through investments in businesses whose management or products help restore healthy ecosystem function.

To pursue these topics, the two workshops brought together scholars in ecosystem analysis, finance, equity and bond market analysis, and business management to consider what approaches might be most effective for assessing a firm's contributions to recovery of ecosystem function in the Great Lakes basin.

The Economic and Investment Context

Correlative associations between corporate environmental management and financial return have been reported widely. However, one should ask also what is the economic model within which such results apply, and what relationships hold between the regional economy and the functioning of ecosystems? Recent approaches to regional economics treat this question through a sophisticated consideration of capital inputs, the goods and services needs of the community, and feedback from the perceived "well-being of the community" that adjusts the intensity of resource inputs to be used.

In this view, the long-term sustainability of a community becomes part of the public goods context for regional economic and quality-of-life-goals. This view frames the economic linkage between the health of the regional ecosystem, the Great Lakes basin, and the activities of firms using or affecting the resources in the region.

Public goods in the community have been referred to as a “commons” in the past, but are frequently cited now as “common pool resources.” An example of a regional resource commons that the workshop considered is the now healthy lobster fishery of the northeastern U.S. coast. This resource is widely recognized as a public “good” that was at one time exploited and degraded in the classical economic model.

The workshops asked whether natural capital and ecosystem functions in the Great Lakes basin might also be improved by imbedding incentives for conservation within the capital markets of the Great Lakes community.

Ecosystem Services, Functions and Feedbacks in the Great Lakes Basin

Functioning of ecosystems was studied first during the International Biological Program of the early 1970s. The functional view has been defined as going beyond conventional reports on the status of resources to full understanding of the similarities and differences among processes that make up ecosystems. Ecosystem “services” are products or outcomes that are useful to humans. However, understanding of function is required to make the best management choices to sustain useful service outcomes. The distinction being made is between ecosystem services (utilitarian view, such as yields to be harvested or wastes assimilated) and ecosystem functions, which serve the system itself and provide the focus for management or restoration of the system. Altogether, 10 functions and 36 valued services were identified as a result of the first workshop.

Past and present impairments of ecosystem function in the Great Lakes basin have been shown to arise as outcomes from human activity in an economy with little feedback from commercial activity into resource functioning. Experience is showing, however, that gradual restoration of ecosystem function is feasible and cost-effective.

Therefore, corporate initiatives intended to improve resource-use efficiencies, reduce waste generation and restore ecosystem services and functions can be seen as creating value in the Great Lakes basin and its human community.

Valuation Approaches and Methods Options

Recent work on rating the environmental or conservation performance of publicly traded companies can be seen in terms of a progression in technical complexity as well as in changing social preferences. The technical improvements involve new ways by which one can more fully use public information on a firm’s products (or life-cycle impacts during production and use) and their environmental management.

However, further steps in rating approaches are needed if region-wide conservation of ecosystem function is to be achieved through the capital markets. Analysts need to continue checking the evidence that competitive to good financial performance goes with good environmental management, firm by firm. As long as this holds, there is no implication that investors are giving up opportunities for income by choosing an environmentally based investment strategy. Participants pointed out that even if monetary returns based on such investments were negative for some business sectors, the investor may be satisfied by knowing the total return can be part of a trade-off in which value is created in the community as well as directly through investment.

The questions still being explored by many financial and environmental analysts are these: What are the root mechanisms that lead to the generally positive relationship between environmental management and financial return?

Does good firm management determine both good environmental performance and financial return, or does a firm's technical commitment to water and energy efficiency and waste reduction lead to reduced costs and good total return? Results to date show no clear dominance of one view over the other.

Valuation Criteria and Metrics

Information provided on historic and current risks to ecosystem function led the workshop to what can be called fundamentals of the metrics for environmental performance of firms or institutions. From the beginning, however, the very different types of value implicit in different kinds of services needed to be recognized. Three general types were distinguished at the workshops, although each blends into the others:

Commerce Support — Services whose impairment or recovery has direct calculable consequences for the Great Lakes economy (e.g., through water levels, forest productivity, etc.).

Consumer Interest — Services whose impairment affects consumers in the Great Lakes basin who may be willing to pay some contingent value for maintenance or recovery of the services (such as fish and big game, or species in decline that have possible medicinal value).

Existence Interest — Services such as wild species pollination, species diversity and food-chain support that appear to be valued by the public but, for now, are beyond monetary determination

Two ecosystem functions, Hydrology and Primary Production, have direct monetary value implications for commerce in the Great Lakes basin. Calculations on potential value creation for transportation, hydropower and lake recreation through conservation of water supply suggest $316 million could be created annually, but discussion indicated this was more detailed than an investment analyst would need. If general criteria were developed, many participants thought that ratings in the form of multi-level letter grades could be adopted.

The Primary Production function was considered through a parallel study of the forest and paper sector's environmental management. Specific thresholds of a resource management criterion allowed letter-level determination of value creation in this sector. The Nutrient and Toxic Residuals Capture function was seen as a series of services that include waste assimilation, water quality maintenance, and mitigation of nutrient enrichment. Being of more interest to the general public than to commercial interests, contingent valuation (willingness to pay) for these services, described in a case study, indicated much potential for value creation.

The Biological Diversity Maintenance function illustrates the valuation challenge for a third class of ecosystem services, essential non- market existence services. These involve public goods with almost no documentable market value, such as species diversity *per se*. Discussion of an example involving introduction of damaging exotic species through ballast water brought into the Great Lakes generally confirmed the importance of a set of "existence " services.

Discussion and Next Steps

To explore the broader scope of environmental and capital market relationships, and to consider next steps, the second workshop used breakout sessions to consider the following questions.

1. Should there be more research on tools and approaches, or more emphasis on applications and testing of current approaches?

Discussion, although not unanimous, indicated little advantage in pursuing more original research at this time. Instead, one could critically evaluate ongoing research by others on linkages between environmental and financial performance. What seems to be needed is informed application of existing tools and testing of next-generation approaches. Discussion also indicated the need for a focus or application with real examples. These examples might range from firms involved with natural resources drawdown to those concerned with insurance and the flows of capital out of some capital markets.

2. What is gained and what may be lost by either going forward with many numerical results on the environmental fundamentals of firms, or presenting an aggregated result in the form of letter grades (C to AAA) based on valuation criteria for functions and services?

This discussion explored mechanisms available for taking advantage of what the capital markets can do to create value in a regional ecosystem. One suggestion was to consider a “Green Great Lakes Market.”

This initiative should include the supply chain (materials sourcing) of large companies and small, and the adapting of environmental management systems to give “regional signals” to consumers as well as to market analysts.

3. Are approaches available for generating information on the environmental impact of bank loan portfolios, insurance, or municipal bond rating services that overlook environmental damages from major projects?

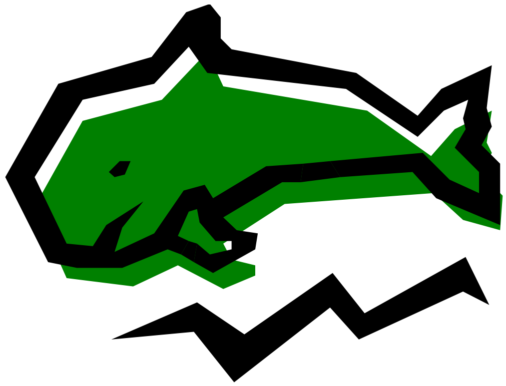
The workshop used this topic to consider how other sectors of the capital markets, particularly corporate and municipal bonds and commercial loans, could be evaluated in terms of an environmental benefits analysis. Full treatment of the capital market underlying suburban development, a major activity affecting the Great Lakes ecosystem, requires that we also think about long-term consequences from commercial project loans, municipal bonds, and insurance on loans or bonds.

One initiative would be to rate the rating agencies in terms of the thoroughness of their treatment of risks to the environment from the activity funded by the bonds. Some environmental risks already are incorporated, but long-term risks to ecosystem functions and to other environmental goods often are not. Insurance companies (underwriting long-term risks and liabilities from projects funded through the sale of bonds) were seen as likely to have a need for full information on environmental risks from the projects they insure. Development of appropriate methods should consider the cost of providing the needed information, building an organization capable of doing it, and being credible in its distribution.

Conclusion

The two workshops provided a framework for examining this proposition: *That the environmental performance and products of companies (or other private enterprises) can be assessed for the purposes of investment in relation to their potential to create value in the Great Lakes regional environment, locally or at a large scale*. Several approaches for estimating the benefits to public goods such as air, water and biodiversity were explored and suggestions made for taking the next steps in demonstrating feasibility. As a result, work is underway on developing up to 10 criteria (differing slightly in relation to commercial sector) for use in rating the potential for environmental value creation.

