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EXECUTIVE SUMMARY

Development of Great Lakes ecosystem and fisheries education literacy goals; *i.e., What should people know about the Great Lakes its fisheries?*

We developed a set of Great Lakes Fishery Trust (GLFT) validated literacy goals consisting of 11 issues and 143 related concepts (pp. 13-22). These issues and concepts relate to Great Lakes fisheries habitat, pollution, non-native nuisance species, ecosystem, biodiversity, building fisheries, treaty rights, managing fisheries, stewardship, fishing, and careers. The literacy goals guided our literature review of opinion surveys and our examination of education efforts.

Literature review of opinion surveys relevant to Great Lakes fisheries; *i.e., What do people believe about the Great Lakes and its fisheries?*

By searching a variety of databases, we identified over 70 studies of surveys of individuals' cognitive, affective and behavioral status with implications for the Great Lakes fisheries. To the best of our knowledge, no single comprehensive opinion survey has focused on the Great Lakes or its fisheries. Instead, surveys have collected data on a variety of topics with a diversity of respondents. Many opinion surveys have been conducted, however, of anglers on fish consumption advisories. Overall, opinion surveys suggest (see pp. 50-53 for details):

- Great Lakes residents are concerned about the Great Lakes but know relatively little about them;
- Great Lakes residents are willing to pay for addressing a variety of Great Lakes issues;
- consumers of Great Lakes fish vary in their awareness of fish consumption advisories (FCA) and in their knowledge of the FCA recommendations (with those most at risk being least knowledgeable); consumers who are aware and knowledgeable about the FCA may not follow them or follow them to a limited extent;
- anglers have a range of barriers that prevent them from fishing on the Great Lakes, they have strong opinions on a variety of fishing regulations, and they tend to know more about the Great Lakes than other residents;
- fisheries managers have a variety of values and priorities that drive their management decisions, some of which are in conflict with anglers and others;
- adults obtain information about the Great Lakes mainly from mass media sources, students from teachers, and teachers from in-service workshops;
- Great Lakes education efforts are able to change individuals' knowledge, attitudes, and behaviors;
- both classroom experiences and vessel-based education foster gains in students' Great Lakes knowledge and process skills;
- teachers have different levels of knowledge about the Great Lakes and preferences for teaching about certain Great Lakes issues.

It is important to know that the majority of opinion surveys focus on assessing cognitive aspects versus affective, skill, or other aspects that are important in promoting environmental behavior/public involvement.

Review of leading K-12 Great Lakes fisheries education materials;
i.e., What resources and opportunities are available for reaching the Great Lakes fisheries education literacy goals?
We reviewed 30 of the leading K-12 Great Lakes ecosystem and fisheries education materials in terms of their content and education (i.e., pedagogy) approach (see Table 3.1, p. 58). The majority of materials claimed that they could be used across K-12 but we feel that most of these would be difficult to adjust to K-3 and grades 9-12.

In terms of content, Great Lakes pollution (Issue 2) and non-native nuisance species (Issue 3) are topics that are well covered by many of the materials. Great Lakes fisheries habitat (Issue 1), ecosystems (Issue 4), building fisheries (Issue 6), and stewardship (Issue 9) receive less but adequate coverage by many of the materials. The management of Great Lakes fisheries (Issue 8) tends to be well covered when it is addressed but this topic is not addressed very often. In contrast, many materials touch on Great Lakes biodiversity (Issue 5) but they generally do not provide much depth on this issue. Lastly, treaty rights (Issue 7), fishing (Issue 10), and careers (Issue 11) receive limited coverage, both in terms of depth and number of materials that address these topics. [Note that many resources are available for fishing education (Crook & Zint 1998, Zint & Crook 1998) and that the GLFT funded *Project FISH* also focuses on fishing education.]

In terms of materials*, The Life of the Lakes* and *Fish Ways* provide the highest coverage of Issue 1 (Habitat). Each includes activities that focus on the importance of maintaining and reestablishing fisheries habitats. Issue 2 (Pollution) was best covered by *Great Lakes Environmental Issues* which devotes one-third of its activities to toxins in the Great Lakes and their effects on aquatic life and humans. *Alien Invaders* offers the best coverage of Issue 3 (Exotic Species). As suggested by its name, the focus of this entire material is on non-indigenous nuisance species, and it emphasizes the importance of preventing introductions. *The Life of the Lakes* has the highest coverage of Issue 4 (Ecosystem). It contains several activities that emphasize ecosystem interactions within the Great Lakes, and how these interactions affect fisheries. Issue 5 (Biodiversity) is best addressed by *The Life of the Lakes* and *Great Lakes Explorer.* These materials include activities that explicitly examine Great Lakes fish biodiversity. Issues 6 (Build Fisheries), 7 (Treaty Rights), and 8 (Manage Fisheries) are best covered by *The Life of the Lakes* which includes activities that focus on sport, commercial, and tribal fisheries. *Fish Ways* has the highest coverage of Issues 9 (Stewardship) and 10 (Fishing) and has interesting activities related to fishing ethics. Only two materials, *The Life of the Lakes* and *Earth Generation,* have coverage of Issue 11 (Careers), with the former having greater coverage. Overall, *The Life of the Lakes* had the best or good coverage of most of the issues relatively to all other materials. *Fish Ways* also covered many issues well.

In terms of pedagogy, the materials scored moderately well across the six characteristics recommended by NAAEE's (1996) *Guidelines for Excellence*. The materials tend to be

weakest in terms of their action orientation and strongest in terms of their depth. Of the 30 materials, *Great Lakes Environmental Issues* scored highest across the six characteristics. Other materials that have many of the recommended qualities included *Fish Ways* (for fairness/accuracy), *Great Lakes Solution Seekers* (for depth), *Alien Invaders* (for emphasis in skills building), *Great Lakes Education Program* (for action orientation), *Alien Invaders, Fish Ways, Great Lakes Education Program, The Life of the Lakes,* and *Zebra Mussel Mania* (for instructional soundness), and *Great Lakes Education Program* (for usability). In terms of additional action criteria that we decided to explore, we found that the *Great Lakes Education Program, Great Lakes Environmental Education Project* and *The Lake Superior Game* stand out because of the many and specific types of actions they describe.

Note that select results of our review of leading education materials are accessible to the public via a web page that we created (currently www.umich.edu/~wongjk/enc - to be moved to www.glft.org shortly)

Examination of other Great Lakes fisheries education efforts

To learn about Great Lakes fishery education efforts in addition to the leading K-12 education materials, we consulted with the education representatives of the organizations on the Great Lakes Fishery Trust and members of the Michigan Alliance for Environmental & Outdoor Education. Individuals from both groups corroborated our list of leading K-12 Great Lakes fisheries education materials and other relevant efforts (e.g. GLIN, Great Lakes Radio and Television Consortia - refer to our web site under Links). We also learned that many of these individuals are aware of GLFT's *Project F.I.S.H* as a relevant education resource.

Importantly, the individuals we consulted agreed on many needs/gaps, including the need to identify and raise awareness of existing Great Lakes fisheries education efforts, to support quality existing (based on evaluation) versus developing new efforts, and to require best practices of education efforts (e.g. evaluation, correlation with education standards, adaptation to local communities, etc.). Education representatives of the organizations on the Great Lakes Fishery Trust also recognized the need for greater collaboration with the tribes on education efforts.

Review of education projects funded by Great Lakes Fishery Trust

In addition to this needs assessment, the GLFT has funded three education efforts so far: *Fish for All*, *Project F.I.S.H*, and *Great Lakes Ecological Information System,* a fish hatcheries interpretation project. *Fish for All* and the fish hatcheries interpretation project are interpretation efforts, and *Project F.I.S.H* is a hands-on education effort. Each of these projects has the potential to fill gaps we identified as part of our content review: *Fish for All* with its focus on Great Lakes fisheries stakeholders/conflicts, *Project F.I.S.H* with its focus on Michigan fishing education, and the hatcheries project because it has the potential to address issues related to stocking. Each of the three efforts has the potential to raise individuals' awareness of Great Lakes fisheries issues, assuming *Project F.I.S.H* and the hatchery interpretation project use a sufficient type and number of Great Lakes examples. If the GLFT wants to promote stewardship, however, it will need to provide

support to enhance these projects so that they address personal relevance, motivations, barriers to action, etc. and provide opportunities to learn and practice relevant skills. Awareness/knowledge is insufficient to promote stewardship behavior. For more details on our assessment and recommendations for these three projects, please refer to pp. 104-109.

Potential funding partners
Through database and Internet searches and based on input from individuals with knowledge of Great Lakes and fisheries education funding sources, we identified a variety of potential funding partners including government, foundation, corporate, and other sources (see pp. 110-114 and our web site under Links). These sources include Michigan Sea Grant and other Great Lakes Sea Grant programs, Great Lakes Protection Fund, individual Lake Protection Funds, U.S. Environmental Protection Agency - Great Lakes Program Office, National Fish & Wildlife Foundation, Michigan Department of Natural Resources (especially through Sport Fish Restoration funds), Charles Stewart Mott Foundation, Recreational Boating and Fishing Foundation, and organizations in the fishing, boating, and recreation industries. There are also organizations that may not be able to provide funding, but could offer other valuable resources. The Future Fisherman Foundation, for example, can assist in helping to set up fishing tackle loaner programs, and local chapters of organizations such as Trout Unlimited may have volunteers to assist with education efforts.

Manuscript based on this project
We are currently working on a manuscript that summarizes the findings of this project and offers recommendations for Great Lakes fisheries education. We will submit this manuscript to the GLFT upon completion.

RECOMMENDATIONS TO GLFT FOR FUNDING EDUCATION EFFORTS
Michigan and the Great Lakes region do not have a leader in Great Lakes fisheries education (in formal, non-formal or in-formal settings). The lack of public knowledge and action on behalf of the Great Lakes and its fisheries, in addition to Michigan's and the region's limited, fragmented education efforts, support the need for such leadership. We recommend that the GLFT play a leadership role in the following (prioritized ways):

Promote awareness and access to existing Great Lakes fisheries education efforts by funding networking opportunities.
Many education resources exist but individuals are not necessarily aware of them or are not able to make use of them (for reasons including but not limited to financial constraints). The problem is not as much a lack of education resources but lack of knowledge of, and access to, quality resources. By supporting networking opportunities, individuals will learn about existing resources, and this will also increase the likelihood that limited funds are allocated to appropriate efforts.

- Fund an annual conference on Great Lakes ecosystem and fisheries education (to promote learning about existing efforts, facilitate opportunities to collaborate, improve coordination, etc.). Such a conference could be held in conjunction with

relevant professional association conferences (e.g. Michigan Alliance for Environmental and Outdoor Education conference, National Marine Educators Association's Great Lakes Educators of Aquatic and Marine Science (GLEAMS) chapter, state and National Science Teacher Association conferences, etc.). The conference might alternate between concurrent meetings with educators in one year and with scientists (e.g. IAGLR) in alternate years, so both groups would learn from each other.

- One theme that the conference should focus on is how to promote environmentally responsible behavior (and reduce barriers to behavior) through education. The conference should invite national speakers with expertise on behavior change and on education interventions. A variety of participants should be encouraged to attend including educators, journalists, policy makers, scientists, students, and leaders working for government, NGOs, and industry.

- Fund meetings/workshops (possibly in conjunction with the above mentioned conference) for organizations interested in funding Great Lakes (fisheries) education efforts to devise a joint funding strategy and/or opportunities for collaboration (e.g., conference mentioned above, joint research efforts such as a regional opinion survey).

- Support the public web page created as part of this project so that it can serve as a central location for learning about Great Lakes fisheries education efforts. Funding will be needed for periodic updates and also to continue to create links to relevant sites and search engines.

Promote excellence in Great Lakes fisheries education by funding relevant <u>education</u> research:

Many resources have been, and continue to be, allocated to the development of education efforts but relatively few resources have been or are currently available for research that can improve education efforts.

- Contribute to funding (in collaboration with other funding partners) a regional survey (every five years) to assess various publics' (e.g. anglers, fishery managers, K-12 students and teachers, journalists, policy-makers, residents) beliefs, self-efficacy, barriers to behavior, sources of information, etc. related to the Great Lakes (fisheries). Such an effort should involve a consortium of leading Great Lakes education researchers and organizations. The literature review conducted as part of this project should be consulted to inform such an opinion survey.

- Fund outcome evaluations of existing Great Lakes fisheries education efforts. Many materials and programs are available, but with a few exceptions, they have not been evaluated in terms of their impact on participants. Outcome evaluations should determine to what extent education efforts have increased audiences' knowledge, skills, self-efficacy, motivations, behaviors, etc. and reduced barriers to behaviors. They should explore to what extent these impacts are long lasting.

This research should lead to recommendations for improving existing efforts, and the results should be widely disseminated.

- Fund research that leads to a better understanding of what it takes to get different groups involved in the protection of Great Lakes fisheries resources. Evaluations can contribute to this, but so can other studies. These types of studies should not be limited to cognitive (beliefs, knowledge) aspects because these may not be sufficient for behavior change. Aspects that should also be explored include affective dimensions, decision making, motivations, skills, barriers to behavior, and others.

- We do NOT recommend funding research related to fish consumption advisories. There has been much research on this topic and there are many funding sources that have, and potentially will, support such research.

Enhance and expand Great Lakes fisheries education by sustaining existing quality (based on evaluation results) education efforts and supporting efforts to fill gaps. Many resources have been developed but some are in need of revisions to make them more up to date, additions to make them more complete, or improvements to enhance their value to educators. In addition, efforts to disseminate and promote the use of existing resources have not been adequate. Funding sources have typically supported the development of resources but not the adequate dissemination and promotion of these resources. NOTE that we recommend that the GLFT only fund efforts to support education efforts that explicitly focus on Great Lakes fish, fisheries, and fisheries management and address aspects of the literacy goals for which we have identified gaps.

- Fund revisions and other improvements to current education efforts or efforts to fill gaps. In supporting revisions, additions, and other efforts particular attention should be paid to the following content areas for which we identified gaps in coverage (see pp. 80-82 for details): fisheries and biodiversity, fisheries and critical habitats, ecosystem (including fisheries) management, treaty fishing rights, fisheries and sustainability. Case studies on these topics may be particularly helpful, especially if they can highlight successes (possibly related to lake trout and lake sturgeon) and give examples of how the actions of a variety of individuals/organizations have contributed to these successes (based on recommendation further below). Given increasing access to the Internet, education efforts should make use of this medium, particularly as a means to access current databases. In terms of education, efforts should follow NAAEE's (1996) guidelines and other relevant best practices (e.g., those currently under development by the Recreational Boating and Fishing Foundation). Based on the results of our review (see pp. 95-97 for details on recommendations), future education efforts should pay particular attention to promoting student action in relevant ways (e.g., providing examples of successful actions taken to address environmental issues that are raised, facilitating the examination of issues in ways so that individuals can form their own opinions on needed actions, and providing opportunities for individuals to obtain the knowledge, skills, and confidence to make decisions, and motivation to act).

- Fund the dissemination of resources through various means (e.g., professional development programs, workshops, conferences, etc.) for various audiences (e.g. teachers, non-formal educators, interested scientists, etc.). Rather than funding the dissemination of any single resource, we recommend that efforts focus on distributing all of the quality resources that exist, possibly choosing among resources depending on audiences' interest. If the target audience is youth, efforts should not only focus on encouraging environmentally responsible behavior but should attempt to enhance student performance/interest in achievement/learning.

- Fund education efforts involving and assisting tribes. The lack of opinion surveys related to Native Americans/First Nations and Great Lakes (fisheries), the lack of content on treaty issues in K-12 materials, the lack of Native Americans in resource/environment departments at universities/agencies/NGOs, and the needs of tribes expressed as part of this project all provide evidence for unique needs in this area.

    - Fund collaborative efforts between the three projects funded by the GLFT to date. For example, *Fish for All* could provide information to supplement *Project F.I.S.H.* and the fish hatchery interpretation project by providing relevant cultural, historical, and tribal information. To promote fishing education, *Project F.I.S.H.* programs could be conducted in conjunction with future exhibits of *Fish for All* and at fish hatchery interpretation sites. To promote stewardship behavior, the GLFT could support conservation demonstration projects - *Fish for All* could provide advice on stakeholder groups to involve, *Project F.I.S.H.* could train individuals from these groups in mentoring, and encourage participants in its programs to follow-up by taking part in such projects, and fish hatchery interpretation sites can provide the project settings.

    - Many quality education efforts exist and these should be supported by the GLFT, if necessary by funding revisions/additions/improvements and importantly, their subsequent dissemination. In terms of new materials, resources targeted at K-3 and grades 9-12 are needed.

Fund internships/fellowships (so that low-income and particularly, minority and Native American students can afford to accept them). Interns should be placed to assist the tribes with their education efforts, tribal and minority interns should be placed within DNR, NGOs, and universities to promote diversity within these organizations. These individuals could be engaged in all types of research and efforts but we recommend that they be engaged in education research and efforts.

Fund an endowed chair for partial-year support of Great Lakes education research, to be filled by individuals known for such efforts and willing to work with an intern/fellow to not only conduct needed research but teach how educational research serves ecosystem education.

Fund a consortium of universities and organizations with leaders in Great Lakes ecosystem and fisheries education to coordinate the accomplishment of the above recommendations.

GUIDELINES FOR EVALUATING FUTURE EDUCATION PROJECTS

The greatest single gap in Great Lakes education is evaluation – of what is, what is needed, who needs it, and what it does in short and long terms. So that the GLFT becomes known for commitment to quality, these are recommended actions:

- Establish an Education Advisory Group in addition to the Science Advisory Board that can advise the GLFT Trustees on future education proposals. Members of the Education Advisory Group should have experience in aquatic, fisheries, environmental and general education in formal, non-formal, and informal settings (we can suggest names for consideration).

- Require that any GLFT funded education efforts explicitly focus on knowledge and other characteristics that promote actions related to the Great Lakes fisheries literacy goals. Avoid duplication of effort by funding only those programs that focus on the gaps identified by our review: fisheries and biodiversity, fisheries and critical habitats, ecosystem (including fisheries) management, treaty fishing rights, and fisheries and sustainability (see pp. 80-82 for details).

- Require "best practices" of GLFT funded education efforts by assuring that they illustrate how they meet NAAEE's (1996) *Guidelines for Excellence* (www.naaee.org/npeee/) and as relevant, the guidelines by the Recreational Boating and Fishing Foundation currently under development (Fedler & Matthews 2001) and others. Specifically:

    - require that proposals demonstrate how they build and improve on the best resources/efforts currently available;

    - require that proposals demonstrate how their messages and channels are appropriate given their target audiences' needs;

    - require that education projects targeting youth or teachers demonstrate how they contribute to Michigan's education reform efforts, even if the proposed efforts are in non-formal education settings (at minimum, correlations with education standards should be provided);

    - require that whenever possible/appropriate, education efforts include outdoor activities because they may be more likely to motivate individuals to care, want to learn more, and do more to protect the environment;

    - require that proposals have an integrated plan to evaluate their education efforts [e.g., the evaluation should focus on outcomes (and environmental impacts) and

not just number of participants; the evaluation should be clearly linked to the proposals' goals, at least 10% of the direct costs of the budget should be allocated to the evaluation.]

- ♦ require that those submitting proposals have multiple partners. Not just in terms of funding but also partners with relevant expertise. For example, if the project is to serve teachers, a potential partner could be a Michigan teachers' association.

- ♦ For additional potential requirements, refer to www.eelink.net/grants-generalinformation.html that provides links to RFPs by some leading sources of environmental education funding.

- The GLFT should consider requiring its projects to have an education component (where appropriate) and not just fund education projects separately.

Objective 1: Development of Great Lakes Ecosystem and Fisheries Education Literacy Goals (i.e., *What should people know about the Great Lakes ecosystem and its fisheries?*)

Introduction

Our first objective was to develop a list of Great Lakes ecosystem and fisheries education literacy goals. We needed such a list of literacy goals to accomplish Objective 2, a review of surveys of public understanding of Great Lakes and Great Lakes fisheries issues, and for Objective 3, a review Great Lakes ecosystem and fisheries education materials. The list of literacy goals determined what knowledge, attitude, etc. and content we looked for in surveys and education materials and thus, provided an organizing framework to identify gaps that GLFT funded education efforts should address.

Methods

To develop the list of Great Lakes ecosystem and fisheries education literacy goals, we followed the process used by Zint and her colleagues of the American Fisheries Society's Youth Education Committee who identified this international professional Society's fisheries education literacy goals (Zint and Crook 1998). Our goal was to adapt and expand upon the national fisheries education literacy goals to fit the GLFT context by adding issues and concepts pertinent to Great Lakes fisheries and the GLFT's member organizations.

We began by gathering relevant Great Lakes and fisheries strategic documents, paying particular attention to identify strategic documents relevant to GLFT priorities (as stated in the GLFT's strategic plans) and GLFT member organization's documents. We then supplemented our identified list of strategic documents with resources suggested by Great Lakes Fishery Trustees and Scientific Advisory Team members. Table 1-1 contains the main strategic documents and materials we consulted in developing the draft literacy goals.

Table 1-1 Main strategic documents and materials used to guide development of the draft Great Lakes ecosystem and fisheries education literacy goals.

AP Wire Service. 2000. Parties in tribal-fishing dispute reach agreement. July 13, 2000. 1 p.

AP Wire Service. 2000. Update on tribal fishing negotiations expected Wednesday. July 4, 2000. 2 p.

Chippewa Ottawa Treaty Fishery Management Authority. 1999. Michigan's 1836 Treaty fishery guide. Public Information and Education Committee. 39 p.

Crook, A. and M. Zint. 1998. Guide to fisheries education resources for grades K-12. American Fisheries Society, Bethesda, MD. 51 p.

Great Lakes Fisheries Commission. 1999. Lake Superior fish community objectives. 4 p.

Great Lakes Fisheries Commission. 1995. Fish-community objectives for Lake Michigan. Special Publication 95-3. 56 p.

Great Lakes Fisheries Commission. 1992. Strategic vision of the Great Lakes Fishery

Commission for the Decade of the 1990's.
Great Lakes Fishery Trust. 2000. Strategic plan 2000 update. 12 p.
Great Lakes Fishery Trust. 1999. Summary of results, GLFT trustee and SAT survey. 10 p.
Jester, D.B. 1996. Considerations for the Great Lakes Fishery Trust program strategy. Interoffice communication, MDNR. 12 p.
Michigan Agricultural Experiment Station, MSU. 1995. Fisheries. Status and potential of Michigan natural resources. Special Report 74. 40 p.
Michigan Department of Environmental Quality. 2000. Great Lakes trends: into the new millennium. 41 p.
Michigan Department of Environmental Quality. 1996. Nonindigenous aquatic nuisance species, state management plan. 42 p.
Michigan Department of Natural Resources, Fisheries Division. 2000 and 1997. Strategic plan (drafts). 128 p.
Michigan Sea Grant. 2000. Strategic plan draft: 2000-2005. 22 p.
Michigan United Conservation Clubs. 1999. Annual Report. 28 p.
Michigan United Conservation Clubs. 1999. 1999 Michigan environmental quality report.
National Wildlife Federation. No date. Who we are. 6 p.
U.S. EPA. 2000. Lake Michigan lakewide management plan. Preface. 17 p.
U.S. FWS. 2000. Great Lakes Basin ecosystem biennial work plan & regional highlights. 14 p.
Zint, M. and R. Fortner. 1999. GLFT meeting minutes, 5/2/99. 3 p.

Next, we validated the draft Great Lakes ecosystem and fisheries education literacy goals by disseminating them for review to the Great Lakes Fishery Trustees and Scientific Advisory Team members. Based on feedback we received through meeting and email discussions, a number of relatively minor additions and changes were made to the draft literacy goals (Table 1-2). A few additional changes, also reflected in Table 1-2, were made as a result of reviewing education materials and identifying gaps in the literacy goals.

Table 1-2 Changes (*in italics*) to the draft Great Lakes ecosystem and fisheries education goals based mainly on feedback by the Great Lakes Fishery Trustees and Scientific Advisory Team members.

1.7 Wetlands in particular often feel the brunt of increased land- *or water*-use pressures; more than two-thirds of the natural Great Lakes wetlands have already been filled in or drained; invasive species also contribute to wetland loss.
1.10 The withdrawal and discharge of water can directly affect fish through *entrainment or* impingement on screens and fish distribution, respectively.
2.6 The movement of ground water is a major pathway for pollution to reach the Great Lakes.
2.9 Contaminants and their bioaccumulative risks to both species and human health threaten sustainable fisheries, and must be minimised.

2.14 The populations most at risk from exposure *to mercury and other toxins* through the consumption of contaminated fish are nursing mothers, pregnant women, women who intend to have children and children under age 15, and people who often consume fish, which may include Native American subsistence anglers, low-income or minority anglers, and sport anglers.

2.20 The U.S. and Canada have had a number of treaties and agreements to protect the Great Lakes from pollution, including the Great Lakes Water Quality Agreement of 1972, which set up the International Joint Commission (IJC).

2.21 The IJC is responsible for reducing pollution in the Great Lakes. It has identified 42 Areas of Concern (AOC's) in the Basin where environmental quality standards have not been achieved. Each has a local Remedial Action Plan (RAP) designed to meet those standards. Citizens are directly involved in planning the cleanup of these targeted areas.

3.3 Introductions can severely impact the sustainability of native fisheries and ecosystems through *direct competition, predation,* habitat alteration, trophic alteration, spatial alteration, gene pool deterioration and disease introduction.

4.13 Ecosystem status can (and should) be monitored through indices of health – *indicator species,* community structure, nutrient levels and flow rates.

6.2 Fisheries are dynamic and can fluctuate widely over time *and space*, as a result of both natural and human impacts.

Results

The final Great Lakes Ecosystem and Fisheries Education Literacy Goals (Table 1-3) contain 11 issues and 143 related concepts. Note that the goals are issue-based. This is because environmental education builds understanding through the examination of environmental issues and promotes taking action based on such understanding (Stapp 1969, USEPA 2001).

Table 1-3 Great Lakes Ecosystem and Fisheries Education Literacy Goals.

Issue 1: Maintain and recover fisheries habitat

CURRENT OR POTENTIAL GREAT LAKES STATUS AND VALUE:

1.1 Habitat forms a key element of sustainable fisheries.

1.2 Aquatic habitats that support, or could support, sport, subsistence and/or commercial fisheries include: streams, rivers, lakes, coastal waters and open Great Lakes waters.

1.3 Particular aquatic or semi-aquatic ecosystems provide critical habitat for some species, and include: inland wetlands, floodplain/riparian zones, tributary streams, and coastal wetlands. Loss of these habitats significantly reduces the potential of fisheries dependent on them.

1.4 Great Lakes coastal wetlands are unique in providing hydrological and habitat benefits that are critically important to sustaining ecosystems and human communities.

1.5 Aquatic habitat is dependent on natural flux of water levels and flows.

CURRENT OR POTENTIAL IMPACTS:

1.6 Many critical (e.g. spawning) habitats have been, and are, under significant pressure from historic and current development. A significant number have been damaged or lost.

1.7 Wetlands in particular often feel the brunt of increased land- or water-use pressures; more than two-thirds of the natural Great Lakes wetlands have already been filled in or drained; invasive species also contribute to wetland loss.

1.8 Fragmentation of wetlands can significantly degrade the productive capacity of the Great Lakes; the remaining wetlands must remain above a critical minimum size to function properly.

1.9 Hydropower facilities and dams are situated on many important rivers in the Great Lakes watershed, and have profound influence on their fisheries.

1.10 The withdrawal and discharge of water can directly affect fish through entrainment or impingement on screens and fish distribution, respectively.

1.11 Water diversions, withdrawals, and excessive discharge (volumes), could affect fish habitat, and need to be carefully controlled.

1.12 Disrupting the natural flow in a stream by pumping or removing groundwater, creating impervious surfaces and accelerating runoff, or physically modifying a stream cannel or a stream bank can seriously disrupt aquatic habitat.

CURRENT OR POTENTIAL MANAGEMENT ACTIONS OR RESULTS:

1.13 Habitat protection, mitigation and enhancement are primary fisheries management activities.

1.14 Sustainability will require an integrated ecosystem approach to fishery-habitat management, including research, education, regulation, restoration and best land use practices. This approach must be applied to the Great Lakes themselves as well as tributary systems.

1.15 Critical habitats can be, and in some cases are being, protected and maintained; damaged habitats can be, and in some cases are being, rehabilitated.

1.16 Wetland restoration should be done in a way that contributes to fisheries values.
1.17 Some former fisheries can be, and in some cases are being, re-established through the reintroduction of native species into rehabilitated habitat (e.g. lake trout, lake sturgeon).

Issue 2: Identify and reduce sources of pollution affecting fisheries habitat.

CURRENT OR POTENTIAL GREAT LAKES IMPACTS:

2.1 One specific cause of fisheries habitat degradation is pollutants which can affect both water and substrate quality.
2.2 Scientists have identified 362 contaminants in the Great Lakes ecosystem: 32 metals, 68 pesticides and 262 other organic chemicals; 11 contaminants are considered critical or priority pollutants by the Great Lakes Water Quality Board; they have been found to accumulate in fish, harm fish and wildlife and pose a risk to human health.
2.3 Pollutants fall into a number of categories. [Each of these creates particular impacts on fisheries habitat, and if pollution is bad enough, may adversely effect fish/aquatic communities, reduce the value of fish for human consumption and within the ecosystem, and cause habitat loss.]

- acid rain and other airborne contaminants
- agricultural/landscape (e.g. lawns, golf courses, roads) runoff
- biological (e.g. exotics, disease)
- industrial (toxic) waste/spills
- post-consumer petroleum products
- sewage and other organic inputs
- silt or sediment, including resuspension
- thermal
- radioactive
- solid waste (especially litter/plastics)

2.4 Point-source pollutants enter the environment from a specific point (e.g. sewage outfall) which can usually be identified.
2.5 Nonpoint-source pollutants usually enter the environment from numerous sources (e.g. lawn fertilizer runoff, pesticides, acid rain) and can be harder to identify and treat than point source pollutants.
2.6 The movement of ground water is a major pathway for pollution to reach the Great Lakes.
2.7 Contaminated sediment is a large-scale, high-cost problem within the Great Lakes Basin.
2.8 Pollutants may affect the Great Lakes directly, or enter by way of tributary systems.
2.9 Contaminants and their bioaccumulative risks to both species and human health threaten sustainable fisheries, and must be minimized.

CURRENT OR POTENTIAL MANAGEMENT ACTIONS OR RESULTS:

2.10 Sources of pollution must be stopped or reduced if safe, quality fisheries are to exist.
2.11 Although industries and sectors (e.g. government) have a responsibility to control

potential pollutants, each individual also has a responsibility to act in ways that can directly or indirectly reduce the impact of pollutants on the environment.

2.12 There has been a long-term trend toward reduced public exposure to mercury, DDT, PCB's, dieldrin, chlordane and dioxin from consumption of sport fish caught in Michigan lakes and streams. However, the reduction of certain contaminants has slowed or stopped over the past 10 years.

2.13 Mercury poses a widespread problem throughout the Great Lakes basin. The Michigan Department of Community Health has issued a special advisory for all inland lakes in Michigan due to mercury. Air emissions of mercury are the largest source of mercury in the water.

2.14 The populations most at risk from exposure to mercury and other toxins through the consumption of contaminated fish are nursing mothers, pregnant women, women who intend to have children and children under age 15, and people who often consume fish, which may include Native American subsistence anglers, low-income or minority anglers, and sport anglers.

2.15 Exposure to individual contaminants varies by region, type of fish and size of fish.

2.16 Although some fish are below the government guidelines set for safe consumption of commercially caught fish, they may still not be safe for consumption, particularly by at-risk populations (see 2.14).

2.17 Fish consumption advisories should be consulted and followed whenever possible before eating fish caught in Michigan waters.

2.18 Despite improvements in reducing public exposures to toxic chemicals from consumption of sport fish caught fish in Michigan lakes and streams, the presence of fish consumption advisories limits the full enjoyment of the Great Lakes fishery.

2.19 Despite the existence and publication of fish consumption advisories, people that consume fish are not always aware of them, specifically those most at risk (see 2.14).

2.20 The U.S. and Canada have had a number of treaties and agreements to protect the Great Lakes from pollution, including the Great Lakes Water Quality Agreement of 1972, which set up the International Joint Commission.

2.21 The International Joint Commission is responsible for reducing pollution in the Great Lakes. It has identified 42 Areas of Concern (AOC's) in the Basin where environmental quality standards have not been achieved. Each has a local Remedial Action Plan (RAP) designed to meet those standards. Citizens are directly involved in planning the cleanup of these targeted areas.

Issue 3: Prevent or control the introduction of non-native nuisance species (exotics).

CURRENT OR POTENTIAL GREAT LAKES STATUS AND VALUE:

3.1 Over 152 species have been established in the Great Lakes since Europeans have arrived; around one-third have arrived since the opening of the St. Lawrence Seaway.

3.2 A number of introduced species are now naturalized – maintaining self-sustaining populations – and should be considered regular components of the fish community; some are considered desirable (e.g. rainbow trout; chinook salmon) while others need to be suppressed (e.g. round goby, sea lamprey).

CURRENT OR POTENTIAL GREAT LAKES IMPACTS:

3.3 Introductions can severely impact the sustainability of native fisheries and ecosystems through direct competition, predation, habitat alteration, trophic alteration, spatial alteration, gene pool deterioration and disease introduction.

3.4 Exotic species in the Great Lakes have caused billions of dollars in economic loss; without efforts to restrict distribution, costs to society will increase.

3.5 Sea lamprey in particular have devastated the Lakes, contributing to the collapse of the lake trout in most Great Lakes.

3.6 Historic purposeful or accidental introduction of species such as alewife, smelt, and salmon, has had a negative impact on the Great Lakes fishery and ecosystem.

3.7 Other species of current concern include, but are not limited to, zebra mussel, European ruffe, round goby, spiny water flea, purple loosestrife and Eurasian water milfoil.

3.8 In just over 10 years, zebra mussels have seriously and perhaps permanently altered the Great Lakes ecosystem; their potential economic impact on the basin is $5 billion over the next 10 years.

CURRENT OR POTENTIAL MANAGEMENT ACTIONS OR RESULTS:

3.9 Additional state, federal and international commitment and funding is required to adequately address the prevention or control of exotic invaders.

3.10 Perfect screening, detection and control of exotics are currently impossible.

3.11 Prevention of exotics is more cost-effective than control; an established organism is virtually impossible to eradicate.

3.12 The rate of exotic invasion is directly related to human activities; activities that lead to unintentional introductions should be identified and controlled.

3.13 Chemical-free solutions are currently being developed to address the problem of nuisance species. These solutions are more environmentally benign and may be more effective than chemical methods, or chemical methods alone.

3.14 The introduction of barrier, lampricide, and sterile male control programs have greatly reduced sea lamprey in all but the areas affected by the St. Mary's River.

3.15 Recent, co-ordinated, international control efforts focused on the St. Mary's River have had a significant impact on larval sea lamprey populations in this area. It is too soon to determine the impacts on adult lamprey or fish populations.

3.16 Recent, unintended introductions have largely come by way of ballast water release; both federal governments need to move toward the establishment of enforceable discharge standards.

3.17 Currently, there are attempts to control ballast water in ships coming into the Great Lakes from outside North America.

Issue 4: Address Great Lakes issues at the ecosystem and watershed level.

CURRENT OR POTENTIAL GREAT LAKES STATUS AND VALUE:

4.1 Fish communities and fisheries are parts and products of complex aquatic ecosystems.

4.2 There are limits on the productivity of these systems.

4.3 Self-sustainability is important to the proper functioning of biological systems.
4.4 There are integral links among ecological health, sustainable development and economic health in the Great Lakes basin and its watersheds.
4.5 Today, the Great Lakes have aquatic communities that are structurally and functionally volatile, and that exhibit reduced numbers of native species and a greatly expanded base of non-native species.

CURRENT OR POTENTIAL GREAT LAKES IMPACTS:
4.6 Many Great Lakes ecosystems have been altered significantly through human impacts, some irrevocably; fisheries must be managed and "ecological rehabilitation" attempted within this context.
4.7 Trends toward lower levels of nutrient loading and overall Great Lakes productivity will have profound impacts on the ecosystem and its constituencies; whether current sport and commercial fisheries can be maintained in light of this change is questionable.
4.8 One challenge to the sustainability of large systems is "jurisdictional stress"; it is important to consider the potential effects on the whole system rather than only within particular jurisdictions.

CURRENT OR POTENTIAL MANAGEMENT ACTIONS OR RESULTS:
4.9 Future sustainability of the Great Lakes and tributary resources depends on our ability to manage these ecosystems through holistic, ecological approaches that integrate knowledge across trophic levels.
4.10 The ecosystem approach to management is well suited to address complex problems that extend over time, space and jurisdictions.
4.11 Ecological rehabilitation involves the reestablishment of ecosystem integrity by repairing the basic structure and energy dynamics of the system.
4.12 In some cases, for example through the introduction of Pacific salmon, progress toward ecological rehabilitation can be, and has been, accomplished by substituting exotic surrogates for extinct or impaired native species.
4.13 Ecosystem status can (and should) be monitored through indices of health – indicator species, community structure, nutrient levels and flow rates.

Issue 5: Manage fishery diversity within the Great Lakes basin.

CURRENT OR POTENTIAL GREAT LAKES STATUS AND VALUE:
5.1 The ecological values related to diversity apply to sport, subsistence and commercial Great Lakes fisheries.
5.2 Some areas of the Great Lakes had naturally limited diversity (e.g. Lake Superior); in other areas, diversity has been reduced through extinctions (e.g. blue pike) and extirpations (e.g. lake trout in Lake Michigan).
5.3 The Great Lakes were vulnerable to introduced species because of relatively low levels of indigenous fish populations.
5.4 Decreased diversity can occur through habitat loss, overharvest, intentional or accidental species introductions, disease and the effects of some stocking practices on genetic or stock variability.

5.5 Fish health issues are key factors affecting abundance and/or sustainability of important Great Lakes fish populations.
5.6 Sport and commercial fishing, if not managed properly, may directly impact the diversity of non-target species (e.g. entanglement of non-target species in gill nets).

CURRENT OR POTENTIAL MANAGEMENT ACTIONS OR RESULTS:
5.7 Any trends toward decreased species and population diversity related to native species or beneficial introductions need to be reversed.
5.8 There may be some conflict over the benefit or harm produced by some introduced species (e.g., alewife) and thus actions to be taken related to it.
5.9 Diversity issues need to be addressed at the individual (genetic), population (stock), species and community levels.
5.10 In particular, the genetic variation of locally adapted wild fish stocks should be protected.
5.11 Diversity needs to be conserved through rehabilitation of native fish populations, species, communities and their habitats.
5.12 Recovery plans should be developed for species that are threatened, endangered or of special concern.
5.13 Specific species of concern include lake trout and lake sturgeon; both are the focus of extensive rehabilitation efforts.

Issue 6: Achieve and maintain sustainable sport and commercial Great Lakes fisheries.

CURRENT OR POTENTIAL GREAT LAKES STATUS AND VALUE:
6.1 Both historic and current fisheries, including losses and closures, have considerable economic, cultural and social significance.
6.2 Fisheries are dynamic and can fluctuate widely over time and space, as a result of both natural and human impacts.
6.3 Accumulated effects of overfishing, exotic invasions, pollution and habitat destruction collapsed most Great Lakes fish stocks by the 1950's.
6.4 Rehabilitation of the Great Lakes fishery has advanced toward re-establishing many major fish stocks and has provided fish to support large, valuable fisheries.
6.5 Currently, the Great Lakes fishery consists of more than 175 species of fish in a series of overlapping, complex fisheries.
6.6 All fisheries have limited productivity and demand is high enough to over-fish many Great Lakes fisheries.

CURRENT OR POTENTIAL GREAT LAKES IMPACTS:
6.7 Overfishing can, if not managed properly, threaten sustainable fisheries, and must be limited through regulations and controlled access.
6.8 Use of public waters for aquaculture can conflict with use of those waters for natural fish production.
6.9 Bycatch can threaten sustainable fisheries, and must be monitored and controlled; move towards minimizing waste in commercial fisheries.

6.10 Conflict exists within and between sport, subsistence and commercial fisheries, and between fisheries and other consumptive and non-consumptive resource users. Any resolution must consider the needs of all groups and the sustainability of the resource.
6.11 Real or perceived conflict may result from competition for food among fish and other taxa (e.g. birds). Any resolution must consider the integrity of the ecosystem as a whole.

CURRENT OR POTENTIAL MANAGEMENT ACTIONS OR RESULTS:
6.12 Restriction of public use of the public fisheries must demonstrably enhance public health, safety or welfare.
6.13 Where appropriate, fisheries managers should make anglers and other consumers aware of alternate species to reduce the pressure on popular sport and commercial fish; e.g. encourage anglers to engage in diverse fishing opportunities.
6.14 Stocking is an important management tool; it has the potential to have both positive and negative consequences.
6.15 Judicious stocking is vital in restoring biological integrity, developing spawning populations, and providing fishing opportunities.
6.16 About one-third of all recreational fishing in Michigan depends on stocked fish, including most of the Great Lakes trout and salmon fishery.
6.17 Genetically diverse, disease-free wild or captive spawn sources are required for a strong stocking program.
6.18 Marking and tagging hatchery fish allows the evaluation of their effectiveness and is an essential tool for fisheries management.
6.19 There is a risk of overstocking in the Great Lakes, where several jurisdictions, many stocking locations and species compete for a common forage base.
6.20 Self-sustainability is preferred; opportunities for increased self-sustainability should be favoured over increased opportunities for hatchery-based fisheries where fishing pressure and fish community structures allow.
6.21 Research and assessment are critical to determining how to sustain fisheries.
6.22 Enforced legislation, interstate and international agreements are essential to maintaining sustainable fisheries.

