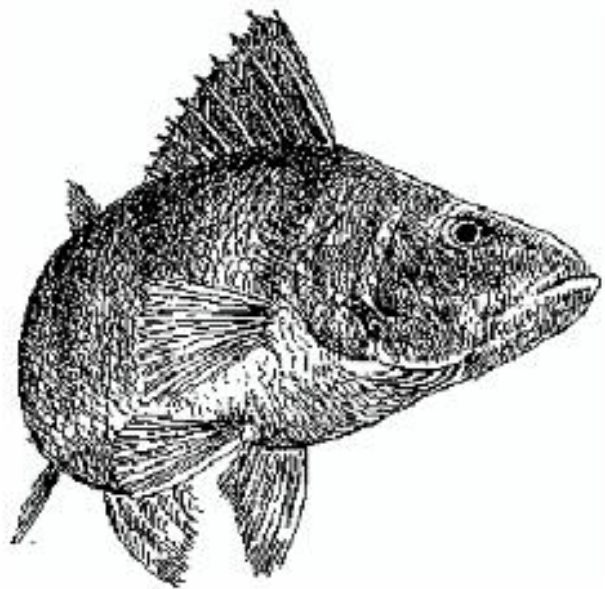`

Human Dimensions Research Needs for Great Lakes Fishery Management

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HUMAN DIMENSIONS RESEARCH UNIT PUBLICATION SERIES

This publication is one of a series of reports resulting from investigations dealing with public issues in environmental and natural resources management. The Human Dimensions Research Unit (HDRU) in the Department of Natural Resources at Cornell University studies the social and economic aspects of natural resources and the environment and the application of social and economic insights in management planning and policy. A list of HDRU publications may be obtained by writing to the Human Dimensions Research Unit, Department of Natural Resources, Bruckner Hall, Cornell University, Ithaca, NY 14853, or by accessing our World Wide Web site at: http://www.dnr.cornell.edu/hdru.

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EXECUTIVE SUMMARY

Background: In 2002, the Great Lakes Fishery Commission (GLFC) developed a Human Dimensions of Great Lakes Fishery Management research theme to guide social science research for the Great Lakes and to help integrate human dimension aspects into decision making (Dobson, Riley et al. 2005). The theme was established for a ten-year period and contained several broad research questions related to three primary areas of inquiry: (1) the use of human dimensions information in natural resource decision making; (2) communication between managers and stakeholders and among managers; and (3) governance and institutional arrangements. During the ten year course of the theme, the GLFC funded seven related research projects ranging from the general use of human dimensions information in Great Lakes fishery management to better understanding how fishery managers responded to specific management threats, like the fish virus VHS.

Our study updates this foundational human dimensions (HD) research theme. We developed this updated theme based on a review of the literature and the direct input of fishery managers and practitioners, with the intent of increasing the integration of HD data into management. The theme will provide more specific guidance for future research than the previous theme and is intended to attract research proposals that are more closely tied to management objectives and information needs. The new theme also aims to encourage more integrative research proposals, based on the complex interactions between social and ecological components of the fishery system in the Great Lakes.

Methods: First, we compiled a literature review about the value and use of HD information in fishery management. We did not limit this review to studies of the Great Lakes; rather, we synthesized information from diverse locations and subjects. The literature provided an overview of the contribution that social science can make to fishery management, indicated some of the challenges in integrating such data, and provided insights into gaps in current knowledge and associated research needs in multiple areas such as fishery governance, economics, community connection to fisheries, and stakeholder attitudes, perceptions, and beliefs. We also conducted 42 face-to-face and two phone interviews with US and Canadian fishery managers, supervisors, and biologists at different governmental levels, and Sea Grant staff to elicit their perceptions of the value of human dimensions information for fisheries in the Great Lakes, their experience in integrating such data, and perceived human dimension information needs from their point of view. We combined research gaps on human dimensions in fisheries cited in the literature with information needs identified by Great Lakes fishery practitioners to ensure that future research not only satisfies information needs of managers and decision makers but also advances scientific knowledge.