An investment strategy based on environmental (or ecosystem) value creation through investment (EVCI) appears to be feasible and competitive now. What remains is to develop means for analysts and the public to become more fully informed about favoring companies achieving high environmental performance in the Great Lakes basin.



1. Introduction

Environmental scientists have shown great interest recently in the gradual acceptance by U.S. financial markets of "socially responsible investment" (SRI) as an investment strategy offering competitive returns. The SRI approach has evolved from one that, in the early years, screened out companies judged to be producing a socially undesirable good, to an approach now known as "community investment".[1]

Here we explore more fully the community investing strategy through an application in which a company's products or culture (including their environmental performance) are rated from the viewpoint of serving a community, rather than being screened in or out. The Great Lakes Protection Fund and the Center for Sustainable Systems Studies (CSSS) at Miami University have been interested in the possibility of using community investing ratings, based on a company's regional environmental performance, to guide steps toward an investment strategy favoring companies that conserve resources and protect the environment.

This report summarizes results from two workshops sponsored by CSSS and the Fund during the summer and fall of 2001. The workshops sought to evaluate the potential for estimating value created in the environment of the Great Lakes basin by investing in firms whose performance protects ecosystem function in the region.

We have called this concept "environmental value creation through investment" (EVCI), rather than simply SRI.

The literature on environment-based management and investment can be seen now as the product of four stages of innovation in environmental accounting and business management during the 1990s. The stages, beginning just over 10 years ago, include: formative articles and books on the concept of environmental accounting for sustainable development; steps toward corporate implementation and standards of practice for environmental reports; recent reports suggesting positive financial returns in relation to environmental performance; and the U.S. Environmental Protection Agency's series of research workshops on the mechanisms that may link corporate environmental performance and financial returns.

A key finding in this literature is that as business models have changed in recent years, responsible environmental performance has become both relatively common and profitable, other considerations being equal. The benefits to society, however, are distributed to everyone, or to every region supplying resources or using the products of such companies nationally and internationally.

What is missing, and could be developed within the Great Lakes basin community, is consideration of the potential for value creation within the region by investing in the companies whose environmental management or products restore healthy ecosystem function and stimulate equivalent responses in the human community.

Thus, the topics that had to be examined during the workshops included:

- The economic model and context for EVCI
- The scope of ecosystem functions and services in the Great Lakes basin that can be benefited through improvements in corporate environmental performance
- The range of tools and approaches available for assessing the value created through conservation or restoration of ecosystem function
- Examples or case studies of how actions within the capital markets could contribute to regional value creation.

To pursue these topics, the two workshops brought together scholars in ecosystem analysis, environmental science, economics, finance, equity and bond market analysis, and business management. Their goal was to consider what approaches would be possible and effective in assessing a firm's contributions to conservation or recovery of ecosystem function in the Great Lakes basin.

2. The Economic and Investment Context

Correlative associations between corporate environmental management and financial return have been reported widely.[2,3,4,5] However, one should also ask what is the economic model within which these results are being found and what is the relationship between a regional economy and the functioning of ecosystems? Let us begin by considering two viewpoints.

Classical economics has viewed the economy as an outcome from the flow-through of inputs such as labor, land, and capital, to meet the goods and services needs of consumers. Land is often understood as a surrogate for the agricultural, forest, mineral and energy resources used by consumers.

In this view, little consideration need be given to public goods such as clean water, clean air, green space, biological diversity, or other ecosystem functions that may be degraded as land is developed.

Recent approaches, however, are considering the more complex array of capital inputs shown in Figure 1. The goods and services needs are met but, through consumer perceptions of the "well being of the community," a means also is provided for reconsidering and adjusting the intensity of capital inputs to be used. In this model, the long-term sustainability of the community becomes a part of the "public good," along with air and water, and becomes part of the context for regional economic and quality-of-life-goals. In this view the workshop participants could see a linkage between the health of the regional ecosystem, the Great Lakes basin, and the activities of firms using or affecting the resources in the region.

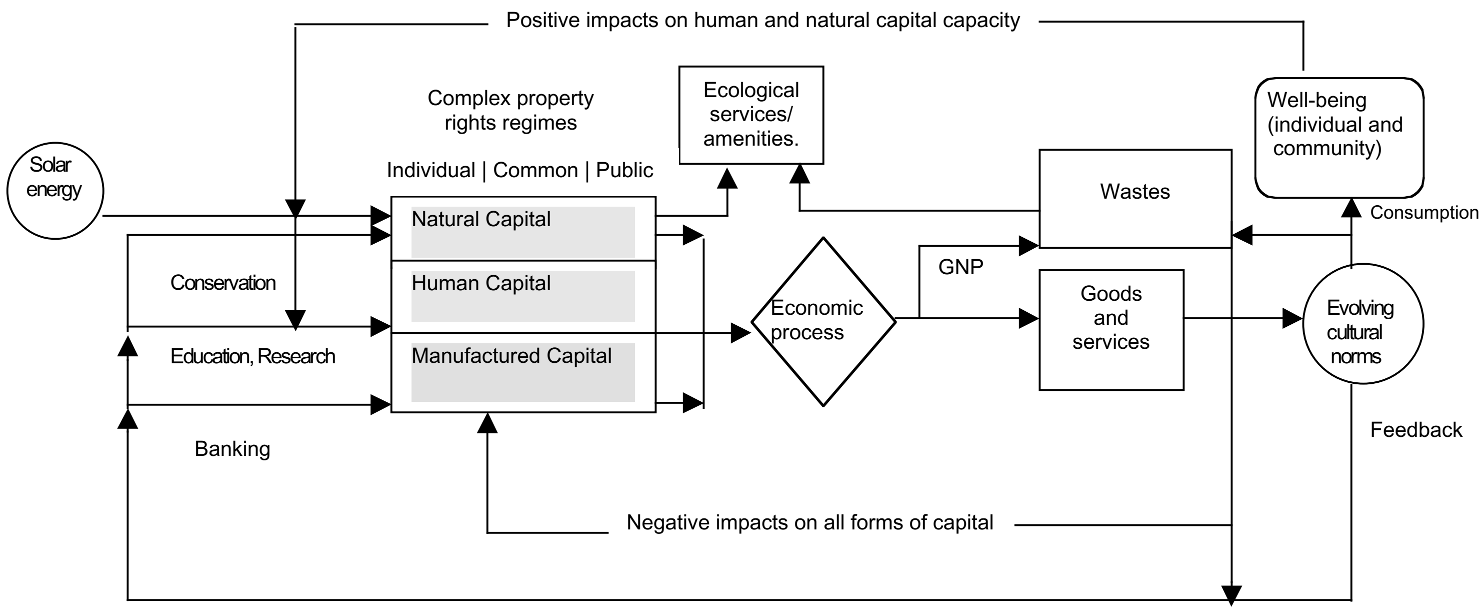


Figure 1. Alternative models of economic activity.[6,7]

In the regional economics context of Figure1, resource use (natural capital drawdown), together with its positive and negative effects on conservation of ecosystem function, creates the means for a feedback from “community well-being” (upper right, Figure 1) to the state or condition of various types of capital inputs. Although monetary value can be attached to the state of resource stocks, the community’s response is to values that are not solely monetary. Although the idea of feedbacks of this form is seen by some observers as speculative, recent case studies of “common pool resources” indicate such feedbacks are more prevalent than once believed.[8]

Conservation of common pool resources and related ecosystem functions

Public goods have been referred to as a “commons” in the past, but are frequently cited now as “common pool resources.” As an example of a regional resource commons, the workshop considered descriptions of the lobster fishery of the northeastern U.S. coast. This resource is widely recognized as a public “good” that was at one time exploited in the classical economic model, natural capital to be used as input to the local economy.[8] The analysis by Jensen (and papers by other authors) summarizes the characteristics recognized now in successful community-based management of these resources. Recognition by the community that the resource is both necessary and scarce is a critical step, Jensen says, as is a sense of boundaries, public obligations, individual participation and a form of self-monitoring. The literature on community-based conservation of public goods also now shows that human uses of a commons need not be “tragic.”

The mechanisms outlined by Jensen illustrate how the feedback from “community well-being” can operate to restore natural and human capital in the region and reinvigorate the capital available for the economy.

The workshops considered whether ecosystem functions and natural capital in the Great Lakes basin might also be benefited by imbedding incentives for conservation within the capital markets of the Great Lakes community. Restoration of resource stocks and the capacity of ecosystems to renew stocks could be seen as value creation in the commons, a potential rebuilding of community well being. In principle, one may argue that constraints on intensive use of public goods should be adjudicated by government, with regulations or green taxes designed to protect the commons and the interest of the community. In an alternative view, one may hold that the community, given full information, will itself take the steps necessary to conserve common-pool resources such as those of the Great Lakes basin. It is this step that could take place if the community were well informed about the environmental performance of the firms affecting the environment of the area.