Issue 7: Native Americans have treaty fishing rights in the Great Lakes.

CURRENT OR POTENTIAL GREAT LAKES STATUS AND VALUE:
7.1 Fishing for food and trade was important to Great Lakes' tribes prior to European settlement; that importance continued after Europeans arrived.
7.2 When the Upper Great Lakes Ottawa and Chippewa tribes signed the Treaties of 1836 and 1855, they retained the right to fish in treaty area waters using traditional gear, i.e. gill nets; this right was upheld in 1976 and 1979 court decisions.
7.3 In an attempt to resolve allocation disputes, the 1985 Consent Decree was put into effect by the U.S. District Court; it allocated and protected fishery resources through a series of commercial, sport and lake trout rehabilitation zones.
7.4 The Consent Decree expired in 2000; a new Consent Agreement has been negotiated that respects treaty rights, works toward a sustainable fishery, and fairly allocates

the resource.

7.5 Commercial and subsistence fishing continue to be important to tribal members who wish to maintain their culture while conserving the resource.

CURRENT OR POTENTIAL GREAT LAKES IMPACTS:

7.6 Trap nets have a potential to reduce bycatch mortality.

7.7 Gill net fishers believe they can minimize bycatch by fishing in specific depths and locations, using the proper mesh size and releasing live, non-target fish.

7.8 Trap nets may be helpful in areas where lake trout and other non-target species exceed target species mortalities.

CURRENT OR POTENTIAL MANAGEMENT ACTIONS OR RESULTS:

7.9 The area governed by this treaty is managed by the tribes through the Chippewa Ottawa Resource Authority (formerly the Chippewa Ottawa Treaty Fishery Management Authority); an Executive Council of tribal chairmen, state and federal representatives has been established to address and resolve any fishery issues.

7.10 Decisions related to treaty fisheries must be based on principles of fisheries economics and conservation, the law and court decisions related to Native American fishing.

7.11 Tribal conservation wardens enforce regulations to protect and conserve the treaty fishery and its fishers.

7.12 Tribal biologists and managers work to both conserve and enhance the fishery, and, together with other resource agencies, set total allowable catches in treaty waters.

Issue 8: Manage for sustainable sport and commercial fisheries.

8.1 Great Lakes fishery resources are both highly desired and subject to many human impacts; they require intensive protection and management.

8.2 Fisheries management should involve diverse interests with a stake in fisheries or aquatic resources; this means increased sharing of management responsibilities.

8.3 Public understanding of, acceptance of, and involvement in, Great Lakes fishery management is desired to help achieve management objectives.

8.4 Fisheries management must consider the impacts of land-based actions, i.e. take a watershed-based approach. This involves interactions among agencies, jurisdictions and countries.

8.5 Fisheries managers must be involved with:

- allocation
- assessment & research
- control of harvest (including enforcement)
- habitat conservation, restoration and enhancement
- managing fish migrations
- mitigation and compensation, where continuing damage to stocks or habitat is unavoidable
- prevention of unintentional introductions
- public education, including sound conservation practices
- stock conservation, restoration and enhancement

- stocking fish

8.6 There are many success stories in Great Lakes management (e.g. collaborations with tribes and among Great Lakes agencies, rehabilitated species/habitats, positive impacts of regulation and mitigation).

Issue 9: Promote resource stewardship.

9.1 The public has a vested interest in the conservation, restoration and enhancement of aquatic resources.
9.2 The public must understand their rights, privileges and responsibilities, and should be made aware of methods to personally help protect and/or improve the resource, and have the opportunity to practice and apply them.
9.3 Public awareness, understanding and action related to the biological, economic, cultural and social consequences of impacts such as exotic species, habitat loss, pollution and overharvest are important to maintaining sustainable fisheries.
9.4 Increased citizen awareness and understanding of the ecology of the Great Lakes will result in citizens as advocates for strategies that support long-term sustainability of the Great Lakes fisheries.
9.5 The public must understand and respect the resource, the regulations and the rights of others, including anglers, commercial fishers, treaty fishers, property owners and the non-fishing public.

Issue 10: Promote responsible recreational fishing.

10.1 Fishing is a positive and acceptable recreational activity for males and females of all races, ages, socio-economic status and physical and mental abilities.
10.2 The benefits of fishing vary from person to person. Some people enjoy the relaxation and beauty of the surroundings, some enjoy the competition, some fish to put food on the table. All forms are acceptable as long as the anglers' actions sustain the resource, respect others and are within the law.
10.3 Fishing safety is important to anglers and those around them.
10.4 Anglers must be front-line stewards with a vested interest in aquatic resource conservation, restoration and enhancement.
10.5 Anglers must be aware of and practice proper release and harvest techniques.
10.6 Anglers, as well as the public, must be aware of their potential role in the dispersal of exotics and the transmission of disease, and take steps to avoid contributing to these problems.
10.7 Anglers must be aware of their potential role in the distribution of toxic chemicals to their families through their catch, and must become knowledgeable of potential health risks and proper cleaning techniques, especially if they are feeding their catch to young children, women of childbearing age and/or senior citizens.
10.8 Maintaining and increasing the number of responsible anglers can help fund management of the fisheries resource. In the US, anglers provide funding for the management of the fisheries resource through licences and the W-B excise tax.
10.9 Participation in recreational fishing has declined in recent years, threatening the future funding of fisheries management, conservation and restoration.

10.10 Access to fisheries, particularly for shore-based anglers, is a critical dimension of the fishing experience; it can be diminished or lost through uncontrolled or inadequately planned development.
10.11 Access is influenced by the availability of fishing and site access information.
10.12 Anglers should understand the variety of equipment and tackle they may choose from and effectively utilize them.
10.13 Resources address: beginning angling techniques, intermediate angling techniques, advanced angling techniques, specific species techniques.

Issue 11: Develop an awareness of fisheries as a profession and help prepare youth for careers in this profession.

11.1 Fisheries and aquatic sciences, together with economics and other social sciences, provide the basis for managing sustainable aquatic resources.
11.2 Fisheries professionals are a credible and reliable source of scientific and technical information concerning conservation and management of fisheries and aquatic resources.
11.3 A variety of fisheries and aquatic management and conservation careers exist. The fields of fisheries science, aquatic conservation and management provide opportunities for motivated, scientifically prepared, and service-oriented people from diverse backgrounds.
11.4 Preparation for a career in fisheries and aquatic science includes an understanding of math and the sciences; professionals should also be well-rounded, with education and experiences in such areas as economics, law, communications, social sciences, and resource management. Fisheries professionals are committed to lifelong learning through continuing education programs designed to increase understanding of ecosystem management.

Also note that the issues and related concepts we developed are specific to a Great Lakes fisheries context as opposed to a more general Great Lakes context. This is in light of the GLFT's focus on Great Lakes fisheries. Finally, we used the Great Lakes ecosystem and fisheries literacy goals as a "filter" to review relevant literature and education materials to establish gaps in coverage. However, the literacy goals can also be used to drive future Great Lakes fisheries education efforts by the GLFT and other organizations.

Objective 2: Literature review of opinion surveys relevant to the Great Lakes fisheries (i.e., *What do people believe about the Great Lakes and its fisheries?*)

Introduction

This section of our report presents a literature review studies involving surveys of individuals' understanding of Great Lakes and fisheries issues, with studies organized based on the Great Lakes ecosystem and fisheries literacy goals, and recommendations in light of the findings from these studies.

Methods

This part of the project focused on identifying and summarizing results of surveys of public understanding (cognitive domain) of Great Lakes fisheries issues, including both attitudinal (affective domain) and behavioral aspects. Some studies that do not address Great Lakes issues are included in the literature review because they focus on relevant fisheries issues, such as the salmon habitat restoration program in New England.

Several different search methods were used to identify studies of public opinion surveys associated with Great Lakes and fisheries issues:

- Journals: We looked for articles in peer-reviewed journals published in the past 10 years. The following journals were reviewed:
  - Great Lakes: *Journal of Great Lakes Research* and *Great Lakes Research Review*
  - Fisheries: *North American Journal of Fisheries Management, Fisheries, Canadian Journal of Fisheries, Fisheries Research, Reviews in Fish Biology and Fisheries,* and *Environmental Biology of Fishes*
  - Environmental Education: *Journal of Environmental Education, Canadian Journal of Environmental Education, Environmental Education Research*

- Opinion survey archives: Nationwide poll archive sites were used to find opinion survey results on relevant issues:
  - The Gallup Organization (http://www.gallup.com/)
  - Polls and Survey Data Findings (http://www.princeton.edu/~abelson/xsurvey.html)
  - Public Opinion: A Selective Guide to Library Resources (http://www-sul.stanford.edu/depts/ssrg/psych/pbopgd.html)
  - The Roper Center for Public Opinion Research (http://www.ropercenter.uconn.edu/)
  - National Opinion Search Center (http://www.norc.uchicago.edu/homepage.htm)

- Mass media reports via the Internet: Newspapers frequently conduct and report polls on regional issues. More than 12 newspapers listed on the Great Lakes Information Network (GLIN, at http://www.great-lakes.net) were searched to obtain survey results on Great Lakes and fisheries issues.

- Newspapers: *Columbus Dispatch, Star Tribune, Chicago Tribune, Detroit News*, etc.

- Radio: Great Lakes Radio Consortium (http://www.glrc.org) and Earth Watch Radio (http://www.seagrant.wisc.edu/earthwatch/)

- Education database: Education databases were searched using keywords including Great Lakes, fisheries, exotics/non-native species, etc.
  - Education Abstracts: 1983-Present
  - ERIC: 1966-Present

- Networking: Within this set of information, data were considered if published in the last 15 years and still available. To find unpublished survey results and reports in the "gray literature," several groups were contacted:
  - Sea Grant Network
  - State departments of natural resources and environment
  - Great Lakes Information Network (http://www.great-lakes.net/index.html)

This report is based on a resulting collection of nearly 100 documents, with 1/3 being technical reports from studies commissioned by Human Dimensions laboratories or state departments of natural resources/environment, and most of the remainder being published research in journals and newsletters. The literature base does not include reports with no empirical data, research published before 1985, or studies of fisheries issues that did not include humans as data sources themselves. From the full set of documents, we selected those that were not duplicative of data, and those with closest relevance to the stated objective.

The results section provides summaries of over 70 of the studies, organized based on the Great Lakes ecosystem and fisheries education literacy goals. Because a large number of surveys that focus on fish consumption advisories and relevant concepts are addressed under a variety of literacy goals (e.g. *2.2, 2.9, 2.13, 2.17, 2.18, 2.19, 4.4, 6.12, 10.7*), the results of these studies are reported separately at the end.

Results

"Fisheries management is in a period of transition that began about 20 years ago. Two major changes associated with the transition have heightened the importance of communication in fisheries management. First, the broad goals of fisheries management have moved toward optimum sustainable yield (OSY). The second major change is greater public involvement in the management decision-making process." (Decker and Krueger 1993)

Issue 1: Maintain and recover fisheries habitat.

- No survey found.
  The researchers believe this to be somewhat of a charismatic issue. It is unlikely that members of the public, whether users of the aquatic environment or not, would disagree with the need to maintain and recover fisheries habitat as a general water protection issue, so the question has apparently not been asked. There are numerous references available on the actions of individuals and groups to maintain and recover

fisheries habitat, but these did not meet the criteria of the objective ("What do people believe about the Great Lakes and their fisheries?")

Issue 2: Identify and reduce sources of pollution affecting fisheries habitat.

- No survey was found dealing with the state of public awareness of this issue, however, preliminary data from the 2001 Ohio Sea Grant Sport Show Survey indicate that over 500 self-selected respondents rated the topic as a high priority ("importance to you"). The mean priority rating for both the following items was 5.4, with 6 being highest priority:
    - Eliminate persistent toxic substances in the Great Lakes
    - Lake Erie water quality

- The only other literature related to this topic is in terms of ecoaction – doing something to reduce pollution sources: project reports, such as community efforts at storm drain stenciling, class projects to monitor water quality, beach sweep campaigns and such. While these reports do indicate substantial local public interest and participation, only "output" measures such as number of participants and amount of beach cleaned are included in the reports. No reports of impact evaluations (change in knowledge or attitudes, skills documented, etc.) have been located.

Issue 3: Prevent or control the introduction of non-native nuisance species (exotics).

- Seven of ten respondents at Boat Shows and Fishing Fairs would like to have some of their current tax monies used for research on zebra mussels and agree that public funding for research on zebra mussels is a wise investment. Boat owners and non-boat owning respondents alike view the zebra mussel as a threat to the Lake Erie's boating and sport fishing industry. Significant differences between boat owners and non-boat owning respondents occurred in four of fourteen items related to awareness of non-native species, with boat owners holding stronger opinions on species control. (Lichtkoppler et al., 1993)

- Surveys were mailed to 2,400 randomly selected boaters (800 in each of three states: Minnesota, Ohio, Wisconsin). More Minnesota boaters (91%) felt that it was very important to take precautions to prevent the spread of Eurasian watermilfoil than boaters in Wisconsin (54%) and Ohio (29%). Generally, Minnesota boaters were more concerned and aware of the threats posed by spreading exotic species than boaters in Wisconsin and Ohio. The media, especially newspapers and television, were the two most important sources of information about exotic species for all three states. When asked what they thought would be the most effective way to deliver the exotic species warnings, boaters in all three states gave high ranks to signs at boat accesses. Boat access signs were ranked first in Minnesota and Wisconsin, and third in Ohio. Boaters in all three states ranked the inclusion of exotic species information in boating and fishing regulation pamphlets second. Minnesota boaters ranked inspection/education programs at boat accesses third, while brochures were ranked third in Wisconsin and second in Ohio. When asked why they didn't take precautions

to prevent the spread of exotic species, boaters in all three states indicated that it was primarily because they didn't know what to do, or that they didn't boat in infested waters. Very few boaters said taking precautions is useless, or that exotic species are not a problem. Boaters were asked how often they took certain precautions to prevent the spread of exotic species. A high percentage of boaters in all three states indicated that they almost always made visual inspections of their boats and drained water from live wells and bilges. In all three states, however, only about 50% of boaters reported almost always dumping out their bait buckets on shore, and only about 30% said they almost always let their boat dry for ten days before going to another lake or river (Gunderson, 1994).

- In a survey of 191 Lake Erie charter boat captains in 1990, concern about zebra mussels was reported as a problem by more than half of the respondents (Lichtkoppler and Hushak, 1995).

- One topic in a Great Lakes regional teacher survey was "exotic species." This biodiversity topic was ranked 12th of 22 topics in order of priority for teaching. Of the responding teachers (300 in the Great Lakes states and Ontario), 60% reported having adequate knowledge for teaching about the topic (Fortner and Corney, accepted).

Issue 4: Address Great Lakes issues at the ecosystem and watershed level.

- Based on general environmental awareness surveys in the early 1990s, the public does not have a good grasp of the term "ecosystem" but most can adequately describe what a watershed is (Fortner, et al., 1991). It is not clear if they associate water resource issues with things happening on land or in the air, or if they think about management of issues in terms that scientists would describe as "multi-media." The researchers feel that most public concerns are with eliminating here-and-now perceivable problems rather than consideration of big picture management (Lee and Fortner, 2000).

- In a survey of middle school science teachers in the Minnesota and Wisconsin counties of western Lake Superior, "Ecosystem Approach to Great Lakes Issues" was ranked by 83% as a high priority topic for students in their schools to know. Only 35% of the teachers, however, felt they had knowledge that was adequate to teach about the topic (Fortner and Meyer, 2000).

- Issue 8 includes a survey of managers that addressed topics related to this issue.

Issue 5: Manage fishery diversity within the Great Lakes basin.

- Ashtabula County (Ohio) voters (N = 231) were asked whether they would vote yes or no on a referendum for annual tax of $25 per household per year for 30 years to finance the dredging and disposal of contaminated sediments from the Ashtabula River, Ohio. The respondents were then asked for a yes/no vote at $50, $100, and $200 per year. From these responses, it appears that the average household's annual willingness to pay is in the $25 to $50 range with a lower bound mean of $32.50

(Lichtkoppler and Blaine, 1999).

- In a related study outside the Great Lakes region, a surprisingly large proportion (83%) of individuals responding to a mail questionnaire noted that they "cared" whether Atlantic Salmon were found in New England rivers. However, a non-respondent follow-up survey revealed that the mail questionnaire was more likely to be returned by those who care about Atlantic salmon. On the basis of the non-response analysis, a conservative adjusted proportion of respondents who "care" about Atlantic salmon was estimated to be 58%. Not everyone who cares about Atlantic salmon was willing or able to sacrifice money to further the restoration program: 43% of those "caring" respondents expecting never to fish; 24% who might someday fish; and 6% of those certain they would someday fish for Atlantic salmon on the 14 rivers in question did not express a positive willingness to pay. The respondents expecting to "certainly fish" for Atlantic salmon someday were willing to pay an average (inclusive of the zero values just noted) of $31.93 above and beyond their maximum willingness to pay for a fishing license. Persons who said they "might" fish for Atlantic salmon someday said they were willing to pay for an average of $10.81 above and beyond their maximum willingness to pay for a fishing license. Persons who were not expecting to ever fish for Atlantic salmon were willing to pay an average of $27.45 in increased taxes or other revenues. Less than one-third of the respondents who cared about Atlantic salmon said they expected to personally see or fish for them someday. However, more than three-fourths said they would be pleased to know that Atlantic salmon could be found in New England rivers even if they never did see or fish for salmon themselves. Just as many (over three-fourths) agreed with the statement that, "I think the return of Atlantic salmon is an important sign that river pollution has been cleaned up." And only slightly fewer (73%) felt that there was a need to act on restoration now for the benefit of future generations. A lower proportion, but still the majority (61%), agreed with the statement that, "I think that Atlantic Salmon should be returned to New England rivers to restore the lost balance of nature" (Kay, Brown and Allee, 1987).

- In school research, questions assessing education about biodiversity are frequently asked in the context of more specific terms such as food webs, or endangered or introduced species. Food webs are always seen as important for teaching in middle school science (e.g. Fortner and Meyer, 2000; Fortner and Corney, accepted), and teachers feel they are adequately prepared for teaching this topic. Surprisingly, however, food webs rank below other biology topics as priorities in the Lake Superior region. As for endangered species, this topic is 4th highest in priority for the Lake Superior teachers surveyed by Meyer (1998). About 42% of 5th grade teachers and 64% of 9th grade teachers felt well prepared to teach it. One topic in a Great Lakes regional teacher survey was "exotic species." This biodiversity topic was ranked 12th of 22 topics in order of priority for teaching while food webs ranked 10th (Fortner and Corney, accepted).

Issue 6: Achieve and maintain sustainable sport and commercial Great Lakes fisheries.

- An angler survey in New York in 1989 revealed that over half of all respondents (54%) had gone Great Lakes fishing within the past five years; 59% expressed intent to fish the Great Lakes in 1989. Of those who do not fish the Great Lakes, the two reasons cited most often (by the majority of non-Great Lakes anglers) were that it was too far from home and that they don't have the necessary boat or equipment. Nearly one-third indicated that contaminants in the fish were a reason for not fishing the Great Lakes. Few mentioned either opposition to snagging or crowding as reasons for not fishing the Great Lakes. Respondents released almost half of all legal size fish caught from Lake Ontario and Lake Erie. The majority of the remainder were eaten by the family that caught them. Over 19% of respondents have gone snagging for Great Lakes salmon at some point in their fishing careers (26% for nonresidents, 18% for New York residents). Of those who went fishing on the Great Lakes in the past five years, 25% went snagging during that time. Most people who have ever gone snagging (80%) have gone in the past five years; 45% went in 1988. Respondents' opinions about the future of snagging on the Great Lakes depended on whether or not they had ever gone snagging and how recent their snagging experience was. At one end of the spectrum were anglers who had fished the Great Lakes in the past five years but who had not gone snagging, one-third of whom wanted all snagging eliminated, while 42% had no opinion. At the other end were anglers who went snagging for Great Lakes salmon in 1988, 42% of whom wanted more areas open to snagging, while only 6% wanted all snagging eliminated and 9% had no opinion (Connelly, Brown, and Knuth, 1990).

- Issue 8 includes information from Knuth, et al. (1994) related to this topic as well.

- Anderson et al. (1998) conducted a mail survey of 2000 Minnesota residents regarding the condition of the Great Lakes. A 51% response rate netted fishing-related concerns from survey respondents:
    - More fish stocking needed,
    - Overfishing and netting should be prohibited,
    - Beaver dams are preventing fish from entering the lake from streams,
    - Get the fish population back (reported to be extremely poor since 1979),
    - No spearing on small lakes,
    - More size restrictions on fish to increase the overall size,
    - More education and promotion of catch and release,
    - Lampreys in the lake killing the "Northerns."

- Based on the type of social unit an individual fished with most often, preferences for 38 site attributes were solicited from a sample of 1,232 licensed Texas anglers. Analysis of variance detected significant differences on 15 site attributes. Most differences detected were between anglers who fished alone and anglers who fished with family members. Most differences involved facilities, services and resources that can be manipulated by managers. Differences were not detected for site attributes dealing with access, user fees, escape motivations, and chance of fishing success:

anglers in all social units rated these important in site selection (Hunt and Ditton, 1997).

Issue 7: Native Americans have treaty fishing rights in the Great Lakes.

- No Great Lakes surveys on this issue were found, but the following information may be helpful in describing the issue.

- Background: The federally recognized Native American tribes in the United States have jurisdiction over a reservation land base of nearly 100 million acres. This figure represents a small fraction of the area they used for fishing and hunting before white settlement. During the westward expansion, Native American tribes signed many treaties with the U.S. government allowing white settlement in exchange for promises to the tribes that they would have permanent fishing rights. Within the past 30 years, Native American treaty rights have been revisited in the courts and through negotiations. The indigenous people's move to self-governance is profound, and has occurred through a slow effort across Canada and the United States, including most recently Hawaiian native peoples. Throughout the North American continent, Native American tribes or First Nations are reasserting treaty rights, including their rights to co-manage resources. Northwestern Native American tribes pursued their fishing rights in the late 1960s and early 1970s. Among the most famous cases was United States vs. Washington, brought forth by several western Washington tribes against the state of Washington. In a case brought by the Columbia River Stevens Treaty Tribes, District Court Judge Robert Belloni held that the states of Oregon and Washington must afford the tribes an opportunity to take a fair and equitable share of all fish the states permit to be taken from any given run, and adopted the 50% share rule. Shellfish were not included, but recently, the Puget Sound tribes pursued their rights to harvest shellfish. The Treaty of Point No Point of 26 January 1855 reads "the right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the United States; and erecting temporary houses for the purpose of curing; together with privilege of hunting and gathering roots and berries on open and unclaimed lands. Provided however, that they shall not take shellfish from any beds staked or cultivated by citizens. The issue went to trial in May 1994, and District Court Judge Edward Rafeedie ruled that public and private tidelands were subject to treaty harvest, except for shellfish contained in artificial beds. Since this ruling, the tribes have participated in management and monitoring of these resources (Mofitt, 2000).

- Other useful information on treaty fishing rights and education implications of the issue can be found in:

Busiahn, T. R. 1984. An introduction to native peoples fisheries issues in North America. *Fisheries* 9(5): 8-11.

Marsh, J. H., and J. H. Johnson. 1985. The role of Stevens Treaty tribes in the management of anadromous fish runs in the Columbia basin. *Fisheries* 10(4): 2-5.

Issue 8: Manage for sustainable sport and commercial fisheries.

- Knuth et al. (1994) surveyed 919 Great Lakes fishery and environmental managers using a combination of content analysis and a self-administered mail questionnaire to
  i) identify how attitudes and values of fishery and environmental managers affect acceptability and attainment of lake trout rehabilitation goals: and
  ii) describe managers' perceptions of the attitudes and values of other lake trout stakeholders.

  Provincial/state fishery managers expressed stronger support for artificial vs. natural systems, for utilitarian vs. ecological goals, and for placing relatively greater emphasis on anglers and economic benefits compared to federal fishery managers. Environmental managers assigned higher priority to goals associated with reestablishing native species, and lower priority to goals associated with satisfying anglers than did their fishery management counterparts. Differences observed for Canadian vs. U.S. fishery managers were similar to those between environmental vs. fishery managers. Canadian fishery managers tended to have a broader view of which groups were important stakeholders in lake trout management, placing less relative emphasis on anglers and more on other citizens in the Great Lakes Basin and on non-consumptive fishery users. Managers perceived the strongest support for lake trout rehabilitation goals as coming from federal government agencies, with support lower among the angling public and the fishing-support industry. Managers perceived that a variety of social, institutional, and biological barriers exist for lake trout rehabilitation for each of the Great Lakes. Differences in perceptions and beliefs exist among fishery and environmental agencies, provincial/state and federal agencies, and Canadian vs. U.S. agencies. The challenge for the future of ecosystem management is to recognize and accept these differences among managers' perceptions and work within their bounds, or to work to change the beliefs held by various stakeholders related to support or opposition for lake trout rehabilitation (Knuth, Lerner, Connelly, and Gigliotti, 1994).

- Telephone interviews of 645 Tennessee anglers indicated that older anglers preferred uniform regulations across reservoirs, whereas more highly educated and active anglers preferred individual reservoir regulations. More active anglers favored implementation of popular (historically well-known and accepted) regulations, even if the management agency believes the regulations to be non-beneficial. Members of fishing clubs did not favor implementing popular regulations over agency objections. Educational level, club membership, and income were correlated with angler perceptions of regulatory complexity. These results suggest that agencies may engage in activities designed to efficiently target informational material to particular segments of the angling population (Jakus et.al., 1996).

- Reed and Parsons (1999) surveyed anglers ($N = 100$) who fish for bluegill on four Minnesota lakes, to determine (1) if they would support regulation changes designed to increase bluegill size structure, (2) if their behavior would allow increase in bluegill size structure to be sustainable, and (3) what they viewed as the causes and

remedies for declining bluegill fisheries. The majority of anglers surveyed would not support regulation changes on bluegill fisheries: 39% - 100% against a bag limit reduction and 56% against minimum size limits. However, most said they would increase the number of fishing trips they took if an increased bluegill size structure could be reestablished. The researchers estimated that a modest increase of two trips annually would result in a 16-34% increase in the rate of exploitation on the four lakes. On certain lakes this could jeopardize the sustainability of a quality fishery. The majority of anglers believed that stunting was the cause of the decline in bluegill populations and that removal by managers and anglers was the most important management tool available (Reed and Parsons, 1999).

- A statewide angler survey was conducted in New York in 1988 in part to estimate the net economic value of the state's recreational fishery. Willingness-to-pay questions from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation were adapted to a mail survey format and respondents were asked how much they would be willing to pay above current expenditures for a specific fishing trip. The net economic value estimated from the responses exceeded $284 million for the freshwater fisheries of New York in 1988. Although inland fisheries accounted for 76% of the statewide net economic value, $69 million was associated with the portion of the Great Lakes assigned to New York. Comparisons with a 1996-1977 analysis of the net economic value of New York's Great Lakes fishers, which used a variation of the indirect travel cost methodology, showed a major shift in net economic value from trips for warmwater species to trips for coldwater or for both warm and coldwater species (Connelly and Brown, 1991).

- Lichtkoppler (2001, in preparation) reports results of the 2001 Sport Show Survey conducted by Ohio Sea Grant. A number of items related to management for sustainability received high priority ratings from more than 500 self-selected respondents. Seventy-eight percent of the respondents were male, and 62% were boat owners. On a scale of 0-6 with 6 being highest priority, their management priorities were:
    - Help elected officials understand the significance of Lake Erie issues (5.1)
    - Improve Lake Erie sport fishing (5.1)
    - Protect wetlands (5.2)
    - Restore coastal wildlife habitat (5.1)
    - Eliminate persistent toxic substances in the Great Lakes (5.4)

- Understanding differences and similarities between anglers and fishery managers can serve to inform and improve communication between the groups. Misperceptions about anglers' desires may lead to inappropriate management responses. (Connelly et al., 2000) compared the views of anglers who bought a license to fish in New York State in l996 with those of New York Bureau of Fisheries (BOF) staff and included a comparison among BOF staff to identify intra-agency differences. Fishing activities were similar between anglers and BOF staff, although BOF staff interests were more strongly linked to coldwater species and ice fishing. BOF staff and l996 anglers had similar preferences and opinions on many fisheries management topics and were

generally satisfied with the bureau's overall performance. Both BOF staff and 1996 anglers also rated their support for many fishery management actions similarly; however, some differences were noted. Compared to BOF staff, 1996 anglers more strongly supported (1) informing anglers about fish consumption advisories, (2) protecting endangered fish and aquatic species, (3) stocking trout in streams, and (4) maintaining walleye fisheries with stocking. BOF staff more strongly supported (1) developing areas on lakes and rivers for shore fishing, (2) maintaining a native muskellunge fishery (3) increasing public access to trout streams, and (4) increasing boat access to lakes, ponds, and rivers (Connelly, Brown and Knuth, 2000).

- A 1999 Texas survey collected data from 314 anglers via Internet. They posted the survey on the Freshwater Fishing section of the Texas Parks and Wildlife Department web site, which reportedly received up to 11,000 "hits" per month in 1999. Of the self-selected respondents, most (98%) were male, licensed Texas anglers (99%) with a median age of 40 years. Stocking fish was reported by 44% of respondents as an action the Texas Park and Wildlife Inland Fisheries could take to ensure excellent fishing. The most frequent response for improving fishing (34%) was regulating personal watercraft. Respondents most frequently reported (43%) that the number of available fishing sites was the thing they liked about fishing in Texas. Personal watercraft was mentioned most frequently (30%) by respondents as something they disliked about fishing in Texas (Smith and Kurzawski, 2000).

Issue 9: Promote resource stewardship.

- A statewide survey of fifth and ninth graders' knowledge about and attitudes toward the oceans and Great Lakes was administered in Ohio in 1979, 1983, and 1987, offering a longitudinal study of awareness change currently unparalleled in environmental education research. Over the years of the study, knowledge scores increased slightly (to 38% and 48% in 1987 respectively) except for humanities items. Earth science topics showed the greatest deficiencies among the science items, and attitudes about the ocean declined over the period. Differences in knowledge scores by race, sex, and coastal proximity, noted in earlier tests, were insignificant by 1987. The 1987 assessment also showed classrooms to be the most important source of student information, as opposed to movies and television for the students tested in 1979 (Fortner and Mayer, 1991).

- The Great Lakes Education Program (GLEP) includes vessel-based education. An evaluation of the knowledge and attitude outcomes for 4th graders in this program revealed that 945 students gained significantly in knowledge about the lakes. Comparison groups that did not have the experience did not change in knowledge between pre- and post-tests. As for attitudes, girls increased significantly, whereas boys did not. The authors note that boys reported much more experience with the lakes and fishing prior to the program than did girls, and they suggest the boy's attitudes may be attributable to an evolution of attitudes over time (Williamson and Dann, 1999). Some examples of changes in correct answers of the treated group between pre- and post-tests are:
  - Drainage of the Great Lakes watershed through St. Lawrence: 44 - 58%

- Exotic species (zebra mussel): 44 – 51%
- Use of plankton net: 52 – 92%
- Reasons for loss of wetlands: 64 – 78%
- Definition of plankton: 71 – 90%

Another evaluation of the GLEP program focused on teachers. Over 86% of 106 evaluation participants, indicated that they planned to continue to take part in the program. Prior to GLEP training, more than 50% of the teachers indicated that they knew little about most Great Lakes topic. Most also lacked confidence that they could teach more about the Great Lakes after GLEP without additional assistance (e.g. through training).

The final GLEP evaluation sought to determine the secondary effects of this program on participating students' parents. These parents (n=179) were found to have significantly higher responsible environmental behavior intentions than parents whose children did not participate. No differences between the groups were found in knowledge tests and attitudes.

- Baseline information about public knowledge of the Great Lakes was collected from two groups in an urban lakeshore area (Table 2-1). Questionnaires were completed by 570 shoppers in two Cleveland, Ohio, shopping malls during April, 1989. This "general public" study revealed that knowledge about the Great Lakes is low. In January 1990, the survey was repeated at a regional boat show in Cleveland, with 425 respondents. Respondents who cited newspapers or lake experiences as their primary source of Great Lakes information were most knowledgeable about the lakes. Boat show respondents ("recreational users") outscored the general public (Table 2-1) on both knowledge and vocabulary related to Great Lakes issues (Fortner, Mayer, Brothers, and Lichtkoppler, 1991).

Table 2-1. Knowledge item topics and percentage of respondents choosing correct answer.

Item Topic	% correct	
	Gen.Publ	Recr.User
Reason to protect estuaries	76.3	58.0
Fish endangered by loss by spawning areas	60.4	69.2
Marshes disappearing by filling in for construction	42.1	67.8
Why sea lampreys were a problem in the lakes	52.5	61.5
Fish advisory in Lake Erie on carp	67.2	43.2
Fish cooking to reduce contaminants	44.2	76.9
Human exposure to hazardous chemicals through fish	36.6	60.0
Importance of Lake Erie in food fish production	49.2	82.7
Nutrients monitored to prevent algae blooms	69.1	42.5
Major source of phosphorus in lakes	16.5	39.9
Phosphorus level changes in last 15 years	15.8	34.7
Definition of eutrophication	45.0	28.0
Air transport of toxicants to upper lakes	10.3	6.8
DDT problems from air transport	11.4	7.7
Management difficulty because of number of governments	49.2	71.7
IJC to oversee uses of Great Lakes	19.3	35.3
Meaning of ecosystem approach	38.7	71.1
Economic value of water-based recreation/tourism	20.4	14.3
Economic value of fishery	13.4	36.1
Great Lakes' share of North America's fresh water	37.8	37.3
Greatest consumptive use of water (municipal)	29.3	49.3
Effect of proposed diversions of lake water	34.3	44.4
Nuclear power plants use lake water for cooling	60.8	35.8
Most economical method of shipping goods	75.5	95.5
Main products shipped on Great Lakes	77.1	96.5
Deposits of salt and natural gas under Lake Erie	68.7	87.5
Fruit crops related to lake climate	16.4	28.2
Most common shoreline use (residential)	26.1	35.0
Waves cause most shore erosion	55.9	41.6
Dredging stirs up hazardous wastes	56.2	44.1
Cause of seasonal changes in lake levels	59.3	67.6
Mean	43.6%	56.0%

(Source: Fortner, R.W., V.J. Mayer, C.C. Brothers, and F.R. Lichtkoppler. 1991. p.398. Underlined items are related to fisheries issues.)

- Science teachers in the Lake Superior counties of Minnesota were questioned about their knowledge of 22 topics related to Great Lakes and general fresh water issues. The teachers reported their priority for teaching the topics, and level at which they were currently teaching them. Discrepancy analyses demonstrated the areas of greatest need for educational programming, those topics for which priority was high but knowledge was low. The authors recommended teacher in-service education and/or curriculum development to address the discrepancies (Figure 1).

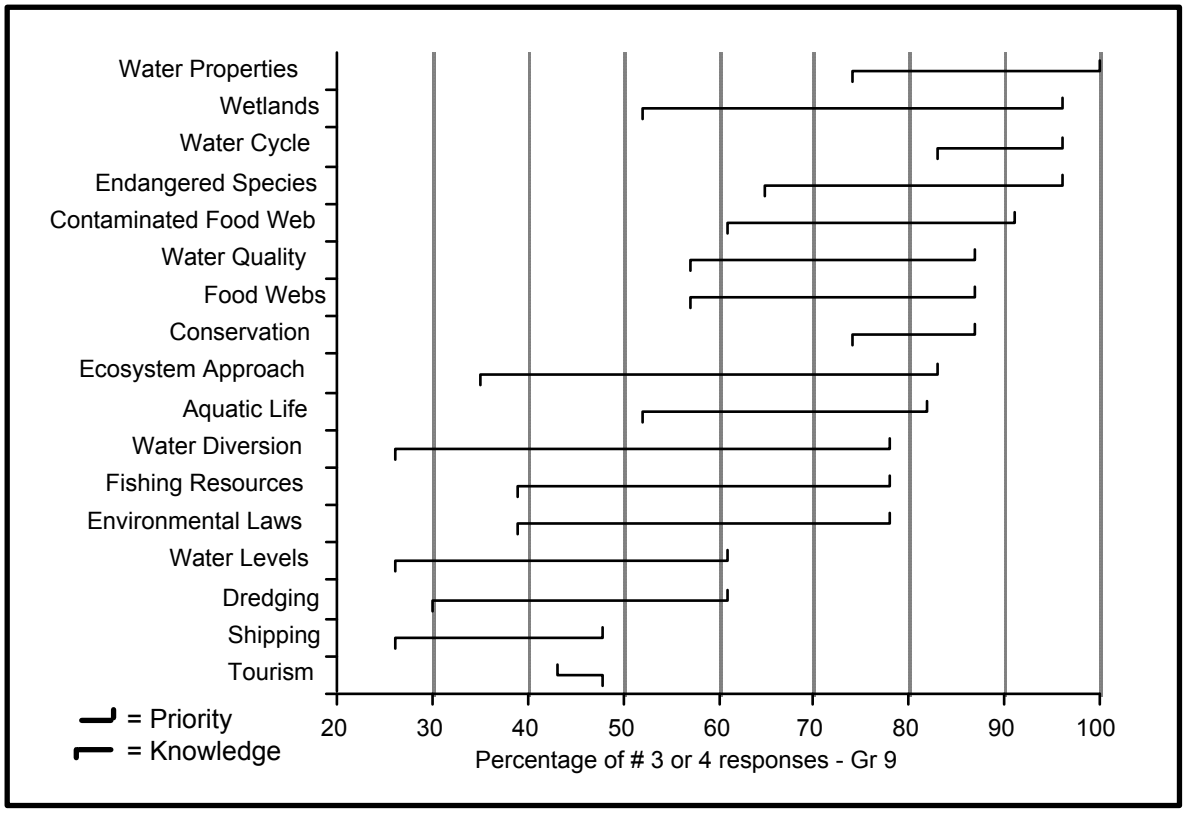

Figure 1. Discrepancies between Minnesota science teachers' knowledge and priority for teaching certain Great Lakes and fresh water topics (from Fortner and Meyer, 2000)

- Middle school science teachers (N=300) throughout the Great Lakes region were asked to rate Great Lakes topics for their priority in teaching, teacher knowledge of the topic, and level of current teaching about it. Only two of the 22 topics, Water Cycle and Environmental Responsibility, were reported as being taught somewhat or taught thoroughly by at least 2/3 of the respondents. These two topics, plus Water Uses and Conservation, Aquatic Food Webs, and Water Quality were the top five best understood by the teachers, with 80% or more considering themselves adequately prepared or very knowledgeable about each (Fortner and Corney, accepted).

- A 1993/94 study (Zint 1996) of Michigan, Ohio and Wisconsin grades 6-12 science teachers found that slightly over half (n=579; 52%) of the teachers who responded to a mail questionnaire reported that they used a variety of Great Lakes examples to teach science. The two most frequently used examples were related to contaminants in fish and toxic pollution whereas the least popular topic was water diversion (Table 2-2). Also, most science teachers indicated that they were interested in teaching about the Great Lakes using a variety of examples in the future. Great Lakes examples of most interest to science teachers were toxic pollution, drinking water, habitat loss and contaminants in fish whereas the least popular topic was recreation (Table 2-2).

The most frequently identified constraint to teaching about the Great Lakes was a lack of materials (Table 2-3). Other important constraints were that science teachers felt they could not take their students on field trips, and that they lacked the preparation time, background, training, and knowledge of how to incorporate Great Lakes education without dropping another important topic. In contrast, few science teachers felt that their subject or grade was inappropriate or that their school did not support Great Lakes education. Lack of materials and training were also frequently identified constraints to Great Lakes education. Only 39% (n=446) were aware of Great Lakes education materials [with 56% (n=249) of these 446 science teachers actually identifying any specific resources] and only 15% (n=193) have ever participated in a Great Lakes education related in-service. However, many (n=1,018, 79%) science teachers indicated that they would participate in a Great Lakes related in-service if provided with the opportunity.

Table 2-2 1993/94 Science teachers' interest in using Great Lakes examples

Great Lakes example	Used in Past %	Interest in Future %
Contaminants in fish	84	88
Toxic pollution	84	92
Drinking water	78	90
Habitat loss	74	88
Other pollution	68	85
Exotic species	66	68
Eutrophication	57	69
Recreation	48	56
Fisheries	48	65
Energy generation	47	76
Water levels	47	71
Water diversion	38	67

Table 2-3. Perceived barriers by 1993/94 science teachers to Great Lakes education

Barrier	%
Do not have materials	87
Can't take field trips	78
Not enough prep time	74
Do not have background	74
Do not have training	73
Other things more important	62
Not appropriate for subject	18
Don't have school support	11
Not appropriate for grade	8

- Responses to a *Star Tribune*/KSTP-TV Minnesota Poll showed that more than twice as many said lake water quality has deteriorated in the past 10 years as say it has improved. Most regular users of the lakes, however, seem unaware of any deterioration in the lakes (Minneapolis *Star Tribune*, July 14, 1991).