Findings and Recommendations

The role of human dimensions in Great Lakes fishery management: Fishery managers and other fishery practitioners valued diverse social aspects of fishery management and identified a range of desired human dimensions management outcomes, even if those outcomes are not explicit in current management goals. We also found that most important management issues were not ecologically based but social and governance related, indicating that the human dimension aspects of Great Lakes fisheries are currently not effectively managed. Managers struggled with

a declining number of users, stakeholder conflicts, and the difficulty of understanding and responding to user values, perceptions, and demands. Governance-related challenges included a decline in available funding for fishery management (caused by decreasing fishing license sales, among other things), inadequate attention to public awareness and education, and low stakeholder engagement. Management-related challenges included multiple drivers that affect fishery management in the basin, such as demographic changes in terms of age, ethnicity, urbanization, economic trends (e.g., local, regional, and/or national recessions or price increases), and interest in and attitudes toward recreational fishing. These findings strongly reflect the need to better understand the human dimensions of fisheries, how they are tied to characteristics of the resource, and underlying drivers of change to improve current management and increase adaptability of fishery management to future changes.

The utility of HD research: Managers and other fishery practitioners were fairly aware of HD data: some have collected or analyzed such data themselves or know about colleagues or others who have done so. Managers and practitioners were also able to identify opportunities to apply HD data to multiple management stages including planning, decision making, evaluation, justification of management decisions, and resource allocations. Practitioners are aware of the potential contribution and value that HD data can provide for fishery management. The actual application of HD data, however, seems to fall short of this potential, based on several factors. Most prominent barriers stem from within agencies such as insufficient staff experience with HD, concerns about the quality of data, and difficulties of integrating different sets of data. Managers also often did not seem to understand the value or applicability of findings in some previous studies on HD in fisheries that were not based directly on their information needs. In fact, the main criterion for "good research" seems to be the usefulness of the information to managers, not so much the advancement of scientific knowledge.

Managers suggested better collaboration with social scientists to foster and demonstrate academic rigor of studies and thereby to increase credibility of findings to fishery managers and encourage the subsequent integration of findings of human dimensions studies into fishery management. This point might be important in particular for qualitative research, since most natural scientists are not familiar with this kind of data and seem to trust quantitative data more. Also cited was the need to increase fishery managers' familiarity with HD aspects in fisheries, to expose them to methodological approaches to investigate human dimensions, and to provide examples for the application of HD research findings. Interdisciplinary research might facilitate the integration of different kinds of data. Teams consisting of fishery managers or practitioners, natural scientists, and HD experts might enhance relevance and applicability of HD information. On a management and decision-making level, the question about the timing of the use of data seems critical. Managers pointed out that HD information should be collected and included right from the start and not as an "appendage at the end" to increase the chances that a fishery management decision will be sound and accepted. In the end, the application of HD information will not only depend on the supply of HD data and tools for more transparent decision making, but even more so on the willingness of managers and fishery supervisors to apply HD data.

Recommendations for future GLFC HD research: We identified seven topic areas for the upcoming HD research theme covering economic, social, and governance aspects of Great Lakes fisheries: (1) Economic value of fisheries; (2) Values, expectations, and beliefs related to fisheries; (3) Fishing patterns; (4) Traditional and local ecological knowledge; (5) Stakeholder

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engagement; (6) New funding models for fisheries; and (7) Evaluation of management effectiveness. Research in these theme areas will provide information for planning and decision making (including policy development) and help to better demonstrate the value of fisheries in the political arena and thereby to attract funding and to address pressing management issues.

We also found that actual HD information needs cited by managers and practitioners, for the most part, seemed to overlap with information gaps cited in the literature. Future research thus should be able to supply relevant information to managers while at the same time advancing scientific knowledge.