An important part of community-based conservation for public goods would be the favoring of people or businesses that manage the resources well. Consideration of the Great Lakes common pool resources, in this view, should assess the community's sense that certain services from ecosystem functioning are scarce, or at risk, and that steps mediated through the financial markets could contribute to restoring those functions and services. Scientific reports on the health of the Great Lakes ecosystem were seen in the workshops as an important step toward providing investors with information on what measures by businesses would help sustain common-pool resources.

Impairments within the Great Lakes basin already are being monitored by the International Joint Commission (IJC), a joint U.S. and Canadian body that oversees implementation of environmental protection goals for the Great Lakes. The IJC has issued guidance in several forms for the remediation of damages from pollutants.[9] Public concern for diminished ecosystem services is reflected in the 14 "use impairments" (Box 1) that have been agreed on by the study boards of the IJC. Many of these impairments derive from the presence of persistent toxic substances circulating in the lakes and from excessive nutrient enrichment. At present, these use impairments are to be prevented or corrected through the joint regulatory efforts of the U.S. and Canadian governments along with the states and provinces, and the major communities and businesses throughout the Great Lakes basin.

Box 1. Significant use impairments of the Great Lakes recognized by the International Joint Commission[9]

1. restrictions on fish and wildlife consumption
2. tainting of fish and wildlife flavour
3. degradation of fish and wildlife populations
4. fish tumors or other deformities
5. bird and animal deformities or reproduction problems
6. degradation of benthos
7. restrictions on dredging activities
8. eutrophication or undesirable algae
9. restrictions on drinking water consumption, or taste and odor problems
10. beach closings
11. degradation of aesthetics
12. added costs to agriculture or industry
13. degradation of phytoplankton and zooplankton populations
14. loss of fish and wildlife habitat

3. Ecosystem Services, Functions and Feedbacks in the Great Lakes Basin

Many authors have written on ecosystem processes, functions and services including several on the Great Lakes ecosystem.[10,11,12] Functions of ecosystems, as opposed to services, were studied first in the U.S. contribution to the International Biological Program in the early 1970s.[13] Functioning of ecosystems is discussed by, Smith[14] and Risser[15] the latter including "productivity, sequestering of carbon and other chemicals, and rates of nutrient cycling" as outcomes of naturally functioning ecosystems.

Services, on the other hand, are outcomes useful to humans. Understanding of function is required to make the best management choices for sustaining useful service outcomes. Some services are the consequence of specific groups of species (e.g., pollinators), while groups of biological processes (such as those involved in photosynthesis) can be aggregated into clusters of activity, referred to here as "functions". We use the general term "primary production" for a function, rather than the more technical and specific "photosynthesis". The distinction being made is between the utilitarian view of services (such as yields to be harvested or wastes assimilated) and ecosystem functions, which serve the system itself and provide the focus for management or restoration of the system.

Ten functions, the major aggregates of processes that control the essence of Great Lakes ecosystem functioning, are summarized in Table 1 along with illustrative services. A distinction being made here is between observable states of the ecosystem (such as the state of nutrient enrichment or the levels of toxic substances), which are indicators considered by the State of the Lakes reporting, and the "degree of impairment" of various functions within the Great Lakes ecosystem.[16] The Boards and Committees of the IJC have addressed this subject in several recent reports, but their strategies for preventing further impairment are through regulation and the setting of limits or standards.

Both the functioning of ecosystems and the services provided to human welfare have been cited and described in many texts and technical papers.[17] The term ecosystem service is defined carefully in the introductory chapter of *Nature Services* volume along with a listing of 13 important services. Alternate phrasings and four additional services were noted during the first workshop. Costanza[18] et al. cite 17 important services at a global scale.

Still, understanding of site-specific functions and processes must be supplemented in the Great Lakes basin by our knowledge of functioning at the regional scale, as with air and water quality renewal, hydrologic functioning (flood or drought buffering), and soil building.

Relevant local processes, aggregated into regional system functions, include infiltration of rainfall into soil or growth of individual organisms, both of which are fine-grained subunits of the activities making up major regional ecosystem functions.

Comprehensive review of the ecosystem services provided by a fully functioning Great Lakes regional ecosystem has led to the listing of functions and services shown in Table 1. Altogether, 36 valued services are provided by the 10 aggregated functions. The working consensus on these services and functions is consistent with many years of technical literature on ecosystem functions and services.

We need also to recognize that it is human intervention in the physical and biological processes of ecosystem functioning that impairs these 36 services, or could restore them now. Thus, a critical need exists for better use of existing knowledge and data for predicting ecosystem states in relation to land use, technology, human population, economic activity and climate change.

Finally, our limited understanding of the interactions among ecological processes and the feedbacks that alter large-system functioning, for the better or worse, requires several stipulations on functioning and scale in the Great Lakes ecosystem. These stipulations include the principles that:

- upland processes affect transpiration and groundwater balance and are integral to inflows of water to and through the Great Lakes.[10,11]

- human uses of water and human effects on other resources, either by harvest or by discharge of emissions or wastes, can be as critical to the functioning of a regional ecosystem as is the presence and functioning of a major native species such as lake trout, or introduced species such as zebra mussels.[19,20]

- removal of habitats through conversion of land or shorelines to intensive commercial uses can induce impoverishment of functions equivalent to effects from chemical alteration of habitats or other factors that diminish primary and secondary production, nutrient assimilation and species maintenance.[21]

With these stipulations, past and present impairments of ecosystem function in the Great Lakes basin can be understood as outcomes from human activity in an economy with little feedback from commercial activity into resource functioning. One school of economists may argue that substitutability of one resource for another should prevail, but others are recognizing that substitutes such as engineered replacement of clean water and clean air may be unacceptably expensive, when all costs are accounted for and included, in comparison to judicious conservation.

In the latter view, the externalities of cheap exploitation lead to significant public costs expressed through beach closings or fish advisories, a form of resource scarcity for which substitutes are not readily available to most people.

Experience also is showing that gradual restoration of ecosystem function has become feasible and cost-effective. Therefore, corporate initiatives designed to improve resource-use efficiencies, reduce waste generation and restore ecosystem services and functions can be seen as having the potential to create value in the Great Lakes basin and its human community. This result may be expected as knowledge and understanding of business contributions to restoration become more widely available.

Table 1. The 10 major ecosystem functions in the Great Lakes Basin and 36 associated services (terrestrial and aquatic)

FUNCTIONS	ILLUSTRATIVE SERVICES
Hydrologic functioning	Water supply, groundwater flow, flood mitigation, transportation, hydro electricity, lake recreation, water quality
Primary production and biomass accumulation	Energy capture, agriculture, timber, food-chain support, carbon storage
Animal populations and secondary production	Energy flow for fish, wild game, songbirds, other wildlife
Biological diversity maintenance	Species diversity, pollination, aesthetics, food-chain support, medicines, pest control
Decomposition	Soil renewal, benthic food-chain
Soil and sediment building	Carbon storage, nutrient storage, soil moisture storage
Nutrient and toxic residuals capture and cycling	Waste assimilation, groundwater quality, renewal of soil fertility
Insect/disease regulation	Pest control, biodiversity support, food-chain support
Vegetation succession and disturbances	Habitat diversity, seed bank diversity, aesthetics, real estate value
Air and climate self-regulation	Air purification, moderation of weather extremes, visibility and human health

4. Valuation Approaches and Methods Options

Recent work on rating the environmental or conservation performance of publicly traded companies[2,4,22] can be seen in terms of a progression in technical complexity as well as in changing social preferences. The technical improvements involve new ways by which analysts can more fully use public information on a firm's products (or life-cycle impacts during manufacturing and use) and its environmental management. This work is leading to improvements in environmental performance scores for firms, and reduced risks to the environment and to ecosystem function. However, further improvements in how we identify good environmental performance are needed if region-wide conservation of Great Lakes ecosystem function is to be achieved through the capital markets.

Methods Context I: Regional Screen or Quantified Contribution to Function

The second workshop heard a brief report on conversations with a former senior manager from PriceWaterhouseCoopers in which this project's focus on investment for the Great Lakes was described. The response was "Oh, a regional screen."

The manager acknowledged the success of mutual funds based on general social or environmental screens (acceptance or rejection of investment in certain firms based on a combination of social and environmental criteria).

He was intrigued by the possibility of doing this for a region such as the Great Lakes. However, the idea here of rating the continuum in how corporations can conserve ecosystem function at a large scale had been reduced in his view to the simple term "regional screen."