- Studies conducted since 1967 show that a large majority of Minnesota's citizens think pollution of the state's waterways is a serious problem. The portion of concerned citizens was found to be 76% in 1967, and 87% in 1991. The poll was repeated in 1999 with 829 adults, 79% of whom responded as in the previous surveys (*Star Tribune*, July 10, 1999).

- According to a survey conducted by the U.S. EPA Great Lakes National Program Office, nearly 80% of responding adults in the region expressed concern about the Great Lakes environment and 48% rated the water quality of the Great Lakes as fair or poor. About 35% felt that unsafe fish (for human consumption) and exotic species are the major problems (Health Education Research, Inc., no date but 1990s indicators).

- RAP (Remedial Action Plan) awareness interviews were completed for 600 randomly dialed Brown County households, Green Bay, Wisconsin, as well as Brown County residents who were purposefully selected from Wisconsin Department of Natural Resources lists of current holders of boat registrations (50 respondents) or fishing licenses (59 respondents). Of the 709 interviews, 484 respondent households indicated that they had used the area of concern by either swimming or fishing in, boating on, or hiking, camping or picnicking on the shore of the lower Fox River or lower Green Bay during 1989. Only 21% of respondents indicated that they had heard about the RAP. Community influentials had predicted 22% would be aware of the RAP. This high level of agreement between sample survey results and perceptions of community leaders suggests that there is regularity and predictability to the environmental awareness and rehabilitation process. Only 1% of the respondents felt that they were very familiar with the details of the Plan and 8% felt that they were somewhat familiar with the details. Among those who had heard of the Plan the sources of respondents' first information about it and the percent of respondents identifying that source are: newspapers (12%), television (4%), word of mouth (1%), clubs or organizations (1%), and radio and school (less than 1% each). One percent did not remember where they first heard of the Plan. Clearly efforts to disseminate information about the Remedial Action Plan among County residents have not succeeded (Baba, Johnson, Knapp, and Smith, 1991).

- Results of the 2001 Sport Show Survey by Ohio Sea Grant indicate that about 450 respondents (primarily males, boat owners) use newspapers, magazines, and friends as their primary information sources (importance of the medium 4.2 of 6 possible). This survey had the first instance of Internet as an information source about the Great Lakes, with the respondents indicating that it rated 3.4 on the importance scale of 0-6. The internet rating was equal to that attributed to museums and nature centers, and greater than boating organizations (Lichtkoppler, in preparation).

- Findings from survey research show reasons for both pessimism and optimism in terms of protecting the oceans. Essentially, Americans have little knowledge of ocean functions, but there is broad awareness of the oceans' vulnerability. However, people do not generally perceive the oceans to be in immediate danger. Fully 92% of

Americans agree or strongly agree that the oceans are essential for human survival. However, only 21%of Americans know that oceans produce more of the earth's oxygen than forests. Indeed, the survey reveals that people's existing concern for the oceans has little to do with specific knowledge of the major role oceans play in producing the oxygen we breathe, regulating the world's climate and providing habitat for countless forms of life. The authors recommended connecting people to the oceans through their values and aesthetic appreciation before attempting to get them to focus on ocean problems (Mott and Boyle, 2000).

- By greater than a 4-to-1 margin, Americans believe ocean exploration is of more vital national interest than space exploration. According to a poll of 1300 adults conducted in May 1996 by SeaWeb, 58% say the condition of the ocean has deteriorated, 52% view the destruction of the ocean as a very serious threat to the quality of life today, and 62%view it as a serious threat ten years from now. More than 70% agree that overfishing is threatening the health and stability of the marine environment. At a time in our political history when most Americans question the role of government, a surprising 85% of Americans believe the Federal government needs to do more to protect the ocean. And, perhaps most dramatically, 98% of Americans say we have a responsibility to protect the ocean so future generations can enjoy them (SeaWeb, 1996; updated regularly by Internet).

- The Chesapeake Bay Foundation (CBF) is the largest regional conservation organization in the country and is known for its grades 5-12 youth and K-12 teacher environmental education programs. These programs include six types of field trips for youth, five middle school curricula, three restoration projects, a student "alumni" program, and teacher training workshops and courses. The CBF education program's outcomes were assessed by examining to what extent the different programs resulted in changes in characteristics associated with environmentally responsible behavior (Hungerford and Volk, 1990). Youth and teachers who participated prior to and during 1998 were sampled. Data were collected through pre/post/retention-tests, mail surveys, and focus groups. Evaluation participants included 3,403 youth and 772 teachers. Results supported improvements in knowledge of ecology, issues, and actions, as well as skill in actions, environmental sensitivity, personal responsibility, locus of control, and intention to act. There was also evidence that environmentally responsible actions increased as a result of participation in CBF education programs (Zint and Kraemer, 2000).

- **According to a recent survey by the Roper polling organization, 2/3 of the American adults (N=1505) responding to telephone interviews in 1997 demonstrated a basic lack of knowledge about pollution, energy and waste disposal. Only 23% correctly answered that the greatest source of water pollution is runoff, while twice as many blamed water pollution on factories. The number of correct responses to this item increased a bit by 2000 when the survey was repeated, but still did not include 1/3 of the respondents. In spite of their own lack of knowledge (average score 30% on a 10-item test of knowledge), 95% of the adults support environmental education in the schools. A growing number**

also believe that corporations and business places should offer adult environmental education. Surveys are repeated annually as the "National Environmental Report Card" (National Environmental Education and Training Foundation, 2001).

Issue 10: Promote responsible recreational fishing.

- The recreational aspects of fishing are not considered appropriate material for classroom education, as teachers in a Great Lakes regional study rated that hobbies and careers related to the Great Lakes were among their lowest priorities for their students (Fortner and Corney, accepted; Zint 1996). However, some aspects of stewardship that are key to sustainable recreational fishing may have a place in the interdisciplinary models of science curriculum restructure (Fortner, 2001).

- Efforts of the Recreational Boating and Fishing Foundation produced a project on "Best Professional Practices in Fishing, Boating and Stewardship Education," which assembled experts in various related fields and synthesized their thinking on this issue (Fedler and Matthews, 2001). While the project has not reported new data, the synthesis is worthy of note, as it presents guiding principles for stewardship education, as well as best practices for
    - Program development and implementation
    - Professional development
    - Program evaluation
    - Research.

- The efficacy of fishing regulations relies on anglers knowing and understanding regulations as well as their ability to identify fish correctly. While the legal harvest of both bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus claeki lewisi*) has been restricted or eliminated in west central Montana to restore these native populations, anglers unintentionally may be harvesting these trout because of an inability to identify them. The researchers studied the ability of 681 anglers to identify 6 salmonid species commonly found in west central Montana and found that 44% correctly identified bull trout, and 76% correctly identified westslope cutthroat trout. Overall, anglers correctly identified salmonid species 63% of the time but frequently confused related species. Resident and more-experienced anglers identified salmonid species better than nonresident and less-experienced anglers, respectively. Managers must develop ways to give anglers identification skills and help them abide by regulations in order to accomplish management and restoration goals (Schmetterling and Long, 1999).

Issue 11: Develop an awareness of fisheries as a profession and help prepare youth for careers in this profession.

- According to Gigliotti and Decker (1990) most New York Bureau of Wildlife (BOW) staff considered human dimensions education/training important for their job. However, only about 12% of BOW staff had taken a human dimensions course and

about 19% had attended in-service human dimensions workshops or seminars (2.5% of the staff had taken both pre-service and in-service human dimensions training). Also, about two-thirds of BOW staff expressed a desire for additional human dimensions education/training.

- A study by Shanks and Decker (1990) of wildlife professionals, about half of whom were New York State Department of Environmental Conservation staff, reported that 95% of the wildlife professionals thought communicating with the public, which is one of the primary functions for application of human dimensions information, was a moderate to very important part of their job, emphasizing the importance of human dimensions to the wildlife profession. Considering the importance of human dimensions skills for wildlife managers it seems reasonable to expect that human dimensions should be included as part of the pre-service education of wildlife managers. This study found that 28% of wildlife professors who responded reported availability of a human dimensions course for wildlife majors. With many wildlife managers and other agency staff recognizing the importance of human dimensions training for their jobs, and with the increasing visibility of human dimensions research in the wildlife literature, more departments with wildlife course curricula at colleges and universities across the U.S. will likely respond to this need. An agency can accelerate this process by making it known that it is interested in wildlife majors having education in human dimensions.

  Although human dimensions courses improve understanding of some aspects of human behavior, they are typically located outside the natural resources departments and serve a broad range of disciplines, therefore they are not likely to focus on natural resources issues. Also, students may not be able to make the connections between basic principles and what to do in actual wildlife management situations. Some wildlife professors integrate human dimensions into their regular wildlife courses. Indeed it appears that human dimensions topics are covered in many wildlife and natural resources management courses. In this study, wildlife professors listed 99 courses which had varying amounts of human dimensions coverage with an overall estimated mean of 20% of the course devoted to human dimensions topics. However, this coverage may not adequately substitute for a specific course with a human dimensions focus, particularly considering that topic areas listed by the wildlife professors ranged widely (Gigliotti and Decker, 1990).

- The career aspects of fisheries are not considered appropriate material for classroom education, as teachers in a Great Lakes regional study rated that hobbies and careers related to the Great Lakes were among their lowest priorities for their students (Fortner and Corney, accepted).

- Knowledge level and inclusion of a topic in teaching are found to be so closely related ($r = .91$ in grade 5 and $r = .94$ in grade 9, $p < .01$) that the two variables can be discussed as a single measure. In general, those who are knowledgeable about topics also rank them as priorities for their classes ($r = .75$ in both grades, $p < .01$). To introduce career information into teaching, making teachers aware of its importance

and knowledgeable about its processes, may allow entry into the curriculum (Fortner and Meyer, 2000).

- Geographic information systems (GIS) technology is rapidly becoming a management and research tool for fisheries professionals. Fisher and Toepfer (1998) surveyed fisheries programs at 42 U.S. universities about their training in GIS and uses of GIS in fisheries research; twenty-four universities (56%) responded. The survey revealed that fisheries students who use GIS take introductory and advanced GIS courses offered in earth science departments at their universities and/or seminars on applications of GIS in natural resources offered in their departments. A core of GIS courses is available at U.S. universities for fisheries students interested in developing this expertise. On average, 21-40% of fisheries faculty and students indicated they occasionally used GIS in their research. The most common fisheries-related uses of GIS were mapping and modeling fish distributions and aquatic habitats (46%), and evaluating the effects of watershed land use on fish population, communities, and habitats (22%). In addition to traditional descriptive applications of GIS for mapping fish distributions and aquatic habitats for research and management purposes, there is potential for prescriptive fisheries applications in areas such as modeling and forecasting changes in aquatic habitats, estimating fish population abundances in unsampled areas, developing fisheries sampling designs, and integrating human population trends with biological and aquatic habitat trends (Fisher and Toepfer, 1998).

- Kohler and Wetzel (1998) mailed survey instruments to 135 faculty and 69 student members of the American Fisheries Society Education Section residing in North America to obtain a preliminary assessment of the mentoring process for new professionals. Results indicate that the process, though working satisfactorily, could be improved. Expectations of doctoral students appear to be met, but master's degree students indicated several areas where advisors were falling short. In particular, many advisors may not be providing their students with sufficient direct training and/or opportunity to receive training in research methodology. Faculty advisors consistently rated doctoral students higher than masters students in mentoring interactions, but both master's and doctoral degree students were rated relatively low by faculty advisors in the areas related to membership and involvement in student and professional organizations. Recognition of areas where advisors and students can improve their mentor-mentoree relationships is an important step toward enhancing graduate education. Opening further the lines of communication between faculty and students is a crucial step toward improving graduate fisheries education (Kohler and Wetzel, 1998).

- The productivity environmental preference survey (PEPS) was mailed to fisheries programs at six academic institutions in the U.S., and 38 surveys were received from graduate students. The results showed the individuality in learning styles. PEPS scores were highly variable for elements in the modality, physical, and environmental categories. The surveyed students seem to be tactile learners who preferred hands-on projects (Guy and Denson-Guy, 1998).

- A survey of fisheries biologists employed 1-6 years with the USDA-Forest Service found that the majority (72%) had mentors. Results confirm the hypothesis that mentors play an important, positive role in career development and job satisfaction of most young biologists. The roles these entry-level professionals said they needed their mentors to fill were to:
    1) help develop values/ethics (3.2, where 1 means highest and 9 means lowest),
    2) encourage achievement of professional and/or career potentials (3.8),
    3) be a role model (4.2), and
    4) sponsor Forest Service advancement (6.2).

  Survey respondents felt most of their mentors adequately fulfilled these needs, and those with mentors consistently expressed high job satisfaction and optimism about future Forest Service careers (Kennedy and Roper, 1990).

- Youth should be aware not only of the range and benefits of careers, but also the concerns of those holding responsible positions in chosen areas. According to Ohio Sea Grant surveys of charter captains conducted in 1985 (N = 107) and 1990 (N = 191), poor weather was reported by 40% and 79%, as a major concern. Other issues were related to conditions of the fishery caused by behavior of others (stewardship issues), economic constraints, and natural factors beyond individual control. Concern about the impact of exotic species (zebra mussels) was the only other item reported as a problem by more than half of the responding captains in 1990. Other primary concerns involved lack of fish (47%), illegal fishing practices (44%), and poor weather forecasting (35%) (Lichtkoppler and Hushak, 1995).

Table 2-4. Frequency of charter fishing captains' major concerns

Lake Erie Concerns	1985 (%)	1990 (%)	Change
Poor weather conditions/climate	40	79	+39
Impacts of exotic species (zebra mussels etc.)	-	58	+58
Lack of fish / fish abundance was down.	19	47	+28
Illegal fishing practice	29	44	+15
Poor weather forecasting	62	35	-27
Boating equipment and operating costs	46	34	-12
The economy	10	33	+23
Unsportsmanlike behavior of captains/anglers	51	27	-24
Overcrowding the fishery	46	26	-20
Toxic contaminants	-	24	+24
Drawing clients	27	21	-6
Lack of information on the fishery	14	16	+2
Fish consumption advisories	-	14	+14

Public opinion surveys on fish consumption advisories

Studies on this topic are reported separately here because of their relatively large number and because relevant concepts are covered under a variety of the issues in the literacy goals.

- A survey was conducted among residents of the Lake Champlain basin. Respondents' knowledge of health advisory information was assessed using 14 questions which

measured knowledge in each of the following six areas: effects of contaminants on fish, negative health effects of fish consumption, positive health effects of fish consumption, risk-reducing behaviors, advisory recommendations, and advisory process. For the questions measuring effects of contaminants on fish, negative health effects of fish consumption, positive health effects of fish consumption, and risk-reducing behaviors, few respondents had inaccurate knowledge but a fair proportion (29 - 55%) were unsure about the correct answers. For the questions measuring knowledge of the advisory recommendations and advisory process, over one-third of respondents were incorrect in their answers. An exception was an item about who to contact for information about contaminant levels in fish.

Differences in knowledge were associated with various sociodemographic characteristics. Most notable were higher percentages of unsure respondents among women, younger respondents, and those with lower income and education levels for questions on the effects of contaminants on fish, negative health effects of fish consumption, and risk- reducing behaviors. Men, older respondents, and those with higher income and education levels were more likely to be correct in their knowledge of these areas. Rural residents of the Basin were more likely than urban residents to know that pan frying does not reduce contaminants. However they were also more likely to believe that broiling does not reduce contaminants, when in fact it may reduce certain contaminant levels in fish (e.g., PCBs, but not mercury). Older respondents were more likely to know about the positive health benefits of fish consumption. Respondents who came from households with women of childbearing age or children under 15 were more likely to be sure of their knowledge of advisory recommendations, but that knowledge was just as likely to be incorrect as correct (Connelly and Knuth, 1995).

- The health of the Lakes' fish is a good clue to the health of the whole system. In 1993, two-thirds of the nation's 1,279 fish consumption advisories were issued in the Great Lakes region, mostly because of the presence of mercury, PCBs, chlordane, dioxins, and DDT (Abramovitz, 1995).

- Based on a 12-month diary methodology, anglers who fished Lake Ontario consumed an average of 30 fish meals in 1992, of which 28% were sport-caught. Virtually all diary participants (>95%) who fished Lake Ontario in 1992 said they were aware of the New York State health advisory. However, 36% of 1992 Lake Ontario anglers consumed fish in excess of the recommended fish consumption limits. Ninety percent of those who actually consumed over the limit said they believed their consumption was within the limits. These anglers may have believed that use of risk-reducing cleaning techniques decreased their risk sufficiently to allow increased consumption of listed species (Connelly, Knuth, and Brown, 1996).

- All states in the Great Lakes region of the U.S., as well as the Canadian province of Ontario, issue some form of public health advisory to warn sport anglers about potential risks from chemical residues in fish. Most of these advisory programs tell anglers which sites have been monitored and found to contain fish with unsafe levels

of chemical contaminants. Only two of the programs tell anglers which sites have been monitored and found to be safe. A contingent valuation study ($N = 951$) of Michigan anglers concludes that more than 86% of survey respondents report having read the advisory and anglers are willing to pay little for continuation ($5.63) or expansion ($0.0046 per added site) of an advisory program that does not inform them of safe sites. They are willing to pay a substantial amount, however, for a program that tells them about relatively safe sites (Krieger and Hoehn, 1998. Tables 2-5 and 2-6 below.)

Table 2-5. Anticipated behavioral responses to differing advisory information, adapted from Krieger and Hoehn, 1998

Behavioral response	Response (%)
Favorite species and site listed as unsafe	
Fished at different sites	36
Continue to fish at the site and …	
Not eat the fish	25
Not change behavior	15
Eat fewer fish	14
Stop fishing	9
Full-disclosure advisory and favorite site not monitored	
Continue to fish at favorite site	68
Select new sites from known safe sites	54
Fish only at safe sites	17
Stopped eating fish from favorite site	16

Table 2-6. Frequency of reported behavioral responses to the current advisory, adapted from Krieger and Hoehn, 1998

Behavioral response	Response (%)
Prepare fish to eat differently	32
Eats fish less often	24
Eats smaller fish	18
Fished at different sites	16
Eats different species of fish	15
Stopped eating fish	5

- More than 5 million U.S. anglers and their families catch and eat Great Lakes fish, according to a 1993 survey by U.S. Public Health Service and the Wisconsin Department of Public Health. The survey showed that 50% of these anglers are not aware of contaminated fish warnings. Of special note is that two out of three female anglers and four out of five minority group anglers are not aware of fish advisories (Sierra Club, 1997).

- A poll ($N = 600$) by EPIC/MRA of Lansing shows that only one out of four Michigan adults surveyed believe it is safe to eat Great Lakes fish as often as once or twice a week or more. Eighteen percent say it is never safe. Women are more conservative

than men: 51% said the fish should be eaten only a few times a year or less often, compared to 39% of men. “What those numbers tell us is that most people know they are supposed to remember something about Great Lakes fish consumption, but they are not sure what they are supposed to remember” said EPA spokesman Mick Hans. Rep. Mary Schroer said that “People are saying, 'I’m just not eating any fish' and that is not good for the fishing industry” (Hoffman, 1997).

- According to Connelly et al., 1990, most fish caught by Lake Ontario anglers are released (49%) and some (2%) are discarded, but a substantial amount is eaten (23%) or given away (17%), presumably to be consumed by someone else, another potential audience for advisories. Different communication strategies may be needed for the variety of clientele that advisories seek to reach. Based on the statewide (New York) angler survey, out-of-state anglers in particular were more reliant for their information about contaminants on the fishing license regulations guide and on information they received from charter boat operators than were in-state anglers. New York City and Long Island anglers, a rather urban clientele, relied more on posted warnings at fishing sites and access points to learn about advisories than did anglers statewide.

  One-quarter of licensed anglers who fish Lake Ontario were unsure if they fish in waters where contaminants are a problem (Connelly et al. 1990). This implies either a lack of knowledge regarding where contaminants are found or a potential disbelief that Lake Ontario waters do indeed contain contaminated species. In any case, the implication is that anglers may be exposing themselves to undue hazards because of lack of knowledge or lack of trust in the sources of information available to them. Further, even though anglers have heard about or read the advisory, they may not understand or believe the information. Some licensed anglers who fish Lake Ontario for species listed on the advisory were unsure if they fish for potentially contaminated species (23%), or believed they usually fished for species in which contaminants are not a problem (28%) (Connelly et al. 1990).

- A majority of Lake Ontario anglers have made changes in their fishing or eating habits to reduce their risks from contaminants in fish (Connelly et al. 1990; Springer 1990). Changes have included switching species or sizes of fish sought, fishing less, changing locations fished, and taking more fishing trips because of a greater feeling of confidence about the relative safety of different water bodies. Anglers can adopt those risk-reducing behaviors without the disruption in their life-style that would come from heeding warnings simply to not eat any fish or not to fish in certain locations. While not eliminating their consumption of sport-caught fish, Lake Ontario anglers appear responsive to other risk-reducing recommendations offered by the state. They include the use of certain fish preparation and cooking methods that may reduce exposure to contaminants. On average, Lake Ontario anglers were more likely to use the risk-reducing methods of puncturing or removing fish skin and trimming ventral meat and dorsal fat than were anglers statewide (Connelly et al. 1990; Springer 1990).

Changes in eating habits made by anglers who become aware of a fish consumption advisory include eating fewer Lake Ontario fish, changing preparation or cooking methods used, eating no sport fish, and eating more sport fish because of a feeling of confidence about the relative safety of fish from particular waters (Connelly et al. 1990; Springer 1990). Again, informed anglers appear willing to make some behavioral changes that still maintain their familiar life-style but decrease the risk to which they are exposed. The response by Lake Ontario anglers regarding changes in cleaning or cooking fish indicates one successful avenue for information and education programs. Few anglers fished more or ate more sport fish, but this must be considered in light of the advisory existing at that time, which did little in the way of actually promoting or emphasizing those New York waters likely to be least affected by chemical contaminants. It does seem possible to encourage positive shifts in angler behavior, given the right information (Knuth, 1992).

- Knuth (1995) summarized how people responded to fish consumption advisories. (See her article for references cited here.) Behavioral compliance with advisory recommendations, based on reported fish consumption patterns, has varied from about 45% to 80% of various populations keeping their fish consumption within levels recommended in health advisories. About 34% of migrant farm workers interviewed lived with women and children who ate sport-caught fish not recommended in the advisory (Velicer and Knuth 1994). Throughout the Great Lakes Basin, about 25% of licensed angler respondents ate fish that advisories recommended should not be consumed (Connelly and Knuth 1993). About 54% of licensed New York Lake Ontario anglers of childbearing age (men and women ages 18-40) ate fish above levels recommended in the advisory. In New York State, 20% of licensed anglers statewide exceeded the advisory recommendations (Connelly et al. 1992). This group, however, tended to be as knowledgeable about the advisory as other fish consumers, but more likely than others to (1) believe that the health risks associated with fish consumption are minor compared to other risks, (2) believe the health benefits are greater than the risks, and (3) have adopted risk-reducing fish cleaning and cooking methods (Knuth, 1995).

- A sample of 30,000 licenses was drawn from resident fishing licenses sold between October 1, 1990, and February 1, 1991, by the New York State Department of Environmental Conservation. The sample included only fishing licenses that had been purchased by individuals aged 18-40 (reproductive years) in any of 16 counties in close proximity to Lake Ontario and its tributaries. Of the 30,000 questionnaires mailed, 612 were undeliverable and 11,717 completed questionnaires were returned, resulting in an adjusted response rate of 40%.

  Awareness. Over 90% of mail questionnaire respondents were aware of the New York health advisory. Advisory awareness increased with age, with years of education, and with income. Female anglers were less aware of the advisory (87%) than male anglers (93%). Non-white anglers were less aware of the advisory than white anglers, with black anglers exhibiting the least awareness (75%).

Sources of information. Respondents who were aware of the health advisory cited the Fishing Regulations Guide (82%), newspaper articles (83%) and friends (81%) most frequently as advisory information sources. Use of the Guide and newspapers was more common among those with higher income and higher age; use of the Guide was more common among those with more years of education. Use of friends was more common among the younger age groups. Television or radio were cited as information sources by two-thirds of respondents, more commonly by women and those with less education.

Health advisory knowledge. Overall knowledge was high on questions dealing with the negative health effects of fish consumption (>70% correct), whereas accurate knowledge of the advisory recommendations was generally low (25-53% correct). Those aware of the advisory were most likely to answer incorrectly a question about the maximum number of fish meals from any New York State water that the state recommends as a consumption limit. Respondents using the Fishing Regulations Guide as a source of information were the most likely to select correct answers for each of the knowledge questions. Knowledge scores tended to increase with increasing age, income, and education. Men had a higher average knowledge score on advisory recommendations than women, although one of the knowledge questions focused specifically on the special advisory recommendations for women of childbearing age. Lake Ontario anglers were more likely to be aware of the health advisory but less likely to answer the knowledge questions correctly than anglers who fished only other waters. Lake Ontario anglers were more knowledgeable than other anglers about the special "eat no fish" recommendation for women of childbearing age and children (Connelly, Knuth, and Vena, 1993).

- A sample of 8,000 licensed anglers was obtained from all Great Lakes states. Any license that permitted fishing (i.e., resident annual, resident short-term, nonresident annual, nonresident short-term) in 1989-90 was considered for inclusion in the sample. The majority of respondents who had fished the Great Lakes in the preceding five years were aware of the health advisories (83%). As in other studies of health advisories, awareness differed by socio-demographic characteristics. Hispanics and those with lower incomes were less likely to be aware of the health advisories. Advisory awareness also differed by waterway. For example, almost 95% of those who fished Lake Michigan or its tributaries were aware of the health advisory for Lake Michigan. In contrast, 39% of anglers who fished the St. Mary's River and 59% who fished the Niagara River were aware of the advisories for those waterbodies. Anglers listed the various states' fishing regulations guides and posted warnings as the two most important sources of health advisory information. A plurality of respondents (43%) favored the fishing regulations guide as the best vehicle to get health advisory information to them (Connelly and Knuth, 1993).

- Responses ($N = 373$) to a bilingual mail survey were used to assess factors explaining seafood consumption in a sample of Hispanics living in New York City, 97% of whom consumed seafood. Multiple regression analysis examined the roles of background characteristics (socio-demographic factors, Hispanic background

characteristics, past seafood experience) and beliefs in explaining the variation in three measures of seafood consumption: past 2-week frequency of all seafood and usual monthly consumption of non-canned and canned seafood. Background and belief variables explained more of the variation in consumption than did either type of variable alone for all three measures of consumption. Overall, explanatory factors for the non-canned and canned models differed. Household size was positively associated with all measures of consumption while country of origin was associated with two measures. Beliefs positively related to consumption were that seafood is healthy and nutritious, part of religious and family traditions, familiar to prepare, worth buying, and tastes good. Dislike for odor and touch and the belief that preparing seafood is too much trouble were negatively associated with consumption. Differences in belief and past experience were observed among the four main countries of origin represented: United States, Puerto Rico. Colombia, and the Dominican Republic (Weinstein, Bisogni, Frongillo and Knuth, 1999).

- A fish consumption health advisory has existed for New York Lake Ontario sport-caught fish since 1978. This study's objectives were to evaluate the effectiveness of the advisory for reaching potential target audiences and to identify appropriate advisory content, style, and dissemination methods using a risk communication planning model as an evaluation framework. A combination of mail surveys and personal interviews were used with three target audiences (opinion leaders among recreational anglers and charter boat operators, migrant farm workers, and low-income individuals) and two communicator groups (fishery experts and health care experts). The New York Lake Ontario advisory appeared to be successful in reaching and encouraging risk-mitigating fish consumption behavior in recreational angler opinion leaders and low-income individuals but not in migrant farm workers. The advisory may not be reaching two sensitive sub-populations, women of childbearing age and children. Communicators and target audiences differed in their assessments of important information to include in an advisory. The health advisory could be improved with additional information such as risk-reducing cooking and cleaning methods and by diversifying the dissemination methods to reach the variety of audiences who potentially consume Lake Ontario fish (Velicer and Knuth, 1994).

- Of the 53 children who were sent diaries in June 1996, all provided some information on their fishing activities during the study period and 52 provided information on their fish consumption. The diary data showed that children consumed an average of 4.8 fish meals from all sources during the diary period (July 1 - Oct. *15,* 1996). If meal size was factored in, an estimated 6.6 g/d of fish from all sources was consumed by children during the diary period. Of this 29% (1.9 g/d) was sport-caught fish and 38% *(2.5* g/d) was canned tuna. Estimates of annual daily consumption based on diary data were lower than during the diary period (4.2 g/d versus 6.6 g/d). The researchers assumed that daily consumption during the part of the year not covered by the diary was equal to the daily consumption of nonsport-caught fish in the last month of the diary, when sportfishing participation and catch were lowest. Almost all families (87%) whose children participated in the diary portion of the study said they were aware of the New York State fish consumption advisory. During the diary time

period, 8% of children consumed fish from waters where the advisory recommended no consumption for children under 15 years old. This represents 3% of all meals consumed by all the children we studied. The majority of fishing effort occurred during the summer months, when the children were not in school. Average fishing effort in July ranged between 1.5 weeks to once every two weeks. In the fall, average fishing effort was less than once a month. Children were generally not fishing the major waterbodies of New York State; the majority of waters fished were ponds or small lakes. On most days (71%)**,** children caught fish. The most commonly caught fish were panfish (Knuth, Connelly and Matthews, 1998).

- **Knuth, et al (1998) concluded their study with the following Discussion and Implications:**

  Risk communication: Although advisory awareness is high among the New York study population, knowledge of specific advice for women of childbearing age and children was lower. More risk communication effort could focus on highlighting information important to certain subgroups (e.g., families with children). Risk communicators could attempt to reach at-risk audiences through multiple channels to maximize the impact of their message. Risk communicators may be able to extend their own efforts by working through "information gatekeepers" such as SAREP, 4-H, Scout, and other youth group leaders to inform children and their families about safe fish consumption.

  Risk communication: Because children tend to fish smaller, local waters that may not be part of a water quality monitoring program, risk communicators should consider providing information in advisories about what to look for in local waterbodies to help an individual judge the potential for that waterbody to be contaminated.

  Risk assessment: Risk assessors and water quality managers should consider the findings that children tend to fish and eat fish from smaller, local waters. Risk assessors concerned with potential mercury exposure should note that canned tuna was the most frequently consumed fish, although overall consumption was relatively low (mean *2.5* g/d; highest individual consumption during the study period, 10.8 g/d).

  Fisheries management: One focus of fishery management efforts might be to enhance children's awareness of and access to waterbodies that may provide easily catchable fish, particularly panfish. Providing access for children to these types of waterbodies might be a focus of management efforts. Advertising where these areas are may raise awareness for children and their fishing partners.

  Use of diaries with children: Diaries appear to be a useful method for collecting fishing activity information from children. After cooperation by the family was secured, participation rates by children far exceeded those found for adults in other diary studies.

Future research needs: Further work is needed with a larger, more diverse audience of children, particularly to estimate fish consumption in urban areas where local waters may be more affected by contaminants. In addition, annual estimates based on year-round data collection would be useful (Knuth, Connelly, and Matthews, 1998).

Results - Highlights

Issue 1: Maintain and recover fisheries habitat.

- No survey found

Issue 2: Identify and reduce sources of pollution affecting fisheries habitat.

- Recreational water users (boaters and fishers) in Ohio place a high priority on Lake Erie water quality and elimination of persistent toxic substances in the Great Lakes.
- Many groups are working to improve local waterways by reducing pollution sources, but the only data to emerge in the literature relates to numbers of participants and extent of work done.

Issue 3: Prevent or control the introduction of non-native nuisance species (exotics).

- There is concern among various groups about this issue, and the concern varies across the region.
- In response to the issue, Great Lakes residents were willing to pay for research on exotic species, and 60% of teachers report adequate knowledge for teaching about it.

Issue 4. Address Great Lakes issues at the ecosystem and watershed level.

- The public does not appear to grasp the full meaning of "ecosystem," but most can describe what a watershed is. The literature does not address whether they associate water issues with things happening in the air or on land.
- Most middle school science teachers surveyed in the western sector of the Great Lakes basin felt that the Ecosystem Approach was a high priority for their students to know, but only 35% felt they had knowledge at a level to teach it.

Issue 5: Manage fishery diversity within the Great Lakes basin.

- Two willingness-to-pay studies showed that Great Lakes respondents would financially support the dredging and disposal of contaminated sediments from rivers and restoration of fish species.
- Two teacher surveys examined components of biodiversity as topics for teaching:
    - Minnesota teachers ranked endangered Great Lakes species as their 4th highest priority for teaching, and about 64% knew enough to teach about them.
    - Teachers throughout the region ranked Exotic Species as 12th priority out of 22 issues for teaching and learning.

Issue 6: Achieve and maintain sustainable sport and commercial Great Lakes fisheries.

- Three major reasons that people do not fish the Great Lakes involved distance from home, lack of necessary equipment, and fish contamination.
- Frequent comments on fishing from respondents included a desire for more fish to be stocked, for prohibition of overfishing, for stronger size restrictions and for education.

Issue 7: Native Americans have treaty fishing rights in the Great Lakes.

- No survey found

Issue 8: Manage for sustainable sport and commercial fisheries.

- Environmental managers assigned higher priority to goals associated with reestablishing native species, and lower priority to goals associated with satisfying anglers than did fishery managers. Managers within fishery, state, and Canadian agencies expressed stronger support for artificial system, utilitarian goals, economic benefits and anglers than did managers in environmental, federal, and US agencies.
- Compared to older anglers, active and educated anglers preferred regulations that were reservoir-specific regulations and preferred historically accepted regulations over agency objections.
- Priority for management activities varies by group. Anglers emphasized informing anglers about fish consumption advisories and protecting endangered fish and aquatic species, whereas Bureau of Fisheries staff more strongly supported developing areas on lakes and rivers for shore fishing and increasing boat access to lakes.
- Technology is beginning to expand the means of reaching people about fisheries issues, and a technological change is one of those issues. An Internet survey found that Texas anglers suggested managing personal watercraft as the best way to improve fishing.

Issue 9: Promote resource stewardship.

- The surveyed public in the Great Lakes region appears to have a great concern for water quality, the ocean's vulnerability, fish contamination, and exotic species. They are, however, unlikely to be knowledgeable of the environment in general, fisheries and marine issues and Remedial Action Plans (RAPs).
- More than half of 1,300 respondents think that the water environment has deteriorated; the destruction of the ocean or Great Lakes is a very serious threat to the quality of life. The majority of Americans believe that the federal government needs to do more to protect water environments, and individuals have a responsibility to protect water for future generations.
- American adults don't know much about the environment, but 96% of surveyed parents want their children to know about environment.

- A longitudinal study showed slight (but not significant) changes of fifth and ninth graders in knowledge of Great Lakes and marine topics among studies in 1979, 1983, and 1987. Results of a short-term study in the Chesapeake Bay area supported improvements in knowledge of ecology, issues, and actions, as well as skill in actions, environmental sensitivity, personal responsibility, locus of control, and intention to act. There was also evidence that environmentally responsible actions increased as a result of participation in education programs.
- Recreational users of the Great Lakes outscored the general public on both knowledge and vocabulary related to Great Lakes issues.

Issue 10: Promote responsible recreational fishing.

- Over one-third of respondents were found to be incorrect regarding fish advisory recommendations. More notable were higher percentages of uncertain answers among women, younger respondents and those with lower income and education level.
- A Montana study showed that anglers frequently confused related species. Programs for anglers should therefore focus on improving their identification skills. Without such skills, anglers are unable to abide by fishing regulations.
- Hobbies and careers related to the Great Lakes were seen by regional teachers as being of very low priority for school students to learn.
- Recent research by the Recreational Boating and Fishing Foundation offers best practices for aquatic resource education among diverse settings and audiences.

Issue 11: Develop an awareness of fisheries as a profession and help prepare youth for careers in this profession.

- Despite great acceptance of the importance of human dimensions knowledge, only a few wildlife staff had taken a human dimensions course or attended in-service workshops. About two-thirds of agency staff expressed a desire for additional human dimensions education/training.
- The self-reported knowledge levels of fifth and ninth-grade teachers regarding Great Lakes topics were found to be moderate and not significantly different between the two groups.
- On average, 21 to 40% of fisheries faculty and students indicated that they occasionally used GIS in their research.
- A survey of young fisheries biologists showed that mentors play an important, positive role in their career development and job satisfaction.
- Working conditions for charter captains include major concerns such as poor weather (79%), impacts of exotic species (58%), and lack of fish (47%).

Public opinion surveys on fish consumption advisories.

- More than 5 million U.S. anglers and their families catch and eat Great Lakes fish. About 50% of them are aware of contaminated fish warnings while 2/3 of women anglers and 4/5 of minority group anglers are not.
- A significant portion of the anglers who were aware of a health advisory consumed fish in excess of the recommended fish consumption limit.
- Only one of four anglers surveyed in Michigan believe it is safe to eat Great Lakes fish as often as once or twice a week or more. Eighteen percent say it is never safe. Most Michigan anglers are willing to pay more taxes for continuation of an advisory program.
- About a quarter of licensed anglers have eaten fish that advisories recommended should not be consumed. The Fishing Regulation Guide (82%), newspaper articles (83%) and friends are most frequently cited as advisory information sources.
- Most people know they are supposed to remember something about Great Lakes fish consumption, but they are not sure what they are supposed to remember.

Recommendations
Each topic below reviews
A) what we know,
B) what we don't know, and
C) what we recommend.

Continuing Comprehensive Surveys:

A) We know that surveys have been administered to limited groups in a few Great Lakes states regarding some selected fishery topics. To our best knowledge, no single comprehensive survey in terms of region and topic has been completed.

B) We do not know much about how people's knowledge of and attitude toward Great Lakes ecosystem and fisheries issues have changed over the last few decades. The lack of such knowledge makes it difficult for fishery managers and educators to decide how much additional future effort should be given to which groups and which topics.

C) To properly understand people's knowledge of and attitude toward Great Lakes fish and fisheries issues, a comprehensive survey should be carefully planned and systematically implemented every five years. A consortium among researchers and organizations needs to be established to cover a variety of groups such as K-12 students and teachers, anglers, decision-makers and journalists.

Follow-up Evaluations:

A) We know that many fisheries and Great Lakes education resources are available now to schools and the public. We also know how many students or adults have taken advantage of some of those resources.

B) We know little about how effective these resources are in enhancing learners' knowledge and promoting environmentally responsible behavior with respect to fisheries issues, and whether beneficial changes last. We need to know the quality of impacts of the programs, not just the number of participants.

C) To estimate and improve efficiency and efficacy of existing fishery education resources, evaluation criteria should be developed and applied as a completion requirement. This evaluation process can be conducted by program developers themselves or by a special group organized for this purpose.

Environmentally Responsible Behavior (ERB):

A) We know that many variables are involved in influencing behavior and it is a time-consuming task for educators and natural resources managers to encourage individuals to reconsider and change their behavior in an environmentally responsible way.

B) We don't know what barriers are preventing individuals from engaging in environmentally responsible behavior, especially in connection to Great Lakes environmental and fisheries issues, nor how we can help people overcome those barriers.

C) To promote environmentally responsible behavior, workshops/symposia should be organized, focusing on identifying major barriers preventing the public from engaging in ERB and developing strategies to overcome those barriers. Target groups of the symposia/workshops include fishery managers, teachers, municipal government, NGO staff, and environmental communicators in mass media.

Communication Strategies:

A) We know that adults generally obtain information about fish, fishing, fish consumption and other fisheries issues mainly from newspapers, friends, television and brochures. We also know that students depend for their information primarily on school activities, and teachers get most of their Great Lakes information from workshops. We know certain communication strategies work for delivery of Great Lakes information: adults learn from TV news programs, and students learn from teachers who have been in intensive in-service programs with innovative materials. Research on ocean awareness gives us the impression that concern for important bodies of water has little to do with specific knowledge of the water body. It is of great importance to connect people to the water through their values and aesthetic appreciation before attempting to get them to focus on issues.

B) Besides those in (A), we do not have experimental research showing how effective other known communication methods are in informing a certain group for a specific issue. For example, we do not know much about information gathering and processing patterns of minority groups, or the extent to which the Internet has become important as a source of Great Lakes fisheries information.

C) Research on effective communication strategies for various issues and target groups should be conducted and guidelines for selecting the best strategies should be

provided to fishery managers. General awareness of the values and aesthetics of water may be key to public understanding and acceptance of management practices. Considerable attention should be paid to how to deliver fishery information as well as what information should be delivered. Learning opportunities for social studies and communication skills through university courses and workshops should be available to fishery professionals. Possible strategies to test are:

A) TV news clips – put short ones on the Internet at GLIN and fish web sites for health information.

B) Speakers list for civic groups and schools.

C) Seminar series for public aquaria and science museums.

D) Service learning opportunities: suggested by fishery groups and implemented by NGOs, classes, etc.

E) Workshops for teachers on topics that fit their curriculum.

F) Match existing fisheries curricula to science education standards (or other subject standards) for states targeted, to assure greater chance of classroom use.

A Decision Approach to Fishery Education:

- We know that there is some consensus among fishery managers as well as policy makers on the importance of public participation in the establishment and implementation of Great Lakes fishery policy.
- We don't know to what extent the public is willing and has the ability effectively take part in such decision-making processes. It is unclear whether current fishery education programs adequately address the complexity and uncertainty associated with real fisheries issues, or whether specific fishery information is required for the public's responsible input to management.
- To enable both youth and adults to effectively participate in fishery-related policy-building processes, a decision approach should be adapted to fishery education. Such education programs and materials should utilize real fisheries issues that audiences face in their everyday life based on recent decision psychological findings. Strategies include
    - "Packaged" workshops (like Environmental Issue Forum, EIF) for use by NGOs in different regions.
    - Development of educational measures to give anglers identification skills and help them abide by regulations in order to accomplish management and restoration goals (Table 2-7).