The question of when to include HD information in management planning seemed quite pertinent to participants in this study. Information on user patterns, values, expectations, attitudes, and local knowledge, for example, were perceived as essential for solid planning and decision making and should be included right from the beginning of a planning process. Economic studies seemed to be primarily important to demonstrate the direct and indirect contribution of fisheries to Great Lakes economies at the local, state, or regional level. With solid economic information, managers believed they could increase political support and funding for fishery management. Research into governance is needed throughout the management process. Examples included the need to know how to better include vocal and no-vocal stakeholders input into planning and decision-making processes and how to acknowledge stakeholder opinions more effectively. A related point was interest in understanding the basic level of knowledge about the Great Lakes so that managers can address knowledge gaps and misperceptions about Great Lake fisheries. Participants also considered important the assessment of management effectiveness. So far, monitoring and evaluation is focused on ecological indicators. The regular assessment of social, economic, and governance indicators seems to be missing.

Another significant finding is the interest of managers and practitioners in better understanding the underlying factors that influence these topic areas so that they may predict change and develop adaptation strategies. Future research, thus, should take into account the multiple dynamics that are constantly influencing and changing HD dimensions in fishery management.

Participants also identified multiple links between the identified theme areas. Yet, if research proposals are to be to integrative and connect too many topic areas, a risk exists that they will become too big to be practical or fundable. Another point is that a HD theme that is too narrow might not attract funding proposals; one that is too broad might not attract research in all identified information needs areas. We therefore suggest that the commission puts particular attention on an area of research every year, economic, social, and governance, to ensure that all identified HD priority theme areas are covered during the duration of this HD research theme.

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INTRODUCTION

Human dimensions (HD)-related issues play a central role in Great Lakes fisheries in terms of fishery values, desired management outcomes, and management challenges. Recognizing the need to better incorporate the human dimension into Great Lakes fishery management, the Great Lakes Fishery Commission (GLFC), in 2002, developed a "Human Dimensions of Great Lakes Fishery Management" research theme (Dobson, Riley, and Gaden 2005). The theme aimed to help researchers develop social science-based projects aimed at improving fishery management. Under the theme, the GLFC funded eight HD research projects ranging from the general use of human dimensions information in Great Lakes fishery management to better understanding how managers responded to specific threats like the fish virus VHS.

The 2002 HD theme, though useful, was developed without substantive input from fishery managers which, the GLFC concluded, potentially reduced the relevance of the research to practitioners. In response, we present a revised HD theme that was informed through semi-structured interviews with active fishery managers, biologists, and other experts (hereafter referred to as "research participants") to understand from the practitioners themselves the intersection of social science and fishery management. The authors also conducted an extensive review of HD-related literature, recognizing the need to integrate a broad understanding of HD with the sentiments of the Great Lakes fishery management community.

The updated HD theme is intended to attract research proposals that improve fishery management and are grounded in rigorous social science theory and methods. This paper offers conclusions distilled from a larger piece of work (Heck et al 2014). This theme will be considered a success to the degree that it:

1. Attracts quality social science proposals directed at informing Great Lakes fishery policy and management.

2. Generates knowledge that is directly applicable to and used in management decision-making.

3. Helps identify, understand, and predict effects of major social and economic changes on Great Lakes fishery policy and management.

4. Develops and maintains an epistemic community of HD researchers that contributes to the theme and Great Lakes fishery management.

METHODS

We elicited fishery managers' views and information needs regarding the integration of human dimensions information into Great Lakes fisheries via semi-structured interviews. We also conducted an extensive literature review to identify research gaps in human dimensions aspects in fisheries. The literature review should help to ensure that future research not only satisfies information needs of managers and decision makers but also advances scientific knowledge (Holmes and Lock 2010).

This research is primarily qualitative and inductive, designed to construct from the participants themselves an understanding of the intersection of social sciences and fishery management. We followed a "grounded theory approach" where the research creates new categories, hypotheses, and theories based on collected data and the literature (Glaser and Strauss 1967). The emerging theory is, in essence, "grounded" in the data—that is, the theory emerges through data analysis. It is a method of conceptualizing data—in this case, better understanding the participants' sentiments about the application of human dimensions information in Great Lakes fishery management.

Literature Review

We compiled a literature review on human dimensions of fishery management in general and the Great Lakes region in particular We encountered a wide range of literature involving governance, the fishery management process, public participation, the use of science, economics (e.g., expenditures and willingness-to-pay), community connection to fisheries, and stakeholder attitudes, perceptions, and beliefs.