The distinction, or lack of one, is an important element in how one considers the methods available for valuing ecosystem functions in the Great Lakes basin. If our goal is to be protection or recovery of specific ecosystem functions, then one should work toward outcomes with a clear potential for community-wide value creation with on-the-ground verification of benefits (long-term). The monetary returns from a regional environmental screen approach might be verified, but it is more difficult to demonstrate an on-the-ground benefit for the ecosystem services. Similarly, the natural resource values created through a national (or international) screen do not serve a specific community that might recognize and value the benefit. Without the linkage to functioning of a regional ecosystem, investment selection using a regional screen may not protect a region's ecosystem services any better then a national screen.

A regional screen also implies an emphasis on companies doing business primarily in the Great Lakes region. A focus on protecting or restoring Great Lakes ecosystem function, however, leads one to consider companies headquartered almost anywhere if they are creating products or innovative manufacturing processes capable of ameliorating dysfunctional ecosystem processes in the basin. Such companies may well be located in the Great Lakes basin, but not necessarily.

The two points just cited lead to the following distinction: analysts need to show evidence of good financial fundamentals and management on the part of the firm, as there need be no implication that investors are giving up any opportunity for income in choosing an environment-based strategy. Secondly, quantifying the contributions of a firm to regional ecosystem conservation, through introduction of low impact new products or new manufacturing approaches, must be based on a repeatable approach to estimating environmental benefits. Using both financial and natural resource valuations in the same analysis is ambitious and involves the expertise of inter-disciplinary business and ecosystem function professionals not previously available.

The workshop also considered the argument that financial institutions generally are not able to evaluate a company's technology and product life-cycle choices. Our desired methods for assessing a firm's contributions to healthy ecosystem functioning should seek to work through this constraint and integrate environmental and financial analysis systematically for a large number of firms.

Methods Context II: Hierarchical Structure

Another element of the technical or methods context is the hierarchical structure of ecosystem functioning. In many ways this structure corresponds to patterns evident in the commercial and government/institutional functioning in the Great Lakes region. The regional ecosystem structure can be conceived of as local fields of function and response being contained within larger fields (such as intermediate-scale watersheds). The largest field can be thought of as the aggregate activity of ecological and socioeconomic processes throughout the Great Lakes basin, considering both land and water systems. Ecosystem functioning is recognized at this large scale, but it can be seen at smaller scales as well.

In this hierarchical view of ecosystem functioning, the potential benefits to the Great Lakes basin can be seen as rooted in tens of thousands of local business activities, corresponding to the way we understand ribosomes in our body; small structures in the cells making up tissues and organs, but controlling whole-body functions such as respiration and metabolism. Any intervention that makes a small change for the better, or worse, in the functioning of tens of thousands of firms or plants, through investment or other open-market strategies, will produce important effects for the whole system. The middle-to-large scales, together with the earlier IJC listing of "impaired uses," also frames and sets a public value context for thinking about Great Lakes ecosystem recovery needs.

For example, modification of some ecosystem functions can be understood as the net difference between the flows (or production of services) from water, carbon dioxide, soil nutrients and native species in a fully functioning reference system, and the flows or products available now with current intensive uses of water and biological productivity. A trend toward widening the difference between reference and current conditions indicates a potential risk of future scarcity. The increase in agricultural yields is being attributed, largely, to the increased use of nitrogen (N) fertilizer, some of which induces negative effects when it reaches streams and lakes at enriched concentrations.[23]

Changes in the primary productivity of aquatic systems have been linked mainly to increases in silt and phosphorus (P) in the stream sediment transported from cultivated land and urban construction sites into the Great Lakes. Recent decreases in productivity of lakes such as Lake Erie are being attributed to reduced phosphorus inputs, and to changes in food-chain structure due to introduced species.

Secondary production functions involving animal populations have been affected greatly by over-harvesting.[24,10] Reproductive failure of other species has been attributed to persistent bioaccumulating toxic substances. Plant growth in agricultural systems has increased when compared to forest and agricultural productivity at mid-century, while productivity of open-lake systems may be referenced to the 1930s.[24]

The workshops heard reports on how the needs and goals for restoration of impaired functions are being reviewed by the Boards and Committees of the IJC and through Remedial Action Plans for “Areas of Concern” (see especially *1995-1997 Priorities and Progress Report* of the IJC.[25] These action plans set targets for function recovery at local sites, but the outcomes can be beneficial for large-scale impairments in the Great Lakes basin. An important further step would be to determine how much the new products or services from companies or communities around the basin could contribute toward the recovery goals.

Methods Context III: Corporate Management and Profitability

Methods for considering corporate environmental and financial performance together, as are being developed by financial and investment analysts, also are essential for considering how environmental value creation through investment (EVCI) could contribute to restoring function in the Great Lakes basin.[2,4] Several approaches are emerging, and both the problems and opportunities can be illustrated in the EcoVALUE ‘21 approach taken by INOVEST Inc.[2]

The approach is illustrated in Figure 2 where the variables being considered range from aspects of corporate management (on the right) to aspects of historical environmental liabilities, reduced operating costs, risks and eco-efficiencies on the left.

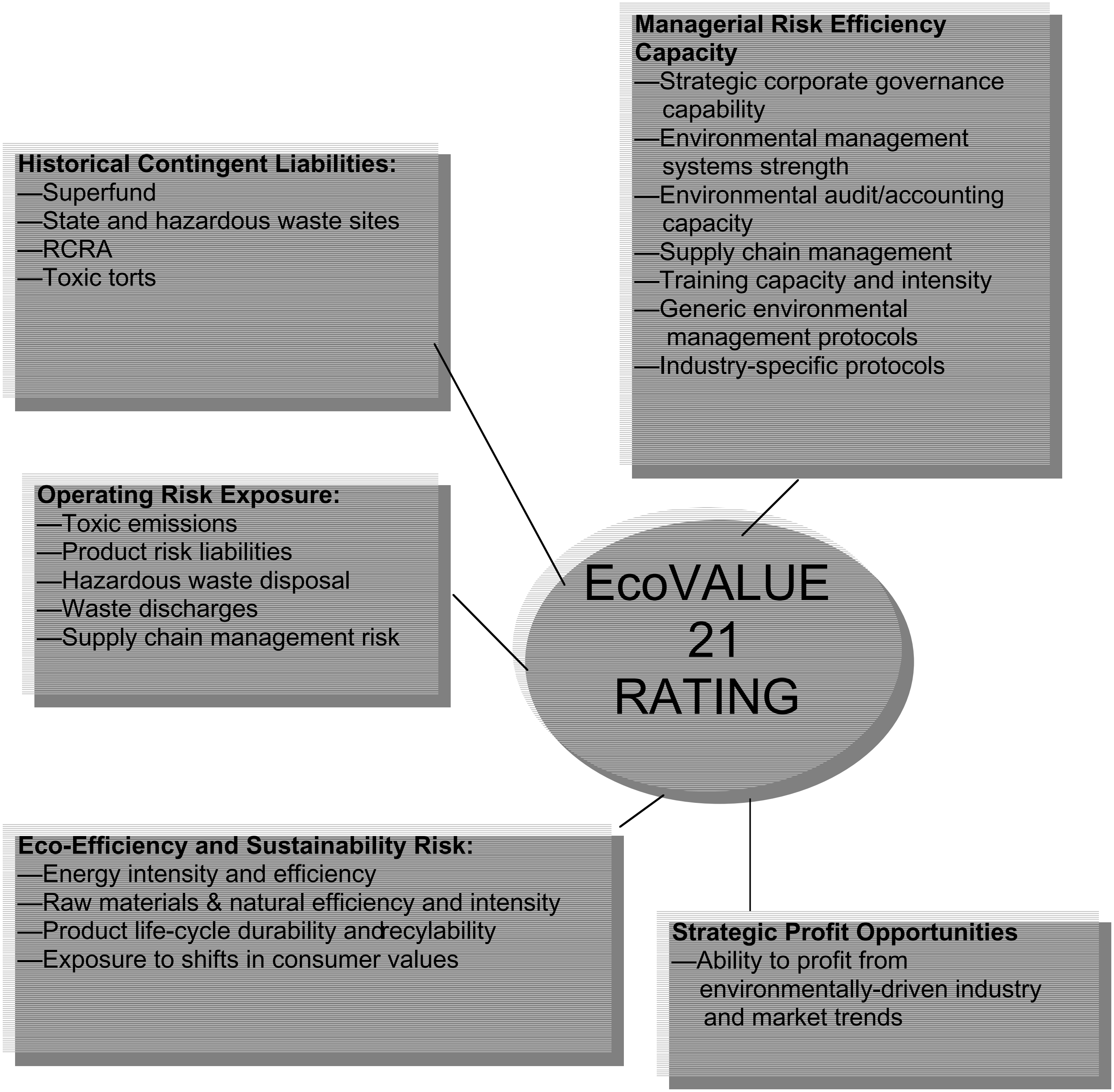


Figure 2. The EcoVALUE 21 rating model analyzes 60 key variables[2]

Back-testing of the financial performance of the companies evaluated here has shown that total return from the top half of the companies rated significantly exceeds the annual return from the half with lower environmental ratings.