Table 2-7. Matrix of agency needs for human dimensions research by planning and decision-making horizons, adapted to fisheries management.

Categories of human dimension inquiry	Information needs by planning and decision-making horizons		
	Broad	Comprehensive	Focused
Surrogate biology	Trends in effort for species groups, waterway types, and methods of fishing	Effort and harvest data to evaluate biological parameters of particular fisheries	Effort and harvest data to evaluate fishing regulations on particular waterways
User participation and interest profiles	Identification of total angling constituency and participation patterns for long-term access and other supply-side planning	Determine needs for shifts in programs based on changing clientele or changing interest profiles	Information on specific publics' socioeconomic characteristics and use of media so information and education programs can be designed appropriately
Administrative justification of programs	Total economic impact of fisheries for budget recognition in attempt to gain long-term funding support	Determine comparative values of fisheries, trends, and implications toward Commitment of agency resources	Determine degree of support for programs or projects as justification for seeking increased funding or reducing the current level of programming
User satisfactions and management preferences	Refinement of long-range program objectives: e.g., including emphasis on appreciative as well as harvest aspects	Evaluation of program success: data inputs to design or modify programs so they are acceptable to particular clienteles	Evaluation of regulations or facilities related to specific fisheries. and determination of modifications desired by anglers
Integrated human dimensions inquiry	Determine antecedents to fisheries recreation interests so some predictions about future participation can be made to aid long-range planning	Assessment of demand for fisheries programs; determination of bioeconomic impacts of pollutants or impaired habitat	Determine information needed to modify education programs (message content, method of delivery, etc.)

(Based on a matrix for wildlife management by Mattfeld et al. 1984. Developing human dimensions in New York's wildlife research program. *Transactions of the North American Wildlife and Natural Resources Conference* 49: 54-65.)

Conclusion

Given the information gathered from this literature review, the Great Lakes Fishery Trust should be able to identify some specific needs for education and mechanisms for reaching target audiences. The combination of elements reveals that knowledge about a topic, or feelings about its importance, may not be sufficient for motivating appropriate behaviors. Such behavior may involve direct involvement in actions for addressing fisheries issues, or supporting those who would do so. Current studies do not provide much insight about the linkages between knowledge, attitudes, motivation and behavior in regard to fisheries.

This study begs the question as to whether the public needs to know all the issues that fishery managers deal with, or whether we expect more than is necessary for making good decisions or evaluating management issues. Would a general knowledge of ecological principles and community stewardship be sufficient to inform the public on most fishery issues, provided that specifics were easily available for those who were interested in the details?

Bibliography for Objective 2 can be found on page 117.

Objective 3: Review of leading Great Lakes ecosystem and fisheries education materials and other education/communication efforts (i.e., *What materials and opportunities are available for Great Lakes ecosystem and fisheries education?*)

Introduction

To accomplish this objective we reviewed leading Great Lakes ecosystem and fisheries education materials. We also sought to learn about other Great Lakes ecosystem and fishery education and communication efforts. Lastly, we reviewed the education projects funded by the Great Lakes Fishery Trust so far. The main purpose of these efforts was to identify gaps that future GLFT education projects could address.

Content review of leading Great Lakes ecosystem and fisheries education materials

Introduction

We began by identifying education materials with a focus on the Great Lakes ecosystem and its fisheries. Of these materials, we selected a subset that we reviewed based on (1) their content in light of the Great Lakes Ecosystem and Fisheries Education Literacy Goals (see Objective 1) and (2) their education approach (i.e., pedagogy) in light of the North American Association for Environmental Education's (1996) *Environmental Education Materials: Guidelines for Excellence.* This part of our report provides details on this review's methods and results. Select findings are presented on a public web site (currently www.umich.edu/~wongjk/enc but to be moved to www.glft.org). Our approach to this review generally followed the process we used for an evaluation of national fisheries education materials for the American Fisheries Society (Crook and Zint 1998, Zint and Crook 1998).

Methods

How relevant were materials identified

To identify leading education materials with a focus on the Great Lakes ecosystem and its fisheries, we:

- reviewed relevant bibliographies such as those listing formal and non-formal fisheries education (Crook & Zint, 1998), Great Lakes education (Great Lakes Environmental Education Center, Forthcoming), and water education (Andrews 1995) materials,
- searched the Internet and requested identification of relevant materials via list-servs (e.g., available through BRIDGE, GLIN, EE-Link, etc), and
- used the snowball technique (i.e., asking providers of Great Lakes ecosystem and fisheries education materials to identify additional relevant materials).

We shared this list with the education contacts of the organizations represented on the GLFT and with members of the Michigan Alliance for Environmental and Outdoor Education. The individuals in these two groups were not aware of any additional materials. Overall, we identified 37 leading Great Lakes ecosystem and fisheries education materials (Table 3-1).

Table 3-1 Leading Great Lakes ecosystem and fisheries education materials (bulleted titles indicate the materials we reviewed).

♦	Alien Invaders: A Zebra Mussel Issue Investigation	1994	S. Ill Univ - Rivers Curriculum Project
♦	Bell LIVE! - Great Lakes: A Superior Adventure	2000	Bell Museum/University of Minnesota
♦	Caring for Planet Earth -- Great Lakes (CD ROM)	1997	Center for Environmental Study
♦	Earth Generation: The Great Lakes	1992	Dow Chemical
♦	Exotic Aquatics (Traveling Trunk)	1994	MN Sea Grant
♦	Exploring the Great Lakes (CD ROM)	1992	US EPA Region 5
♦	Fish Ways	1991	Canadian Wildlife Federation
	Fishes of the Great Lakes	1998	University of Guelph (Canada)
	Great Lakes Climate and Water Movement	1997	OH Sea Grant
	Great Lakes Collaborative Science Activities	1995	Wayne County RESA
♦	Great Lakes Education Program	1999	MI Sea Grant
♦	Great Lakes Environmental Education Project	1997	East Michigan Environmental Action Council
♦	Great Lakes Environmental Issues	1997	OH Sea Grant
♦	Great Lakes Explorer: Biodiversity (CD ROM)	1998	University of Guelph (Canada)
♦	Great Lakes in My World	1993	Lake Michigan Federation
♦	Great Lakes Solution Seeker (CD ROM)	1996	OH Sea Grant
♦	Great Lake Superior Learning Kit (Traveling Trunk)	1992	Great Lakes Aquarium/Lake Superior Center
♦	G.L.I.M.C.E.S.	1995	OH Sea Grant
♦	Great Minds? Great Lakes!	1997	US EPA Region 5
♦	Inland Seas Education Association	2000	Inland Seas Education Association
♦	Lake Effects: The Lake Superior Curriculum Guide	1998	Great Lakes Aquarium/Lake Superior Center
♦	Lake Erie…a day in the life of a fish	1991	OH Sea Grant
♦	Lake Erie…build a fish to scale	1991	OH Sea Grant
♦	Lake Erie…take a bow	1986	OH Sea Grant
	The Lake Game	1996	MN Sea Grant
♦	Lake Superior A-L Learning Kit	1992	Great Lakes Aquarium/Lake Superior Center
♦	Lake Superior Ecosystem Learning Kit	1992	Great Lakes Aquarium/Lake Superior Center
	Lake Superior Learning Kit: People and Places	1992	Great Lakes Aquarium/Lake Superior Center
	Land and Water Interactions	1997	OH Sea Grant
♦	The Lake Superior Game	1996	MN Sea Grant
♦	Lake Superior M-Z Learning Kit	1992	Great Lakes Aquarium/Lake Superior Center
♦	Life in the Great Lakes	1997	OH Sea Grant
♦	The Life of the Lakes	1995	MI Sea Grant
♦	Our Great Lakes Connection	1985	WI Sea Grant
♦	Supplemental Activities for Paddle to the Sea	1988	OH Sea Grant
♦	Zebra Mussel Mania	1997	IL-IN Sea Grant

For abstracts and results for all reviewed abstracts, please refer to the Appendices.

How materials were selected for review

We decided to review 30 of the 37 identified leading Great Lakes ecosystem and fisheries education materials because they meet the following selection criteria:

- They cover one or more of the concepts addressed by the Great Lakes ecosystem and fisheries education literacy goals.
- They are designed for youth or can clearly be adapted for youth.

- They are interactive (i.e. require thought or action); i.e., they are not just a reference or support material.
- They are at least 10 pages long; i.e., they are not a brochure or single activity.

How materials were reviewed in terms of the Great Lakes ecosystem and fisheries education literacy goals

The Great Lakes ecosystem and fisheries education literacy goals (see Objective 1) guided our review of the materials' content. We began by determining the extent of coverage of the literacy goal's 143 concepts by assigning each concept a score of 0 (not present) to 4 (extensive coverage) (Table 3-2).

Table 3-2 How concepts were scored/rated to determine content coverage by the materials

Criteria	Score	Rating
Concept not addressed	0	Not Present
States concept and may include **one** of the criteria under *Fair*	1	Brief
Does **at least three** of the following: States concept Defines/explains concept Provides simple examples or context Links concept to one or two others under issue Provides 1-3 references	2	Fair
Does **at least three** criteria under *Fair*, plus **five** of the following: Context expanded to historic perspective, if applicable Examines concept components, if applicable Moderate linkage to related concepts Explores one or more implications of related change or manipulation; encourages speculation Encourages/requires manipulation of concept or active discovery of concept components Links concept to current environmental concerns on at least one of the following levels: global, regional, local Contains extensive reference list (four or more; current) Encourages related action	3	Thorough
Does **at least 5** of *Thorough,* plus **five** of the following: Complete linkage to associated concepts Clear ties to major issue, including implications of current conditions and implications of any change Linkage to associated issues where appropriate	4	Extensive

Links concept (or encourages linking) to environmental concerns at all appropriate levels: global, regional, local
Encourages examination of local materials and related issues, and provides structure to do so
Provides (or encourages discovery of) all major perspectives (with rationales), particularly if contentious issue or concept
Focused references (use required for completion of topics)

We then generated a percent of coverage score for each of the 11 issues using the following process:

- we determined the number and percent of concepts covered briefly, fairly, thoroughly and extensively for each issue,
- we assigned the values .00 (not present), .25 (brief), .50 (fair), .75 (thorough) and 1.0 (extensive) to each concept,
- we multiplied the percent as a whole number by the numeric value for each category, and added.

This process yields a maximum score of 100 for complete coverage per issue.

If, for example, we determine that, for a particular issue, 10% of the concepts are not covered at all, 40% of the concepts are covered briefly, 30% are covered fairly, 15% are covered thoroughly and 5% are covered extensively:

10 x .00 = 0.0
40 x .25 = 10.0
30 x .50 = 15.0
15 x .75 = 11.3
5 x 1.0 = 5.0
41.3 (issue score) of a possible 100%

This report includes the scores of each concept and issue for all reviewed materials (Table 3-4 provides an overview of the scores for the issues only. The disc that accompanies this report contains a table that contains the scores for all issues and concepts).

Note that the public web site does not provide results for each of the 143 concepts but summarizes results for the 11 issues. In addition, the public web site does not report the actual scores each resource received for the issues covered. Instead, the extent to which the issues were addressed by each material is described based on the scale below (Table 3-3). This scale was derived from the distribution of scores for the issues, which ranged from 0% to 60%. We decided not to report actual scores on the public web site for two reasons: First, we felt a scale would provide users of the web site with a quick and easy overview of issue coverage and gaps among the materials. And second, relative scores are easier to defend than individual concept and issue ratings.

Table 3-3 How scores/ratings were generated for results reported on the public web site

ISSUES	
0%	No fish symbol = not covered
1%-12%	Outline of fish symbol = limited coverage relative to all issues and materials
13%-24%	25% shade of fish symbol = fair coverage relative to all issues and materials
25%-36%	50% shade of fish symbol = moderately well covered relative to all issues and materials
37%-above	Solid black fish symbol = well covered relative to all issues and materials

Some details on how the 143 individual concepts were scored/rated

The following paragraphs describe our general approach to evaluating the 143 concepts, and these paragraphs are followed by remarks on specific decisions that affected select concepts.

- Lumping: In some cases, concepts have more than one component (see, for example, 2.3 and 8.5). As a result, one concept component may be covered, while another is not. If a concept component was covered well, and the concept did not have too many components, the concept generally received a full rating. In the case of something like 2.3, however, when only one or two concept components were covered well and the rest barely mentioned or missing, the concept received a lower score, e.g. from 3 to 2. In general, however, concept components were covered broadly enough to avoid a lower score.

- Conservatism: In several cases, concepts and thus, issues received lower ratings than possibly appropriate if, for particular reasons, the materials at hand did not reflect all potential learning opportunities. These reasons included: not all integral materials were provided, either for review or as part of the resource (e.g. videos, slide shows that may need to be ordered separately); process allowed choice of issues, only some of which were fisheries-related; process required students to conduct research from sources other than those provided (thus, there was no way to tell how broadly or deeply a particular concept/issue would be explored); other programs were referenced for use.

- Criteria: As a result of the ways concepts were rated, there is a broad range of coverage under "2" (*fair*). Anything from a brief paragraph that included an introduction, definition or example, to pages of text that elaborate, but do not quite make it to "3" (*thorough*, which requires a process orientation in most cases), received a "2". In other words, if only background or reference information was provided, concepts almost never received more than a "2". However, if considerable background, or reasonable background and some process were provided, concepts received a "2.5".

- Focus: There is potential for overlap between many of the concepts. Thus, if the intent, or focus, of a particular resource or section was deemed to be within a particular concept or concept cluster, then that is where it was rated. For example, 5.13 *Specific species of concern include lake trout and lake sturgeon in particular; both are the focus of extensive rehabilitation efforts* - and - *1.17 Some former fisheries can be, and in some cases are being, re-established though the reintroduction of native species into rehabilitated habitat (e.g. lake trout, lake sturgeon)* are similar. *1.17*, however, would have been rated only if the content addressed habitat restoration.

- Concept Coverage: Several issues have many related concepts, far more than would ordinarily be covered by any one particular resource. As a result, the issue scores appear relatively low (all below 60%), even for materials that focus on particular issues. For example, Issue 6, *Achieve and maintain sustainable sport and commercial Great Lakes fisheries,* has 22 related concepts ranging from the cultural effects of historic fisheries closures to current international fisheries agreements. A material focused on historical fisheries in the Great Lakes may therefore not score well on the overall issue. This does not necessarily suggest poor coverage of the issue but rather the breadth and scope of potential programming within the issue. To understand how well issues were covered, each concept's coverage needs to be interpreted from the perspective of how well the concept was covered by a particular resource and how many materials addressed the concept. To use an extreme example, Issue 11, *Develop an awareness of fisheries as a profession and help prepare youth for careers in this profession,* received the best coverage where it was addressed by individual materials, but it was only addressed by two.

Specific decisions that affected the score/rating of individual concepts (by concept):

Issue 1: Maintain and recover fisheries habitat

1.3 Particular aquatic or semi-aquatic ecosystems provide critical habitat for some species, and include: inland wetlands, floodplain/riparian zones, tributary streams, and coastal wetlands. Loss of these habitats significantly reduces the potential of fisheries dependent on them.

Critical habitat as a concept is poorly identified in the reviewed materials. Most often, critical habitats are treated simply as fish habitat types; at times, critical habitats are linked to particular life stages or processes. Ratings were not lowered if the word *critical* was not used. This comment also applies to other concepts that refer to critical habitat; i.e., *1.6 Many critical (e.g. spawning) habitats have been, and are, under significant pressure from historic and current development. A significant number have been damaged or lost* and *1.15 Critical habitats can be, and in some cases are being, protected and maintained; damaged habitats can be, and in some cases are being, rehabilitated.*). If the resource has a focus on wetlands, *1.4 Great Lakes coastal wetlands are unique in providing hydrological and habitat benefits that are critically important to sustaining ecosystems and human communities*, was rated.

1.6 Many critical (e.g. spawning) habitats have been, and are, under significant pressure from historic and current development. A significant number have been damaged or lost.

If the resource has a focus on wetlands, *1.7 Wetlands in particular often feel the brunt of increased land- or water-use pressures; more than two-thirds of the natural Great Lakes wetlands have already been filled in or drained; invasive species also contribute to wetland loss*, was rated instead.

1.9 Hydropower facilities and dams are situated on many important rivers in the Great Lakes watershed, and have profound influence on their fisheries.

Current and historic dams of any type were included when this concept was rated.

1.12 Disrupting the natural flow in a stream by pumping or removing groundwater, creating impervious surfaces and accelerating runoff, or physically modifying a stream cannel or a stream bank can seriously disrupt aquatic habitat.

Any mention of excessive runoff from developed land was included in rating this concept.

1.13 Habitat protection, mitigation and enhancement are primary fisheries management activities.

This concept is probably underrepresented to some degree by the rating it received. Mention of these activities are most commonly covered under *1.15 Critical habitats can be, and in some cases are being, protected and maintained; damaged habitats can be, and in some cases are being, rehabilitated* when specific habitats are discussed, or under *8.5 Fisheries managers must be involved with...* when the actions of managers or agencies are discussed. Given the three concepts with their slightly different approaches, this concept is probably covered reasonably well.

1.17 Some former fisheries can be, and in some cases are being, re-established through the reintroduction of native species into rehabilitated habitat (e.g. lake trout, lake sturgeon).

Again, rating of coverage was split. Habitat emphasis was rated here, general species rehabilitation under *5.11 Diversity needs to be conserved through rehabilitation of native fish populations, species, communities and their habitats*, and lake trout/lake sturgeon rehabilitation was rated under *5.13 Specific species of concern include lake trout and lake sturgeon; both are the focus of extensive rehabilitation efforts*.

Issue 2: Identify and reduce sources of pollution affecting fisheries habitat.

2.2 Scientists have identified 362 contaminants in the Great Lakes ecosystem: 32 metals, 68 pesticides and 262 other organic chemicals; 11 contaminants are considered critical or priority pollutants by the Great Lakes Water Quality Board; they have been found to accumulate in fish, harm fish and wildlife and pose a risk to human health.

Rarely are the total numbers of contaminants or numbers by contaminant type mentioned. The focus is largely on the 11 priority contaminants. Materials did not receive a lower rating if they did a reasonable job of addressing the range of contaminants in the system.

2.9 Contaminants and their bioaccumulative risks to both species and human health threaten sustainable fisheries, and must be minimized.
This was rated whether the topic was bioaccumulation, bioconcentration/ magnification, or health risks. Most content addresses bioconcentration.

2.10 Sources of pollution must be stopped or reduced if safe, quality fisheries are to exist.
This concept often seems assumed rather than explicitly mentioned. It was rated, however, when contamination and links to fish consumption and human health are covered (i.e., there is an emphasis on "safe").

2.11 Although industries and sectors (e.g. government) have a responsibility to control potential pollutants, each individual also has a responsibility to act in ways that can directly or indirectly reduce the impact of pollutants on the environment.
This concept was rated if industry, government or individuals are referred to. Most often the emphasis is on what individuals can do.

2.12 There has been a long-term trend toward reduced public exposure to mercury, DDT, PCB's, dieldrin, chlordane and dioxin from consumption of sport fish caught in Michigan lakes and streams. However, the reduction of certain contaminants has slowed or stopped over the past 10 years.
In some cases, particularly with older programs, only reduction is mentioned. Ratings were not lowered in these cases.

2.14 The populations most at risk from exposure to mercury and other toxins through the consumption of contaminated fish are nursing mothers, pregnant women, women who intend to have children and children under age 15, and people who often consume fish, which may include Native American subsistence anglers, low-income or minority anglers, and sport anglers.
This concept originally only focused on mercury. However, "and other toxins" was added as materials addressing this concept discuss it in relation to all toxins, not just mercury.

2.17 Fish consumption advisories should be consulted and followed whenever possible before eating fish caught in Michigan waters.
Any mention of advisories, whether Michigan's or not, was rated.

Issue 3: Prevent or control the introduction of non-native nuisance species (exotics)

3.1 Over 152 species have been established in the Great Lakes since Europeans have arrived; around one-third have arrived since the opening of the St. Lawrence Seaway.
This concept received a rating if the emphasis is on overall numbers, exotic introductions related to the increase in ocean ship traffic, or to the opening of the Seaway, specifically.

3.2 A number of introduced species are now naturalized - maintaining self-sustaining populations – and should be considered regular components of the fish community; some are considered desirable (e.g. rainbow trout; chinook salmon) while others need to be suppressed (e.g. round goby, sea lamprey).
"Naturalization" seems largely assumed and is rarely addressed directly. The ratings here mostly reflect coverage of the desirable aspect of naturalized exotic species.

3.7 Other species of current concern include, but are not limited to, zebra mussel, European ruffe, round goby, spiny water flea, purple loosestrife and Eurasian water milfoil.
If only zebra mussels are discussed, *3.8 In just over 10 years, zebra mussels have seriously and perhaps permanently altered the Great Lakes ecosystem; their potential economic impact on the basin is $5 billion over the next 10 years* was rated instead.

3.13 Chemical-free solutions are currently being developed to address the problem of nuisance species. These solutions are more environmentally benign and may be more effective than chemical methods, or chemical methods alone.
Chemical-free solutions related to lampreys specifically were rated under *3.14 The introduction of barrier, lampricide, and sterile male control programs have greatly reduced sea lamprey in all but the areas affected by the St. Mary's River.*

Issue 4: Address Great Lakes issues at the ecosystem and watershed level.

4.6 Many Great Lakes ecosystems have been altered significantly through human impacts, some irrevocably; fisheries must be managed and "ecological rehabilitation" attempted within this context.
Most of the emphasis here is on ecosystem impacts; few materials address rehabilitation within an ecosystem context.

4.12 In some cases, for example through the introduction of Pacific salmon, progress toward ecological rehabilitation can be, and has been, accomplished by substituting exotic surrogates for extinct or impaired native species.
Any mention of salmon controlling alewives was rated here; it is rarely presented in the ecosystem context suggested by this concept.

4.13 Ecosystem status can (and should) be monitored through indices of health – indicator species, community structure, nutrient levels and flow rates.

"Indicator species" was added to this concept as an indicator of health because most relevant content relates to this aspect.

Issue 5: Manage fishery diversity within the Great Lakes Basin.

In general, this issue is poorly covered, with the emphasis (or lack of) reflected best by the results of *5.1 The ecological values related to diversity apply to sport, subsistence and commercial Great Lakes fisheries* and *5.9 Diversity issues need to be addressed at the individual (genetic), population (stock), species and community levels*. Often, ratings were given for related issues addressed by the concepts as there are few ties made to biodiversity per se (see below).

5.2 Some areas of the Great Lakes had naturally limited diversity (e.g. Lake Superior); in other areas, diversity has been reduced through extinctions (e.g. blue pike) and extirpations (e.g. lake trout in Lake Michigan).

This concept was rated if content addressed any extinctions or extirpations, whether linked directly to biodiversity or not.

5.4 Decreased diversity can occur through habitat loss, overharvest, intentional or accidental species introductions, disease and the effects of some stocking practices on genetic or stock variability.

This concept was rated if content provided discussions of actual or potential species or population loss related to these factors, whether biodiversity was mentioned or not.

5.7 Any trends toward decreased species and population diversity related to native species or beneficial introductions need to be reversed.

This concept was rated if content gave information on endangered species or potential extinctions or extirpations, whether their relation to biodiversity was discussed or not.

5.11 Diversity needs to be conserved through rehabilitation of native fish populations, species, communities and their habitats.

Any mention of fish rehabilitation was rated here, unless the focus was specifically on habitats, or on lake trout or lake sturgeon (see 5.13).

Issue 6: Achieve and maintain sustainable sport and commercial Great Lakes fisheries.

6.1 Both historic and current fisheries, including losses and closures, have considerable economic, cultural and social significance.

Note that both fisheries, and fisheries losses/closures, are included in this concept. In terms of coverage, however, materials focus on current/historic fisheries (by a ratio of at least 2:1).

6.5 Currently, the Great Lakes fishery consists of more than 175 species of fish in a series of overlapping, complex fisheries.

This concept was rated if several fisheries are mentioned or several species are listed.

6.22 Enforced legislation, interstate and international agreements are essential to maintaining sustainable fisheries.
Ratings of this concept reflect mention of legislation at any level, with the exception of pollution control (rated under *2.20*).

Issue7: Native Americans have treaty fishing rights in the Great Lakes.
No particular concerns with rating relevant concepts.

Issue 8: Manage for sustainable sport and commercial fisheries.

8.4 Fisheries management must consider the impacts of land-based actions, i.e. take a watershed-based approach. This involves interactions among agencies, jurisdictions and countries.
This concept was rated when any relation between watersheds and fisheries is addressed. This occurs predominantly in the context of land-based impacts. Rarely is management raised explicitly; its absence did not result in a lowered rating.

8.6 There are many success stories in Great Lakes management (e.g. collaborations with tribes and among Great Lakes agencies, rehabilitated species/habitats, positive impacts of regulation and mitigation).
This concept is probably a bit underrepresented by its rating. Content had to explicitly be presented *as* a success story to be rated here.

Issue 9: Promote resource stewardship.

9.1 The public has a vested interest in the conservation, restoration and enhancement of aquatic materials.
This concept seemed to be often assumed rather than made explicit and therefore was rarely rated.

9.2 The public must understand their rights, privileges and responsibilities, and should be made aware of methods to personally help protect and/or improve the resource, and have the opportunity to practice and apply them.
This concept was rated when specific actions are suggested for individual involvement.

9.3 Public awareness, understanding and action related to the biological, economic, cultural and social consequences of impacts such as exotic species, habitat loss, pollution and overharvest are important to maintaining sustainable fisheries.
This concept was rated when the involvement of individuals in these issues is encouraged. The *need* for this involvement, however, is rarely stated and its absence is not reflected in the ratings of this concept.

Issue 10: Promote responsible recreational fishing.

This issue is not well covered by the materials we reviewed. However, there are a numerous fishing programs available [refer to the *Guide to Fisheries Education Materials for Grades K-12* (Crook and Zint 1998)] that can be used for this purpose. In addition, *Project F.I.S.H* currently under development and funded by the Great Lakes Fishery Trust) focuses on recreational fishing including fishing ethics.

Issue 11: Develop an awareness of fisheries as a profession and help prepare youth for careers in this profession.

No particular concerns with rating relevant concepts.

Results

Results for this part of the review are presented in several ways. First, overall results are presented for the materials in terms of their coverage of issues. Then, results for materials targeted at grades 7 and higher are presented. This allows us to compare results from this review with that of the review of national fisheries education materials (Crook and Zint 1998). Results are also presented for K-3 materials because this is an area where fisheries education materials have been identified as lacking (Crook and Zint 1998). Lastly, results are presented in terms of specific concepts.

Overall results

Table 3-4 summarizes the issue scores for each of the reviewed Great Lakes ecosystem and fisheries education materials whereas the table on the disk also includes the individual concept scores that these issue scores are based on.

Table 3-4 Issue scores for each of the reviewed Great Lakes ecosystem and fisheries education materials.

	Grade Level for which appropriate	1 Habitat	2 Pollution	3 Exotic Species	4 Ecosystem	5 Biodiversity	6 Build Fisheries	7 Treaty Rights	8 Manage Fisheries	9 Stewardship	10 Fishing	11 Careers
		%	%	%	%	%	%	%	%	%	%	%
ALIEN IN	9-12*	0	5	46	7	0	4	0	8	28	0	0
BEL LIVE	4-8	1	16	18	0	4	2	2	0	10	4	0
CA PL EA	7-12	23	32	19	12	10	5	4	0	28	0	0
EARTH GEN	4-8	21	23	3	9	11	7	0	4	20	0	13
EXO AQU	3-5	6	1	24	0	2	0	0	0	28	4	0
EXPL GL	9-12*	21	26	21	15	8	16	2	4	5	0	0
FW IS	7-12**	27	17	13	22	15	26	6	31	18	4	0
FW PJ	1-6	28	11	15	0	12	17	0	10	50	26	0

GL ED PROG	4	13	17	34	16	4	0	4	0	10	6	0
GL EE PR	7-12	24	51	1	19	8	9	4	0	10	4	0
GL EV IS	7-12	4	57	9	12	4	12	12	0	0	10	0
GL EXPL	9-12*	23	24	18	12	19	25	4	0	10	0	0
GL IN WLD	K-8	14	32	18	6	4	3	0	0	10	2	0
GLIMCES	7-12	21	40	26	21	12	9	0	0	15	5	0
GL SOL SE	7-12	16	41	35	15	2	12	0	0	10	5	0
GLS L KIT	1-12	1	25	1	2	0	0	0	8	0	0	0
GM GL!	1-5	9	22	0	0	0	3	0	0	0	0	0
ISEA	5-12	6	6	23	2	0	8	0	0	5	0	0
LK EFFS	K-8	9	27	37	9	12	9	2	4	20	6	0
LK ERIE	1-5	1	2	0	0	0	4	0	0	0	0	0
LKS A-L	K-3	3	10	0	0	0	0	0	0	0	0	0
LKS M-Z	K-3	0	0	10	0	0	0	0	0	0	0	0
LKS ECO	4-7	0	2	23	0	0	0	0	0	13	0	0
LKS GAME	5-12	7	25	7	0	0	2	0	0	0	4	0
LIFE GL	7-12	18	7	23	18	4	29	2	46	0	0	0
LIFE LKS	7-12	36	45	40	36	20	40	28	54	43	19	50
O GL CON	K-8	1	10	13	4	4	6	2	0	0	0	0
PADDLE	3-6	9	12	0	0	0	3	0	0	0	0	0
ZM MANI	5-6	1	1	17	2	4	7	0	0	13	0	0
MEAN		12	21	17	8	5	9	3	6	12	3	2
MAXIMUM		36	57	46	36	20	40	28	54	50	26	50

* Included in 7-12 analysis. **Contains some dedicated 9-12 materials.

Concept and issue scores for each of the reviewed Great Lakes ecosystem and fisheries education materials can be found on the disc accompanying this report (table is too large to be included here).

In terms of materials*, The Life of the Lakes* and *Fish Ways* provide the highest coverage of Issue 1 (Habitat). Each includes activities that focus on the importance of maintaining and reestablishing fisheries habitats. Issue 2 (Pollution) was best covered by *Great Lakes Environmental Issues* which devotes one-third of its activities to toxins in the Great Lakes and their effects on aquatic life and humans. *Alien Invaders* offers the best coverage of Issue 3 (Exotic Species). As suggested by its name, the focus of this entire material is on non-indigenous nuisance species, and it emphasizes the importance of preventing introductions. *The Life of the Lakes* has the highest coverage of Issue 4 (Ecosystem). It contains several activities that emphasize ecosystem interactions within the Great Lakes, and how these interactions affect fisheries. Issue 5 (Biodiversity) is best addressed by the *The Life of the Lakes* and *Great Lakes Explorer.* These materials include activities that explicitly examine Great Lakes fish biodiversity. Issues 6 (Build Fisheries), 7 (Treaty Rights), and 8 (Manage Fisheries) are best covered by *The Life of the Lakes* which includes activities that focus on sport, commercial, and tribal fisheries.

Fish Ways has the highest coverage of Issues 9 (Stewardship) and 10 (Fishing) and has interesting activities related to fishing ethics. Only two materials, *The Life of the Lakes* and *Earth Generation,* have coverage of Issue 11 (Careers),, with the former having greater coverage. Overall, *The Life of the Lakes* had the best or good coverage of most of the issues relatively to all other materials. *Fish Ways* also covered many issues well.

In terms of issues, Issues 2 (Pollution) and 3 (Exotics) are generally reasonably well covered in terms of both depth and breadth [by 25-28 (86%-96%) of the materials] (Table 3-4), although some concepts under these two issues may not receive sufficient coverage. This reflects the prominence of these issues both in the long-term (pollution) and short-term (exotic species), and general awareness across society.

A second cluster of issues receives adequate coverage: Issues 1 (Habitat), 4 (Ecosystems), 6 (Build Fisheries) and 9 (Stewardship). Issue 6 (Build Fisheries) was rated relatively low as a result of the number of concepts it contains, but even if that is taken into account, it still probably does not belong in the top grouping. Overall, Issue 4 (Ecosystems) ratings reflect increasing emphasis on relevant ecosystem concepts by some of the more recent materials, particularly those targeted at grades 7 and higher (e.g. *Great Lakes Instructional Materials for a Changing Earth System*, *Great Lakes Solution Seeker*). Some of this growth in emphasis on Issue 4 (Ecosystems) may be at the expense of Issue 1 (Habitat) because the broader coverage of ecosystems tends to subsume habitat-related concepts.

Coverage of two issues is limited either by depth or breath. Issue 8 (Manage Fisheries) tends to be relatively well covered when it is addressed [similar to Issue 3 (Exotics) in depth of coverage], but it is not addressed all that often [i.e., by 9 (31%) materials with 4 at the K-6 level). Issue 5 (Biodiversity), while touched on by 19 (65%) materials, is often just that, "touched on", with a mean rating of only 5%. *The Life of the Lakes* had the highest (i.e., 20%) coverage of this Issue. In part, this may be due to the "newness" of the concept of biodiversity in the general education community, and in society as a whole. Biodiversity often appears to be more of a "buzz word" than a topic examined in depth.

Three concepts receive very limited coverage: Issues 7 (Treaty Rights), 10 (Fishing) and 11 (Careers). Of these, Issue 10 (Fishing) is covered well by many non-Great Lakes focused materials (Crook and Zint 1998) and is a focus of the Great Lakes Fishery Trust funded *Project FISH*. Issue 11 (Careers) is reasonably well-covered but only by two materials (*The Earth Generation/The Great Lakes, The Life of the Lakes*). Issue 7 (Treaty Rights) receives minimal coverage (mean=3%, maximum score 20% by *The Life of the Lakes*] by 12 (41%) materials, with much of the coverage focusing on historical perspectives of native resource use. Treaty issues generally do not receive much attention.

Overall results by grade level

It is important to note that although many materials purport to cover a broad range of grade levels (i.e., K-12), there are few relevant materials that adequately meet the needs

of K-3 or grades 9- or 10-12. We believe that there are only two (7%) materials that focus on the K-3 level (*Lake Superior A-L, Lake Superior M-Z Learning Kits*). In addition, these two materials have very limited coverage of any issue, including the two issues that they focus on [i.e., Issues 2 (Pollution), 3 (Exotics)]. There are also only three (10%) materials for grades 9-12 (*Alien Invaders, Exploring the Great Lakes,* and *Great Lakes Explorer*). There are, however, 11 (38%) materials that are appropriate for grades 7 and higher; i.e. 12% more materials than those identified by our 1997 review of North American fisheries education materials (Crook and Zint 1998). This relatively large number of Great Lakes fisheries education materials for grades 7 and higher is mainly due to a number of recent materials designed for grades 7-12. These new materials are also driving the introduction of concepts under Issue 4 (Ecosystems) and Issue 5 (Biodiversity), and the use of computer- and Internet-related materials and data bases.

In general, the 11 (38%) materials for grades 7-12 have broader coverage of Great Lakes fisheries issues compared to all 30 materials. Every issue is covered by a higher percent of grades 7-12 materials, and four issues are covered by all grades 7-12 materials: Issues 2 (Pollution), 3 (Exotics), 4 (Ecosystems) and 6 (Build Fisheries). As might be expected, grades 7-12 materials also go into more depth, although to a minimal degree for Issues 7 (Treaty Rights), 9 (Stewardship), 10 (Fishing) and, somewhat surprisingly, 5 (Biodiversity). Significant increases in coverage by grades 7-12 materials were found for Issues 1 (Habitat; 13-21%), 2 (Pollution; 21-31%) and 8 (Manage Fisheries; 19-29%). Coverage only increases somewhat by grades 7-12 materials for Issues 3 (Exotics), 4 (Ecosystems), 5 (Biodiversity) and 6 (Build Fisheries). Low coverage of Issue 11 (Careers) limits the value of comparing grades 7-12 materials to all materials.

Coverage of issues by grades 7-12 materials is generally similar to that of all materials, with some exceptions. Issue 1 (Habitat) moves into the "reasonably well-covered" cluster with Issues 2 (Pollution) and 3 (Exotics), although Issue 2 (Pollution) outperforms the other two in coverage by a significant margin. Issue 8 (Manage Fisheries) is covered deeply enough to fit into this grouping as well, but it is only addressed by 5 (17%) [as opposed to 10-11 (33%-37%)] materials. Issues 4 (Ecosystems), 6 (Build Fisheries) and 9 (Stewardship) receive adequate coverage at this grade level too. Issues 5 (Biodiversity) and 7 (Treaty Rights) receive limited coverage by grades 7-12 materials. Similar to all Great Lakes fisheries education materials, coverage of Issue 11 (Careers) is very limited, and Issue 10 (Fishing) is not covered well by grades 7-12 Great Lakes fisheries education materials.

Additional comments by concept

Issue 1: Maintain and recover fisheries habitat.

1.1 Habitat forms a key element of sustainable fisheries.

This concept often seems assumed, rather than explicitly addressed, by many materials. It gets covered reasonably well, but indirectly.

1.2 Aquatic habitats that support, or could support, sport, subsistence and/or commercial fisheries include: streams, rivers, lakes, coastal waters and open Great Lakes waters.

There is limited coverage of this concept. Many habitats may be mentioned but the pervasiveness of fish in these habitats is assumed and rarely made explicit. This may not be a major concept but more emphasis needs to be placed in most instances on the adaptability of fish in general, their broad distribution, their value as an indicator organism, and the significance of their absence.

1.3 Particular aquatic or semi-aquatic ecosystems provide critical habitat for some species, and include: inland wetlands, floodplain/riparian zones, tributary streams, and coastal wetlands. Loss of these habitats significantly reduces the potential of fisheries dependent on them.

This concept generally receives reasonable coverage but *critical habitat* as a component (here and within other concepts) is poorly covered or even discussed. Most often, critical habitats are treated simply as fish habitat types; at times, critical habitats are linked to particular life stages or processes. (This concept did not receive a lower rating if *critical* is not mentioned.)

1.5 Aquatic habitat is dependent on natural flux of water levels and flows.

This concept receives almost no coverage.

1.8 Fragmentation of wetlands can significantly degrade the productive capacity of the Great Lakes; the remaining wetlands must remain above a critical minimum size to function properly.

Habitat loss in general, and wetland loss in particular, are reasonably well covered. Wetland fragmentation, however, is not.

1.9 Hydropower facilities and dams are situated on many important rivers in the Great Lakes watershed, and have profound influence on their fisheries.

1.10 The withdrawal and discharge of water can directly affect fish through entrainment or impingement on screens and fish distribution, respectively.

These two concepts are generally not covered. Dams are covered to some degree but their focus is rarely on hydro facilities or their specific effects. There is almost no coverage of fish distribution effects.

1.12 Disrupting the natural flow in a stream by pumping or removing groundwater, creating impervious surfaces and accelerating runoff, or physically modifying a stream cannel or a stream bank can seriously disrupt aquatic habitat.

Most of the coverage here relates to runoff from impervious surfaces. It is usually addressed in the context of non-point source pollution, and never a focus itself.

1.14 Sustainability will require an integrated ecosystem approach to fishery-habitat management, including research, education, regulation, restoration and best land use practices. This approach must be applied to the Great Lakes themselves as well as tributary systems.

This concept receives almost no coverage. This may be due in part to its detailed and specific focus, and the failure of most materials to deal with "sustainability" in any fundamental way.

1.16 Wetland restoration should be done in a way that contributes to fisheries values.

This concept receives no coverage.

1.17 Some former fisheries can be, and in some cases are being, re-established through the reintroduction of native species into rehabilitated habitat (e.g. lake trout, lake sturgeon).

Although lake trout and lake sturgeon re-introductions are mentioned, there is no strong programmatic focus on these management activities.

Issue 2: Identify and reduce sources of pollution affecting fisheries habitat.

This issue contains the most consistently well-covered concepts, with some covered by 90% of the materials. Please note the addition of concept *2.6* (groundwater as a pollution pathway) and *2.9* (bioaccumulation) to the original, approved list of literacy goals. *2.6* reflects an important pollution pathway covered by a minority of materials and *2.9* had been mistakenly excluded from the list of literacy goals.

2.13 Mercury poses a widespread problem throughout the Great Lakes basin. The Michigan Department of Community Health has issued a special advisory for all inland lakes in Michigan due to mercury. Air emissions of mercury are the largest source of mercury in the water.

Mercury is rarely covered by itself. It is more commonly addressed along with other toxins, such as organic chemicals or heavy metals.

2.16 Although some fish are below the government guidelines set for safe consumption of commercially caught fish, they may still not be safe for consumption, particularly by at-risk populations (see 2.14)

When toxins and safe levels of exposure are discussed, there is rarely any mention of commercially caught fish, or any differences in guidelines between sport and commercial fish.

2.19 Despite the existence and publication of fish consumption advisories, people that consume fish are not always aware of them, specifically those most at risk (see 2.14).

This concept receives minimal coverage.

Issue 3: Prevent or control the introduction of non-native nuisance species (exotics)

3.4 Exotic species in the Great Lakes have caused billions of dollars in economic loss; without efforts to restrict distribution, costs to society will increase.
This concept receives minimal coverage, mostly because cost in a general sense is rarely discussed. Usually, costs are linked to particular species, most often zebra mussels.