Semi-Structured Interviews

We conducted 42 face-to-face and 2 telephone interviews with US and Canadian managers, fishery supervisors, biologists at different governmental levels, and Sea Grant staff members (Table 1).

Participants were selected based on information provided by the GLFC. We interviewed each lake committee member (representing the entire pool of senior fishery managers on the Great Lakes), several technical committee members, senior fishery supervisors (defined as senior officials who do not sit on the lake committees), and Sea Grant staff members that are involved in the fishery management process.

Table 1 Participants based on institution and job position

Country	Institution	Job position	
Canada	Federal	Biologist	2
	OMNR	Biologist	2
		Senior fishery supervisor	1
		Manager	4
USA	Federal	Biologist	3
		Senior fishery supervisor	2
	Tribal	Biologist	1
		Manager	1
	State	Biologist	6
		Manager	17
	Sea Grant	Director	4
Bi-national		Senior fishery supervisor/director	1

As information needs of decision makers and others are usually context sensitive (Pollnac et al. 2001; Cinner and Pollnac 2004; McClanahan, Marnane, et al. 2006; McClanahan, Verheij, et al. 2006; Jacobs 2003), we first gathered information about how practitioners view the Great Lakes management setting. We then explored the experience of fishery practitioners with social science data including perceived benefits and challenges to applying social science to fishery management, and managers' perceptions of information needs that should be addressed in future research. HD-related topics included fishery management values, goals, definitions of success, and perceived challenges.

Focus Groups

We grounded our findings through two focus group meetings with fishery managers and supervisors that included some people interviewed: essentially, this phase sought to confirm whether our interpretations of the manager interviews were valid and useful. Both groups consisted of seven participants and one additional participant that joined by telephone. Both groups lasted 90 minutes. Questions for the group included feedback on the content and number of potential HD topic areas and associated research. We also encouraged discussion about underlying general principles for future research proposals and how to increase the applicability of future research projects to fishery management.

Analysis

Content Analysis of Interviews

With the consent of participants, interviews were audio recorded and transcribed. We analyzed the transcripts using Atlas.ti. The interview data were coded through an on-going process whereby we first engaged in 'pattern coding' to identify broad themes, contexts, and relationships; then "open coding" to sort sentiments in greater detail, line by line; and finally 'cluster coding' to take the detailed codes and reconstitute them into more general themes that emerged through the open coding process. In addition, we analyzed frequencies for individual codes using the statistical software package SPSS. Results are primarily presented in the form of interview excerpts, which were selected to provide evidence of the essence of a point and/or the range of perspectives with regard to various topics.

Assessing Research Quality

Given the interview results are based on small, purposefully selected samples, we acknowledged issues of reliability and validity and strived to increase both. Reliability means consistency or repeatability of findings (Carmines and Zeller 1979). Results based on qualitative, interpretive research depend on the subjective coding of interviews, and categorizations and conclusions are in turn generally influenced by the researcher's perspective. We sought to improve reliability by transcribing the interviews verbatim (allowing us to return to them later if need be), and coding them systematically following established protocols.

Validity refers to accuracy of quantitative data and asks whether the researcher is really measuring what he/she sets out to measure (Kaplan 1964; King et al. 1994). A major point of this research was to gauge the sentiments of the primary participants in the Great Lakes fishery management process. While the data analysis (through coding, primarily) was a subjective

process, all lake committee members were interviewed; no member was excluded from the interview pool and no member declined to be interviewed. Other participants (biologists, Sea Grant officials, senior fishery supervisors) were also interviewed, though in smaller numbers. Participants were selected based on expert advice from the Great Lakes Fishery.

RESULTS AND DISCUSSION

Fishery Management Goals and Values

We investigated current fishery management goals and assessed managers' and practitioners' views about fundamental fishery values, perceived management challenges, and definitions of success. Results are based on all respondents irrespective of their profession. However, if there were obvious differences among the groups, we indicated it in the text.

Great Lakes fishery management emphasizes three primary goals: providing recreational fishing opportunities, maintaining native species, and the overall sustainability of fish resources. Other goals such as habitat protection, controlling invasive species, and maintaining commercial fisheries were less often mentioned. Biologists had a narrower view than managers, emphasizing the control of invasive species and sustainable fish resources as predominant goals.