The questions being explored now by many analysts are these: What are the root mechanisms that lead to this positive outcome? Does good quality management of the firm determine both the good environmental performance and the financial return, or does a firm's technical commitment to water and energy efficiency, reduced risks and waste avoidance, lead to reduced costs and good total return? Results to date show no clear dominance of one view over the other, and probably both are involved. A few studies suggest that these factors operate interactively to produce the linkage between good environmental management and financial performance.[26,22]

Further documentation of the linkage between environmental drivers and financial outcomes was presented to the workshop from the report "Buried Treasure."[5] The "Environmental Process Focus" (4th row, Figure 3) influences three of the four financial performance measures strongly and positively and influences the fourth one moderately but positively. The environmental product focus also is a moderately positive influence on financial drivers such as innovation, risk profile and brand reputation. Since this study was based on intensive interview-based data from 20 companies or institutions, the report provides some detail on the mechanisms underlying the positive relationships.

In addition to general environmental and corporate management, however, methods for evaluating a company's potential contribution to Great Lakes conservation also needs to consider life-cycle impacts of its products or manufacturing processes. A wide variety of reports illustrate the kind of life-cycle assessment data available now for many kinds of products.[27] Such assessments can be thought of as part of the "environmental fundamentals" of products as opposed to the fundamentals of a firm's environmental management noted above.

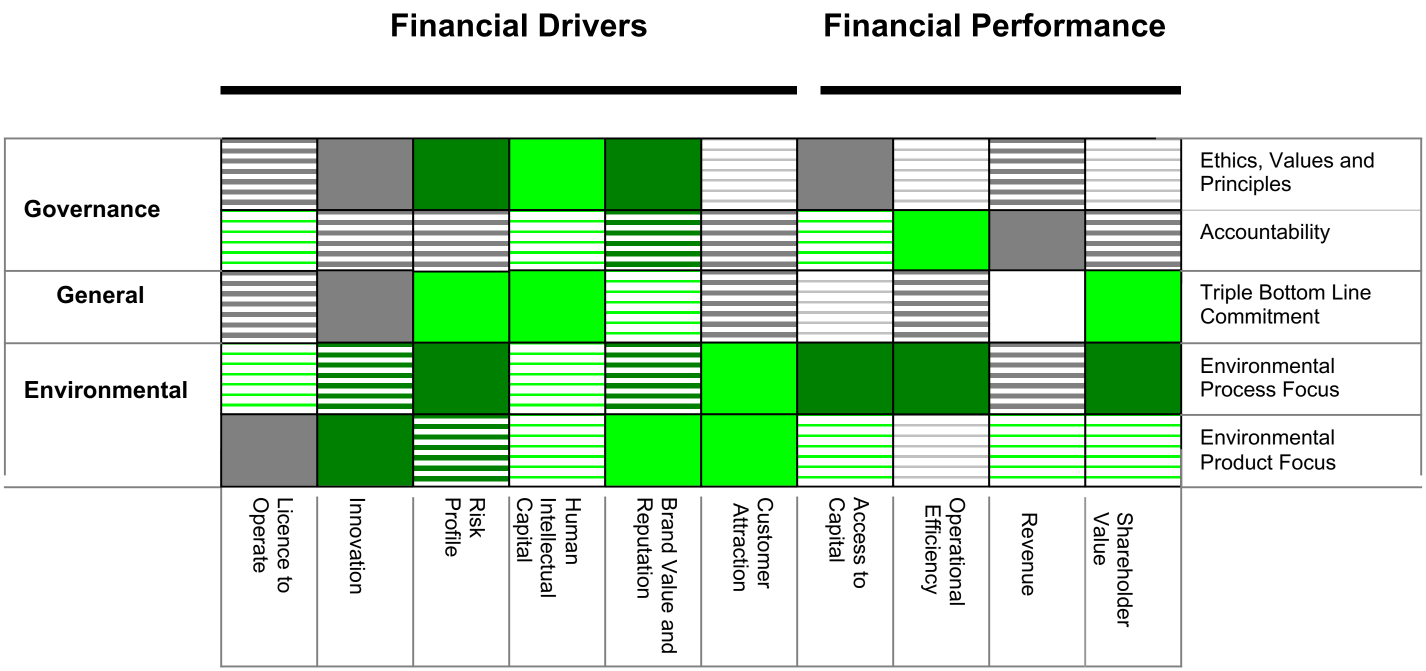


Figure 3. A matrix summary of measures influencing business success. Dark and gray-green squares, and dark and gray-green horizontal etching show strong and moderate positive associations respectively, while light gray and gray horizontal etching indicate almost no association, and the sharply dark gray horizontal etching is a negative association. Note that the fourth row, a firm's Environmental Process Focus, contributes more positively than any other to financial performances measures (after van Heel et al.)[5]

5. Implementing Valuation Criteria and Metrics

The services listed in Table 1 and the information outlined in Appendix A on the potential for impairment leads us to consider a systematic approach to rating corporate “environmental fundamentals,” the criteria and metrics for evaluating the products and environmental management of individual firms or institutions. From the beginning, however, we need to recognize the three very different types of value associated with different kinds of services. These three general types are defined as follows, with each blending into the others:

Commerce Support — Services whose impairment or recovery has direct calculable consequences for the Great Lakes economy (e.g., water levels, forest productivity, etc.)

Consumer Interest — Services whose impairment affects consumers in the Great Lakes basin who may be willing to pay some contingent value for maintenance or recovery of the services (such as fish and big game, or species in decline that have possible medicinal value)

Existence Interest — Services such as wild species pollination, species diversity, and food-chain support that appear to be valued by the public but, for now, are beyond monetary determination.

These three types of valuation are given short acronyms in Column 1 of Table 2, together with the ecosystem services to be valued under each type. Each of the lower types of valuation might some day be integrated into the upper types. For example, services involving existence interest may some day qualify for contingent valuation. The functions subject to alteration here (i.e., the functions or processes through which services may be put at risk or restored) are summarized with their respective services and the type of potential valuation in Table 3.

Table 2. Summary of the services associated with three types of valuation

VALUATION TYPE	ECOSYSTEM SERVICES
Nonmarket services with direct monetary value (NMS/DMV) (Commerce Support)	Water supply, transportation, hydro power, flood mitigation, lake-based recreation, agricultural products, growing of timber, carbon storage
Nonmarket services with contingent monetary value (NMS/CMV) (Consumer Interest)	Groundwater storage, water quality, recreation, risk of flooding, sport fishing, wild game recreation, pest control, medicinal species, human health, waste assimilation, visibility, aesthetics
Essential nonmarket or existence services (ENES) (Existence Interest)	Food-chain support, species diversity, songbird community, wild species, pollination, soil renewal, nutrient and moisture storage, habitat diversity, air purification, moderation of climate and weather extremes

Table 3. Ecosystem functions and services shown with the type of valuation available for each service (see Table 2 for definitions)

FUNCTIONS	ILLUSTRATIVE SERVICES	TYPE OF VALUATION
Hydrologic functioning	Water supply, groundwater flow, flood mitigation, transportation, hydro electricity, lake, recreation, water quality	DMV, CMV
Primary production and biomass accumulation	Energy capture, agriculture, timber, food-chain support, carbon storage	DMV, CMV, ENES
Animal populations and secondary production	Energy flow for fish, wild game, songbirds, other wildlife	ENES
Biological diversity maintenance	Species diversity, pollination, aesthetics, food-chain support, medicines and pest controls	CMV, ENES
Decomposition	Soil renewal and benthic food chain	CMV, ENES
Soil and sediment building	Carbon storage, nutrient storage, soil moisture storage	CMV, ENES
Nutrient and residuals capture and cycling	Waste assimilation, groundwater quality, renewal of soil fertility	CMV, ENES
Insect/disease regulation	Pest control, biodiversity support, food-chain support	CMV, ENES
Vegetation succession and disturbances	Habitat diversity, seed bank diversity, aesthetics, real estate value	CMV, DMV, ENES
Air and climate self-regulation	Air purification, moderation of weather extremes, visibility, and human health	CMV, ENES

These valuation options were considered at the second workshop through hypothetical case studies for each type. Each of the hypothetical situations and example valuations was discussed and elaborated on during subsequent review.