3.9 Additional state, federal and international commitment and funding is required to adequately address the prevention or control of exotic invaders.
This concept is not covered. Where funding or costs are mentioned, the focus is not on the need for "additional funding".

3.10 Perfect screening, detection and control of exotics are currently impossible.
This concept receives minimal coverage. The focus is generally on prevention (*3.11*).

3.12 The rate of exotic invasion is directly related to human activities; activities that lead to unintentional introductions should be identified and controlled.
This concept is covered indirectly for the most part. Programs relate introductions to ballast water, canals, boat traffic, etc., without specifically connecting increases in human activities with increases in exotic species. The second part of this concept is rarely covered.

3.13 Chemical-free solutions are currently being developed to address the problem of nuisance species. These solutions are more environmentally benign and may be more effective than chemical methods, or chemical methods alone.
Apart from sea lamprey control, this concept is not adequately addressed.

3.15 Recent, co-ordinated, international control efforts focused on the St. Mary's have had a significant impact on larval sea lamprey populations in this area. It is too soon to determine the impacts on adult lamprey or fish populations.
This concept is not covered, possibly because these efforts have occurred too recently to be incorporated.

Issue 4: Address Great Lakes issues at the ecosystem and watershed level.

4.3 Self-sustainability is important to the proper functioning of biological systems.
Self-sustainability is not effectively covered, particularly from the perspective of stocking strategies and the continuation (or not) of put and take, or put, grow and take, fisheries.

4.7 Trends toward lower levels of nutrient loading and overall Great Lakes productivity will have profound impacts on the ecosystem and its constituencies; whether current sport and commercial fisheries can be maintained in light of this change is questionable.

The specificity of this concept limits effective coverage. However, little connection is made between pollution reduction and nutrient load in general, and almost no connection is made between changes in nutrient loading and fishery productivity.

4.8 One challenge to the sustainability of large systems is "jurisdictional stress"; it is important to consider the potential effects on the whole system rather than only within particular jurisdictions.

4.9 Future sustainability of the Great Lakes and tributary materials depends on our ability to manage these ecosystems through holistic, ecological approaches that integrate knowledge across trophic levels.

4.10 The ecosystem approach to management is well suited to address complex problems that extend over time, space and jurisdictions.

These three concepts receive minimal coverage.

4.11 Ecological rehabilitation involves the reestablishment of ecosystem integrity by repairing the basic structure and energy dynamics of the system.

This concept receives no coverage. A few materials examine the specific effects of Pacific salmon introductions on alewife and smelt (covered in *4.12*), but do not address this more general perspective.

4.13 Ecosystem status can (and should) be monitored through indices of health – indicator species, community structure, nutrient levels and flow rates.

The coverage of this concept is moderate because of the addition of *indicator species* as a health index. Community structure, nutrient levels and flow rates are not discussed in this context.

Issue 5: Manage fishery diversity within the Great Lakes Basin

5.2 Some areas of the Great Lakes have naturally limited diversity (e.g. Lake Superior); in other areas, diversity has been reduced through extinctions (e.g. blue pike) and extirpations (e.g. lake trout in Lake Michigan).

There is almost no mention of "naturally limited diversity" and what the weaknesses or sensitivities of such systems are.

5.3 The Great Lakes were vulnerable to introduced species because of relatively low levels of indigenous fish populations.

This concept receives no coverage.

5.5 Fish health issues are key factors affecting abundance and/or sustainability of important Great Lakes fish populations.

This concept receives minimal coverage.

5.6 Sport and commercial fishing, if not managed properly, may directly impact the diversity of non-target species (e.g. entanglement of non-target species in gill nets).

This concept receives no coverage.

5.7 Any trends toward decreased species and population diversity related to native species or beneficial introductions need to be reversed.
This concept receives minimal coverage. It seems assumed and rarely addressed directly.

5.8 There may be some conflict over the benefit or harm produced by some introduced species (e.g., alewife) and thus actions to be taken related to it.
This concept receives minimal coverage. In fact, no materials looked specifically at the costs and benefits of particular introduced species (from the perspective of diversity or anything else), and there is no mention of conflict over any control actions.

5.9 Diversity issues need to be addressed at the individual (genetic), population (stock), species and community levels.
This concept receives minimal coverage.

5.10 In particular, the genetic variation of locally adapted wild fish stocks should be protected.
This concept receives no coverage.

5.11 Diversity needs to be conserved through rehabilitation of native fish populations, species, communities and their habitats.
This concept receives minimal coverage. Rarely is a link made between rehabilitation and the promotion of diversity.

5.12 Recovery plans should be developed for species that are threatened, endangered or of special concern.
This concept receives no coverage.

5.13 Specific species of concern include lake trout and lake sturgeon; both are the focus of extensive rehabilitation efforts.
This concept receives minimal coverage. Only 4 materials (*Caring for Planet Earth, Great Lakes in My World, Lake Effects,* and *The Life of the Lakes)* examine it, none at a level greater than 2.

Issue 6: Achieve and maintain sustainable sport and commercial Great Lakes fisheries.

6.1 Both historic and current fisheries, including losses and closures, have considerable economic, cultural and social significance.
Curiously, little is done with the second part of this concept (i.e., losses and closures), relative to the coverage of the first part (i.e., historic fisheries in particular). In addition, closures or losses are often simply mentioned without any detail related to personal, economic, or social costs.

6.4 Rehabilitation of the Great Lakes fishery has advanced toward re-establishing many major fish stocks and has provided fish to support large, valuable fisheries.
This concept receives minimal coverage.

6.5 Currently, the Great Lakes fishery consists of more than 175 species of fish in a series of overlapping, complex fisheries.
This concept receives minimal coverage; some of the coverage reflects mention of some, but not all, species or species numbers (sometimes in a particular Lake), and the complexity of the fisheries is not addressed.

6.8 Use of public waters for aquaculture can conflict with use of those waters for natural fish production.
Coverage here is relatively limited, particularly given aquaculture's potential for growth and additional conflict.

6.9 Bycatch can threaten sustainable fisheries, and must be monitored and controlled; move towards minimizing waste in commercial fisheries.
This concept receives minimal coverage, particularly at the K-6 level.

6.10 Conflict exists within and between sport, subsistence and commercial fisheries, and between fisheries and other consumptive and non-consumptive resource users. Any resolution must consider the needs of all groups and the sustainability of the resource.
More materials for grades 7-12 cover this concept in comparison to all materials but not necessarily in greater depth.

6.11 Real or perceived conflict may result from competition for food among fish and other taxa (e.g. birds). Any resolution must consider the integrity of the ecosystem as a whole.
This concept receives minimal coverage, but we suspect that coverage may increase given the recent status of cormorants in the Great Lakes.

6.12 Restriction of public use of the public fisheries must demonstrably enhance public health, safety or welfare.
This concept receives no coverage.

6.13 Where appropriate, fisheries managers should make anglers and other consumers aware of alternate species to reduce the pressure on popular sport and commercial fish; e.g. encourage anglers to engage in diverse fishing opportunities.
This concept receives minimal coverage.

6.14 Stocking is an important management tool; it has the potential to have both positive and negative consequences.
This concept receives mention but is rarely examined in any depth (particularly in terms of the consequences of stocking).

6.15 Judicious stocking is vital in restoring biological integrity, developing spawning populations, and providing fishing opportunities.
This concept is mentioned but rarely examined in any depth.

6.16 About one-third of all recreational fishing in Michigan depends on stocked fish, including most of the Great Lakes trout and salmon fishery.

6.17 Genetically diverse, disease-free wild or captive spawn sources are required for a strong stocking program.

6.18 Marking and tagging hatchery fish allows the evaluation of their effectiveness and is an essential tool for fisheries management.
These three concepts receive minimal coverage.

6.19 There is a risk of overstocking in the Great Lakes, where several jurisdictions, many stocking locations and species compete for a common forage base.
This concept receives no coverage.

6.20 Self-sustainability is preferred; opportunities for increased self-sustainability should be favored over increased opportunities for hatchery-based fisheries where fishing pressure and fish community structures allow.
This concept receives minimal coverage. See comments *4.3*.

6.21 Research and assessment are critical to determining how to sustain fisheries.
Compared to all materials, grades 7-12 materials are more likely to cover this concept. In comparison to our analysis of North American fisheries education materials (Zint and Crook 1998), the greatest relative increase in coverage of any concept occurs here.

Issue 7: Native Americans have treaty fishing rights in the Great Lakes.
With the exception of the historical perspective of concept *7.1 Fishing for food and trade was important to Great Lakes' tribes prior to European settlement; that importance continued after Europeans arrived*, no aspect of the native fishery is covered by more than 3 (10%) of the materials generally, or 2 (20%) of grades 7-12 materials. There is very little coverage of allocation conflicts between Native American, subsistence, or commercial fisheries. In fact, the Native American subsistence perspective is not common throughout the materials, and no material focuses on it. Coverage of concepts under this issue is generally minimal, with only three concepts receiving a score over 2 (i.e., *7.1, 7.2, 7.3*). No concepts rate as high as a 3 (mean or individual score).

7.4 The Consent Decree expired in 2000; a new Consent Agreement has been negotiated that respects treaty rights, works toward a sustainable fishery, and fairly allocates the resource.

7.8 Trap nets may be helpful in areas where lake trout and other non-target species exceed target species mortalities.

The above two concepts receive no coverage.

Issue 8: Manage for sustainable sport and commercial fisheries.

This issue was interpreted primarily as agency-based management. Generic management was covered elsewhere (see *Management Actions* under each Issue). Less than half the materials address this issue; most focus on some aspect of *8.5 Fisheries managers must be involved with allocation, assessment & research, control of harvest (including enforcement), habitat conservation, restoration and enhancement, managing fish migrations, mitigation and compensation, where continuing damage to stocks or habitat is unavoidable, prevention of unintentional introductions, public education, including sound conservation practices, stock conservation, restoration and enhancement, stocking fish.* This was one of the difficult concepts to rate because of its many components. The remaining concepts under this issue receive very little, agency/management-related attention. The few materials that focus on this issue are *Fish Ways I/S*, *Life in the Great Lakes*, and *The Life of the Lakes*).

8.1 Great Lakes fishery materials are both highly desired and subject to many human impacts; they require intensive protection and management.

This concept is covered by only a few materials but it is addressed relatively well by these materials. It seems assumed by other materials.

8.3 Public understanding of, acceptance of, and involvement in, Great Lakes fishery management is desired to help achieve management objectives.

This concept receives minimal coverage.

8.6 There are many success stories in Great Lakes management (e.g. collaborations with tribes and among Great Lakes agencies, rehabilitated species/habitats, positive impacts of regulation and mitigation).

This concept receives minimal coverage, but is probably underrepresented. It was rated only if there was an emphasis on success, not simply a statement of positive result. Still, there is plenty of room to celebrate successes.

Issue 9: Promote resource stewardship.

9.1 The public has a vested interest in the conservation, restoration and enhancement of aquatic materials.

Few materials cover this concept directly, it generally seems assumed. There may be a need to *start* here with focused programming to convince individuals that there is a need for them to act. Although many materials deal with personal involvement and methods, the link to *why*, i.e., the direct, vested interest, is often not made. Typically, there is a leap from, "fish are in bad shape," to "here's what you can do", without addressing why individuals should care. This is an often-missed step in the EE process.

9.4 Increased citizen awareness and understanding of the ecology of the Great Lakes will result in citizens as advocates for strategies that support long-term sustainability of the Great Lakes fisheries.

This concept receives minimal coverage. There are few specific links between an increased understanding of ecology and informed citizen advocacy.

9.5 The public must understand and respect the resource, the regulations and the rights of others, including anglers, commercial fishers, treaty fishers, property owners and the non-fishing public.

This concept receives almost no coverage.

Issue 10: Promote responsible recreational fishing.

As mentioned elsewhere, this Issue is not a focus in Great Lakes fisheries education materials. A number of other materials cover it effectively, however, and these are applicable to the Great Lakes region. For example, a review of North American fisheries education materials completed for the American Fisheries Society found that this issue was well-covered (Crook and Zint 1998), second only to pollution in overall rating. In that review, fishing had more materials dedicated to it than any other issue. When fishing is addressed by the Great Lakes materials that we reviewed, the emphasis is on the potential role of anglers in the dispersal of exotic species (*10.6*) and, to a greater extent, to toxic chemicals and their health risks (*10.7*).

Issue 11: Develop an awareness of fisheries as a profession and help prepare youth for careers in this profession.

Limited coverage of this issue by grades 7-12 materials should possibly be addressed.

Recommendations

In light of the gaps in coverage we identified through our content review of leading Great Lakes ecosystem and fisheries education materials, we recommend that revisions to current materials or development of new efforts, focus on the following content areas:

Fisheries and biodiversity: The general lack of coverage of this topic provides a broad scope of opportunities. Because most of the content in current materials focuses on biodiversity at the species level, aspects of ecosystem, habitat, community, population (stock) and individual (genetic) diversity should receive consideration by future efforts. Materials should focus on the benefits of diversity to the functioning of ecological systems, and the actual or potential implications of diversity loss. Possible case study: Do introduced species benefit the diversity of a system?

Fisheries and habitats: Critical habitat needs to be addressed as a fundamental ecological and management concept, together with the implications of its loss, protection or enhancement. Particular impacts that should also be examined include water level flux and habitat fragmentation, especially of wetlands. Of importance, given the interests of the GLFT, is the examination of the specific effects of hydroelectric facilities on fish

habitat and fish populations, including the role of mitigation. Of growing concern in light of global warming will be the effects of diversions and withdrawals and thus, this area should also receive more emphasis by future education efforts.

Introduced species: The quick pace of change in this area requires easily updateable materials, information, and databases. The support data necessary for materials should therefore reside on the internet where it can be regularly updated to reflect new introductions, expanded ranges, new control methodologies, etc. Possible case study: Are there "beneficial" introductions?

Fisheries and ecosystems: There is an increase in ecosystem-based information within the materials developed over the past several years but more direct, process-based coverage is needed on a wide range of concepts. A number of concepts (*4.4*, *4.6- 4.10*) could be integrated through a case study linking pollution control, nutrient reductions, fishery productivity, and fishing economics. There is also a lack of Great Lakes watershed- or individual lake watershed-focused materials.

Fisheries: A number of gaps in this area provide opportunities for future education efforts including:

- Aquaculture: advantages, limits, and conflicts
- Harvest: effects of gear selection, techniques and effort (sport and commercial)
- Sport and commercial fishing: Can they coexist in the Great Lakes?
- Sharing the resource: Fisheries and interspecific competition
- Stocking: advantages and limits (a case could evaluate Pacific salmon vs. lake trout stocking and the implications of supporting a popular put, grow and take fishery or eliminating it in favour of a less-popular, but possibly self-sustaining native species).
- Encouraging diverse fishing opportunities in the Great Lakes. This could be one growth area for fishing-focussed programming

Treaty fishing rights: Currently there is almost no coverage of court-supported native rights, their implications, and the ways in which federal, state and provincial agencies are working with Native Americans/First Nations to develop sustainable and fair resource allocations. This is a case that should be examined by educators and their students.

Fisheries management/the role of government agencies: A case needs to be made for the role and value of agency-based management in sustaining our aquatic and fisheries resources. Such a case should include specific "good news" and success stories, including collaborations among agencies and between agencies and various user groups, rehabilitated habitats, population or species restoration, and the positive impacts of regulation and mitigation. Such a case should also address ecological and watershed-based management. Care needs to be taken that such a case is not developed as self-promotion.

Fisheries and stewardship: Future education efforts need to:

- make personal connections between the individual and the resource, so that what happens to the resource matters to the individual. Individuals indeed have a vested interest in the conservation, restoration and enhancement of aquatic resources. This needs to be included as an explicit motivating factor.
- examine individual and collective rights and responsibilities toward the resource, particularly in situations related to allocations or potential/actual conflict.

Fisheries as a profession: Information on fisheries as a career may need to be made available, aimed primarily at counsellors. A number of materials have components that highlight individual fisheries scientists or managers, or simulate fisheries careers in ways that encourage students to consider them. This type of effort should continue to be supported.

Fisheries and sustainability: While not an issue *per se,* sustainability is addressed a number of times in the literacy goals, and has become a major thrust of many environmental programs. The materials we reviewed address sustainability peripherally and do not focus on this topic. Areas that could be addressed include: what sustainability actually means, particularly from a functional, action-based point of view; how do fisheries, as a renewable resource, fit within this functional structure; and what are the implications of a truly sustainable fishery? Such a unit or material could integrate many issues and concepts part of the literacy goals.

Lake trout/lake sturgeon: Another overarching approach to integrating issues and concepts lies in using case studies related to these two heritage fish. An exploration of their history, current management and rehabilitation, and potential future could involve habitat, exotics, ecosystems & watersheds, fisheries, management and stewardship. Parts of these stories are currently told, but not fully, and not in an integrated way.

Pedgagogy review of leading Great Lakes ecosystem and fisheries education materials

Introduction

In addition to a content review of the 30 leading Great Lakes ecosystem and fisheries education materials, we reviewed them based on their education (i.e., pedagogy) approach. Select findings of this part of our review are also presented on the public web site that we created.

Methods

How materials were reviewed in terms of their pedagogy

The main criteria used to evaluate materials in terms of their education approach (i.e., pedagogy) were NAAEE's (1996) *Environmental Education Materials: Guidelines for Excellence* (Table 3-5). These *Guidelines for Excellence* call for high quality environmental education materials to have six key characteristics, each supported by several guidelines (28 in total). Indicators (143 in total) for each of

these guidelines give specific measures or conditions for evaluating environmental education materials.

Table 3-5 Overview of NAAEE's (1996) *Environmental Education Materials: Guidelines for Excellence*

#1 Fairness and accuracy **1.1 Factual accuracy.** **1.2 Balanced presentation of differing viewpoints and theories.** **1.3 Openness to inquiry.** **1.4 Reflection of diversity.**
#2 Depth **2.1 Awareness.** **2.2 Focus on concepts.** **2.3 Concepts in context.** **2.4 Attention to different scales.**
#3 Emphasis on skill building **3.1 Critical and creative thinking.** **3.2 Applying skills to issues.** **3.3 Action skills.**
#4 Action orientation **4.1 Sense of personal stake and responsibility** **4.2 Self-efficacy**
#5 Instructional soundness **5.1 Learner centered instruction** **5.2 Different ways of learning** **5.3 Connection to learners' everyday lives** **5.4 Expanded learning environment** **5.5 Interdisciplinary** **5.6 Goals and objectives clearly conveyed** **5.7 Appropriateness for specific learning settings** **5.8 Assessment**
#6 Usability **6.1 Clarity and logic** **6.2 Easy to use** **6.3 Long-lived** **6.4 Adaptable** **6.5 Accompanied by instruction and support** **6.6 Make substantiated claims** 6.7 Fit with national, state, or local requirements

Each of the 30 materials was reviewed to assess which of the 143 indicators are "present" or "not present." Next, the percent of indicators present for each of the guidelines was calculated and each percent was converted to a numeric score and rating (Table 3-6). Then, the mean of the guideline scores under each key characteristic was calculated to produce a score for each of the six key characteristics. Lastly, the mean score of the six key characteristics was calculated to produce an overall score for each of the 30 materials. The highest score any of the key characteristics (and thus the entire material) could receive was 4; the lowest was 0.

Table 3-6 Scoring and rating of the 30 reviewed materials based on NAAEE's (1996) *Guidelines for Excellence*

Criteria	Score	Representation on public www site	Rating
No indicators present for a particular guideline	0	No star symbol	None
1-34% of indicators present for a particular guideline	1	Outline of star symbol	Limited
35-54% of indicators present for a particular guideline	2	25% shade of star symbol	Fair
55-74% of indicators present for a particular guideline	3	50% shade of star symbol	Moderate
≥75% of indicators present for particular a guideline	4	Solid black star symbol	Good

Because we wanted to give special attention to the extent to which the materials we reviewed promote environmentally responsible behaviors or actions, we developed several criteria in addition to the action-related guidelines and indicators in the *Guidelines for Excellence* (see key characteristic #3, emphasis on skills building and key characteristic #4, action orientation). Specifically, we examined:

- **at what levels actions are targeted (i.e., individual, organization/family, community, government/policy, unspecified range),**
- **if specific actions are advocated or if learners are encouraged to choose actions based on critical thinking and decision-making processes,**
- **if actions address only immediate threats (i.e., mitigation) or sources of the environmental threat (i.e., prevention), and**
- **if examples or case studies of successful action strategies are presented.**

Note the following limitations of this aspect of our review:

- The *Guidelines for Excellence* indicators were evaluated as either "present" or "not present" and thus, this aspect of the review does not reflect differences in quality.
- Many of the 28 guidelines in the *Guidelines for Excellence* have four or fewer indicators (e.g., eight guidelines have four indicators, two guidelines have three or fewer indicators, one guideline has only two indicators) and we did not weight scores based on this difference in indicators.

- Electronic, web-based, or CD-ROM based materials are relatively new and unique compared to print-based materials. The *Guidelines for Excellence* do not include sufficient indicators for these types of materials and thus, some of them may not have received as high a score as may be appropriate.

Results

This section briefly summarizes overall results and then describes results for each of the six key characteristics in the *Guidelines for Excellence*. In some instances, results for certain guidelines under the six key characteristics are also addressed.

Table 3-7 summarizes results of the review of the 30 leading Great Lakes ecosystem and fisheries education materials for each of the six key characteristics and ranks them accordingly.

Table 3-7 Summary of review results in terms of the six NAAEE (1996) key characteristics (range 0-4)

Key Characteristic	Lowest score	Highest score	Mean score	Rank
Fairness and accuracy	1.0	3.5	2.12	5
Depth	1.5	4.0	2.98	1
Emphasis on skills building	.33	4.0	2.31	4
Action orientation	0.0	3.5	1.44	6
Instructional soundness	.88	3.5	2.58	2
Usability	.43	3.4	2.47	3

Table 3-8 lists the mean score each material received for each of the six key characteristics and an overall score. The mean score for all thirty materials based on all six key characteristics was 2.40 (range 0-4). The highest overall mean score was 3.39 (*Great Lakes Environmental Issues*) and the lowest was 1.43. Eight (27%) materials received a score of 3 or greater.

Table 3-8 Mean pedagogy scores for each of the reviewed Great Lakes ecosystem and fisheries education materials (range 0-4).

Key Characteristic	Target Grade Level	Fairness/ Accuracy	Depth	Emphasis on Skills Building	Action Orientation	Instructional Soundness	Usability	
		1	2	3	4	5	6	MEAN
ALIEN IN	9-12	2.75	3.50	4.00	2.50	3.50	2.71	3.16
BEL LIVE	4-8	2.75	3.25	2.67	1.00	3.13	3.14	2.66
CA PL EA	6-12	2.75	2.75	2.00	2.50	2.13	2.70	2.47
EARTH GEN	7	1.00	3.25	2.33	1.50	2.88	2.43	2.23

EXO AQU	4-5	1.25	3.00	1.67	1.00	2.38	2.57	1.98
EXPL GL	7-12	1.75	3.25	1.67	0.50	1.50	2.00	1.78
FISH WAYS	K-12	3.25	3.75	3.00	2.00	3.50	3.14	3.11
GL ED PROG	4	2.75	3.50	3.00	3.50	3.50	3.60	3.31
GL EE PR	9-12	2.25	2.25	2.67	1.50	0.88	0.43	1.67
GL EN IS	7-12	3.50	3.75	3.67	3.00	3.13	3.29	3.39
GL EXPL	7-12	1.25	2.75	2.67	1.00	2.50	2.00	2.03
GL IN WLD	K-8	2.25	2.50	1.67	2.00	2.34	1.86	2.10
GLIMCES	7-12	2.75	3.00	2.67	1.00	2.86	3.00	2.55
GL SOL SE	7-12	2.50	4.00	3.67	2.00	3.13	2.29	2.93
GLS L KIT	1-12	1.25	3.25	1.67	0.50	2.75	2.43	1.98
GM GL!	K-5	2.00	3.75	1.33	1.00	1.88	1.57	1.92
ISEA	5-12	1.50	3.25	2.33	0.50	3.13	3.14	2.31
LK EFFS	K-8	2.50	3.75	3.00	2.00	3.38	3.29	3.00
LK ERIE… BOW	K-5	1.75	2.00	2.00	0.50	2.13	2.28	1.78
LK ERIE… FISH	K-5	1.00	1.50	1.33	0.00	1.88	2.00	1.28
LK ERIE… DAY	K-5	1.50	3.00	2.00	0.00	2.13	2.00	1.77
LKS A-L	K-3	1.67	2.25	0.33	0.50	2.13	1.71	1.43
LKS M-Z	K-3	1.67	2.50	1.00	0.50	2.25	1.86	1.63
LKS ECO	7-10	1.75	2.75	1.67	1.00	2.88	2.00	2.01
LKS GAME	5-12	2.50	2.25	2.67	3.00	2.75	3.00	2.70
LIFE GL	7-12	3.00	3.50	3.33	2.00	3.40	3.43	3.11
LIFE LKS	7-12	3.00	3.75	3.67	2.00	3.50	3.43	3.23
O GL CON	K-8	3.00	3.00	2.30	1.00	2.38	2.71	2.40
PADDLE	3-6	2.50	3.75	2.33	2.00	2.63	3.14	2.73
ZM MANI	5-6	2.50	3.75	3.33	3.00	3.50	3.43	3.25
MEAN		2.19	3.08	2.39	1.48	2.67	2.55	2.40

Key Characteristic #1: Fairness and Accuracy

*"*Environmental education materials should be fair and accurate in describing environmental problems, issues, and conditions, and in reflecting the diversity of perspectives on them*." (NAAEE 1996)*

Mean score: 2.19
Materials scoring 2.19 or higher: 17 (57%)
Highest score: 3.5 (*Great Lakes Environmental Issues*)
Rank: 5

This key characteristic focuses on the accuracy of information presented in materials and on the diversity of viewpoints that are presented. Emphasis is placed on referencing sources of factual information, and identifying source of opinions or policies when these are presented in the material. This characteristic also emphasizes the importance of providing multiple perspectives (cultural, historical, political, scientific, etc.) on a particular issue, and the creation of a learning atmosphere in which students are

encouraged to examine and develop their own personal views on environmental issues. Materials that best accomplish this are *Great Lakes Environmental Issues* (mean=3.5) and *Fish Ways* (mean=3.25*).*

Great Lakes Environmental Issues is noteworthy in that it clearly identifies sources of factual information and/or policies and opinions. In the lesson "How skillfully can you read science articles?," students are provided with the publication source of several scientific articles as well as with background information about the author and the organization the author represents. Many lessons in *Great Lakes Environmental Issues* also provide historical and contemporary perspectives of environmental issues affecting the Great Lakes (e.g., "Who owns the resources of the Great Lakes?", "Could we live without chlorine in the Great Lakes?", "Great Lakes water quality: background and issues").

The fact that this key characteristic ranked fifth among the six characteristics is somewhat misleading. It is not that the materials are generally not fair and accurate in their presentation (the reviewers rarely encountered inaccurate information). Rather, the majority of materials lack referencing of sources of information, and/or lack incorporation of multiple perspectives on an issue. The lack of these two indicators contributed greatly to the low scoring, and therefore low overall rank, of this key characteristic.

Key Characteristic #2: Depth

*"*Environmental education materials should foster awareness of the natural and built environment, an understanding of environmental concepts, conditions, and issues, and an awareness of the feelings, values, attitudes, and perceptions at the heart of environmental issues, as appropriate for different developmental levels*." (NAAEE 1996)*

Mean score: 3.08
Materials scoring 3 or greater: 21 (70%)
Highest score: 4 (*Great Lakes Solution Seeker*)
Rank: 1

This key characteristic focuses on how concepts are organized by materials, and also the extent of coverage these concepts receive. Are the concepts arranged by theme? Are the concepts presented in a logical manner? Are concepts connected throughout the materials, and if so, do those connections make sense? Do materials provide more than just a fact-based understanding of the concepts? This key characteristic calls for an emphasis on depth of understanding rather than breadth. The materials that best meet this key characteristic are *Great Lakes Solution Seeker* (mean=4.0), and *Fish Ways*, *Great Lakes Environmental Issues*, *Great Minds? Great Lakes!*, *Lake Effects, The Life of the Lakes*, *Paddle-to-the-Sea*, and *Zebra Mussel Mania* (mean=3.75, each).

Great Lakes Solution Seeker scored highest on this characteristic in part due to the large amount of information and activities it contains. The index lists approximately 55 activities that cover a range of Great Lakes issues in depth: pollution and Areas of

Concern, habitat loss, ecology and food chains, exotic species, and water movement throughout the Great Lakes. Concepts covered by each activity are clearly linked to the material's conceptual framework. Many of the activities build-on and reinforce lessons learned in other activities. Students are encouraged to bring their own experiences and opinions into the learning process, particularly through the use of role play and simulation activities. Social, economic, and cultural perspectives of Great Lakes issues are addressed throughout the activities, as are different scales (local, regional, and global). The other materials mentioned above also include activities that are logically organized and connected, contain multiple perspectives including those of the students, and provide in-depth coverage of various Great Lakes issues.

This key characteristic ranked highest among the six key characteristics. This is because most materials present environmental concepts in a context relevant to learners' lives, tend to use unifying themes to link the main concepts, and provide an awareness of the role that personal feelings, experiences, and attitudes play in shaping the perceptions of environmental issues. Where many materials fall short, however, is in not providing a conceptual framework of concepts to be learned, and in not applying different temporal and geographic scales when presenting environmental issues. Short and long term time spans, and local, regional, and global perspectives of environmental issues can help to increase depth of understanding and could be provided by these materials.

Key Characteristic #3: Emphasis on skills building

*"*Environmental education materials should build lifelong skills that enable learners to prevent and address environmental issues*." (NAAEE 1996)*

Mean score: 2.39
Materials scoring 2.39 or greater: 13 (43%)
*Highest score: 4 (*Alien Invaders*)*
Rank: 4

This key characteristic focuses on the types of skills that should be promoted by materials. The guidelines emphasize critical thinking, communication, and classroom laboratory and field skills, as well as skills that help students develop their own conclusions about environmental issues when faced with different evidence and perspectives. This key characteristic also covers skills that allow students to participate in solving environmental problems. Materials that best meet this key characteristic are *Alien Invaders* (mean=4), and *Great Lakes Environmental Issues, Great Lakes Solution Seeker,* and *The Life of the Lakes* (mean=3.67, each).

The format of *Alien Invaders* contributes to the very high score for this key characteristic. The material is formatted as an issue investigation, and provides opportunities for students to use many different skills throughout the unit. Communication and problem solving skills are emphasized by the cooperative learning approach promoted by this material, as well as by a role-play simulation game. Throughout the material, students are encouraged to identify and define issues based on multiple perspectives and evidence they gather. Critical and creative thinking skills are emphasized as students define

problems and hypotheses to test during the classroom laboratory experiments, and then collect and interpret their data. Higher learning skills such as inference and modeling are also promoted throughout the material.

Great Lakes Environmental Issues addresses critical thinking and communication skills in the role-play activities "How should public health be protected", "Who owns the resources of the Great Lakes", and "Could we live without chlorine in the Great Lakes?"; enhances critical thinking skills in the activity " How skillfully can you read science articles "; and promotes laboratory and field skills in the activity "How much is one part per million?", "What happens when nutrients enter an estuary?", "How can an oil spill be cleaned up?".

Great Lakes Solution Seeker is also notable in how it promotes critical thinking and data interpretation skills in the role-play activity "What can you do to save a lakeside town from toxic sediments?", and in the activities "Hot and bothered – what are the temperature effects on the Great Lakes?" and "How (environmentally) insulting can we get?". Critical thinking and communication skills are enhanced in the activity "Toxics in the lake". Laboratory and field skills are promoted in the activity "Exploring the school site: Increasing environmental sensitivity close to home". Several other activities in this material emphasize data collection and interpretation skills.

The Life of the Lakes promotes laboratory, data collection and/or interpretation skills in the activities "Where have all the lake trout gone?" and "Contaminants in Great Lakes fishes". Critical thinking skills are enhanced in "Great Lakes fisheries and the economy", "Great Lakes food web", and the video discussion activity "Great Lakes fisheries: The future".

This key characteristic ranked fourth compared to the other five characteristics, mostly because few materials give students the opportunity to learn and practice "action skills" – skills needed to participate in solving environmental issues. Most materials also lack a list of a variety of materials/organizations that students can explore/contact on their own, and also lack exercises aimed at evaluating information sources. Increased attention to both of these indicators would improve the materials.

Key Characteristic #4: Action orientation

*"*Environmental education materials should promote civic responsibility, encouraging learners to use their knowledge, personal skills, and assessments of environmental issues as a basis for environmental problem solving and action*." (NAAEE 1996)*

Mean score: 1.48
Materials scoring 1.48 or greater: 15 (50%)
*Highest score: 3.5 (*Great Lakes Education Program*)*
Rank: 6

This key characteristic focuses on how the materials convey a sense of personal responsibility and efficacy in contributing to or resolving environmental issues. This

characteristic emphasizes the historical and geographic factors that contribute to environmental issues. This characteristic also emphasizes the different social perspectives that influence how people respond to environmental issues, as well as the importance of individual and collective action to resolve environmental issues. Materials that best meet this key characteristic are *Great Lakes Education Program* (mean=3.5), and *Great Lakes Environmental Issues, The Lake Superior Game,* and *Zebra Mussel Mania* (mean=3, each).

Great Lakes Education Program is notable in its action orientation, particularly in the post-cruise activities "Learn about personal water use", "Hydropoly; A decision-making game", "Deadly waters", and "Interpreting on-board water quality results". Students are encouraged to use critical thinking skills to identify individual and collective impacts on the Great Lakes, and to develop and present individual and group action plans for addressing various Great Lakes environmental issues.

Overall, many materials promote both intergenerational and global responsibility for environmental issues. Fewer materials, however, provide students with an opportunity to reflect on the effects of their personal decisions. This key characteristic ranked lowest compared to the other five characteristics [consistent with the relatively low coverage for stewardship (Issue 9)] due to the following: Few materials encourage students to act on environmental issues or provide a variety of strategies for students to become involved in environmental problem solving. Even fewer materials provide case studies or examples of successful actions to address environmental issues. Perhaps also contributing to the low overall score (and thus overall rank) of this key characteristic is that seven (23%) of the materials have no action component (no suggestion or encouragement to take action on environmental issues). Three of these seven provide information about Great Lakes fish in general, and do not address Great Lakes or Great Lakes fisheries issues and thus, it may be appropriate that they not include an action component. The remaining four materials address one or more Great Lakes environmental issue but provide no activities or suggestions for taking action to address them.

Key Characteristic #5: Instructional soundness

*"*Environmental education materials should rely on instructional techniques that create an effective learning environment*." (NAAEE 1996)*

Mean score: 2.67
Materials scoring 2.67 or greater: 14 (47%)
*Highest score: 3.5 (*Alien Invaders, Fish Ways, Great Lakes Education Program, The Life of the Lakes, Zebra Mussel Mania)
Rank: 2

This key characteristic focuses on the types of instructional techniques that are promoted by materials. Guidelines emphasize allowing student interest to guide the learning process, and offering different methods of teaching and learning (visual, auditory, tactile; research, creative expression, lecture). This characteristic also calls for an interdisciplinary approach, and for creating a diverse learning environment in and out of

the classroom. Clearly stated goals, objectives, and assessment tools are also important components of this key characteristic. Materials that best meet this key characteristic are *Alien Invaders, Fish Ways, Great Lakes Education Program, The Life of the Lakes,* and *Zebra Mussel Mania* (means=3.5, each).

These five materials scored high for "Instructional Soundness" for several reasons. They promote student-centered learning, which allows student interest to direct the learning process. These materials are also quite interdisciplinary in nature, and employ different learning techniques, such as auditory, visual, experiential, etc., throughout the activities. These materials provide activities that occur in multiple learning environments, ranging from the classroom to a laboratory, community project, and/or a field trip. *Alien Invaders* and *Zebra Mussel Mania* in particular also have strong learner assessment tools.

This key characteristic ranked high among the six characteristics due to the following: Almost all materials include clearly stated goals and objectives, and many materials provide opportunities for different ways of learning (visual, auditory, experiential, etc) and make clear connections to students' lives. Many materials also include an interdisciplinary approach to teaching about Great Lakes fisheries. Few materials, however, include assessment tools, or allow for student-centered learning.

Key Characteristic #6: Usability
*"*Environmental education materials should be well-designed and easy to use*." (NAAEE 1996)*

Mean score: 2.55
Materials scoring 2.55 or greater: 16 (53%)
*Highest score: 3.6 (*Great Lakes Education Program*)*
Rank: 3

This key characteristic focuses on the design, structure, and layout of materials. Guidelines emphasize organizational logic, adaptability, and an appealing and easy-to-use layout. This characteristic also calls for the importance of providing additional support for instructors (such as continuing technical support, a network of other educators using the same material, information about training and professional development related to the material), accomplishing what materials claim, and being aligned with education requirements (e.g. standards). The materials that best meet the indicators of this key characteristic are *Great Lakes Education Program, Life in the Great Lakes, The Life of the Lakes,* and *Zebra Mussel Mania.*

Great Lakes Education Program is exceptionally easy to use. The materials are in a tabbed 3-ring binder, separated in "Pre-Cruise", "Cruise", and "Post-Cruise" sections. Each activity provides clearly stated objectives, an activity summary, a list of needed materials, subjects and skills covered, references to a conceptual framework, duration, adaptations, computer extensions, additional materials, and clearly written procedures, all presented in a logically organized format. Additional materials include local and regional contacts, Internet contacts, teaching materials, and references for similar activities in

other aquatic education materials. No other reviewed material consistently provided as many suggested components for each activity.

Some of the indicators of this key characteristic are well met by the materials. Most of the materials have an easy-to-use format and are either correlated with (or could easily be correlated with) state and/or national education standards. Few materials, however, provide additional technical, networking, or professional development support to teachers, and even fewer materials provide suggestions for how to adapt lessons/activities to a range of factors (culture, language, age, physical ability, etc.).

Additional action criteria **(Table 3-9):**
As mentioned earlier, not all of the reviewed materials have an action component. Not having an action component may be appropriate, especially if materials target young learners (NAAEE 1996). The lack of an action component may also be appropriate if the intent of a material is solely to teach learners how to identify and classify fish, about fish biology, or to appreciate fishing as opposed to fisheries or other environmental issues.

Twenty three (77%) of the materials have some action orientation. Of these 23, three materials, *Alien Invaders, Great Lakes Environmental Education Project* and *The Lake Superior Game,* stand out as having the best action orientation. *Alien Invaders* is notable in that the material includes an activity in which the students develop and conduct an community survey to gain an understanding of local public awareness about exotic species issues. Students then use the results of this survey to develop and target their community action efforts. *Great Lakes Environmental Education Project* is notable in that it presents many examples (newspaper articles) of actions taken in response to different Great Lakes issues. These cases present various levels of action (i.e. action targeted at different social levels: individual, organization/family, community, government/policy, unspecified range) and provide specific examples of actions. The material also encourages students to use critical thinking skills to develop their own action plans to address Great Lakes issues. Lastly, the material encourages action targeted not only toward mitigation of impact but toward prevention. Although it doesn't have activities that involve direct student action outside the confines of the game, *The Lake Superior Game* rated high in these criteria based on the large number of examples it gives of different actions individuals can take related to Great Lakes environmental issues.

Table 3-9 Results for each material based on additional action orientation criteria.

Material	Present	Level of action					How determined		Action Type		Case Study
		I	O	C	G	R	Spec	Crit Det	Mitigate	Prevent	
ALIEN IN	4					X	X	X	X	X	
BEL LIVE	3	X					X		X		
CA PL EA	3					X	X		X	X	X
EARTH G	3	X			X		X		X	X	
EXO AQU	2	X			X		X	X	X		
EXPL GL	1					X	X	X	X	X	
FISH WAY	3					X	X	X	X	X	
GL ED P	3					X	X	X	X	X	
GL EE PR	4					X	X		X	X	X
GL EN IS	2	X						X	X	X	
GL EXPL	0										
GL I WLD	2					X	X	X	X		
GLIMCES	1	X	X				X		X		
GL SO SE	2					X		X	X	X	
GLS LKI	1					X	X	X	X	X	
GM GL!	1					X		X	X		
ISEA	0										
LK EFFS	3					X	X	X	X	X	
LK ER BO	0										
LK ER FI	0										
LK ER DA	0										
LKS A-L	0										
LKS M-Z	1					X		X	X	X	
LKS ECO	1					X	X	X	X	X	
LKS GAME	4					X	X	X	X		X
LIFE GL	3	X			X			X	X	X	

LIFE LKS	2					X		X	X		
O GL CON	0										
PADDLE	2	X	X	X			X		X		
ZM MANI	3					X		X	X		

Present: 0=no action orientation present, 1=very limited presence, 2=limited presence, 3=adequate presence, 4=good presence.
Level of action: I=individual, O=organization/family, C=community, G=government/policy, R=unspecified range
How determined: Spec=specific action(s) advocated, Crit Det=learners choose action(s) based on critical thinking
Action Type: Mitigate=action(s) address immediate threats (mitigation), Prevent=action(s) address source of threat (prevention)
Case Study: Example(s) or case study or studies of successful action strategies are presented

Recommendations
In light of the gaps we identified through our review of how well Great Lakes ecosystem and fisheries education materials follow education guidelines, we recommend the following related to each key characteristic:

Key Characteristic #1:

- provide more references for factual information. *Great Lakes Environmental Issues* provides a good example of this as factual information, as well as opinions/philosophies of various agencies, organizations, and scientific bodies are clearly referenced.

