

**GREAT LAKES FISHERIES EDUCATION ASSESSMENT
AND
SUMMARY OF NEEDS**

Prepared for:

Great Lakes Fishery Trust

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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 1996 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 1996 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
<u>Reason to protect estuaries</u>	76.3	58.0
<u>Fish endangered by loss by spawning areas</u>	60.4	69.2
<u>Marshes disappearing by filling in for construction</u>	42.1	67.8
<u>Why sea lampreys were a problem in the lakes</u>	52.5	61.5
<u>Fish advisory in Lake Erie on carp</u>	67.2	43.2
<u>Fish cooking to reduce contaminants</u>	44.2	76.9
<u>Human exposure to hazardous chemicals through fish</u>	36.6	60.0
<u>Importance of Lake Erie in food fish production</u>	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
<u>Economic value of fishery</u>	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).

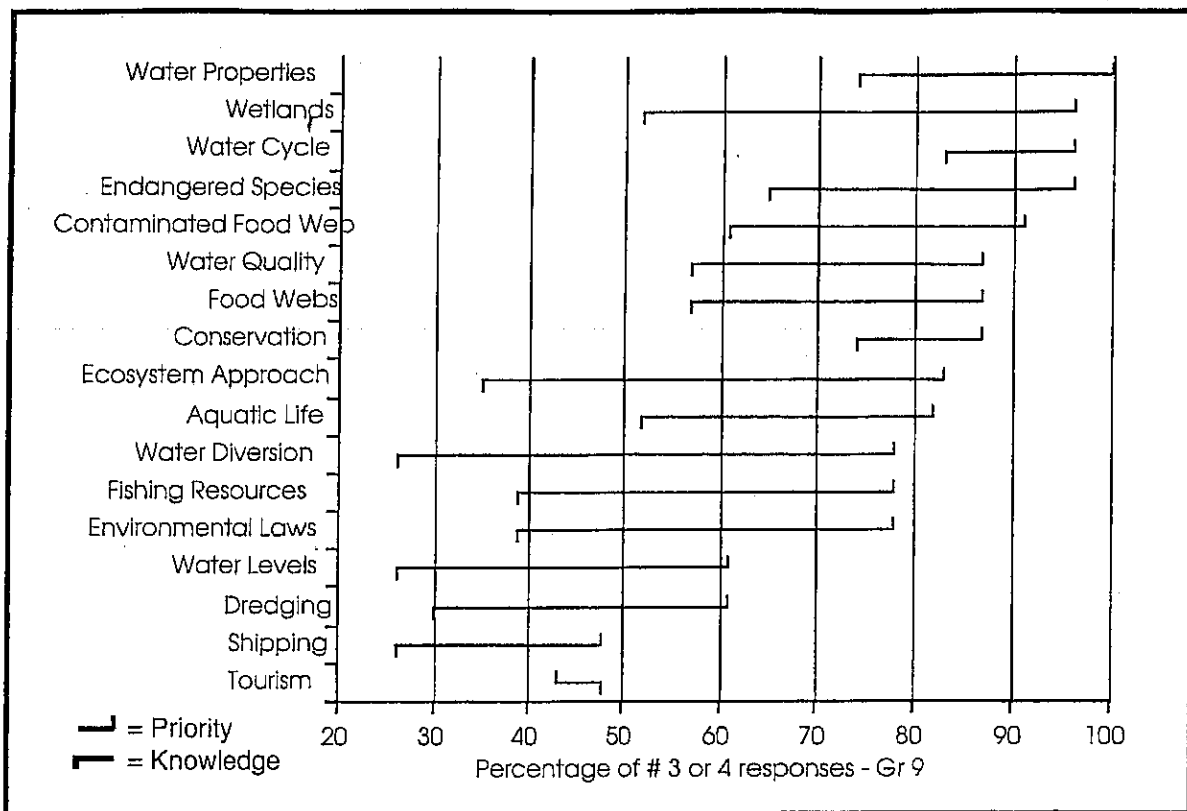


Figure 1. Discrepancies between Minnesota science teachers' knowledge and priority for teaching certain Great Lakes and fresh water topics (from Fortner and Meyer, 2000)

- 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

page 38 missing from original

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 claekei 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 ...	25
Not eat the fish	15
Not change behavior	14
Eat fewer fish	9
Stop fishing	
Full-disclosure advisory and favorite site not monitored	68
Continue to fish at favorite site	54
Select new sites from known safe sites	17
Fish only at safe sites	16
Stopped eating fish from favorite site	

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.

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