Direct Monetary Value Creation

The first two ecosystem functions from Table 1 have services with direct monetary value (DMV) implications for environmental management of the Great Lakes basin. The potential for impairment or recovery is very different between on-land hydrology and open-lake transportation, or the on-land agricultural production and growth of timber. Thus, the calculation of risks or benefits must differ according to business sector. We will illustrate with an example for each of the two functions treated under the DMC type.

Case I: Hydrology-related Services

For purposes of an example, Box 2 presents a calculation of the value created in water supply, transportation, hydropower and lake recreation services from full hydrologic functioning. A study by David et al.[28] allowed calculation of “damages” to Great Lakes shipping and hydro electricity generation associated with a range of water use intensity (diversions) and resultant lower water flows.

Recent work[29] shows that the MH/10 scenario (Michigan-Huron, 10,0000 cubic feet per second of water diverted) considered by David is essentially equivalent to the level of consumptive water use present in the basin today.

The results in Box 2 show findings expressed as year 2000 dollars, but with damages expanded to include lake-based recreation effects (reduced boat access in channels, docks and marinas, lowered water intakes and loss of shallow bay habitat), set at equal to the shipping and hydro values. One body of comments on the example sought to improve on the specificity or realism of the example and to improve on the financial considerations (such as return time on the investment being made, tax considerations, etc.). Another view suggested that such calculations, while interesting, are more detailed than an investment portfolio analyst would need. A general assessment of the potential for value creation, through technical review supported by illustrative calculations, could provide equally valuable information to financial analysts. The workshop agreed that further iterations in the valuation of benefits from water conservation would be useful for Great Lakes ecosystem conservation, but that, if detailed criteria were developed, ratings in the form of multilevel letter grades could be adopted.

Box 2. Hydrology-related services, illustrating calculation of direct monetary values

A publicly owned, multistate agricultural production company, with operations in the Grand River, Maumee and St. Joseph river valleys of Michigan, Ohio and Indiana is considering replacing its aging spray irrigation equipment. The motors in the pump systems are inefficient, the groundwater levels and stream flows have been drawn down due to the pumping, and the circular irrigation is inefficient in land coverage. Pumpage is about 100 million gallons per day total in the three states, of which 75% is lost to evaporation without reaching the crop root systems (see below). Soil surface drip irrigation lines could be installed at lower replacement capital cost and water use efficiency would be greatly improved. Also, drip irrigation would provide more complete watering of the rectangular fields. However, there is a greater operating cost for laying out the drip irrigation lines each year. Should the company choose drip irrigation, the value created through conservation of water in the basin is estimated at $316 million annually from this one large hypothetical operation.

Sample calculation of water conserved (million gallons per day [Mg/d]) and the value created by the water conservation measures (million dollars per year [M$/yr])

	Water Pumped (Mg/d)	Water Lost to Evaporation (Mg/d)	Returned to flow (Mg/d)	Value created (M $/ yr)
Spray irrigation	100	75	25	
Drip irrigation	25	5	20	
Comparative gain			70	$316

Case 2: Primary Production Services

A specific study of environmental management by companies in the forest and paper sector of the Standard and Poors 500 allowed consideration of an approach for estimating the value created (or lost) by 10 companies in this natural recourses sector. Following the principles developed through the Caux Roundtable and the Total Social Responsibility Index,[30] Loucks, Erekson, and Springer[22] defined thresholds for rating the companies' conservation and management of timber resources and land (Box 3). The sources for the information used were the companies own annual environmental reports and websites.

Box 3. Threshold definitions for three levels of environmental performance for the timber production criterion

Criterion: Corporate environmental management engages in restoration and conservation of natural resources, and sets future program targets.

Performance thresholds:

(+) Substantial information with details on land and water outcomes are provided for the companies restoration, tree planting, wildlife or fishery considerations and special area conservation programs and targets.

(0) Broad but general information is provided on the scope of the company s resource restoration and tree planting programs and special conservation targets.

(--) Minimal or superficial information is available as to specific goals for restoration, tree planting and future restoration or conservation targets.

Experience in the course of rating 10 companies according to the thresholds for this primary production criterion indicates that four of 10 companies warranted a '+', four warranted a '—', and two were neutral. These results could be converted readily into a letter grade between C and AAA.

Contingent Monetary Value Creation

The series of services listed for this type of potential value creation (Tables 2 and 3) include waste assimilation, stream water quality, groundwater maintenance, and mitigation of enrichment. These tend to be of more interest for consumers or the general public in the Great Lakes community than for businesses concerned with the direct commercial consequences noted above. As such, there is often a measurable willingness to pay" (WTP) to reduce the risks to these services,[31] and the WTP values can be useful in estimating value created in the basin by avoiding damages.

Nutrient and Residual Toxics Capture Services: Two examples

The example described in Box 4 illustrates how a series of contingent valuations could be used in a technical assessment of the potential value added in the region through the protection by residential developers of water quality in streams and groundwater. Discussion of the example was limited, but concerns raised included the relative absence of actual WTP valuations for recovery or protection of the varied services. In the absence of such data there were questions as to whether this valuation could be carried out. Some participants pointed out, again, that well-informed results would be available through technical consultations with environmental scientists and economists who have done this kind of work. A test case could be elaborated more fully using "expert" evaluation as an approach.

An alternate approach for assessing value created by managing nutrient and other discharges has been adopted for companies in the forest and paper sector.[22] For this sector one can use information on emissions and discharges provided in the annual reports of the companies. The three levels (two thresholds) for emissions and discharges are shown in Box. 5. While the information provided by the best performers in their annual reports is modest, it sets a tone of transparancy and engagement that builds public confidence. Four comapnies qualified for '+' ratings and five were given '--' ratings, translatable again to letter grades.

Box 4. Nutrient and residuals toxics capture services for water quality, illustrating contingent monetary valuation

A publicly traded residential development company has three 100-acre properties in the headwaters of a Lake Erie side-stream near Cleveland. The lower parts of the stream and adjacent areas along the lake are already developed with a modest commercial area and a local population of 25,000 people. Conventional development of the 300 acres would create a risk of flash floods downstream, and generally degrade surface water quality. Contingent valuation studies show the collective willingness to pay to prevent these risks is $20.00 per adult per year, applicable to an estimated 250,000 people in the surrounding area. The total WTP value, while only an indicator, can be estimated at $5,000,000.

The developer has considered the resistance to conventional development of the three large projects, and has found suitable low impact designs with only slightly greater costs. These designs intercept stormwater runoff on site so as not to increase peak flows significantly or stimulate enrichment of nitrogen and phosphorus in the Lake Erie shoreline. The company and its associated lending institutions conclude that the homes can be sold at a slightly higher price to make up for the cost of the conservation design.

The value estimated to have been created in the basin through the market consequences of this firm s decision to conserve ecosystem services can be represented as the aggregated willingness to pay $5,000,000 annually.

Box 5. Three performance levels applied to emissions and discharge information from 10 companies in the forest and paper sector

Criterion: the Company publicly discloses annual environmental data on emissions and discharges from its U.S. operations.

(+) Company publicly discloses, through annual environmental reporting, data on 10 or more variables for domestic and international operations.

(0) Company publicly discloses, through annual environmental reporting, data on at least four but less than 10 variables for domestic and international operations.

(--) Company publicly discloses, through annual environmental reporting, data on less than four variables for domestic and international operations.

Although some ecosystem services cannot readily be valued through contingent valuation methods, a few participants noted that there may be amenities that people might like to see protected "as an option," far into the future. The method of "real option" analysis[32] has a potential application for computing benefits created by protecting these kinds of services as an option for the future. However, a great deal of research would be required before a value could be estimated for any of these services using the real options approach. Discussion at the workshop indicated the data requirement for applying this approach would not be available anytime soon. A preference was expressed for incorporating this class of interest into one of the others being considered.

Essential Nonmarket Existence Service Value Creation

Third class of interest in ecosystem services involves public goods with almost no documentable market value. Included here are pollination of wildflowers (as opposed to pollination of crops), and species diversity *per se*, both of which are services derived through the biodiversity maintenance function. Other important existence services include nonagricultural soil building and air purification by trees.

WTP contingent valuation methods might be applied to the biodiversity services, but the results appear likely to understate the existence worth that the public associates with these services (dependent as they often are on insects or other non-charismatic life forms).

Although there are relatively few business decisions that directly affect these services in the Great Lakes basin, one activity is very significant, and that is the transport of overseas ballast water up the St. Lawrence Seaway to the interior freshwater ports of the Great Lakes basin. This situation is presented in Box 6 where the value created (by reducing the risk) has been evaluated only qualitatively.