- provide multiple perspectives/viewpoints of issues: cultural, political, organizational, historical, scientific, etc. In particular, tribal (e.g. treaty fishing and historic and current fisheries use) and multi-cultural (role of fish and/or fishing in different cultures) perspectives of Great Lakes and Great Lakes fisheries issues should be incorporated in education materials. *Caring for Planet Earth*, *GLIMCES,* and *Our Great Lakes Connection* are among the best examples of materials that incorporate a tribal perspective.

Key Characteristic #2

- provide a conceptual framework of concepts to be learned (e.g. Great Lakes fisheries education literacy goals can serve in this capacity). Materials from the ES-EAGLS series (*Great Lakes Environmental Issues* and *Life in the Great Lakes), GLIMCES, Great Lakes Education Program, The Life of the Lakes,* and *Lake Effects* are good examples of materials that include a conceptual or curriculum framework for the concepts included in their lessons and activities.

- include applications of different temporal and geographic (local, regional, and global) scales when presenting environmental issues. In particular, the CD-ROM *Great Lakes Explorer* is notable in its presentation of different temporal scales (historical, contemporary, and future factors of Great Lakes environmental issues).

Key Characteristic #3

- present the opportunity to learn and practice "action skills" – skills needed to participate in solving environmental issues. Good examples of materials that provide these opportunities include *Alien Invaders* and *Great Lakes Environmental Education Project.*

- include a list of a variety of materials/organizations that students can explore/pursue on their own. Many materials already do a good job of this. However, it is recommended that the lists provided include resources and/or organizations with varying perspectives on particular issues.

- include exercises/activities aimed at evaluating information sources. *Great Lakes Environmental Issues* and *Great Lakes Environmental Education Project* are notable in their inclusion of activities that specifically address evaluating sources of information.

Key Characteristic #4

- encourage students to take action on environmental issues. In particular, the materials *Alien Invaders, Great Lakes Environmental Education Project, the Lake Superior Game,* and *Zebra Mussel Mania* promote learner action. Several other materials also promote learner action, but only as extension activities rather than being the focus of activities.

- provide a variety of strategies for students to become involved in environmental problem solving. This relates closely to providing examples of successful actions (see next).

- provide case studies or examples of successful actions taken by individuals and groups to address environmental issues. Only three of the reviewed materials provide examples and/or case studies of successful action strategies in response to Great Lakes environmental issues. Such concrete examples can be helpful in providing learners with both encouragement and models on which to build their action strategies.

Key Characteristic #5

- when appropriate, encourage learning based on student interest (learner-centered instruction). *Great Lakes Environmental Issues, Life in the Great Lakes,* and *Lake Erie…A day in the life of a fish* are among the best materials to provide opportunities for student-centered learning.

- provide more opportunities for students to learn in environments outside of the classroom (suggestions should include vessel based experiences and lower cost alternatives). Vessel-based programs such as *Inland Seas Education Association* and *Great Lakes Education Program* are good examples of out-of-classroom experience. However, materials should also incorporate opportunities for local out-of-the-classroom field studies (on school or neighboring property, for example).

- provide a variety of methods/tools for assessing student progress. *The Earth Generation, Great Lakes Environmental Issues, Lake Effects, Life in the Great Lakes,* and *Zebra Mussel Mania* are good examples of materials that present different methods to assess learner progress.

Key Characteristic #6

- include information to help substantiate education claims made (providing a list of reviewers and a list of educators who piloted the material; providing results of evaluations in terms of impacts on students). In particular, *Great*

Lakes Environmental Program and *The Life of the Great Lakes* are materials that both provide extensive lists of developers and reviewers (with credentials) of the material.

- provide suggestions on how to adapt lessons/activities to a range of factors (culture, language, age, physical ability, etc.). *Lake Effects* provides grade-specific adaptations for some of the activities. However, adaptations to address different cultures, languages, or physical ability are missing from all reviewed materials.

Additional Action Criteria

- generally improve emphasis on action, any emphasis on action should flow from the environmental issues that are addressed and should be appropriate for the target age group. Care must be taken, however, that the approach taken is education (i.e. students determine actions through problem solving) versus advocacy (i.e. students are told what actions they should take).

Please note:

With regard to evaluating Great Lakes ecosystem and fisheries education materials in terms of their content, it is important to note that it is not reasonable to expect that each material address ALL of the literacy goals. In fact, it is desirable that materials focus on select issues in depth. With regard to evaluating Great Lakes ecosystem and fisheries education materials in terms of their education approach, it is generally desirable for them to meet as many of the *Guidelines for Excellence* (NAAEE 1996) as possible. However, even in terms of these guidelines, it may not be appropriate for particular materials to meet select indicators. This is the case, for example, for action-related indicators for materials targeted at grades K-6 where it may not be appropriate to promote certain environmentally responsible behaviors but more appropriate to focus on affective development (NAAEE 1996).

Some general limitations of our review

Our review of the 30 leading Great Lakes ecosystem and fisheries education materials has several limitations:

- Only a single reviewer examined the materials in terms of their content and another in terms of their pedagogy. Ideally, several individuals striving for consensus would have reviewed each resource's content and pedagogy. Due to financial and time constraints, such an approach was not possible.
- The materials we reviewed were not designed to meet our literacy goals and due to the relatively recent publication of the *Guidelines for Excellence*, they were probably also not designed to meet the suggested indicators.[1] As a result, scores/ratings are not as high as they could be if the materials had been designed with these goals and indicators in mind.

[1] To the best of our knowledge only the Great Lakes Education Program was designed in part based on the *Guidelines for Excellence*.

- We conducted an extensive search to identify leading Great Lakes ecosystem and fisheries education materials. Despite our best efforts, however, it is possible that our search missed relevant education materials.

Examination of other Great Lakes ecosystem and fishery education efforts
To learn about Great Lakes ecosystem and fishery education efforts other than the leading education materials, we consulted with the education representatives of the organizations represented on the Great Lakes Fishery Trust and members of the Michigan Alliance for Environmental & Outdoor Education.

Education efforts and perceived needs by education representatives of the organizations represented on the Great Lakes Fishery Trust
The following minutes of a meeting with the education representatives of the organizations represented on the Great Lakes Fishery Trust describes the Great Lakes ecosystem and fishery education efforts that they are engaging in, and more importantly, these individuals' perceived needs.

GLFT Education Contacts' Education Efforts and Perceived Needs
Based on February 23, 2001 Meeting

Participants: Jennifer Dale (via conference call), CORA; Shari Dann, MSU & GLFT Project F.I.S.H; Ken Dodge, MDNR-Fisheries Division; Sharon Hanshue, MDNR-Fisheries Division; Patty O'Donnell, GTBOCI; Brandon Schroeder, MUCC; Carey Rogers, NWF; Allison Schuster, SNRE/UM; Michaela Zint, SNRE/UM. Guest: Michael Chiarappa, WMU (GLFT Fish for All).

The meeting began with introductions. Next, Zint reviewed the agenda and gave an overview of the GLFT education needs assessment grant project. This meeting with the education contacts of the organizations represented on the GLFT was organized to meet one of the grant objectives. The goal was to learn more about these organizations' (Great Lakes fisheries) education activities and to focus on these organizations' perceived Great Lakes fisheries education needs. Zint indicated that input received during the meeting will be included and addressed in the final report to the GLFT.

Because most participants prepared a paper in advance of the meeting summarizing their organizations' (Great Lakes fisheries) education efforts and needs (see end of these minutes), this information will not be repeated here. Instead this summary focuses on the highlights of the discussions during the meeting.

Individual organizations' perceived needs:

Michigan State University & GLFT funded *Project F.I.S.H.*

Dann began with a brief overview of *Project F.I.S.H.*, a GLFT-funded education project. A complete report including an evaluation and impact data is available at http://www.projectfish.org. This program has trained over 270 educators to date, and an estimated 12,000 youth have been impacted. The program is currently taking a watershed approach and targeting urban areas. It is hoped that the program will be able to provide small grants to local fishing clubs for conservation activities. Some efforts to obtain on-going funding from industry are currently underway.

MSU's prioritized needs were described as follows:

1. **Sustain effective programs/education efforts by providing financial and institutional support.**
2. **Evaluate and revise/update (based on evaluations) existing efforts to maintain viability.**
3. **Be responsive to stakeholder needs while being strategic with planning (i.e. Listen to the stakeholders, and at the same time be responsive to emerging issues.)**
4. **Continue research and evaluation on program effectiveness for a variety of intended audiences.**

There was a question regarding the importance of evaluation/research on program effectiveness. The group discussed the importance of evaluation (e.g. to guide planning and implementation, legitimize effort), and highlighted that more funding sources are requiring evaluations of education programs.

CORA (Chippewa Ottawa Resource Authority) http://www.cotfma.org

The prioritized education needs for CORA are as follows:

1. Think long-term for future generations – provide curriculum for stewardship of the Great Lakes.
2. Address the lack of information on the historic ecology and peoples of the Great Lakes (Native American history of the Great Lakes).
3. Improve communication and education related to fishing regulations, and the risks and benefits of fish consumption.
4. Develop and distribute updated fishery publications.
5. Improve and increase available education materials (for better-educated – and more active – citizens).
6. Support internships to provide services and expertise to develop education materials and implement programs.

Dale and other participants commented that they perceived the potential for collaboration and sharing of resources resulting in more effective education efforts.

GTBOCI (Grand Traverse Band of Ottawa and Chippewa Indians)
The prioritized needs for the GTBOCI are as follows:

1. Promote participation of adult mentors to help teach youth about commercial, subsistence, and recreational fishing.
2. Promote the Native American cultural connection to the Great Lakes fisheries.
3. Fish education (fish identification, life span/cycle, etc.) efforts in schools, day care, community and youth group meetings
4. Increase education on fishing regulations
5. Hands-on outdoor fishing demonstrations
6. Provide fishing equipment for youth

Expected outcomes of these efforts (including efforts focused on young children) include: promotion of cultural and traditional activities relating to the Great Lakes, ties to existing tribal programs, and "keeping youth out of trouble."

There was a question regarding the education of tribal conservation officers. O'Donnell stated that officers are trained by the NAFWS, but that GTBOCI tries to train/work with officers to monitor soil erosion and spills that affect the watershed.

There was a question regarding sharing sources of information such as tribal newsletters. Can tribal newsletters or articles be made available on the web to expand outreach and access to information? A list serv by NWF as well as GLIN's list serv were identified as ways to assist in disseminating these resources.

MDNR – Fisheries Division
The prioritized needs for the MDNR-Fisheries Division are as follows:

1. Make a financial and institutional commitment to aquatic resources education. Hire an aquatic resources education coordinator, and develop fishing education as a component.
2. Work on creating better working relationships with project partners – be more productive with existing partners, and have more realistic expectations of partnerships.
3. Assess cross communication within different departments and divisions within the DNR, and also between other agencies and organizations (e.g. DEQ).

There was a question regarding the need to evaluate how much existing education/information materials (e.g. LAPs) are being used.

Dale commented on the effective partnership that existed within the Public Information and Education Committee, a standing committee that reported to the Executive Council established by the 1985 Consent Order. The committee was quite effective in collaborating and developing information materials. This comment reinforced that some type of forum/structure for communication/collaboration can be helpful.

MUCC

Schroeder stated that he expects to distribute a paper outlining MUCC's education efforts. He described the prioritized needs for MUCC as follows.

1. Improve coordination and delivery of existing efforts/programs.
2. Increase sustainability of existing efforts (both MUCC programs and club programs). (MUCC has over 500 affiliated clubs, many of which have their own watershed, aquatic, and fisheries education efforts.)
3. Develop more comprehensive programs to fill existing gaps in effort. Match programs that can support and compliment one another.

There was a question regarding clubs: Can MUCC encourage clubs to have representatives participate in Project F.I.S.H. training? Dann and Schroeder announced that MUCC and MSU Extension just established a staff position to coordinate programs to better share and deliver existing programs. There are also partnerships between MUCC and tribal organizations, and between tribal organizations and Michigan Sea Grant.

NWF

Rogers commented that because NWF's education programs are being reorganized, it would not be appropriate to provide a written summary of education efforts and needs at this time. Rogers, however, offered a verbal summary of current relevant efforts and needs.

Most NWF education programs are land-based. NWF's niche focuses on the health of the land and the connection to community and human health. Curricula focus mainly on habitat and ecosystems education. The largest education efforts in Michigan include: Urban Ecosystems, Habitat Stewards, and Earth Tomorrow, a high school program focusing on the Detroit River watershed and connecting schools with local resources. High school is the target age for NWF's action-based programs.

The prioritized needs of the NWF are as follows:

1. Adapting existing national/regional programs for local use
2. Emphasizing the importance of qualitative and quantitative evaluations and dissemination of results.
3. Creating diversity (ties in with funding): Help secure funding for internships to allow for more diversity within intern positions. Increase diversity among mentors (how each culture uses the Great Lakes).
4. Promoting volunteerism and service learning, and making these sustainable/long term.
5. Putting tools in place so that individuals promote environmental education, not advocacy.
6. Providing resources to get youth outdoors, especially urban youth, and offering hands-on experiences.
7. Partnering with existing programs (e.g. "Wet in the City" and utilizing ponds and fishing areas).

A number of miscellaneous comments were made next, including the need to: (1) raise (historical) awareness of the Great Lakes, especially in urban areas and that this awareness should be tied into the local community and make land/water connections; (2) increase diversity in natural resource organizations; (3) inform individuals about different ways to enjoy the natural resources/environment in local communities; (4) start education programs in elementary school and focus on action in high school.

There was a question regarding reaching African American youth. Rogers indicated positive results of involvement of African American youth in NWF's EE programs, leading to the pursuit of environmental careers.

"Fish for All" presentation

Chiarappa gave an overview of this GLFT-funded project and its objectives. The project focused on developing a traveling museum exhibit (but also produced a book from the oral histories and a NPR documentary) that presents different historical and cultural perspectives of four Great Lakes fishery stakeholders, and how these perspectives shape management and policy (values that individuals bring to the resource). The four perspectives are tribal, government, commercial fishers, and sportsfishers. Oral histories are a large component of the exhibit. The project hopes to portray the experiences (history and culture) of these different groups to provide a comprehensive, and systemic perspective of the Great Lakes fisheries. More information about the exhibit is available through the Michigan Maritime Museum website www.wmich.edu/history/maritime.

Chiarappa also emphasized the importance of bringing cultural perspectives to education efforts. This generated the idea of creating a smaller version of the exhibit (for display in local museums and other places) – preferably interactive - and of creating an accompanying activity packet. Using this project as a model, students could collect oral histories in their own communities to gain different perspectives. This discussion resulted in the suggestion of a "Fish Bus" to travel to different shows and venues.

Some common perceived needs

After each organization had the opportunity to describe its needs and perspectives, the group engaged in a discussion of common themes regarding Great Lakes fisheries education needs (in no particular order):

- Identify existing materials, programs, resources and gaps.
  Zint commented that this was a focus of the grant.

- Evaluate materials, programs, and other relevant resources in terms of their outcomes/impacts (not just # of participants) to determine which are best and require evaluations of any new efforts to help ensure a research-based approach.
  Evaluations of education efforts are increasingly being recognized as key to developing and implementing successful programs, and are starting to be required by most funding sources.

- Increase awareness and access to existing materials, programs and other relevant resources by providing networking opportunities.

  A lot of resources exist but individuals are not necessarily aware of them or are not able to make use of them (possibly because of financial constraints). The problem is not as much a lack of education resources but lack of knowledge and access to resources and/or knowing which are the best resources. By supporting networking opportunities individuals can learn about existing resources.

- Sustain quality (based on evaluation results) education efforts, both financially and institutionally.

  Quality efforts exist and should be supported. A collaborative effort between the three GLFT funded education efforts so far (i.e., Fish for All, Project F.I.S.H., and Hatcheries Interpretation), for example, was seen as appropriate (especially if latter two also addressed historical, cultural and tribal issues).

- Support new efforts to fill important gaps.
  - The tribes have a variety of important needs for which there are very few resources.
  - The need for diversity and understanding of diversity issues needs to be addressed (tribes could offer insights and in return, receive education materials, resources, equipment).
  - Currently funded GLFT education projects would benefit from integrating historical, cultural, and tribal issues (through partnerships with tribes).
  - Certain audiences (e.g. urban, tribal youth) should be targeted with existing programs.
  - Aquaria and museums (including small local) may provide unique education outlets, as would various recreation, trade shows and events.
  - The general public has not been targeted sufficiently with professional mass media efforts (e.g. NPR's Great Lakes Radio Consortium, PBS, IMAX).

- Require "best practices" of funded education efforts

  Recommendations for such "best practices" are currently being compiled by the Recreational Boating and Fishing Foundation. Such best practices should include:
  - Evaluating the outcomes/impacts (not just # of participants) of education efforts
  - Meeting the needs of local communities by offering programs in local communities, providing funding for individuals/families to attend programs that they could otherwise not attend, and adapting programs to make them relevant to local communities
  - Including outdoor experiences
  - Involving role models, families
  - Encouraging partnerships
  - Supporting comprehensive (vs. single) long term programs

Two particular strategies were identified to address some of these needs:

- Fund internships (so that low-income students can afford to accept them). Interns should be placed to assist the tribes with their education efforts, and tribal and minority interns should be placed within DNR, NGOs, and universities to promote diversity within these organizations.

- Fund an (annual) working conference (to promote learning about existing efforts, facilitate opportunities to collaborate, improve coordination, etc.). Such a conference could be held in conjunction with relevant professional association conferences (e.g. National Marine Educators Association - Great Lakes chapter, state National Science Teacher Association conferences, Michigan Alliance for Environmental and Outdoor Education conference, etc.).

Please refer to the attached papers (in Appendices) prepared in advance of this meeting. Note that MUCC intended, but did not submit a paper summarizing its education efforts and needs. NWF's education efforts are in the process of being restructured and therefore no written paper is prepared. USFWS education representatives have not been able to participate so far.

Review of education projects funded by Great Lakes Fishery Trust

In addition to this project, the GLFT has funded three education efforts to date: *Fish for All*, *Project F.I.S.H.*, and a fish hatchery interpretation project.

Fish for All
Fish for All involved research on historic and cultural aspects of the Great Lakes fishery with a focus on learning about the major stakeholder groups and the commercial, sport, and tribal fisheries. This project resulted in a traveling exhibit as well as a book and NPR documentary. Relevant information can be found at www.wmich.edu/history/maritime/projects/index.html. In light of the amount of funding the GLFT provided for *Fish for All*, much appears to have been accomplished by this project.

Given that the issues/concepts addressed by *Fish for All* are included in the literacy goals (under Issues 6, 7, 8, 9), address some of the gaps we identified through our review of leading K-12 materials (gaps in fisheries, treaty fishing rights, fisheries management), and are likely to be of interest to a variety of stakeholder groups, we recommend that the GLFT consider funding additional efforts related to this project. Funding could support displaying the exhibit at additional sites, having the entire exhibit or parts of it displayed permanently at select sites (e.g., hatchery interpretation centers), promoting discussion events around the issues raised by the exhibit, and developing K-12 education activities (disseminated through teacher workshops) to accompany the exhibit. Activities could be combined into a unit that incorporates some of the exhibit materials in the form of pictures or audio-tapes, or a CD. Such resources should be developed so that they could be used by *Project F.I.S.H.* and others. If the latter recommendation is supported,

relevant stakeholder groups (students, teachers, curriculum developers, etc.) should be involved and best education practices should be followed.

Project F.I.S.H.

Project F.I.S.H. focuses on fishing education and includes aquatic education activities. One of the products consists of a curriculum with activities adapted from the National 4-H Sportfishing curriculum and others. Adaptations include content changes with examples relevant to Michigan and the Great Lakes as well as education process improvements. The curriculum is disseminated via a "train the trainer" approach, consistent with the method of dissemination used by many environmental educators. Many different and appropriate stakeholders/partners are involved in *Project F.I.S.H.* and in a variety of capacities. Another *Project F.I.S.H.* product consists of an Internet site (www.projectfish.org) that provides information about the program including a report with results of an outcome evaluation. In light of the amount of funding the GLFT provided for *Project F.I.S.H.*, much appears to have been accomplished by this project.

Note that we did not include the curriculum material in our review of K-12 Great Lakes ecosystem and fisheries education materials because the final version of this resource was not available in time. Based on what we saw and in light of the GLFT's focus on Lake Michigan/Great Lakes, however, we would like to see *Project F.I.S.H.* have a greater emphasis on the Great Lakes. We also recognize, however, that such an emphasis may limit the material's perceived application to Michigan fishing education.

Although we did not include the *Project F.I.S.H.* curriculum material in our review of leading K-12 Great Lakes ecosystem and fisheries education materials, we reviewed the draft activities that we received. Table0 provides some strengths and recommendations we identified in light of the literacy goals and NAAEE's (1996) *Guideline's for Excellence*.

Table 3-10 Evaluation of *Project F.I.S.H.* based on literacy goals and NAAEE' (1996) *Guidelines for Excellence*

Key Characteristic	**Score**
Fairness & Accuracy	2.5
Depth	3.75
Emphasis on skills building	2.67
Action orientation	3
Instructional soundness	3.38
Usability	3.14

Overall score	3.07
Additional Action Criteria:	
Presence	4 (good presence)
Level of action	Range
How action determined	Specific AND Critically Determined
Action type	Mitigation AND Prevention
Case study presented	NO

Strengths:

Fairness and accuracy:

- Sources of activities used in this material are clearly referenced at the end of each lesson.
- Factual information is presented using language appropriate for education rather than for persuasion.
- Materials encourage learners to explore different perspectives of an issue, and form their own opinion.

Depth:

- Activities encourage students to identify and express their own opinion regarding relevant issues.
- Concepts to be learned are logically organized by unifying themes, and connected throughout the material.

Emphasis on skills building:

- Angling ethics activities provide learners with opportunities to apply critical thinking and decision-making skills.
- "Community Service" and "Exhibits/Sharing" activities provide opportunities to develop citizenship and communication skills.

Action orientation:

- Each lesson contains community service action suggestions.
- Material includes a variety of strategies for actively addressing and resolving environmental issues.

Instructional soundness:

- Material provides an opportunity for learning environments that extend outside the classroom.
- Goals and objectives for each lesson are clearly conveyed.

Usability:

- Material is very easy for teachers to use; well organized format.

Recommendations:

Fairness and accuracy:

- Provide references for sources of factual information.
- Include background information and perspectives from different cultures, especially Native American culture.

Depth:

- Provide a clearly articulated conceptual framework for the concepts to be learned.

Emphasis on skills building:

- Provide a list of other resources, especially those with different perspective on the issues, for learners to explore on their own.

Action orientation:

- Include examples of people of different ages, cultures, races, etc., who have made a difference by taking responsible action.

Instructional soundness:

- Include a variety of means for assessing learner progress.

Usability:

- Include suggestions for adapting lessons and activities to students with different cultural backgrounds, and students with different physical needs and/or special learning needs.

Given that the K-12 Great Lakes ecosystem and fisheries education materials that we reviewed do not focus on fishing, and that to the best of our knowledge, Michigan does not have a coordinated fishing education program, *Project F.I.S.H.* can serve to fill this gap. The GLFT needs to decide, however, in light of its interests, if it would like this material to have more of an emphasis on Lake Michigan and the Great Lakes. If so, a collaboration of *Project F.I.S.H.* with *Fish for All* and the tribes might be appropriate (e.g., on stakeholders and conflicts), as may be other topics for which we have outlined content gaps. Before such additions/changes are made, however, a detailed framework is needed for fishing education, similar to that for hunting education (Hunter Education Standards Task Force 1999) and making use of relevant work by the American Fisheries Society (Zint & Crook 1998) and the Recreational Boating and Fishing Foundation (Fedler & Matthews 2001). This is important in terms of deciding on a testable scope and sequence of activities that can promote Great Lakes fishing and stewardship. In addition, the GLFT could consider supporting conservation activities in association with *Project FISH* to enhance its action component. It also seems appropriate for the GLFT to fund further *Project F.I.S.H.* programming involving the tribes and at fish hatchery interpretation centers.

Great Lakes Ecological Information System

The fish hatchery interpretation project is a major undertaking. This is clear from the reports and materials we have received for review. We agree that Michigan's fish hatcheries provide an opportunity to educate visitors about these facilities and related issues. We feel that strengths of this project are that:

- investigators visited select fish hatcheries with interpretation efforts, consulted with fish hatchery staff members, implemented visitor surveys, and conducted research on hatcheries and other relevant topics to inform their efforts;
- investigators chose a unifying theme,
- individuals with expertise in a variety of relevant areas are involved (as represented by investigators and advisory committee members),
- the project actually focuses on fish and hatcheries. Our own investigations have revealed that even though one would think that this would be the case, some similar efforts do not focus on fish/hatcheries but broader environmental issues. We feel that the focus on hatcheries is particularly valuable in light of the importance of stocking to Great Lakes fisheries management and because we identified this topic as one on which education efforts are lacking.

In term of the interpretive text that we have seen so far, it seems fair in terms of presenting issues, although we would like to see more on tradeoffs of stocking. The style (amount of text, clarity of text, target reading level etc.) seems appropriate. We assume that there will be extensive pilot testing in appropriate venues. In addition to such pilot testing, we also recommend that the opinions of national individuals who have been actively involved with fish hatchery interpretation projects (we can recommend names) be sought out before any final decisions are made. We feel such individuals have unique expertise that is currently not represented by the investigators or advisory board members.

The main concern we have based on what we know about this project at this time is its focus on knowledge (e.g. about fish, hatcheries, and select environmental issues) but not on other aspects that are critical to promoting stewardship. For example, although there is some focus on personal relevance (i.e. why individuals should care about fish, hatcheries, stocking), we are not sure that what is provided is sufficient in making individuals recognize how relevant issues/activities are impacting *them*. Pilot tests should examine this to support or refute this hypothesis. In addition, we do not feel there is sufficient focus on helping individuals act based on the information they may learn from the exhibits. Information should be provided on actions that individuals can take in order to impact the issues that are discussed (e.g. information about groups to join, events to take part in, etc.). The following is beyond the scope of this particular project, but if stewardship is the goal, hands-on opportunities to learn relevant skills must also be provided (e.g., demonstrations of various habitat improvement efforts that individuals can engage in on their own or with others).

Lastly, GLFT's projects (other than those focused on education) currently do not have an education component. The GLFT should consider requiring all of its projects to have a greater interdisciplinary approach that should include an education component.

Objective 4: Identification, validation and prioritization of gaps [includes identification of potential funding partners] (i.e., *What remains to be done to achieve literacy about the Great Lakes ecosystem and fisheries?*)

Identification, validation and prioritization of gaps
The executive summary identifies the gaps that we detected as a result of work associated with meeting objectives 2 and 3 (for details on gaps see results sections) and validated through conversations with environmental education leaders at the state, regional, and national level. The recommendation section of the executive summary provides a list of our prioritized suggestions based on these gaps.

Identification of potential funding partners
Based on our experience, by searching the Internet, and by talking with individuals at relevant organizations, we have compiled the following list of sources with an interest in funding/supporting Great Lakes (fisheries) education efforts (in Michigan):

Government (and closely related) sources include:
- Michigan Sea Grant
  http://www.engin.umich.edu/seagrant/research/funding.html
  and other regional Sea Grant programs
  http://www.mdsg.umd.edu/NSGO/SGDirectory/
- Great Lakes Protection Fund
  http://www.glpf.org/
- individual Lake Protection Funds
- National Fish & Wildlife Foundation
  http://www.nfwf.org/
  and their partners
  http://www.nfwf.org/partners.htm
- U.S. Environmental Protection Agency, Great Lakes National Program Office
  http://www.epa.gov/glnpo/fund/glf.html
- U.S. Fish and Wildlife Service, Great Lakes-Big Rivers Region - Federal Aid
  http://midwest.fws.gov/fed_aid/index.html
- U. S. Environmental Protection Agency. Environmental Education Grants
  http://www.epa.gov/enviroed/grants.html
- National Forest Foundation
  http://www.nffweb.org/
- National Environmental Education and Training Foundation
  http://www.neetf.org

Foundation sources include:
- Blandin Foundation
  http://www.blandinfoundation.org/
- Charles Stewart Mott Foundation
  http://www.mott.org/
- Detroit Edison Foundation

http://www.detroitedison.com/aboutus/whoweare/foundation.html

- Fish America Foundation
  http://www.asafishing.org/programs/conservation/fishamerica/
- Ford Foundation
  http://www.fordfound.org/
- George Gund Foundation
  http://www.gundfdn.org/
- Great Lakes Aquatic Habitat Network & Fund (via C.S. Mott Foundation)
  http://www.glhabitat.org/
- Joyce Foundation
  http://www.joycefdn.org/
- Laidlaw Foundation
  http://www.laidlawfdn.org/
- Recreational Boating and Fishing Foundation
  http://www.rbff.org
- Richard Ivey Fund
  http://www.ivey.org/index.html
- Wege Foundation
  www site planned, Ph: 616/957-0480
- W.K. Kellogg Foundation
  http://www.WKKF.org/
- Local community and family foundations may also be interested, search the Foundation Center Guide for appropriate sources
  http://fdncenter.org/

Corporations are a potential source of funding and equipment/resources including:

- those in fishing, boating, recreation, and related industries (e.g., Bass Pro, Orvis, Zebco, etc.; organizations such as the American Sportfishing Association and the Recreational Boating and Fishing Foundation may help to provide a link to these sources), some of these sources are currently being pursued by Dr. Shari Dann to help support the Great Lakes Fishery Trust's *Project F.I.S.H* (e.g. Gander Mountain).
- Anheuser-Busch Companies, Inc.
  http://www.abenvironment.com/noflash.html
- Ameritech Foundation
  http://www.ntlf.com/html/grants/6693.htm
- Shell Canada - Shell Environmental Fund
  http://www.shell.ca/code/values/environment/sef.html

  and similar companies with interests in environmental education, contact corporation's foundations and/or their environmental health and safety departments.

The following government organizations do not have grant programs but could provide funding for relevant projects:

- Great Lakes Commission
  http://www.glc.org/
- Great Lakes Fishery Commission

http://www.glfc.org/

- Michigan Department of Natural Resources (can allocate up to 10% of its annual Sport Fish Restoration funds to education)
  http://www.dnr.state.mi.us/

Note that the International Joint Commission www.ijc.org actively supported Great Lakes education projects until a change in leadership after 1995 (e.g., *Directory of Great Lakes Education Materials,* a satellite conference).

Local fisherman's clubs might be interested in helping to raise funds and/or be a source of volunteers and equipment\supplies:

- Trout Unlimited - local chapters might be particularly helpful.
  http://www.tu.org/

The following organization helps to link local (service, fishing) organizations with industry to obtain (lower cost) fishing tackle for fishing education programs:

- Future Fisherman Foundation
  http://www.asafishing.org/programs/education/foundation.htm

Other potential funding sources may be found via:

- GLIN - has a list of funding and grants sources in the Great Lakes region
  http://www.great-lakes.net/infocenter/news/funding.html
- EE-Link - has a list of funding sources for environmental education
  http://eelink.net/grants-generalinformation.html
- Currently, there does not appear to be a similar site listing funding sources for fish/fisheries/fishing education.

Confirmation of the validity of the above list is provided by the list of organizations that funded or otherwise supported the leading K-12 Great Lakes ecosystem and fisheries education materials that we reviewed (Table).

Table 4-1 Funders and other supporters of leading K-12 Great Lakes ecosystem and fisheries education materials

Material	Year	Funders & Other Supporters
Alien Invaders: A Zebra Mussel Issue Investigation	1994	Ameritech, IL-IN Sea Grant, IL Board of Education, IL DNR, IL EPA, NSF, USDC, NOAA, NSGCP, USDED, OERI, Dwight D. Eisenhower National Mathematics and Science Education Program
Bell LIVE! Great Lakes: A Superior Adventure	2000	ADC Telecommunications, James Ford Bell Foundation, General Mills Foundation, Medtronic Foundation, Hugh J. Anderson Foundation, David Winton Bell Foundation, Deluxe Corporation Foundation, John G. Dill, Jr. Ecolab Foundation, Margaret Rivers Fund, 3M Foundation, Imation Corporation, Hutchinson Technology, Marbrook Foundation, The Martin Foundation
Caring for Planet Earth—Great Lakes (CD ROM)	1997	The Wege Foundation, The Grand Rapids Foundation, Steelcase Foundation, Peter Cook, Robert Woodrick, Sr. Meijer, Inc., CPR MicroAge, Lacks Industries

ES-EAGLS: Great Lakes Environmental Issues	1997	OH Sea Grant
ES-EAGLS: Life in the Great Lakes	1997	OH Sea Grant
Exotic Aquatics (Traveling Trunk)	1994	MN Sea Grant
Exploring the Great Lakes	1992	U.S. EPA Great Lakes National Program Office, Purdue University
Fish Ways	1991	Ontario Ministry of Natural Resources
Great Lakes Education Program	1999	NOAA, USDC, State of Michigan, The Detroit Edison Foundation
Great Lakes Environmental Education Project	1997	Junior League of Birmingham and Eastern MI Environmental Education Project
Great Lakes Explorer: Biodiversity (CD ROM)	1998	Max Bell Foundation, Human Resources Development Canada
Great Lakes Solution Seeker (CD ROM)	1996	Great Lakes Protection Fund, OH Sea Grant College Program, The George Gund Foundation, Canadian Studies Program of the US
Great Lakes Superior Learning Kit (Traveling Trunk)	1992	Lake Superior Center
Great Lakes in My World	1993	Lake MI Federation, Great Lakes Commission
Great Lakes Instructional Materials of the Changing Earth System	1995	USDC, NOAA, NSGCP
Great Minds? Great Lakes!	1990	U.S.EPA
Inland Seas Education Association:	2000	Inland Seas Education Association
Lake Effects: The Lake Superior Curriculum Guide	1996	Blandin Foundation
Lake Erie…a day in the life of a fish	1991	OSU College of Education and School of Natural Resources, USDC, NOAA, NSGCP
Lake Erie…build a fish to scale	1991	OSU College of Education and School of Natural Resources, USDC, NOAA, NSGCP
Lake Erie…take a bow	1986	OSU College of Education and School of Natural Resources, USDC, NOAA, NSGCP
Lake Superior A-L Learning Kit (Traveling Trunk)	1992	Lake Superior Center
Lake Superior Ecosystem Learning Kit (Traveling Trunk)	1992	Lake Superior Center
Lake Superior M-Z Learning Kit (Traveling Trunk)	1992	Lake Superior Center
The Lake Superior Game	1988	USDC, NOAA, NSGCP
Life of the Lakes	1995	National Fish & Wildlife Foundation
Our Great Lakes Connection	1985	The Joyce Foundation, WI Coastal Management Program
The Earth Generation: The Great Lakes		The Dow Chemical Company, U.S. EPA, National and Michigan Audubon Societies
Supplemental Activities to Accompany Paddle to the Sea	1988	OH Sea Grant
Zebra Mussel Mania (Traveling Trunk)	1997	IL-IN Sea Grant, NSGCP, Ameritech

* Abbreviations used above are explained below
NOAA-National Oceanic and Atmospheric Administration
USDC-United States Dept. of Commerce
NSGCP-National Sea Grant College Program
USDED-United States Dept. of Education
OERI-Office of Educational Research and Improvement

Objective 5: Final products (i.e., *How can the GLFT foster education efforts that will constitute the next best steps toward Great Lakes ecosystem and fisheries literacy?*)

We agreed to deliver:

- a practitioners' guide to Great Lakes ecosystem and fisheries education resources on the Internet

  The site that we created can currently be found at www.umich.edu/~wongjk/enc and will be moved to www.glft.org shortly.

- a comprehensive final report to the GLFT detailing:

  - validated literacy goals for Great Lakes ecosystem and fisheries education.
    >>> See Objective 1 of this report.

  - recommendations for advancing Great Lakes ecosystem and fisheries education based on identified gaps.
    >>> Gaps and details on select recommendations are provided as part of the results sections of Objectives 2 and 3 in this report.
    >>> Our overall recommendations are provided in the executive summary.

  - a set of guidelines for evaluating future education project funded by the GLFT.
    >>> See the final section of the executive summary for these guidelines.

- A manuscript to be submitted to a peer-reviewed journal.
  >>> A manuscript is being prepared and will be submitted to you upon completion.

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APPENDICES

Alien Invaders: A zebra mussel issue investigation

Edition: 1995
Series: Rivers Curriculum Project
Publisher: Southern Illinois University, Edwardsville
Grade: 9-12
Subjects: environmental studies, history, science, social studies
Cost: $12.00
Format: Printed manual, spiral bound

Abstract: This program is an interdisciplinary case study to educate students about the potential dangers of invading exotic species and the importance of preserving native ecosystems. The program was developed based on a cooperative group learning model. The Rivers Project began in 1990 as a pilot program involving eight high schools along the Mississippi and lower Illinois River, and has since been expanded to include formal curriculum in biology, chemistry, earth science, geography, and language arts for use with any river. This unit of the Rivers Project is heavy in content, and introduces students to exotic species in general, and the zebra mussel in more detail. The case study is organized into four levels. *Foundations* introduces student to continental drift, ecosystems, examples of exotic species, and the Great Lakes. *Issue Awareness* examines the zebra mussel life cycle in detail, control methods, and preventative measures. *Student Activities* provides classroom exercises related to the zebra mussel invasion, including a role-play simulation which examines the effects of mussels on a community. Finally, *Issue Investigation* allows students to examine the issue locally through a survey instrument they develop and implement. Students then plan and carry out community-based actions related to informing their local community about the threat of zebra mussels. Activities are designed to have the students work in cooperative groups to: map the spread of zebra mussels in Europe, the Great Lakes, and river systems in the United States; simulate a town meeting to devise a plan to combat the zebra mussel menace; and use diagrammatic webs to trace various effects of zebra mussels on the ecosystem. The teacher section summarizes learner objectives, provides information about cooperative learning, answer keys for the pre- and post tests, and overhead masters.

Strengths:
- One of the few materials targeted to high-school students
- Strong coverage of skill-building activities, particularly community-based action projects
- Easily adaptable to other exotic species
- Emphasizes cooperative learning strategies

Limitations:
- Entire curriculum requires a minimum of 12 days to complete – could be prohibitive for many teachers/classes.

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:

Southern Illinois University Rivers Curriculum Project
Box 2222
Edwardsville, IL 62026
618.692.3378
rivers@siue.edu

Bell LIVE! The Great Lakes: A Superior Adventure

Edition: 2000
Series: Bell LIVE!
Publisher: Bell Museum, University of Minnesota
Grade: 4-8
Subjects: environmental studies, history, geography, math, science
Cost: $75, includes mini-kit and video of live broadcast
Format: Mini-kit includes printed curriculum guide and various supplemental materials (see "Contents" below). Also includes a video recording of October 2000 live broadcast and an on-line resource.

Abstract: Bell LIVE! is an annual series of virtual field trips, accompanied by demonstrations and experiments. The year 2000 focuses on a journey to the Great Lakes. The intention of the program and curriculum is to raise awareness of the Great Lakes, specifically Lake Superior, by raising the understanding of forces that influence these lakes. The curriculum guide contains activities that focus mainly on issues related to Lake Superior, where the Bell LIVE! 2000 broadcast took place. The program provides a broad introduction to Lake Superior, beginning with its creation. The curriculum is divided into four sections – Skills, Setting the Stage, All About Water, and Life in the Lake – each providing a variety of activities and experiments related to that topic. An index of lessons indicates which national science standards are met by each lesson. The Bell LIVE! 2000 website (www.BellLIVE.umn.edu) provides supplemental information to some activities. It also provides activities and information not found in the curriculum guide, including chat sessions with researchers and experts, online ecogames, teacher and student bulletin boards, a Great Lakes field guide, and the Minnesota and National Science Standards. The Bell LIVE! broadcast took place on October 12, 2000 from Lake Superior itself and from the Great Lakes Aquarium in Duluth, Minnesota. A 1-hour video features the best of the October 12, 2000 on-line broadcast, and is available for purchase.

Strengths:
- Examines Great Lakes pollution (particularly through groundwater seepage) and introduced species
- Emphasis on scientific inquiry and use of scientific method
- Kit includes a lot of support and background material
- Program is supplemented by on-line component involving virtual trips to Lake Superior sites

Limitations:
- Content does not specifically focus on fish/fisheries issues
- Live broadcast occurs only once
- Limited action orientation

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Bell Museum of Natural History
College of Natural Resources
10 Church Street S.E.
Minneapolis, MN 55455
612.624.7083
http://www.BellLIVE.umn.edu

Caring for Planet Earth: The Great Lakes (Volume 1)

Edition: 1997
Series: Caring for Planet Earth CD-ROM Series
Producer: Center for Environmental Study & Cameo Multimedia Productions
Grand Rapids, MI
Grade: 3-12
Subjects: environmental studies, geography, health, science, social studies
Cost: $39
Format: CD-ROM

Abstract: *The Great Lakes* interactive CD-ROM program takes learners on a journey of discovery through the Great Lakes. It is designed to strengthen decision-making and problem-solving skills as well as to promote an understanding of the Great Lakes. Students are challenged to learn about major topics concerning the Great Lakes ecosystem including: Science, Land, Air, Water, Biodiversity, Community, and Human Health Issues. The first part of the journey begins in the future and takes the learner through the history of the Great Lakes region. The second part takes place on the five Great Lakes during the end of the 20th century, and is exploratory in nature. Students travel in a spaceship throughout the Great Lakes, discovering keys and tokens, completing learning events, and discovering and reviewing ecological facts. Much of the learning occurs through simple content review and taking "recharge" quizzes. The last part of the journey involves traveling back to the future to address various environmental crises. Students must process what they have learned by sorting a range of responses to the crises into categories: preservationist, equilibrium (the "right) category, and development. The CD also includes a learning-focused Great Lakes Resource Guide, which provides support materials for educators. These materials are designed to help students master the major topics discovered while playing *The Great Lakes* game. The Resource Guide also includes information about regional organizations that students can become involved with. The Resource Guide is in Portable Document Format (pdf file) that can be opened in Adobe Acrobat Reader, and printed if desired.