Some management goals seem in direct conflict. Whereas native species are primarily restored for ecological purposes, including potentially higher adaptation capacity to ecosystem change, non-native stocked species (i.e. Pacific salmon) are important for recreational fishing and economies.

Participants also attach a range of social values to Great Lakes fisheries. Most frequently mentioned among all groups were recreational and commercial fishing, economic benefits, and fishery culture and heritage in the Great Lakes region. Sea Grant participants in particular mentioned non-consumptive values such as recreation, future enjoyment, aesthetics, and opportunities for research.

Recreational fishing is highly valued due to the uniqueness of the fishery and the setting, as a relaxing activity, a way to continue family tradition, and an opportunity to socialize with family and friends. Commercial fisheries, in contrast, were referred to primarily in an economic and cultural sense. In the U.S., where sport fisheries dominate, the commercial industry is seen as part of local culture as "*fishing licenses have been passed down from generation to generation*" and commercial fisheries are "*very well supported by the communities even though it's not a big industry.*" Irrespective of the type of fishery, both recreational and commercial fisheries are perceived as an important means to maintain function of the Great Lakes ecosystem, thus emphasizing the relationship between ecological and human fishery management aspects.

> *Recreational and commercial fisheries … are extremely important to the economy, but also in the sense of the ecology of the system, trying to keep the system working and functional.*

Participants recognized the diverse economic values of fisheries; they emphasized how local communities around the lakes gain from recreational and commercial fishing, how fishermen

derive benefits, how local business and restaurants profit, how the fishery produces local employment opportunities, and how the fishery creates income for state and provincial economies.

Also mentioned were social values such as recreation, aesthetics (e.g. seeing fishing boats and harbors), research opportunities, and the existence of subsistence and tribal fisheries. Participants rarely mentioned these values explicitly as management goals.

Fishery Management Challenges

Our investigation revealed that most management challenges are human issue-based challenges. While invasive species and funding were major management challenges to all groups, managers additionally struggled to fulfill user demand while maintaining fish resources, to address conflicts among users, and to deal with a decline in users.

The decline in users is a critical challenge for fishery agencies, as this trend could mean lower budgets for agencies that depend on license sales for operational funds. Participants suggested that this decline was driven by urbanization, migration, an aging population, decreased interest in outdoor activities generally, and more competition with other activities. Further mentioned were perceptions among people that fishing requires a lot of expertise and involves "*special equipment, special concern for weather*" or that "*fishing is expensive and requires a large boat with a pot of specialized equipment, which seems to limit people from entry into that fishery*". Participants also pointed out economic factors, such as an increase in fuel costs, might contribute to the decline in fishing.

Insufficient agency funding was in fact seen as a major challenge to implementing programs and maintaining hatcheries, collaborating with other agencies, engaging with stakeholders, and enforcing regulations. In addition to declining license sales, participants cited multiple reasons for funding cuts including state and federal budget restrictions and a weak economy. Canadian respondents mentioned that they receive, together with the Ministry of the Environment, "*less than one percent of the provincial budget*". Due to hard economic times and fiscal constraints, participants worried that government priorities shift towards "*the economy, health, and education*" and that "*the environment has become relatively low priority these days*". US respondents pointed out that the current funding system, which is often based on income from license sales, is "*archaic*", especially since the number of license sales is continuously decreasing. This system leaves agencies vulnerable to such changes, and is widely seen as not sustainable.

The struggle to balance the needs of recreational, tribal, and commercial fishers while sustaining fishery resources is inherent to fishery management. Difficulties arise, for example, over conflicts between the high demand by anglers for introduced Pacific salmonids and managers aim to restore native, self-sustaining fisheries. Catch limits are often opposed by anglers and might reduce participation in fishing. The problem of balancing user demand and ecological realities seems to be easier for commercial fisheries, which were seen as more adaptable to "*just catch more of the underutilized species*" if necessary, even if they might forego some economic return.