Box 6. Biodiversity maintenance conservation: an essential nonmarket existence service

Two overseas shipping companies serve ports in Eastern Europe and North America, using the St. Lawrence Seaway and the Great Lakes. Details are sparse, but one company has a reputation for discharging its ballast water of European origin in the St. Lawrence River estuary (where fresh water overlies salt water), and taking on fresh water there. This practice is a goal of U.S. and Canadian IJC and shipping authorities to prevent the introduction of exotic species, but regulation is difficult. The second company has a reputation for discharging its ballast water in the Great Lakes headwater ports where it loads cargo. This practice creates opportunities for the introduction of additional exotic species that threaten the native biodiversity and productivity of the Great Lakes ecosystem.

No satisfactory method exists for valuing the tiny, cold-tolerant invertebrate species that make up the essential food web of the Great Lakes, from algal primary production to secondary production of fish and waterfowl. Accordingly, a qualitative rating of AAA can be recommended for the company exchanging ballast water in the St. Lawrence River approach area.

Discussion of this example generally confirmed the importance of a set of existence services, and agreement on the importance of the ballast water problem as a threat to native biological diversity in the Great Lakes. However, the companies involved are mostly small, usually not publicly owned, and fragmented under a variety of small-nation flags. In addition, their crews are generally not familiar with North American host port regulations.

Still, the discussion indicated a need for additional consideration of this and related examples. Participants also observed that for these essential nonmarket existence services, we may find other linkages between the services and the capital markets associated with tourist facility development.

6. Discussion Issues and Next Steps

To explore other issues for broader consideration of the capital markets than just publicly traded equities (implicit in the previous section), the workshops used assigned topics in three breakout sessions. The following ideas were developed in the course of these sessions and the full workshop discussion that followed.

Should there be more research on tools and approaches, or more emphasis on application and testing of current approaches?

Discussion indicated there would be little advantage in pursuing more original research at this time (although diverse opinions were expressed). Instead, one might want to critically evaluate ongoing research by others on the possible linkage between environmental and financial performance. What is needed is informed application of existing approaches and the testing of next-generation tools in the marketplace.

Participants also indicated their preference for a focus on further applications with real examples. These examples might focus on companies affecting natural resource drawdowns or flows of capital out of some capital markets, while considering subsequent changes in company behavior. Water use in the Great Lakes basin would be a good example to expand on.

An additional focus might consider communications issues and whom to communicate with, including those who manage pension funds. Would they invest as we might hope? This work might also map out the network of interactions among fund managers and identify meaningful capital and information flows for each of the examples considered above. One also should look broadly at what is imported, exported and subsidized, within and between regions.

Further effort could be focused on ecosystem-function problem areas and the impediments to solving those problems. Examples include:

- Assessment of the food processing sector, including comparative ratings of apparent value creation (or drawdown) by these firms. They might be rated on pollution control as well as resource use. Poor investments could be identified when a firm's spending on environmental management appears to control the wrong end of the pipe.

- Real-world interventions, such as finding a drip irrigation specialty firm and assessing its performance. One could propose a rating approach that considers capital flow toward new technologies in resource conservation and assess the outcomes financially. Also needed is work on differential methods for debt versus equity capital flows.

- Assessment of the political dimensions of the water pollution control laws, including the public protest about sale of water from the Great Lakes and the role of public education campaigns.

What is gained and what may be lost by going forward with many numerical results on the environmental fundamentals of firms, or by presenting an aggregated result in the form of letter grades (C to AAA) based on valuation criteria for all functions and services?

This discussion explored the mechanisms available to take advantage of what the capital markets do. Options suggested include:

- Develop assessment mechanisms or criteria that include corporate environmental performance linked into management performance. Aspects of investment management, measures of good environmental performance, and steps toward a Great Lakes regional focus should be included, along with new metrics, patterns of mobilization of funds, and the record of disinvestments.

- Develop specialty funds that allow a positive approach. Possible examples include sustainable forestry, green electrical power, and organic farming.

- Consider a “Green Great Lakes Market.” This initiative should include the supply chain (materials sourcing) of large companies and smaller firms, and the adapting of environmental management systems to give “regional signals” to consumers as well as to market analysts.

- Develop criteria that consider ecosystem restoration through conservation farming, new urban design, or zero emission industrial parks.

- Develop approaches that are applicable to small companies as well as large companies.

- Consider how the approach is going to work in the Great Lakes basin region. It will need generalized metrics, with specificity to the region, including firms that are local, national or global, and firms from outside that have impact inside the basin.

- Evaluate consumptive use of water by general methods. These include issues of metrics, data collection, reporting, risk analysis, and the role of corporate feedback loops. Know or at least define, for all approaches, what is to serve as the baseline for healthy ecosystem functioning.

- Be aware of the impact these valuation approaches may have on other socially responsible mutual funds or foundation endowments.

Are other approaches available for generating information on the environmental impact of bank loan portfolios, insurance, or municipal bond rating services that ignore environmental damages from major projects?

The workshop used this topic to consider how other sectors of the capital markets, particularly corporate and municipal bonds and commercial loans and project insurance, could be evaluated in terms of environmental risks or benefits. Several suggestions made before the workshops indicated that bonds issued by companies with publicly traded stock might be given the same rating (by the same criteria) as would be identified by considering the company's management and product life-cycle data, but the discussion showed many more issues must be considered.

Full treatment of the capital markets underlying suburban residential and commercial development, a major agent affecting the Great Lakes ecosystem, requires that we also think about the commercial loans, municipal bonds, and insurance on loans or bonds that make such projects possible. These issues are particularly important in land development, housing, retailing facilities such as shopping malls, and the associated municipal infrastructure. Commercial banks are an important source of such capital, but not the only source, and ordinarily there is no public access to information on their loan portfolios.

Discussion began by asking whether long-term environmental risks are reflected fully in current bond ratings. The workshop agreed the answer, generally, is no. Ratings agencies are predisposed to stay with long-standing risk analysis criteria emphasizing contingent liabilities. These approaches have lagged behind current scientific understanding of new environmental risks, especially on long-term trends and their consequences for the real property value underlying long-term loans or bonds.

One initiative would be to rate the rating agencies in terms of the thoroughness of their consideration of long-term risks to the environment due to the activity being funded by bonds. Some near-term environmental risks are incorporated already, but risks to ecosystem functions or other significant public goods often are not. Insurance companies (underwriting long-term risks and liabilities from projects funded from the sale of bonds) were viewed as likely to have the most appetite for information on the environmental risks of projects they insure. Insurance against damage to unregulated resources, such as groundwater, also is changing rapidly now as the resources are exposed to more risks and are becoming more regulated.

There is also a need to look at the barriers to more widespread use of environmental information and the analysis of long-term projections. Development of EVCI methods should consider the cost of developing the information, building an organization capable of doing it, and being credible in its distribution. The group noted that 15 years ago Morningstar didn't exist, and now its ratings of mutual funds are depended on by hundreds of institutions.

There is a need also to be precise as to what is not being done well at this time. We should not try to quantify the environmental outcomes specifically, but instead map the trends and probabilities of new risks. The problem is one of developing such forward-looking approaches.

An alternative might be to just list the main risks to the environment from development projects and show how firms in the insurance, loan, or bond-rating sectors rank in relation to them. This would let the market decide how this information should relate to the capital flows. One does not have to explain immediately why the issue could be important. Class-action lawsuits in relation to environmental damage from a poorly planned bond or loan-based project are more viable now, and can inform valuation (if not regulation).

Wainwright Bank of Massachusetts is one example of a banking institution adopting such practices. Wainwright has just recently received a 2001 Corporate Conscience award from the Center for Responsibility in Business.[33] for its socially responsible lending. The award recognized a long-standing public record of loans to emerging businesses that contributed to rebuilding the human environment in urban areas.

Another example that illustrates some of these points is the Bank of America's current environmental management program. Their risk management executive reports directly to the bank president. Among the Bank's environmental programs is a "Smart Growth" commitment. Through it the company focuses its lending and investment so as to favor firms that pursue smart growth planning and design. Examples include brownfields redevelopment, inner city housing, and protection of open space, water quality and ecologically valuable land (i.e., biodiversity considerations) in the suburbs. In 1999, the Bank funded 52 smart growth transactions and they believe this area has significant growth potential.[34] Interestingly, these factors may well be associated with the Bank's very favorable recent one-year total return in comparison to three national competitors.

7. Conclusions

The two workshops focused on how to use elements of ecosystem function and services in the Great Lakes basin to inform investment. They have provided a framework for examining this proposition: *That the environmental performance and products of companies can be assessed for the purposes of investment in relation to their potential to create value in the regional environment, locally or at a large scale*.