Strengths:
- Strong interdisciplinary approach
- Provides many different perspectives on Great Lakes issues, including Native American perspective
- Strong action component, with examples of actions others have taken to address certain issues
- Fisheries receive some focused attention during discussions of biomagnification, habitat loss, and exotic species invasions

Limitations:
- Fisheries per se are not a direct focus of this CD, but are instead ancillary to an exploration of general development and pollution issues
- Material is limited to those with access to a computer with a CD-ROM drive
- Time consuming – can take several hours to complete every component

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:

Center for Environmental Study
Grand Rapids Community College
143 Bostwick NE
Grand Rapids, MI 49503
616.234.3935
email: ces1@iserv.net
http://cesmi.org

The Earth Generation: The Great Lakes

Edition: 1993
Series: The Earth Generation
Publisher: The Earth Generation and Dow Chemical Company
Grade: 7
Subject: environmental studies, science
Cost: free
Format: Kit includes video and printed educator's guide

Abstract: The Earth Generation is an activity-based educator's guide that focuses on four environmental issues: Achieving Air Quality, Preserving Water Quality, Living for the Ecosystem, and Caring for the Land. The guide's aim is to help students gain an understanding of these environmental issues because they are thought to impact their home state and communities. Something of note is that the issues addressed in the guide are general and thus, can be taught using contexts other than the Great Lakes. The Earth Generation contains six classroom/lab projects that may be used in sequence or as stand-alone activities, and are designed to coordinate with Michigan's seventh grade core curriculum guidelines. With each project, students utilize the scientific method to investigate and evaluate an issue, then take action to apply what they have discovered. Student assessment is emphasized by this program, and each project is accompanied by several suggestions for pre- and post-activity assessments. The program provides a notable amount of background information for each project. The program is also accompanied by a materials overview list that indicates the Michigan Essential Goals and Objectives for both Math and Science that are met by each project.

Fish content: Because of the general treatment of most topics, there are few links made to fisheries issues. The materials could, however, be easily adapted to Great Lakes (fisheries) issues.

Strengths:
- Very strong learner assessment component
- Extensive background information provided for each lesson
- Topics of ecosystem and biodiversity covered better than in most other materials
- Middle school target audience

Limitations:
- Very limited coverage of Great Lakes fisheries issues

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
The Dow Chemical Company- Education Initiatives
47 Building
Midland, MI 48667
sdust@dow.com
517.636.2815
Fax: 517.638.7238

Exotic Aquatics

Edition: 1994
Series: NA
Publisher: Minnesota Sea Grant
Grade: 4-12
Subjects: art, environmental studies, geography, language arts, math, science
Cost: rental fee of $45-60+
Format: Traveling trunk, including educator manual, video, activities and supporting resources

Abstract: Exotic Aquatics is a learning resource science kit and curriculum that provides experiments, games, stories, and other hands-on activities to help educators teach about a wide range of problems associated with aquatic exotic species; specifically the Eurasian ruffe, spiny water flea, Eurasian watermilfoil, purple loosestrife, sea lamprey, and zebra mussel. The curriculum guide outlines nine lessons that start with focus questions, and leads students through activities that involve exploration, observation, measurement, classification, inference, prediction, communication, formulation of hypotheses, experimentation, and interpretation of data. Most of the activities are better suited for younger students. The lessons focus on adaptations of specific exotic species that provide competitive advantages, and human interventions that may reduce the spread of exotic species. Topics addressed throughout the curriculum include biodiversity, competition, exotic species, habitat, native species, parasites, predators, and wetlands. Concepts are simply but clearly addressed.

Strengths:
- Activities are relatively simple, and can be accomplished in a short amount of time.
- Concepts related to exotic species are simply and clearly addressed.

Limitations:
- Materials indicate target audience to be grades 4-12, but materials seems much more appropriate for early elementary grades

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Minnesota Sea Grant
Exotic Species Information Center
2305 East Fifth Street
Duluth, MN 55812-1445
218.726.8712
http://www.d.umn.edu/~seagr/

Exploring the Great Lakes

Edition: 1999
Series: Exploring the Great Lakes, Teacher's Edition
Publisher: US Environmental Protection Agency, Great Lakes National Program Office, Purdue University
Grade: 7-12
Subjects: environmental studies, health, math, science, social studies
Cost: $10.00
Format: CD-ROM, PDF format student worksheets and key, PDF format teacher's guide

Abstract: Exploring the Great Lakes contains an interactive learning activity called "Great Lakes Adventure." During this activity, students learn about and research six "hot topics" or relevant issues that are impacting the Great Lakes: Eutrophication, Fish Communities, Exotic Species, Beach Closures, Loss of Habitat, and Toxics. During the adventure, students get a virtual tour of the *Lake Guardian*, the EPA's newest and largest research and monitoring vessel that operates on the Great Lakes. During this virtual tour, students have the opportunity to gather data on chemical and biological conditions of the Great Lakes and to monitor pollutant concentrations in the water, sediment, air, fish, and other biological matter. Some of the tests performed include fish identification, testing for concentrations of various toxins, and dissolved oxygen concentrations and water temperature. Students work their way through the adventure, reaching a point where they put their new skills to the test by trying to solve an aquatic mystery. Students use their newly acquired knowledge to identify critical pieces of information, formulate a hypothesis, run tests on various samples, and report their findings during a virtual press conference. A printable student worksheet assesses the knowledge learned during the *Great Lakes Adventure*. The CD-ROM also contains *The Great Lakes: An Environmental Atlas and Resource Book*. The atlas has a great deal of information about the area, people, natural processes, management and new directions for the Great Lakes. Many maps, diagrams, and fact sheets are also included. This information may also be found online at http://www.epa.gov/glnpo/atlas/

Strengths:
- Presents a broad range of Great Lakes issues
- Strong assessment component: includes pre and post-experience worksheets
- *Great Lakes Atlas* is comprehensive reference material on the Great Lakes, and provides good supplemental information

Limitations:
- The only interactive activity in which students apply the knowledge gained has a quite narrow focus in terms of concepts
- Many issues have little background information or examples
- Material is limited to those with access to a computer with a CD-ROM drive

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:

Center for Technology Transfer and Pollution Prevention
Purdue University
1146 AEB
West Lafayette, IN 47907-1146
765.494.1178

Fish Ways

Edition: 1991
Series: NA
Publisher: Canadian Wildlife Federation
Grade: K-12
Subjects: art, environmental studies, language arts, math, physical education, science, social studies
Cost: Fish Ways can be obtained only through participation in a workshop, and cost varies depending on the state or province
Format: Two printed manuals in 3-ring binders

Abstract: *Fish Ways* is an extensive collection of fish and fisheries management education materials for students in grades K-12. *Fish Ways* consists of two resource guides for teachers (as well as for leaders of other youth groups): the Primary/Junior guide and the Intermediate/Senior guide. The 426-page Primary/Junior manual is organized into three units. Unit A, Discovery of Fishes, examines the physical characteristics of fish, including fish parts and functions, adaptations, life cycles, fish identification. Unit B, Fishes and Habitat, explores the role of the ecosystem in providing food, shelter, space, and water for an aquatic organism, and some ecosystem dynamics. Unit C, Fishes and People examines the values of fish and the many ways people may be involved with fish. The 346-page Intermediate/Senior manual is for students in grades 7-12, and is organized into three main units based on grade level: grades 7-8, grades 9-10, and grades 11-12. Within each unit, issues related to fish and fisheries management are addressed, including aquatic ecology, habitats, and food webs, fish stocking, toxins, exotic species, problem-solving approach toward fish management, and awareness of various fisheries stakeholders. Great Lakes examples are mentioned, and several individual activities relate directly to the Lakes. *Fish Ways* is interdisciplinary in nature, and the activities may be used to teach science, environmental studies, math, language arts, music, visual and dramatic arts, and physical education. Related subjects are suggested in each activity. The overview chart at the beginning of each unit provides a summary of grade level, subject area, key concepts, activity type, and suggested activity links for each activity in that unit. *Fish Ways* also includes information on how to keep live fish in a classroom, and encourages students to develop respect for living things. Fish Ways was designed to comply with Ontario Ministry of Education curriculum guidelines, which have changed since the development of this material.

Strengths:
- Extensive and comprehensive curriculum of fish/fishery issues
- Lessons can be used independently or in conjunction other lessons
- Although issues and examples are found in Ontario, many are broad in scope
- Great fish flash cards for identification

Limitations:

- Curriculum provides many suggested action-based activities, but generally only in the extension part of the lesson
- Most activities are not specific to the Great Lakes

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:

Fisheries Education Coordinator
Fisheries Branch
Ministry of Natural Resources
5th Floor, ICI House
90 Sheppard Avenue East
Toronto, Ontario M2N 3A1
CANADA

Great Lakes Education Program

Edition: 1999
Series: NA
Publisher: Michigan Sea Grant
Grade: 4-5
Subjects: environmental studies, geography, history, math, music, science, social studies
Cost: $600 for 35 people (including teacher, students, and adult chaperones). Includes 3 hours on vessel, and field trip to study wetland and shore habitats. Handbook is included as part of the shipboard experience. It may not be purchased separately
Format: Printed handbook and shipboard field trip

Abstract: Based in southeast Michigan, the Great Lakes Education Program introduces fourth-graders to the unique features of the Great Lakes through a combination of classroom learning and hands-on experience. The program is designed to stimulate interest in the Great Lakes and help students understand their role in protecting freshwater resources. The program integrates elements of geography, history, biology, and physical sciences in each of its three components: classroom pre-trip introduction, shipboard field trip, and post-trip classroom follow-up. The pre-trip activities include learning about such concepts as the aquatic food web, the water cycle, the role of oxygen in water, and the effects of exotic species. A two-hour boat trip on the Clinton River and Lake St. Clair provides an opportunity for hands-on experiences such as examining plankton samples, testing water clarity, marine knot-tying, and more. Back in the classroom, students conduct experiments and discuss what they have learned based on the data they collected on the field trip. Activities are organized within four major themes: Water, Land, Life, and People. Within the Educator's Handbook, activities are coded by theme and grouped in sections (pre-cruise, shipboard, post-cruise). Suggestions are provided on how to sequence particular activities. In addition, the Great Lakes Education Program created a curriculum framework consisting of six major learning objectives: Knowledge of Natural Systems, Knowledge of Human Systems, Inquiry Skills, Investigation and Analysis Skills, Skills for Decision and Action, and Sense of Personal Responsibility.

Fish content: There is limited content on Great Lakes fish but the program does focus on water quality, pollution, and exotic species, and provides some implications for fisheries. Although designed for the Lake St. Clair/Clinton River area, the program could be adapted to most areas of the Great Lakes.

Strengths:
- Provides ship-board experience
- Includes excellent references and resources
- Contains community-based extension activities
- Clearly tied to Michigan Science Standards

Limitations:
- Limited content on fish/fisheries issues

- Cost of ship-board experience may be prohibitive to some schools
- Limited age range of target audience

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:

Great Lakes Education Program
Michigan Sea Grant Extension
334 Natural Resources Building
Michigan State University
East Lansing, MI 48824
571.353.9568
http://www.miseagrant.org/glep

Great Lakes Environmental Education Project

Edition: 1994
Series: NA
Publisher: East Michigan Environmental Action Council
Grade: 7-12
Subjects: environmental studies, history, science, social studies
Cost: single copy free; may copy as needed
Format: Printed manual

Abstract: **This program provides activities and plans for a two-week curriculum focused on the issue of toxic chemicals in the Great Lakes, particularly in the Lake St. Clair and Detroit River areas. The curriculum has two components: a set of questions and background material focusing on particular aspects of toxic chemicals in the Great Lakes; and a mock mediation session related to a specific environmental case involving toxic contamination. Students work as groups to research a particular question and then share that information with the other groups. Exercises in values clarification help the students relate the material to their own experiences. Following group reports, the class participates in a detailed mediation role-play based on a fictional toxics-related issue. The role-play is notable in that it deals with a transnational issue (Canada and U.S.), focuses on native concerns regarding loss of fisheries, and addresses the impact of those losses in human and ecological terms. Organizing questions include such topics as toxic substances in the Great Lakes, human health and wildlife effects of exposure to Great Lakes toxins, legislation addressing water quality issues, and community efforts to improve water quality.**

Strengths:
- Extensive background and resource information
- The culture of Great Lakes tribes are addressed, and are integral to the mock mediation/role play
- Role-play activity addresses a transnational issue
- Provides many examples of individual and community action related to issues

Limitations:
- Background materials is quite technical, and may be difficult for some students to understand
- Some background material is outdated
- Provides very little guidance and few instructions for teachers. Success could be very dependent upon the interest and dedication of the teacher
- Intended goals and objectives are not provided
- Time commitment needed to complete the curriculum could be prohibitive for some teachers/classes

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
East Michigan Environmental Action Council
21220 West 14 Mile
Bloomfield Hills, MI 48301
248-258-5188
http://www.emeac.org

Great Lakes Environmental Issues

Edition: 1997
Series: ES-EAGLS: Earth Systems – Education Activities for Great Lakes Schools
Publisher: Ohio Sea Grant Publications
Grade: 7-12
Subject: environmental studies, geography, history, math, science, social studies
Cost: $8.00
Format: Printed manual

Abstract: This 180-page manual is one of a series of subject area activity books related to the Great Lakes. The series is based on Earth Systems Education, a process designed to "create a curriculum more responsive to human needs and future quality of life." They are all data-rich, and include a significant number of both standard and web-based references, some of which are required to complete activities. Included with the activities are some suggestions about possible ways to use them in cooperative learning situations and how lessons can be structured according to the learning cycle. Subject matter is compatible with existing curriculum, and the activities require minimal preparation time and equipment needs. This material covers a range of environmental issues in the Great Lakes: resource use, water quality, bioaccumulation of toxins in the food chain, human health risks associated with eating contaminated fish, watershed management issues, and oil pollution. Other subject areas available in this series are Great Lakes shipping, climate and water movement, land and water interactions, and life in the Great Lakes.

Strengths:
- Student-centered; focused on student-guided inquiry
- Pollution and fisheries habitat issues are clearly addressed
- Activities emphasis skill development in data collection and analysis
- Presents relatively balanced viewpoints of issues
- Include significant printed and web-based references

Limitations:
- Heavy reading load for students
- Better suited to older grades (10-12)
- Some activities require internet access

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, OH 43212-1194
614.292.8949
www.sg.ohio-state.edu/osgrant/education

Great Lakes Explorer: Biodiversity

Edition: March 1998
Series: Great Lakes Faunal Atlas Series
Publisher: University of Guelph, Department of Zoology
Grade: 7-12
Subject: environmental studies, geography, history, math, science, social studies
Cost: $39.99 (Canadian)
Format: CD-ROM

Abstract: *Great Lakes Explorer: Biodiversity* is the first in an interactive series that is intended to help students gain an understanding of the Great Lakes and the organisms that live in them. This interactive CD provides the opportunity for students to conduct "research" expeditions with different virtual researchers in three areas: (1) fish biodiversity differences between inshore and offshore sites, sites in Lakes Erie and Superior, and polluted and non-polluted sites; (2) toxicity levels of heavy metals and other chemicals found in the Lakes; and (3) changes in the Lake Erie fishery over the past 10,000 years due to development, pollution, over harvest, and exotic species introductions. Students study the natural and human factors that have impacted the fish communities. Data for these issues are, wherever possible, based on actual data that have been gathered by researchers studying the Great Lakes. Sample variability adds to the reality of the research. The CD also contains an extensive, easily printable teacher's manual that provides resources to support educators in effective use of the software. The manual describes the content and structure of the software, provides suggestions for its use in the classroom, and discusses the data students are able to gather while using it. The manual also describes the assignments and reports students are given, and offers suggestions on their evaluation and extension exercises. Detailed goals and objectives are provided, as well as adaptations for the various activity areas.

Strengths:
- Emphasis on scientific method in activities and virtual research
- "Real time" sampling and sampling variability adds to the reality of research
- Worksheets and reports are useful both in complementing the virtual activities and in assessing the program's impact with students
- Information in printable teacher's manual greatly enhances the program activities

Limitations:
- Some of the activity areas require completion before moving to another area – can be cumbersome and time consuming
- Program contains no action component
- Material is limited to those with access to a computer with a CD-ROM drive

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:

Department of Zoology
University of Guelph
Guelph, Ontario, CANADA
N1G 2W1
519.824.4120 x8524
http://aquatic.uoguelph.ca

The Great Lakes in My World

Edition: Fall 1990
Series: NA
Publisher: Lake Michigan Federation
Grade: K-8
Subjects: art, environmental studies, geography, language arts, music, science, social studies
Cost: $25.00
Format: Printed manual, unbound, 3-hole punched

Abstract: **This 160-page manual provides information and activities that are designed to fit into regular curriculum units in the subject areas of science, social studies, math, and language arts. While some of the activities are linked, most are designed for independent use, or to be sequenced at the discretion of the teacher. Activities include role plays, board games, demonstrations, data analysis, and experiments, some of which require innovative problem solving. The table of contents provides a target grade range and subject area(s) for each activity. In addition, the section titled "Natural Processes in the Great Lakes" indicates whether the activity focuses on Wildlife, Geology, and/or Ecology. In the first section, students learn about and explore issues of values clarification surrounding economic, land use, and water quality issues. The second section contains activities that address specific concerns affecting the Great Lakes today: toxic pollutants, biomagnification, toxic sediments, remedial action plans, and exotic species. The final section provides students with activities focusing on natural processes addressing geology, geography, limnology, and ecology. Students learn about aquatic food chains, rock formation, erosion, and topography of the Great Lakes, and lake stratification. Glossaries are provided at the beginning of each section, and two foldout game boards are provided in the back of the manual.**

Strengths:
- Major emphasis on toxic contaminants and their impact on the inhabitants of the Great Lakes
- Emphasis on creative arts: performance, creative writing, music, and drawing
- Strong interdisciplinary approach
- Goals, objectives, references, and additional resources are clearly stated throughout the curriculum

Limitations:
- Background information for teachers may not be adequate for someone with no previous knowledge of content or context
- Activities that encourage learners to form and express their own opinions occurs mostly in activity extensions
- Data provided in curriculum is out-dated (pre-1990)

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Lake Michigan Federation
220 S. State Street, Suite 1900
Chicago, IL 60604
312.939.0838
http://www.lakemichigan.org/store/products/productlist.asp

Great Lakes Instructional Materials for the Changing Earth System (GLIMCES)

Edition: 1995
Series: NA
Publisher: Ohio Sea Grant Publications
Grade: 5-12
Subjects: environmental studies, geography, history, math, science
Cost: $3.00 for GLIMCES/$6.00 for scenarios
Format: Printed activity book / folder with loose leaf material

Abstract: GLIMCES presents activities that help students learn about the Great Lakes region and its ecology. Based on "Earth Systems Education", this 203-page activity manual is designed to "create a curriculum ore responsive to human needs and future quality of life". GLIMCES uses 30 activities to address such issues as global climate change, biodiversity, estuaries, and shipping. The activities make extensive use of data sets, which enhance the critical thinking process. Most activities are the paper and pencil variety, but hands-on components help give meaning to the data. Student worksheets are supplied in the activity book, and each activity includes background information, objectives, procedure, and topics for discussion, as well as references and suggestions for extension activities.

The companion material, *Global Change in the Great Lakes Scenarios*, is designed to help students understand how global change may affect the Great Lakes region. Ten different scenarios describe the scientific community's prevailing interpretations of what may happen to the Great Lakes region in the face of global warming.

Fish content: Although fisheries are not the major emphasis of this program, it does address the potential effects of global warming on the Great Lakes fisheries. It also has a number of units that relate to nonindigenous species, Great Lakes fish, estuary values and changes, and toxic chemicals.

Strengths:
- Program is most effective at upper grade levels (10-12)
- Extensive use of data sets in activities
- Extensive use of computers to access information
- Emphasis on different perspectives and viewpoints about environmental issues
- Emphasis on role-play activities for issue investigations

Limitations:
- Written on high reading and comprehension level, especially the accompanying scenarios. Not well-suited for middle school students
- Limited action orientation

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, OH 43212
614.292.8949
www.sg.ohio-state.edu/osgrant/education

Great Lakes Solution Seeker

Edition: 1996
Series: NA
Publisher: Ohio State University
Grade: 9-12
Subjects: environmental studies, geography, math, music, science, social studies
Cost: $5.00
Format: CD-ROM and printed user guide

Abstract: This program provides users with a resource of Great Lakes information and ideas for solving problems related to the Great Lakes. The program is designed so that learners have the opportunity to construct their own understanding about the problem under investigation. The opening screen of Solution Seeker is a Great Lakes Bioregion map, which allows users to visit each Great Lake by clicking on it. Once in a lake, learners can travel to any of the areas identified as being of particular concern. Each site is accompanied by information, images, and maps with aerial photographs, contact information, and search and navigation tools. The program also includes Phenomenaria, which contains a set of phenomena to be explored. A sizable set of additional tools includes an image analysis program, a concept mapping tool, built-in Internet access, and a set of writing tools. These can all be used to complete new data arrangements that are helpful in completing the activities. A Macintosh computer is required for access to all components of the CD-ROM, while use of a PC results in incomplete activity access.

Fish content: Exotic species and water quality issues are found throughout the program, with some emphasis on Areas of Concern and their Remedial Action Plans

Strengths:
- Emphasis on use of data (collection, interpretation, and inference) in activities
- Provides set of tools to assist with data manipulation and interpretation
- Strong skill-development and action orientation
- Contains complete curriculum *"Great Lakes in my World",* plus selections from other Great Lakes curricula

Limitations:
- Incomplete access to activities and data when using program on a PC – need a Mac computer to have full access
- Material is limited to those with access to a computer with a CD-ROM drive

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, OH 43212
614.292.8949
www.sg.ohio-state.edu/osgrant/education

The Great Lake Superior Learning Kit

Edition: 1992
Series: Lake Superior Learning Kits
Publisher: Lake Superior Center (Great Lakes Aquarium)
Grade: 3-6
Subject: environmental studies, geography, health, language arts, science
Cost: No cost –"rental" kit must be returned
Format: Traveling kit

Abstract: This traveling kit contains activities and resources for discovery-based classroom activities focusing on Lake Superior. Resources include books, magazines, video and/or audio tapes, posters, maps, and all materials or equipment (including lesson plans) necessary for each activity. This traveling kit features six activities that address the following issues: world fresh/salt water comparison; cooperative stewardship; biomagnification and bioacccumulation in food chains; watersheds; and animal adaptations.

Fish content: Fisheries issues are not the focus of this kit but some issues are touched on in select activities (i.e., introduction of exotic species, human use of fisheries), and one activity (Food Chain Tag) focuses on issues of toxic pollution and bioaccumulation in Great Lakes fish.

Strengths:
- Rental kit provides resources that might otherwise be expensive, difficult, or time-consuming to obtain
- Kit provides many additional resources and research material
- Includes lesson on local government and community cooperation

Limitations:
- Target audience is very broad (1-12) – materials don't provide suggestions on how to adapt activities to different grade levels
- Some activities require a lot of prep work by the instructor
- The kit is a rental, and therefore must be returned

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Great Lakes Aquarium/Lake Superior Center
353 Harbor Drive
Duluth, MN 55802
218.740.2007
877.866.3474, ext.1007
http://www.glaquarium.org

Great Minds? Great Lakes!

Edition: June 1990
Series: Great Lakes National Program Office
Publisher: U.S. Environmental Protection Agency
Grade: 3-5
Subjects: art, geography, history, math, science, social studies
Cost: free
Format: Booklet

Abstract: **Great Minds? Great Lakes! is divided into three subject areas: History, Social Studies, and Environmental Sciences. Each section of this 23-page booklet contains background information, discussion points, and a variety of hands-on activities designed to illustrate the major points of each lesson. The emphasis is on content, with each content area having discussion questions and activity ideas. Students learn how Canada and the United States are both responsible for protecting Great Lakes resources. The material introduces issues that play important roles in the Great Lakes ecosystem, including pollution, Remedial Action Plan areas, and shipping. Students follow the journey of the research vessel, the *Lake Guardian*, as it travels from lake to lake introducing them to some of the more compelling environmental problems affecting the Great Lakes of the early 1990's. A map of the Great Lakes region is provided for photocopying.**

Strengths:
- Use of stories to convey Great Lakes concepts
- Good depth of information provided for many Great Lakes topics
- Emphasis on pollution and Remedial Action Plan (R.A.P.) areas

Limitations:
- Limited activity instructions provided for teachers
- Limited coverage of fisheries topics

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
U.S. EPA - Great Lakes National Program Office
230 South Dearborn Street
Chicago, IL 60604
Document No. 905/M/90/004
http://www.epa.gov/region5/enved/pubslibrary.html

Inland Seas Education Association

Edition: 2000
Series: NA
Publisher: Inland Seas Education Association
Grade: 4-8
Subjects: history, math, music, science, social studies
Cost: $5.00 for teacher's guide, $800 for ½ day experience for 32 people
Format: Printed, spiral-bound teachers guide, field trip experience

Abstract: The Inland Seas Education Program (ISEA), located in the Grand Traverse Bay region of northern Michigan, is based on a half-day schoolship experience that is supplemented by pre- and post-schoolship activities in the classroom. On the Schoolship, students are engaged by trained staff and their classroom teacher in a hands-on, multi-disciplinary program organized as learning stations. Important concepts related to the Great Lakes are covered, including the food web, watersheds, and exotic species. Various subject areas are covered at each station: math and geography (navigation station), chemistry (limnology station), biology, geology, and earth science (sediments-benthos station), biology (plankton and fish stations), and physics and history (seamanship station). The activities are organized as follows: Geography/Navigation, Limnology, Weather, Seamanship, and Sediments/Benthos, Plankton, and Fish. ISEA's educational objectives are correlated to some of the science objectives of the *Michigan Essential Goals and Objectives for Science Education (K-12)*. Some related social studies benchmarks are also included. Thirteen pre- and post-trip activities are provided in the teacher's guide to help students prepare for some of the activities on the Schoolship and to reinforce concepts addressed on board. ISEA also provides a web site for schools to input photos of the trip as well as data that the group collected, and links to related web sites and activities.

Strengths:
- Provides up-to-date references for web-based resources
- Provides vessel-based field trip experience for learners

Limitations:
- Cost of field trip may be prohibitive for some learners
- Availability is limited by proximity to the ship's launch site
- Pre- and post-trip activities have no action orientation

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Inland Seas Education Association
101 Dame Street, PO Box 218
Suttons Bay, MI 49682
231.271.3077
isea@traverse.com
http://www.schoolship.org

Lake Effects: The Lake Superior Curriculum Guide

Edition: 1998
Series: N.A.
Publisher: Lake Superior Center
Grade: K-8
Subjects: environmental studies, history, language arts, math, science, social studies
Cost: $30
Format: Printed activity guide, spiral bound

Abstract: This 182-page activity guide focuses on Lake Superior and its watershed. The material covers topics ranging from physical evolution to current human impact concerns, and is organized into four sections: the physical Lake Superior, the living Lake Superior, the cultural Lake Superior, and a synthesis section. Each of the first three sections has a fairly detailed background section, and additional background is provided with each activity. A very detailed "how to" guide for field trips is also provided.

Fish content: Fish and fisheries are discussed, but they are not the primary focus of this guide. Related issues that receive significant coverage are pollution and exotic species in Lake Superior.

Strengths:
- Most activities can be done either in or outside of the classroom
- Provides thorough background information
- Well-organized and easy-to-use curriculum
- "Synthesis" section provides very interdisciplinary activities

Limitations:
- Limited action orientation

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Great Lakes Aquarium/Lake Superior Center
353 Harbor Drive
Duluth, MN 55802
218.740.2007
877.866.3474, ext.1007
http://www.glaquarium.org

Lake Erie…build a fish to scale!

Edition: 1991
Series: Oceanic Education Activities for Great Lakes Schools (OEAGLS) – Unit 2
Publisher: Ohio Sea Grant Publications
Grade: K-4
Subjects: art, math, music, science
Cost: $5.00
Format: Printed activity guide

Abstract: This 101-page booklet is the second unit in a three unit series about Lake Erie for children in elementary school. Fairly simple, interdisciplinary activities are linked to basic facts about the Lake and fish. This unit focuses on fish parts, basic classification, and identification. In the activities of this unit, children learn the parts of a fish; assemble a model fish; build a fish to scale using puzzle parts; classify fish according to tails, fins, body shapes, markings, and spines; name ways animals can protect themselves; become familiar with fish-related vocabulary words; and name different types of fish. The booklet includes background information for teachers and accompanying worksheets. Activities include fish parts card games, fish characteristics bingo, dot-to-dot activities, art activities, fish printing, crossword puzzles, and matching activities. The booklet also contains a list of 23 suggestions for related art activities; a list of 46 books on ships and boats, Ohio, rivers, fish, food, animals, water pollution, erosion, and ecology; a list of 62 songs about bodies of water, fish, fishing, pollution, ships, and sailing; a list of 10 records; and a poster for a bulletin board.

Fish content: This program covers the basics regarding the parts of a fish, fish classification, and identification.

Strengths:
- Emphasis on observational skills
- Emphasis on different ways of learning
- Provides good list of additional resource materials
- One of only a few Great Lakes curricula specifically targeted to early elementary students

Limitations:
- No action orientation
- Very limited coverage of Great Lakes fisheries issues

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, OH 43212
614.292.8949
www.sg.ohio-state.edu/osgrant/education

Lake Erie…a day in the life of a fish

Edition: 1991
Series: Oceanic Education Activities for Great Lakes Schools (OEAGLS) – Unit 3
Publisher: Ohio Sea Grant Publications
Grade: K-4
Subjects: art, math, music, science
Cost: $5.00
Format: Printed activity guide

Abstract: This 87-page booklet is the third unit in a three unit series on Lake Erie for children in elementary school. Fairly simple, interdisciplinary activities are linked to basic facts about the lake and fish. Activities in this booklet focus on fish behavior, adaptation, and habitat, and include fairly detailed observations and activities that form an introduction to experimentation and the scientific method. In this unit, children examine a moving fish, conduct experiments with live fish, examine the swimming habits of fish, learn how fish breathe, examine how fish can protect themselves, examine fish habitats, and compare a fish and a whale. The booklet includes background information for teachers and students, experiments, worksheets for guiding student observations, worksheets for recording data, and other accompanying activity worksheets. Activities include collecting data and evaluating the findings to determine where most goldfish feed; examining goldfish response to various types of stimuli (sound, light, touch); and generating experiments to investigate the relationships between water temperature and breathing rates of fish, and between light intensity and breathing rates. Activities are designed so that they may be done individually, in small groups, or in large groups. The booklet also contains lists of suggested classroom activities and independent activities; a list of 13 suggestions for related art activities; a list of 46 books on ships and boats, Ohio, rivers, fish, food, animals, water pollution, erosion, and ecology; a list of 62 songs about bodies of water, fish, fishing, pollution, ships, and sailing; and a poster for a bulletin board.

Fish content: This program provides basic information on fish behavior, adaptation, and habitat requirements.

Strengths:
- Very learner-centered – emphasis on encouraging learners to develop their own questions and investigate
- Provides good list of additional resource materials
- One of only a few Great Lakes curricula specifically targeted to early elementary students

Limitations:
- Very limited coverage of Great Lakes fisheries issues
- No action orientation

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, OH 43212
614.292.8949
www.sg.ohio-state.edu/osgrant/education

Lake Erie…take a bow

Edition: 1986
Series: OEAGLS – Unit 1
Publisher: Ohio Sea Grant Publications
Grade: K-4
Subjects: art, geography, history, language arts, music, science, social studies
Cost: $5.00
Format: Printed activity guide

Abstract: This 69-page booklet is the first unit in a three unit series on Lake Erie for children in elementary school. The unit includes general information about Lake Erie (origin, uses, size, geography, geology, economic importance, pollution), maps of the region, and an experiment that demonstrates the effects of glaciers on landscapes. Fairly simple, interdisciplinary activities are linked to basic facts about the lake and fish. The booklet contains activities for teaching and reinforcing information about the Lake Erie region and attitudes toward Lake Erie. Activities include games, map work, writing activities, constructing a word web, and art activities. The booklet also contains 1) a list of 46 books on ships and boats, Ohio, rivers, fish, food, animals, water pollution, erosion, and ecology; 2) a list of 62 songs about bodies of water, fish, fishing, pollution, ships and sailing; 3) a list of ten musical recordings; and a poster for a bulletin board.

Fish content: A few links are made to core fisheries issues.

Strengths:
- Emphasis on gaining a greater appreciation for Lake Erie
- One of only a few Great Lakes curricula specifically targeted to early elementary students
- Provides good list of additional resource materials

Limitations:
- Limited coverage of Great Lakes fisheries issues
- No action orientation

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, OH 43212
614.292.8949
www.sg.ohio-state.edu/osgrant/education

Lake Superior Ecosystem Learning Kit

Edition: 1992
Series: Lake Superior Learning Kits
Publisher: Lake Superior Center
Grade: 4-10
Subject: environmental science, geography, math, science
Cost: No cost – "rental" kit must be returned
Format: Traveling trunk

Abstract: This traveling kit contains activities and resources for discovery-based classroom activities focusing on Lake Superior. Resources include books, magazines, video and/or audiotapes, posters, maps, and all materials or equipment (including lesson plans) necessary for each activity. The traveling kit features five activities that address the following topics: exotic species, depth profiles, geology, and the biological, chemical, and physical components of a lake. The activity "What is a Lake?" provides students with an introduction to the scientific process through an in-depth study of a lake, the creation of an artificial lake, sampling, conducting research, and analyzing and interpreting data.

Fish content: Fisheries issues are not the focus of this kit, but issues of exotic species and their impacts on Lake Superior's ecosystems are addressed in one activity.

Strengths:
- Kit provides resources that might otherwise be difficult, expensive, or time-consuming to obtain
- Emphasis on both the physical and biological aspects of Lake Superior
- Focus of skill development through research and sampling

Limitations:
- Limited action orientation
- Some of the resources are out-datec

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Great Lakes Aquarium/Lake Superior Center
353 Harbor Drive
Duluth, MN 55802
218.740.2007
877.866.3474, ext.1007
http://www.glaquarium.org

The Lake Superior Game

Edition: 1991
Series: NA
Publisher: Minnesota Sea Grant
Grade: 5-12
Subjects: environmental studies, geography, science, social studies
Cost: Free
Format: Printed activity/game guide

Abstract: This 18-page booklet provides the framework for a role-play activity related to Lake Superior. In this activity, learners assume the roles of various Lake Superior stakeholders and make decisions to either pollute or protect the lake. These actions are simulated by adding things to, or taking water from, a bucket of water representing Lake Superior. This game requires players to make choice or perform assigned actions appropriate to their roles, and thus they experience the challenges of preserving and enhancing the Lake Superior ecosystem. Roles are reinforced with information on the consequences of actions, and on things that can done particularly by individuals to either mitigate or eliminate consequences of actions. The game is designed to help learners understand the complexity of economic decisions facing potential polluters of Lake Superior; to help learners understand how they can change their own actions to minimize pollution of the Lake; and to have learners realize how many people depend on, and enjoy, Lake Superior. The game takes about an hour to play, depending on the size of the group and the amount of discussion during the game – ideal numbers of players range from ten to thirty people. The game booklet includes background information on Lake Superior for game organizers, instructions for preparing players, instructions for setting up and making needed materials, instructions for play, and game cards. The booklet also includes a map of Lake Superior and its drainage basin, a worksheet on Lake Superior, worksheet answers, follow up instructional suggestions, and five references. Although a few specific examples in the game relate specifically to Lake Superior, most of the examples are general enough that the role-play could be used with almost any lake. Similar versions are available for lakes in general: *The Lake Game/Youth* and *The Lake Game for Adults.*

Strengths:
- Well-designed role-play activity, with impacts that are general enough that it can be used with almost any lake
- Provides balanced presentation of viewpoints regarding Great Lakes issues
- Provides examples of actions that address Great Lakes issues

Limitations:
- Limited background information or material about Great Lakes issues

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
University of Minnesota/Minnesota Sea Grant
Room 302
1518 Cleveland Avenue
St. Paul, MN 55108
612.625.9288
http://www.seagrant.umn.edu/pubs/freeorder.html

Lake Superior: A-L Learning Kit

Edition: 1992
Series: Lake Superior Learning Kits
Publisher: Lake Superior Center (Great Lakes Aquarium)
Grade: K-3
Subjects: art, history, language arts, science
Cost: No cost –"rental" kit must be returned
Format: Traveling kit

Abstract: This traveling kit contains activities and resources for discovery-based classroom activities focusing on Lake Superior. Resources include books, magazines, video and/or audiotapes, posters, maps, and all materials or equipment (including lesson plans) necessary for each activity. This traveling kit introduces students to Lake Superior through lesson plans as well as suggested activities depicting aspects of the lake that relate to the letters A-L. Lesson plans are included for some letters, but teachers are also encouraged to develop activities for the remaining letters. This kit allows for student-directed learning, as teachers can also let students choose research topics related to a specific letter. Lesson plans are included for five letters: A is for Agates; B is for Bridges; F is for Fish and Food Chains; G is for Geology, and L is for Lighthouse. Also included is an extensive list of resources, organized alphabetically by topic and subject area. This list should be useful for teachers and students.

Fish content: Fisheries issues are not the focus of this kit, but some core topics are touched on in one activity (i.e., F is for Fish and Food Chain). To what extent other fisheries issues are covered depends on the interests and guidance of the teacher, and the interests of the students.

Strengths:
- Kit format provides resources that might otherwise be difficult, expensive, or time consuming to obtain.
- "Alphabet" approach provides an easy format for a general overview of Great Lakes topics
- Can easily adapt activities to locally relevant issues or topics
- One of only a few Great Lakes curricula specifically targeted to early elementary students

Limitations:
- Limited instructions for teachers
- Involves more teacher preparation time than other kits
- No action orientation explicitly written into materials

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:

Great Lakes Aquarium/Lake Superior Center
353 Harbor Drive
Duluth, MN 55802
218.740.2007
877.866.3474, ext.1007
http://www.glaquarium.org

Lake Superior: M-Z Learning Kit

Edition: 1992
Series: Lake Superior Learning Kits
Publisher: Lake Superior Center (Great Lakes Aquarium)
Grade: K-3
Subject: art, geography, science
Cost: No cost –"rental" kit must be returned
Format: Traveling kit

Abstract: This traveling kit contains activities and resources for discovery-based classroom activities focusing on Lake Superior. Resources include books, magazines, video and/or audiotapes, posters, maps, and all materials or equipment (including lesson plans) necessary for each activity. This traveling kit introduces students to Lake Superior through lesson plans as well as suggested activities depicting aspects of the lake that relate to the letters M-Z. Lesson plans are included for some letters, but teachers are also encouraged to develop activities for the remaining letters. This kit allows for student-directed learning, as teachers could also let students choose research topics related to a specific letter. Lesson plans are included for six letters: M is for Map; O is for Otter; R is for Rainbow Trout; T is for Tugboat; W is for Waves; and Z is for Zebra Mussel. Also included is an extensive list of resources, organized alphabetically by topic or subject area, which can be useful for both students and teachers.

Fish content: While fisheries issues are not the focus of this kit, some core issues are touched on in two activities – R is for Rainbow Trout, and Z is for Zebra Mussel. Coverage of other fisheries issues is dependent on the interests and guidance of the teacher, and the interest of the students.

Strengths:
- Kit provides resources that might otherwise be difficult, expensive, or time consuming to obtain.
- Emphasis on zebra mussels and other Great Lakes exotics
- One of only a few Great Lakes curricula specifically targeted to early elementary students

Limitations:
- Limited instructions provided for activities
- No action component

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:

Great Lakes Aquarium/Lake Superior Center
353 Harbor Drive
Duluth, MN 55802
877.866.3474, ext.1007
http://www.glaquarium.org

Life in the Great Lakes

Edition: 1997
Series: ES-EAGLS (Earth Systems – Education Activities for Great Lakes Schools)
Publisher: Ohio Sea Grant
Grade: 7-12
Subjects: history, math, science, social studies
Cost: $8.00
Format: Printed manual, bound

Abstract: This 118-page manual is one of a series of subject area activity books related to the Great Lakes. The series is based on Earth Systems Education, a process designed to "create a curriculum more responsive to human needs and future quality of life." Each book in the series provides a lot of data, including web-based data, some of which are required to complete the activities. Included with the activities are suggestions about possible ways to use them in cooperative learning situations and how lessons can be structured according to the learning cycle. This program covers organisms living in the Great Lakes, ecological relationships, wetlands and critical habitats, and estuary changes and values. Other subject areas available in this series are Great Lakes shipping, climate and water movement, land and water interactions, and Great Lakes environmental issues.

Strengths:
- Emphasis on student-centered instruction
- Emphasis on learner assessment
- Includes a lot of reference material (both in the manual and on-line)
- Provides balanced presentation of viewpoints

Limitations:
- Limited action orientation

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, OH 43212-1194
614.292.8949
www.sg.ohio-state.edu/osgrant/education

The Life of the Lakes

Edition: 1996
Series: The Life of the Lakes
Publisher: Michigan Sea Grant
Grade: 7-12
Subjects: health, history, math, science, social studies
Cost: range (see below)
Format: Video, printed manual, booklet, posters

Abstract: The Life of the Lakes is a multi-media educational package designed for educators working with youth ages 12-18 (middle and high school youths). The activities, background information, curriculum materials, concepts and teaching ideas are appropriate for school settings and for non-formal youth education settings such as camps, 4-H clubs, and nature centers. The package consists of four different components, with an hour-long video forming the centerpiece of a detailed examination of Great Lakes fisheries. The four components may be purchased separately to meet the needs of each educator. The components include a background information guide, an educational materials (activities) guide, and a poster series. Together, these components divide the history of the lakes and their fisheries into five eras, and examine the social, technological, and environmental changes that resulted in changes in the fisheries. The activities can be adapted to age level and educational setting, and many are designed for cooperative learning by groups of youth working together. Content within The Life of the Lakes package focuses on: Great Lakes ecology, fisheries careers, contaminants in Great Lakes fishes, and the economy of Great Lakes fisheries.

The Life of the Lakes: The Great Lakes Fishery (VT-044, $25.00) This 55-minute video portrays the Great Lakes fishery today, how it has changed since the Great Lakes were formed, and presents future challenges faced by the fishery.

The Life of the Lakes: A Guide to the Great Lakes Fishery (E-2440, $7.50) This 64-page booklet provides clear, interesting graphics and comprehensive background information to supplement the concepts presented in the video. The booklet comes with three poster inserts: a time-line of the Great Lakes fishery, a listing of all fish species found in the lakes and tributaries, and a map of the Great Lakes basin.

The Life of the Lakes: A Guide to Great Lakes Fishery Education Materials (E-2441, $7.50) This 80-page curriculum provides teaching outlines/plans for a two-week thematic unit about Great Lakes fisheries. Included are six activities based on the video presentation, as well as many ideas for short, warm-up activities and long-term, individual or group study projects. It comes with pre- and post-activities, overheads and handout masters, a curriculum framework that meets the *Michigan Essential Goals and Objectives for Science Education K-12*, and a comprehensive listing of related educational materials.

The Life of the Lakes: Posters (E-2442-2447, $1.50 each)
A set of six posters featuring maps of each lake and one of the Great Lakes basin, text describing various aspects of the fishery and illustrations of some Great Lakes fishes.

Strengths:
- Most comprehensive program reviewed in terms of Great Lakes issues and concepts
- Video component is very well produced
- Provides suggested activities for before and after watching the video
- Extension activities suggest involvement with community

Limitations:
- Most lessons have limited action orientation
- Limited resources for learner assessment

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Michigan Sea Grant Extension
334 Natural Resources Building
Michigan State University
East Lansing, MI 48824
571.353.9568
http://www.coastwatch.msu.edu

Our Great Lakes Connection

Edition: 1985
Series: NA
Publisher: University of Wisconsin Extension
Grade: K-8
Subject: art, geography, history, language arts, music, science
Cost: unavailable – material not distributed
Format: Printed manual, unbound, 3-hole punched

Abstract: **This 204-page activity guide presents teachers with 24 activities that provide historical, social, economic, and ecological perspectives related to the Great Lakes. The materials can be integrated into classroom activities, and are designed to fit into art, drama, economics, geography, history, language arts, math, music, science, and social studies curricula. Map reading, math calculation, and social studies, in particular, are emphasized in the activities. Each activity includes information about some aspect of the Great Lakes and directions for student activities that exercise skills of observation, creativity, expression, inquiry, analysis, and problem solving. The developers have not included specific objectives for each lesson, as they believe that teachers best know the abilities and needs of their students. Each activity, however, provides background information and suggestions for additional resources. The Activities at a Glance section indicates the target grade level(s) and subject areas for each activity. An extensive list of additional resources includes the categories of books, periodicals, audio/visuals, filmstrips/slides, records, maps, and curricula.**

Fish content: **Although the coverage of Great Lakes fisheries issues is not extensive, the materials touch on them in three areas: the value of fish to, and the fishing techniques of, the woodland Indians; some of the major sport, commercial, and forage fish in the Lakes, and impacts of exotic species introductions (smelt, lamprey, alewife); and the impact of pollutants in the lakes.**

Strengths:
- Emphasis on the cultural history of the Great Lakes region
- Good background information for each activity

Limitations
- No action orientation
- Not a specific curriculum – rather it is intended to supplement existing curricula in a variety of subject areas

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
University of Wisconsin – Extension Environmental Resource Center
1450 Linden Drive
UW-Madison
Madison, WI 53706

Supplemental Curriculum Activities to Accompany Paddle-to-the-Sea

Edition: 1988
Series: NA
Publisher: Ohio Sea Grant Publications
Grade: 3-6
Subjects: art, geography, history, language arts, math, music, science, social studies
Cost: $10.00
Format: Printed activity guide

Abstract: This series of activities is designed as a supplement to *Paddle-to-the-Sea*, a story book written by Holling Clancy Holling. Teachers may choose any or all of the activities outlined in the guide to reinforce and extend the experiences and understanding provided by the story. A chart indicates which activities relate to each chapter in the book. The interdisciplinary activity topics relate directly to the experiences of characters in the story, and include Great Lakes geography, the hydrologic cycle, animal tracks, beaver ponds, fish anatomy, estuaries, forestry and tree use, food webs, locks, shipping, weather folktales, and ecosystems. The activities provide students with a variety of hands-on experiences like model building, role-playing, story writing, carving, and drawing. Accompanying the guide are worksheets and answer keys, discussion questions, and extension activities.

Fish content: Many of the activities are language-arts based and the curriculum as a whole focuses on the area's geography and human development. Several activities, however, touch on a number of fisheries issues and concepts. Coverage of fisheries issues depends on the interests of the teacher and students, and the quality and depth of discussion that accompanies the activities.

Strengths:
- Emphasis on geography and human development in the Great Lakes region
- Emphasis on an ecosystem approach to conceptualizing the Great Lakes
- Activities can be done independently or linked to others

Limitations:
- Limited content on Great Lakes fisheries issues
- Limited action orientation

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, OH 43212
614.292.8949
www.sg.ohio-state.edu/osgrant/education

Zebra Mussel Mania

Edition: 1997
Series: N.A.
Publisher: Illinois-Indiana Sea Grant
Grade: 5-6
Subjects: history, language arts, math, science
Cost: range (see below)
Format: Traveling trunk including curriculum guide, resource portfolio, and additional materials

Abstract: Zebra Mussel Mania is a science kit and curriculum that provides experiments, games, stories, and other hands-on activities to help educators teach about a wide range of problems associated with zebra mussels and other exotic species. The curriculum guide outlines ten activities that integrate science with math, social studies, language arts, fine arts, health, and physical education. The activities are hands-on, and emphasize inquiry-based cooperative learning. The instructional guidelines of each activity relate to the *Benchmarks for Science Literacy, Project 2061* (American Association for the Advancement of Science). Each of the ten activities is prefaced with specific goals and objectives to be met, and addresses the process skills students need to learn science: observation, measurement, classification, inference, prediction, communication, formulation of hypotheses, experimentation, and interpretation of data. The instructional approach used by this curriculum allows students to work in cooperative groups, and the guide provides detailed instructions on how to promote cooperative learning within such groups. The materials also have a strong emphasis on assessment.

Educators can choose from one of three options:

- Borrow the complete traveling trunk from one of the 27 lending sites across the U.S. and Canada. A user fee or deposit may be charged.
- Duplicate the trunk by purchasing the curriculum guide ($35), resource portfolio ($35) and materials at local stores (about $200).
- Purchase a complete trunk, curriculum guide, and resource portfolio for $360, plus $20 for shipping.

Strengths:
- Well-organized and easy to use format
- Provides resources and materials that might otherwise be difficult, expensive, or time-consuming to obtain
- Emphasis on community outreach and action orientation

Limitations:
- Rental kit – materials must be returned after use

For Table of Contents, please refer to the abstract listed on the website.

Vendor Information:
Illinois-Indiana Sea Grant
University of Illinois, 65 Mumford Hall
1301 West Gregory Drive
Urbana, IL 61801
217.333.9448
http://www.ansc.purdue.edu/il-in-sg/

Illinois Rivers Project
Box 2222, SIUE
Edwardsville, IL 62026
618.692.3788
rivers@siue.edu

Chippewa Ottawa Resource Authority Education Needs

Great Lakes Fishery Trust Education Assessment Project

Submitted Feb 1, 2001 by
Jennifer Dale, CORA Public Information & Education
Bay Mills Indian Community
12140 W. Lakeshore Dr.
Brimley MI 49715
ph: 906-248-3241, ext. 1170
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newspaper@bmic.net

1. Describe CORA's general philosophy toward Great Lakes fisheries education

The Chippewa Ottawa Resource Authority (CORA) Information & Education program works with an eye toward CORA's management philosophy: work to ensure conservation and enhancement of the Great Lakes fishery for future generations.

- In addition to the lack of education regarding tribal issues, there has been a general lack of education on many aspects of Great Lakes ecology history.
- A properly directed educational program regarding tribal issues is sorely needed. For sound decision making and for social reasons, many myths that have been generated about tribal fishing must be dispelled.
- A sound understanding of Great Lakes ecology and history can impact future decision makers, natural resource specialists, and citizens individual behaviors.

An example of a successful educational program is the GLFC campaign to educate the public about sea lamprey in the Great Lakes, which has positively impacted funding levels for lamprey control measures and research, with the understanding and support of citizens.

2. Provide an overview of CORA's current activities [(if possible, with reference to the Great Lakes fisheries education framework in terms of content addressed by current efforts

A. Background

The Chippewa Ottawa Resource Authority (CORA) Public Information & Education program is administered by the Bay Mills Indian Community under subcontracts with member tribes Bay Mills Indian Community, Grand Traverse Band of Ottawa and Chippewa Indians, and Sault Ste.

Marie Tribe of Chippewa Indians, and also services Little River Band of Ottawa Indians, and Little Traverse Bay Bands of Odawa Indians.

The Bay Mills Indian Community newspaper director implements the Public Information & Education program on a half-time basis. The program operates with only $29,000 in annual funding.

B. Mission
The specific mission of the CORA Information & Education program is to foster an understanding of the 1836 treaty fishery.

C. Objectives
Program objectives are to provide treaty fishery information and education to the CORA tribes' members and to the public; provide public relations for CORA; and to act as an information clearinghouse for CORA and the tribes.

D. FY 2001 Program Goals
- Provide the *Tribal Fishing* newsletter to CORA tribal fishers and personnel, and produce an electronic version for downloads.
- Provide news coverage for CORA and the Executive Council and their programs and committees for inclusion in tribal/non-tribal newspapers/newsletters, and write and disseminate news releases as needed.
- Offer information packet regarding the Treaty Fishery, Consent Order, CORA and Executive Council functions and progress.
- Arrange for media coverage of important functions of CORA and its programs and committees.
- Provide background educational materials to the public.
- Offer up-to-date website.
- Keep abreast of treaty fishery activities, current events, legislative and biological trends.
- Promote the inclusion of Native American history in appropriate public/educational projects. (e.g. developing curriculum, online teaching modules, or museum exhibits).
- Build networks, build alliances: establish contacts in the government, professional and educational system to help them understand and access information about CORA and the 1836 treaty fishery.
- Continue to act as liaison between the Lake Superior Aquatics Committee and Communications Committee.

E. Regular program activities include:
- Monitor outside media and special interest group publications.
- Respond to one-sided newspaper or radio media pieces.
- Identify, research, write, and disseminate press releases.
- Attend meetings.

- Reach out to relevant groups, persons (e.g. youth groups, GLIFWC, fisher's associations).
- Compile updated materials for information packets and disseminate as needed.
- Create online versions (PDF files) of educational materials.
- Update website with current newsletter, press releases, relevant documents, etc.
- Archive photos for future projects, e.g., publications, website, slides.

F. Public Information & Education Program Budget

This program is seriously under-funded. $29,034 is provided for the Public Information Officer's time and some of the program expenses.

CORA PIE annual spending, adjusted for 2001

Public Information Officer	$15,889
ARI network fee	950
Internet fees	2000
Printing costs	5700
Supplies	1500
Postage	500
Phone	274
Travel	800
Space	1421
$	29,034

2001 Needs:

• Due to HACCP education needs, a new Consent Decree, and a new intertribal authority with new regulations, all current publications must be updated.

New CORA regulations publication	$ 5,000 (first run)
Consent Decree publication	$ 5,000 (first run)
Updated four-fold CORA brochure	$ 5,000 (first run)
Updated Treaty Fishery Guide 6 x 9	$ 14,000
Treaty education literature 8.5 x 11	$ 15,000
Video	$ 5,000*
subtotal:	$ 49,000
Federal funds earmarked for 6 x 9 update:	$ 5,000
total:	$ 44,000 unfunded

* The video, an in-house quote,will probably have to be adjusted.

• More staff, on at least a part time basis, is needed. There is simply not enough time to implement an efficacious program with a single, half-time person.

G. Discussion

• This program suffers from a lack of funding.

This PE & I has always operated with the smallest budget of all COTFMA (and now CORA) programs. Program activities are insufficient in scope to adequately promote an educated understanding of CORA and treaty fishing rights in general.

• The public needs more access to more information.

What little has been provided has been effective. As recently as 2000, some members of the media and the public, and even some state officials were not aware of the distinction between the 1836 treaty and the 1985 Consent Order. They do not understand gear types and how they work, that the treaty fishery is regulated, or the contribution of tribal biologists. Many misconceptions are still held.

Since 1997, this program has worked to educate Native and non Native alike, having some success within its scope. A communications plan for outreach to tribal members, the public and the media was developed and implemented. Efforts were made to impact developing curriculum such as Project FISH and the GLIN online teaching module, with limited success. The program assisted efforts like the Fish for All mobile exhibit. In 1999, the program worked to ensure the production of the interagency publication "Michigan's 1836 Treaty Fishing Guide."

• A successful example

The reaction to the "Michigan's 1836 Treaty Fishing Guide" illustrated the need for more such materials. Distributed to the media and Michigan legislative representatives, the publication was used by the FBI for sensitivity training, by the Inter Tribal Council of Michigan, by colleges and universities for law and natural resource classes, and was requested by many private citizens around the Great Lakes. Requests are still coming in for the booklet, which is now outdated. It helped filled a void in information and education about the history, ecology, economy, culture and politics of the fishery, and tried to address some major misconceptions about tribal commercial and subsistence fishing. But we still have a long way to go.

(3) Describe CORA's prioritized needs (possibly specific examples).

1. Curriculum development:

• The 1836 treaty fishery is a part of the rich history of the Great Lakes Fishery. Schoolchildren do not learn enough about the

historical periods of the ecosystem or Great Lakes peoples prior to European occupation.

- **As future stewards, fishers, leaders and citizens, they will be able to make more informed decisions that come from well considered, well educated opinions.**

A comprehensive Great Lakes ecosystem curriculum should start with the glaciers, not the arrival of Europeans. Children should learn how the lakes came to be; how life filled the lakes; and early human interaction with the Great Lakes, such as technologies, culture, and economy of the various pre-historical peoples that created a way of life that revolved around the fishing seasons. The children ought to know how the ecosystem looked and functioned before invasive species arrived, or European industry made its impact. All this, instead of the usual page or two before hitting the 1950s. Children can grow up with an understanding and appreciation of the Great Lakes in the context of millennia rather than decades to better understand the big picture.

- **A Native cultural component could be added to this curriculum for appreciation and enrichment purposes.**

Teaching kids how fish was smoked and powdered or how they tied nets back in the old days (living history) gives them a chance to cultivate a greater appreciation of the fishery. The Native events I have attended have been fun and enriching. Some children may even be interested in using these skills.

Students would also benefit from learning about Native values to better understand tribal stakeholders on the Lakes, and to learn a value-system compatible with good stewardship of the Lakes.

2. Development and distribution of up-to-date treaty fishery publications

- **Specific tribal fishing publications are very much needed to provide current information to tribal members, the public, and the media.**

These could be used in middle school through college classes, as background materials for the media, for tribal members and other citizens of the Great Lakes to help them understand their fishery and its users, and perhaps their own role.

Needed and not funded are:

- New CORA regulations publication
- Consent Decree publication

• Updated four-fold CORA brochure
• Updated Treaty Fishery Guide 6 x 9
• Video illustrating treaty fishery on the Great Lakes.

Subsequent printings may not even be necessary if a good PDF version is developed for downloading to schools and homes.

3. Background educational materials

• Better educated citizens may become more productively active.

More materials are needed for the above mentioned groups to better understand, for example:

- Native American treaties and treaty rights,
- Native American history of the Great Lakes,
- HACCP regulations,
- Weighing risk in fish consumption,
- How the following affects (or could affect) the Great Lakes fishery:
  - Water diversions,
  - Contaminants (industrial and individual),
  - Invasive exotic species.
- How individual actions collectively impact the fishery (pollution of all sorts, fish harvesting, boater / fisher safety, are examples).

Discussion

A thorough grounding in the Great Lakes fishery politics is needed. Public officials and even some state DNR staff were confused about the difference between the 1985 Consent Order and the 1836 Treaty as well as the nature of treaty rights.

A publication about Native history through a certain period could be used for years. Usually only those in specialized study areas access this information. A middle school publication of this sort could also be used for public distribution.

4. Internships

• The lack of funding for this program has caused a lack of services: there is not enough time, space, or budget to complete the work.

Interns from various colleges might be of help, and learn something in return. Students involved in certain concentrations within the natural resources, communications, journalism, public relations or even education fields could learn more about —

- The 1836 treaty fishery
- Michigan Indian treaties

- Tribal communities and government
- Chippewa Ottawa Resource Authority, its committees and programs
- Community / tribal newspapers
- Public relations / public information & education programs.

- **A group of graduate students could go to work on the above described curriculum. Some could spend the summer with the tribes to learn more about what is needed. Then, they could all come together to write the curriculum.**

— END OF PAPER—

NEEDS ASSESSMENT AND PRIORITIES FOR FISHERIES EDUCATION IN THE GREAT LAKES (MI)
Grand Traverse Band of Ottawa and Chippewa Indians

Needs by priority:

1. Promote participation with having adults teach the children commercial, subsistence and recreational fishing activities.
2. Cultural connection.
3. Fish identification/life spans education
4. Regulations education
5. Hands on outdoor demonstrations
6. Need equipment for the youth that do not have the funds to have their own.

Suggested outcomes:

Help to keep the youth out of trouble
Promote cultural/traditional activities
Utilize the Grand Traverse Band Youth programs
Project Fish curriculum promotion

PUBLIC EDUCATION AND OUTREACH
MDNR Fisheries Division
DRAFT January 2001[2]

Mission: The mission of the Fisheries Division is to protect and enhance the public trust interests in populations and habitats of fishes and other forms of aquatic life, and promote optimum use of these resources for the benefit of the people of Michigan. In particular the division seeks to:

- Protect and maintain healthy aquatic environments and fish communities and rehabilitate those now degraded;
- Provide diverse public fishing opportunities to maximize the value to anglers of recreational fishing;
- Permit and encourage efficient and stable commercial fisheries which accommodate Native American fishing rights and do not conflict with recreational fisheries;
- Foster and contribute to public stewardship of natural resources through a scientific understanding of fish, fishing, and fisheries management.

Division education and outreach efforts are developed and reviewed by a Division Communications committee. The committee is also guided by the *Strategic Plan for Building Michigan Anglers*, by Bruce Matthews and the Hunting and Fishing Heritage Task Force report of 1995. The specific objectives of the Division's aquatic resource education program are:

- **Improve the public's understanding of the state's aquatic resources.**
- **Promote stewardship for aquatic resources.**
- **Provide training and materials for educators, staff and volunteers.**
- **Improve public understanding of fisheries management principles and techniques.**
- **Produce more responsible and better-informed anglers.**
- **Facilitate partnerships with other agencies and organizations to promote and implement aquatic resources education.**
- **Evaluate programs and materials to determine needs, use and effectiveness.**

Current and Past Activities:
Fisheries Division has been involved with a number of communications efforts, including:

- Urban Fisheries Program (recruitment of young anglers)
- Sports Shows (for example, Outdoorama)
- State Fairs (U.P. and L.P. Pocket Parks)
- Weekly Fishing report and Fishing Hotline "1-800-ASKFISH"
- Free Fishing Weekends
- Hatchery Interpretive Centers
- Fisheries Division Website

[2] Prepared for the Great Lakes Fishery Trust education needs assessment project.

- Project F.I.S.H. (Friends Involved in Sportfishing Heritage)
- Fisheries Division Publications (limited)
- "Ask the DNR" TV Show in the U.P. (#1 rated public TV show in the U.P.)
- Limited involvement with the Michigan Out-of-Doors and Practically-a-Sportsman public TV shows.
- MDNR Millenium Education Project for 4th graders based on L.A.P.'s – Learn from the past, Appreciate the present, Preserve our outdoor heritage.

Although these efforts have been good, they have primarily concerned fishing information and promotion and have not given emphasis to aquatic resource education. Much more needs to be done to educate anglers about resource conservation and management.

Priorities for future education and outreach:

- **Provide direct experiences with natural resources that promote a sense of advocacy and stewardship for natural resources.**
- **Provide aquatic resource education to the general public that develops appreciation for aquatic resource values and fosters a conservation ethic.**
- **Recruit anglers from non-traditional demographic and socio-economic groups and overcome obstacles to fishing participation associated with age, race, residence, gender and family status.**
- **Ensure public understanding of the need for adequate pollution control standards to protect air and water quality, the importance of wetland preservation and restoration, and the need for use of agricultural best management practices.**
- Develop and distribute targeted tools (videos, publications, promotional items, and programs).
- **Improve public knowledge about the Fisheries Division mission and programs.**

Key Messages need to include:

- **information about the diversity of and opportunity to access various fish species, waters, seasons and fishing techniques in Michigan;**
- **the economic, cultural and recreational values of fish and fishing;**
- **the need for regulations to prevent over-fishing;**
- **how hatcheries contribute to recreation and research**
- **how aquatic nuisance species arrive, spread and their adverse effects on aquatic resources**
- **the role of local ordinances in protecting aquatic habitat, improving public safety and minimizing user conflicts**
- **public access rights to fish**
- **equipment taxes and other funding sources that support fishing and aquatic resources**

Michigan State University Fisheries Education Philosophies, Priorities, Activities and Perceived Needs

Summary prepared for the Great Lakes Fishery Trust – Fisheries Education Needs Assessment Project (2/23/01)

Submitted by: Shari L. Dann, Associate Professor and Extension Specialist, Dept. of Fisheries and Wildlife, Michigan State University, E. Lansing, MI 48824 (517-353-0675; fax 517-432-1699; email: sldann@msu.edu)

Organizational Philosophy toward Great Lakes Fisheries Education

Describing activities of a large organization such as MSU even within one realm of education is challenging. Consistently, however, underlying the MSU philosophy on education is the land-grant university mission to integrate research, teaching (of undergraduates and graduate students), and outreach to specific local and regional audiences. At the core of the land-grant university mission are these principles:

- research-based knowledge generation, and application of this research to real problems and communications;
- meeting needs identified by stakeholders and of importance to Michigan and regional residents;
- partnership in program design, implementation, evaluation, revision, and maintenance;
- two-way communications flow between stakeholder groups or audiences for outreach;
- utilization of the specific MSU Extension delivery system for educational program design and implementation locally (this network includes local-level agents, some with specialized background in specific content area such as Great Lakes, fisheries, natural resource management, youth development, or marine/aquatic resource education).

Most (but not all) of the activities within MSU which focus on Great Lakes and fisheries education are housed within the Department of Fisheries and Wildlife, College of Agriculture and Natural Resources. The mission of the MSU Department of Fisheries and Wildlife is:

- To provide the education, research and outreach needed by society for the conservation and rehabilitation of fish and wildlife resources and their ecosystems.

The vision of the MSU Department of Fisheries and Wildlife is:

- To develop cooperatively sufficient understanding of the structure and function of ecosystems to allow reasoned conservation, rehabilitation and management of fisheries and wildlife resources.

One "arm" of the MSU Department of Fisheries and Wildlife is the outreach branch of Michigan Sea Grant. The mission for the Michigan Sea Grant Outreach efforts is:

- To enhance and facilitate the wise use of the Great Lakes through increasing public awareness and understanding of Great Lakes resources and issues and through the education of resource users, managers and policy makers.

Overview of Current Activities

Project F.I.S.H. (Friends Involved in Sportfishing Heritage)

- Goal: to initiate and provide aquatic education and fishing skills to interested adult volunteers and teachers and youth, in order to foster long-term stewardship of Great Lakes watersheds and fisheries resources.
- Audiences: 270 adults trained in train-the-trainer workshops reaching over 12,000 youth in K-12 and nonformal education settings
- Implementation: through the MSU Extension/4-H network, as well as through local-level partnerships; state advisory committee meets annually to guide program design and development
- Evaluation: pre- and post-workshop survey of educators; 3-month follow-up phone survey of educators to document usage, impact for youth.
- For complete "Final Report" regarding initial funding provided by GLFT see http://www.projectfish.org
- Current funding: GLFT, Harold & Jean Glassen Memorial Foundation, Gander Mountain, Inc. and National Fish and Wildlife Foundation (pending)

- *Program expansion: SWIMS (Schools Welcoming In Michigan Salmon)* In several west coast states, "salmon in the classroom" programs developed by the state fisheries agencies directly education youth about anadromous fisheries biology, ecology, conservation and management. About a dozen Michigan schools have been using the western curricula under the guidance of MDNR Fisheries Biologist Tom Rozich. This project brings together teachers using the program, fisheries biologists, and results of a survey of educators and fisheries stakeholders to adapt the existing curricula to meet Michigan's fisheries education needs.
- *Great Lakes and Inland Fisheries Education program partnership expansion:* collaboration to offer hands-on educational displays at Outdoorama (MUCC show) and OutdoorExpo (MSUE's family-oriented hands-on outdoor summer event); collaboration network with retailers and manufacturers for fisheries stewardship education (Gander Mountain, Cabela's, BassPro Shops, Mason Tackle, and Jay's Sporting Goods, as well as many others)

Michigan Sea Grant Extension

This specific network of researchers, Extension professionals, educators and communicators addresses many aspects of Great Lakes fisheries education.

Research focuses on education program effectiveness and critical fisheries management questions. Staff coordinate strategic planning to work with fisheries and Great Lakes stakeholders to identify needed education programs. For more details, see these documents: Michigan Sea Grant FY 2001-2003 Omnibus Proposal (Volume I Project Summaries and Budgets, Volume II Proposal Text and Vitae, and Appendices: Annual Report and Implementation Plan). In addition, see the strategic plan at the Michigan Sea Grant web site: http://www.engin.umich.edu/seagrant.

- *GLEP (Great Lakes Education Program):* vessel-based aquatic resource education on Lake St. Clair and the Detroit River for thousands of K-12 youth per year.
- *4-H Great Lakes and Natural Resources Camp*: teen leadership and career development program for 50 teens statewide annually; specific focus on incorporation of Great Lakes fisheries issues and Project F.I.S.H.
- *Purple Loosestrife Project and other education regarding Great Lakes exotic species:* workshops and materials designed for educators by educators for hands-on study of Great Lakes watersheds and ecosystems, exotics and related issues; an Exotic Species "Day Camp" offers training for educators on classroom projects.
- *Other education programs offered annually* meet specific educational needs of Great Lakes charter fishing operators, coastal communities and their interests in Great Lakes fisheries-related tourism, commercial and tribal fisheries operators, and many other audiences.

PERM (Partnership for Ecosystem Research and Management)

- This partnership, between the MDNR and MSU's College of Agriculture and Natural Resources, provides for ongoing research and outreach regarding Great Lakes fisheries issues, particularly in the areas of: ecosystem dynamics and temporal/spatial variability and in community/habitat dynamics within Michigan watersheds (with some implications for dam removal, stream habitat improvement for anadromous fishes, etc.). See the PERM web page for more details regarding philosophy, activities, accomplishments and prioritized needs: http://www.fw.msu.edu/orgs/perm.
- Additional partnerships with other organizations such as the Great Lakes Fishery Commission provide for faculty research and outreach regarding innovations in adaptive management of Great Lakes fisheries and in sea lamprey control and management. Research and outreach are approached collaboratively with sponsoring organizations.
- Primary audiences for outreach are fisheries management policymakers in executive and judicial branches of government. In addition, ongoing direct involvement of PERM faculty in standing MDNR Fisheries Division committees (e.g., setting regulations, establishing watershed management approaches, conducting resource inventories) and on MDNR stakeholder bodies (such as each Great Lake Fisheries Advisory Committee) ensures rapid dissemination of critical research through direct outreach/education with constituencies.

Other Related Activities and Units Housed at MSU

- *North Central Regional Aquaculture Center* – conducts research and outreach (primarily to aquaculture producers and product consumers) regarding the culture of various fish species, primarily for the food market and not for release into aquatic systems; some species and research/outreach projects involve Great Lakes fisheries, such as perch, salmonids, etc. See the Center web page at: http://ag.ansc.purdue.edu/aquanic/ncrac.

- *Institute for Water Research* – sponsors research and public outreach regarding watershed education in the Great Lakes region; for more information, contact: http://www.iwr.msu.edu

- *MSU Museum and Center for Great Lakes Culture* – the MSU Museum conducts the GLFT-funded project updating the MDNR Fish Hatchery interpretive and educational display materials; Center for Great Lakes Culture (spearheaded by the MSU Museum) is networking cultural resource scholars and community members to assess needs throughout the region – one particular area relates to Great Lakes maritime heritage (including fishing). See the MSU Museum web page at: http://museum.cl.msu.edu. In addition, see the Center for Great Lakes Culture web page at: http://www.greatlakes.msu.edu.

Prioritized Needs

- Sustaining Great Lakes fisheries education programs which have proven (through evaluative research) to be of value. Examples include: Project F.I.S.H., 4-H Great Lakes and Natural Resources Camp, vessel-based Great Lakes education programs such as GLEP, other Sea Grant fisheries education efforts. Often, funding support is available for the establishment of programs and formative evaluation, but then support is limited for program institutionalization.

- Responsiveness and strategic thinking (with program partners and advisory committee structures which exist through MSU Extension, Sea Grant Extension, and MDNR Fisheries staff committees and stakeholder Advisory Committees) on Great Lakes fisheries emerging topics for which education efforts are warranted.

- Continued research on education program effectiveness, for educators, and for the ultimate intended audiences.

Survey of members of the Michigan Alliance for Environmental & Outdoor (MAEOE) education.

Below are the results of a survey of MAEOE members to determine their awareness of Great Lakes ecosystem and fisheries education resources as well as their perceived needs in this area.

Results from survey on Great Lakes Ecosystem and Fisheries Education in Michigan, completed by participants at the MAEOE Conference, October 2000
Number of respondents: 38

1) Do you teach about Great Lakes fisheries and/or offer K-12 programs/curricula on this topic?
NO_____ YES_____ Please tell us briefly about what you teach -or- what you offer:

NO 76% (n=29)

- Fisheries, no – fish, yes.
- We do a pontoon boat study of Whitmore Lake, which is 4 blocks from our school

YES 24% (n=9)

- Fisheries as industry/history; being located on Lake Huron discuss the life cycle of the salmon
- Lamprey, PCB's, Changes in fish populations, Exotics
- Watershed connection to Lake Michigan as students study inland fish ecology and enjoy fishing.
- Work with scout groups and 4-H; teaching about Great Lakes fisheries and Michigan fishing heritage.
- But only very briefly and only indirectly: I teach a little about lake ecology and some of the trophic relationships. I also teach a little about lampreys.
- I am developing a "Great Lakes Invaders" program (at Cranbrook).
- Teacher training; college and high school biology; K-12 life science
- I am busy with Project G.R.E.E.N. (Global Rivers Environmental Education Network), a watershed water quality monitoring project involving high school kids, incorporating hands-on field experiences, linking this to civic action and (hopefully) increasing "ownership" by these young people for their local watershed.
- Environmental science classes (10^{th} graders): 1) Video: The Life of the Great Lakes and printed materials, 2) Field trip: fish weir trap and transfer facility in Traverse City

2) Are you aware of other K-12 Great Lakes fisheries education resources (including by not limited to curricula) that are not included on the attached list?
NO_____ YES_____ Please provide information that will help us find and learn about these resources:

NO **82% (n=31)**

YES 18% (n=7)

- "Buck Wilder's" Fishing books – contact Fish Division (DNR) in Lansing for more information
- Project FISH *(already on our list)*
- 1) GVSU: vaily@gvsu.edu Study lake ecosystem, GL ed. & research vessel incorporates GLOBE protocols on Lake Michigan; www.globe.gov 2) "Salmon in the Classroom" (contact Tom Rosich, Cadillac DNR District office)
- "Hooked on Fishing Not on Drugs" program; Ohio DNR?
- GVSU: W.D. Jackson and D. J. Angus (*vessels*)
- Sea Grant curriculum on Sea Lamprey; Should you include programs which presents information to students and the public on Great Lakes fisheries – like the Inland Seas (ship) and Grand Valley State University's ships Angus and Jackson.
- Project WET – adapted to Michigan; Aquatic Project WILD – adapted to Michigan
- Great Lakes Sea Cadet Program (serves as a research vessel (crewed). Call Luke Clyburn/Kathy Trax 248-666-9359

3) What do you feel is needed to improve Great Lakes fisheries education in Michigan?

- Materials and training through sessions at conferences, such as the MSTA (Michigan Science Teachers Association), MDSTA (Metropolitan Detroit Science Teachers Association), MAMSE (Michigan Association of Middle School Educators).
- Getting info to teachers so they can find out about curriculum related to this topic.
- Not sure
- Great awareness of materials; greater awareness of issues; greater awareness of importance of G.L.
- Education of the general public about pollution, conservation and protection.
- Many educators are reluctant to include worthwhile topics such as this into their planned curriculum unless it is part of the statewide objectives for their grade level. The lack of time to teach related topics such as this program would be, is, an ongoing source of frustration.
- Much more emphasis on exotic species mgt!
- Comprehensive overview program that can be sent to a target grade(s) statewide or regional to increase awareness.
- Awareness of the subject
- Most students do not have much information about the Great Lakes in the inner city
- Educate the educators first.

- Getting info out to teachers
- I've never really thought about it.
- The schools need to see a correlation with the Mich. Curriculum Framework
- I feel it is very important to study about fish. I am involved in our Jackson County Elf-Lake Victoria Endangered Fish.
- More direct experience with Great Lakes ecology. More emphasis on Great Lakes specific environmental education.
- 1) include it on the MEAP 2) Watershed education – understanding of a student's local lake or river connection to a Great Lake.
- For K-12 education Great Lakes fisheries programs would probably need to be linked to the MEAP and MEGOSE.
- Align with state objectives
- I'm not sure that we need to educate so much about GL fisheries – however, educating about GL fish is extremely important. Getting kids to water – streams, rivers, ponds, lakes, and the Great Lakes – wetlands – helping them get hands-on experience will get them get excited about the subject and begin to understand its significance.
- Advertisement
- Since I teach earth science, I would be interested in some information and/or activities that start with physical limnology conditions in the Great Lakes (e.g. stratification, topographic relief of sea floor, bottom sediments, currents, turn-over, etc.) – and then explain how these features are important for particular fish species.
- PR aimed at teachers and educators
- Get beyond the recreation aspects; instill an appreciation for fish; focus on curriculum.
- Have more boat based education programs
- Dissemination of resource materials
- Improve the fisheries themselves. My understanding is that all lakes have PCB contaminants.
- Working with the public school systems to incorporate envir. Ed.(Great Lakes fisheries education included) into all curricula, all grade levels.
- $, support, direct mailing lists to science educators and primarily environmental science educators like me.
- Awareness of it's possibilities related to Mich Educ Standards
- Great Lakes are a vital resource and mean many things to many people. Without education, Great Lakes are just a name – not a vital resources and critical component of North America.

4) Do you offer programs/curricula that focus on teaching youth how to fish?
NO_____ YES_____ Please tell us briefly about what you offer:

NO 74% (n=28)

- But…Paul Drummond, science coordinator for West Bloomfield public schools ran an extensive fly fishing program with K-6 kids.
- Might in the future, I do volunteer at DNR Pocket Park fishing pond, and as a naturalist explain to kids how great blue herons fish.

YES 26% (n=10)

- Informal with my kids and all their friends how to cast, id fish, fish nests
- Kindergarten fishing program (1/2 day)
- Only through Cub Scouts on a gentleman's private pond.
- In our area, the Steelheaders and other local sportsfisherman sponsor a "take a child fishing" day (for salmon and lake trout). This past summer over 40 kids went out on the lake.
- K-12 outdoor education program and residential camp. Focus on catch and release fishing in inland lake to see health of lake. We use cane poles with barbless hooks and leafworms for bait. Mostly a "fishing appreciation" activity. We deal with fish identification and anatomy of the fish we catch and release.
- Project FISH, KC4 (Kent County Collaborative Core Curriculum)
- Project FISH, school groups and Intergenerational Elderhostel, and had arranged visiting a fish hatchery on the Manistee River.
- Teacher workshops to introduce K-12 educators to Project FISH through the Higgins Lake Env. School.
- Project FISH
- Project FISH, Zepco *(check on this/sp?)*

5) Are any of these programs/curricula specific to the Great Lakes?
NO_____ YES_____ If yes, which ones:

NO 24% (n=8)

YES 18% (n=6)

- Maybe parts of KC4
- We will be combining Project FISH with the GVSU edu and research vessel on Lake Michigan incorporating GLOBE with an Intergenerational Elderhostel program.
- Sections of Project FISH
- Yes, we do teach and lead programs specific to the Great Lakes
- Project FISH?
- Adapted from…show educators how to adapt general info to MI specific
- Don't know
- The Grand River Watershed, which feeds into Lake Michigan

N/A 58% (n=19)

6) Are you aware of any programs/curricula designed to teach youth how to fish that are specific to the Great Lakes?

NO 78% (n=25)

- Not beyond those you have found.
- Not exclusively

YES 22% (n=7)

- Kensington Metro Park – day fishing program during summer sessions (I did an internship at the Nature Center this past summer)
- MI DNR Program – youth angler program
- There is a program focused on sea lampreys but I don't know specifically what it is right now. I will send you the info if I remember.
- Yes, in the Leelanau/Grand Traverse region, we have a wealth of programs.

7) Any other comments related to K-12 Great Lakes fish education, or about teaching youth how to fish?

- Make and use correlations with Michigan Standards and Benchmarks. Teachers can use these to justify cost of workshops/attendance at workshops to administrators. (Administrators have to give approval for teachers to attend.) Teachers can be sure to accomplish benchmarks using fish ed materials, or through teaching youth how to fish.
- JASON Project several years ago focused on the Great Lakes. Detroit Edison – Zebra Mussel Project/Fish Counts. DetKids.com – interactive web site for kids, might have info about fish/zebra mussels. Traverse Bay – Malabar (*vessel*) limnology studies.
- Department of Natural Resources (in Lansing) Fisheries Division Office: 1) Free Fishing Weekend, 2) Detroit and Escanaba have "Pocket Parks" that contain fishing ponds, on-site instruction (i.e. technique) is provided. Fishing opportunities are available at the Pocket Parks located at the Fair Grounds.
- A focus on Great Lakes fish in the classroom is important for our students. More important than a focus on other systems, i.e. rainforest. <u>Local</u> focus.
- I don't think that there is much going on out there.
- Very important topic.
- The environmental approach of stewardship as related to fishing is an important issue.
- I have not had the opportunities to learn about the ecosystem of the Great Lakes.
- Sorry I couldn't have been of more help – or maybe I was with all the "no's"!
- We have wrestled with the environmental ethic of catch and release fishing. Especially when we find we are catching fish with "perforated lips" due to being caught repeatedly. Our program seems to be more students feeding worms to fish and the small fish getting lots of feed.
- Sorry, my facility and programs do not lend themselves to fishery education.
- We have a place at Au Gres with fishing boat and I am very interested in Lake Huron and fishing. I teach at Hanover-Horton – southwest of Jackson.

- I'm not sure where this fits in but in one of my classes at CMU I introduce my college students to (who will be both formal and non-formal educators) to fishing in general and also concentrate on Great Lakes fish species, rules and regulations.
- Kids need to know about fish advisories and how our lakes became contaminated with PCB's and mercury.
- Show educators how to adapt general info to Michigan specific.
- I would be interested in learning more about curriculum for young elementary students, but have not information to share with you unfortunately.
- No, just teaching about watershed fisheries and how to take action on issues deemed important.
- The high school classroom is limited to very few field trips that require transportation. Therefore, reality steers us to multimedia, especially via the ever increasing web sites on the internet. The conclusion can not avoid the significance of using technology to bring curriculum to our students. Please visit my website at www.myschoolonline.com. This is a fabulous free source via the Learning Network, and several educational groups. Select site (state), Traverse City Central H.S., Env Science/Chem with Mr. J Homepage.
- I'm interested in teaching it to my students.