Several approaches for estimating the benefits to public goods such as air, water and biodiversity were explored and general findings agreed on. Suggestions for next steps included demonstrating the feasibility of the approach. As a result, work is underway now in which up to 10 criteria (differing slightly depending on commercial sector) are being used to test a benefits ratings approach. Sectors being evaluated include electric utilities, forest and paper, food processing, banking and insurance.

An investment strategy based on environmental (or ecosystem) value creation through investment (EVCI) appears to be feasible and competitive now. The strategy will be facilitated by increased adoption of public reporting of environmental management and product life-cycle outcomes by business, thereby allowing analysts and the public to be more fully informed and to favor investment in high performance companies doing business in the Great Lakes basin.

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Appendix A

Great Lakes Ecosystem Function Information Sources

Following up on Table 1, the first workshop considered brief summaries of information needs for each of the major Great Lakes ecosystem functions. The following paragraphs outline how business decisions and new products might create value among these functions and services. Also important are the nature of the risks involved for each function and the prospects for information on the degree of alteration (and potential for recovery) of the 10 functions in relation to community goals or historical reference conditions.

1. *Hydrologic functioning* (yielding water supply, recreation, electricity generation and transportation services)

   Data on Great Lakes basin precipitation, stream flows, evaporation and lake levels are available from many sources, including the National Oceanic and Atmospheric Administration, the U.S. Army Corps of Engineers, and several IJC reports. Studies of the effects of expanding irrigation and consumptive water use have explored the cumulative effect of increased water withdrawals (often summarized as “diversions”) as they affect services such as hydropower and shipping.[1,2]

Very recently, grants from the Great Lakes Protection Fund have been made to document further the magnitude of these water withdrawals, and to consider their significance in relation to the risk of low water supply due to expanded consumptive use and long-term changes in climate.

2. *Primary production and biomass accumulation* (yielding agricultural products, timber supply and carbon storage services)

   Net primary production (NPP) by plants is the foundation for most biological components of ecosystem functioning. In forests, NPP data document growth and sustainable harvests as well as the potential for long-term carbon sequestration. In lakes, however, high NPP levels can be a nuisance, attributable to increased nutrient concentrations or to dysfunctional food-web structure.[3,4] When excessive algal growth continues through the growing season, the accumulated biomass (and odors during its decomposition) represents a failure of ecosystem function that then defines an impairment of use and a goal for recovery. Firms whose production processes affect NPP of streams or lakes (e.g., the food canning industry) should be asking whether alternative production processes are available that could provide improved performance for this ecosystem function.

3. *Animal populations and secondary production* (yielding fish, wild game, songbirds and other wildlife)

Native fish populations, including trout, have been drawn down extensively by many mechanisms, but some species (including salmonid introductions) are doing well even as damaging exotic species are spreading into the Great Lakes. Important data here include those relating to historical sport and commercial fish harvests the effects of exotic species, and concerns for other wildlife dependent on fish or the aquatic food chain in the Great Lakes basin.[5] The World Resources Institute[6] shows this function to be both improving and deteriorating in freshwater ecosystems world wide, an outcome that is also reported by the State of the Lakes reports.[7]

4. *Biological diversity maintenance and species invasions* (yielding species diversity, pollination, aesthetics, and biological productivity or its impairment)

A comprehensive report on prospects for biodiversity maintenance has been prepared by the Great Lakes Program of The Nature Conservancy.[8] The report found unique biological diversity and conservation opportunities throughout the land and water environments of the Great Lakes basin. Habitat destruction through suburban, lakeside or streamside sprawl (land development) has been identified by state agencies as well as TNC as a major threat.[8,9]

Such development is facilitated through the capital markets, especially lending institutions. Incentives may be found within the capital markets, broadly defined, for subtle amelioration of the habitat destruction, erosion and lake enrichment that comes from relatively unrestricted sprawl.

5. *Decomposition processes* (yielding soil renewal and the benthic food chain)

A major part of the functioning of ecosystems involves the decay or “reduction” during subsequent years of much of each growing season’s primary productivity. The resulting fine organic matter and elemental nutrient release derives from a series of processes collectively know as decomposition, resulting in soil building and benthic habitat development. Without these processes (which are facilitated by a wide range of biota), ecosystems can be starved of essential nutrients and even of productivity. Except in deep waters characterized by occasional anoxia, and at industrial brownfield sites, impairment of the decomposition function is not widespread.

6. *Soil and sediment building/carbon sequestration* (yielding the natural storages of carbon, nutrients, and soil moisture)

Much of soil fertility arises from an accumulation of carbon and nutrients that makes up the capital stock we know as soil and organic matter. The multi-decadal accumulation of organic matter (mostly carbon) in soil and lake sediment is a natural outcome of these processes. At a regional scale they represent a significant opportunity for enhancing carbon storage to reduce greenhouse gas accumulation in the atmosphere. Under some types of intensive cultivation (e.g., soy beans), soil carbon is lost to the atmosphere, although stream and lake sedimentation rates may be increased. On the other hand, other crops such as corn and certain timber species can be managed so as to achieve sequestration of carbon in soil.

7. *Nutrient and residuals capture and cycling* (yielding waste assimilation, mitigation of enrichment and groundwater quality services)

Nutrient assimilation and cycling, as an ecosystem function, is comprised of interactions between atmospheric depositions, biological processes, and water percolation through the soil and mineral exchange sites. The processes making up cycling have been altered in varying degrees by forest clearing and intensive agriculture. In addition, emissions of toxic pollutants and acid gases have led to mercury and acid ion deposition over much of the Great Lakes basin. Some hundreds of articles are available. For the purpose of rating corporate performance, one should be concerned with steps being taken to manage the major causes of change in nutrient inputs to (or from) the land and its aquatic environments, the determinants of urban stormwater loadings, industrial emissions and discharges, and the gaseous emissions of sulfur and nitrogen.

8. *Insect and disease regulation* (yielding pest control and biodiversity maintenance services)

In healthy, fully functioning ecosystems, natural products of plant and animal metabolism aid greatly in controlling the risk of damages from herbivorous insect populations and diseases. Plants and animals under stress from gaseous pollutants or toxic stressors in aquatic systems experience an altering of their defenses against insects and diseases (even as some species may be strengthened by added nutrients). Several mechanisms increase the prospect for insect and disease outbreaks and impairment of primary and secondary production.

Corrective measures have been successful aroundlarge industrial and smelter sites in the past, suggesting that related environmental management measures could create value by restoring more natural insect and disease regulation function at a future time.

9. *Vegetation succession and disturbances* (yielding habitat diversity, seed bank diversity and aesthetic services)

Natural change in vegetation on land and along the water's edge, commonly viewed as succession, is a nearly universal aspect of aesthetics in the Great Lakes basin. For such a function to be expressed, however, wildfires and
windstorms once provided initial conditions for succession. Some such events remain, but in a very different proportion, and human land-clearing and farmland abandonment are now the dominant agents. The results are evident from successive satellite observations and land use maps. There is only a small likelihood that businesses could contribute to restoration of this function in the Great Lakes basin.

10. *Air and climate self-regulation* (yielding air purification, moderation of weather extremes, visibility and human health.

The major constituents of the earth's atmosphere often are thought of as being in a gas exchange balance controlled by the photosynthesis of plants and the respiration of animals and microbes, both on land and in the water.

Anthropogenic components such as ground-level ozone, particulates originating from emissions of nitrogen and sulfur oxides, vehicle emissions, chlorofluorocarbons and greenhouse gases such as carbon dioxide ($C0_2$) and nitrogen oxides are now important constituents in the lower atmosphere, each one subtly altering solar radiation inputs, the water balance, climate, and biological processes. Ecosystems depend on vegetation to remove many of these constituents.

The capacity of vegetation to renew air quality can be exceeded in metropolitan areas, however, overwhelming this component of regional ecosystem functioning locally, at least.

Several studies of the potential for fossil-based energy industries and electric utilities to pursue carbon sequestration in forests are appearing now and some projects are being undertaken in the Great Lakes basin.[10] Specific calculations could be made of the CO_2 removal and storage planned by various industries in the region, providing a basis for quantifying the extent to which this function could be used to ameliorate greenhouse gas emissions (and reduce the risks from climate change), thereby creating value in the region.

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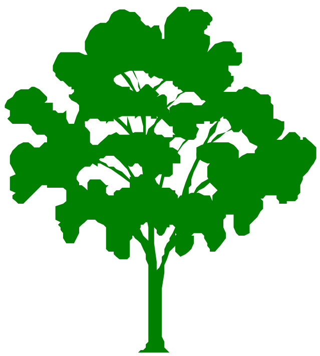

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