Another frequently mentioned challenge was user conflicts, such as

- Clashes between recreational and commercial fishermen, or even members within each group, over types of fish to be emphasized, harvest quotas, appropriate methods/techniques, and physical space (e.g., "*a net is in the way of a boat that wants to troll a lure*"),

- Disagreement about allocations as "*there can be perceptions on either side that the other group is getting more than they should*",

- Conflicts between non-aboriginal and aboriginal fishers about harvest levels,

- Conflicts between fishers and non-fishers, such as when "*non-fishermen might want to see continued great water clarity and no inputs in the system and then you look at how that might affect fisheries negatively*", and

- Disagreements among disparate state and federal agency priorities, such as about the restoration of native species (e.g., "[*The] federal government wants to see the natural restoration... Hey, if Alewives go way down, that's great from maybe their perspective*"), and internationally between American and Canadian agencies (e.g., the stronger focus on commercial fishing in Canada and recreational fishing in the US).

The Application of HD Information to Fishery Management in the Great Lakes

This section explores the perceived potential of HD information to fishery management, previous experience in applying HD data, previous challenges to integrate HD information into fishery management, and suggestions to enable the integration of HD information to Great Lakes fisheries in the future.

The Value of HD Information to Fishery Management

Most participants were able to point out multiple areas where HD information could make a valuable contribution to fishery management.

Some respondents, for example, believed that ecological science has limitations, is often imperfect, and should be integrated with local ecological knowledge to achieve more in-depth understanding. These respondents mentioned that quantitative data provide only one side of the picture and can be misleading, which makes it important to complement such data with qualitative, anecdotal information.

> *We had our creel data which was the quantitative stuff, but getting those anecdotal reports really drove home the fact that it looks like there is a problem with the population of bass on the south shore. We need to ...not just look at data, because that can be misleading at times if [you] don't have more pieces of the puzzle.*

Stakeholders' expectations, concerns, and values were cited as important input to the planning process to allow managers to "*be in touch with people, so we know what their concerns and*

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issues are", to know "*what people really want*" in order to use resources (financial and other) efficiently, and to understand and address potential or actual user conflicts. One manager summarized the crux of these sentiments well:

> *If we're spending a lot of money developing a great fishery for channel catfish in the Great Lakes, but nobody is fishing for them, then that is money we are wasting.*

Stakeholder values and expectations were also seen as important to help develop goals and objectives. Respondents, however, disagreed about the appropriate weight of stakeholders' input. Some participants think stakeholders' input should be used to set broader goals and objectives e.g. "*help us define our management goals*" or "*to help us set fish population objectives and harvest objectives*" but to "*let us worry about the tactics and the details, that's our job.*" Other participants would use stakeholders' input for specific management actions like "*a regulation, maybe the season closure is not long enough, [but] nothing as high up as changing a goal or objective*".

Participants mentioned that social science also helps to identify the current level of public understanding and awareness of fisheries and its management. This information is useful to identify and address potential misconceptions about the Great Lakes ecosystem and fisheries, to tailor information to certain audiences, and to prevent unrealistic expectations by anglers and commercial fishermen that cannot be fulfilled by the ecosystem in the Great Lakes.

Participants reported that social science surveys and fishermen comments provide valuable input for decisions on stocking, allocation, size and bag limits. Although this might be an exception rather than the rule, such information might sometimes strongly influence decisions about harvest allocation for example as indicated in the comment below:

> *The commercial fishermen were able to persuade the managers that they needed more harvest. And . . . those data were not the results of a socioeconomic survey, those were the commercial fishermen going forward and saying socioeconomically, this is the impact on us.*

Some participants expressed concern, however, about the added volume of information that social science data brings into the decision-making process, as "*human dimensions isn't going to replace any of the other [information], it's going to augment [it]*". Some managers thought decision making should aim to satisfy user expectations: "*our job is to ensure that we are managing it in the way that the citizens want it to be managed*" (state manager). Other managers cautiously pointed out the need to weigh user expectations against ecological realities. In this case, discussions were seen as more valuable to make users feel more engaged in the process, potentially increasing their acceptance of the ultimate decision, even if their particular outcomes were not met.

Social science information is not always used proactively. Economic information, in particular, was mentioned as critical to defend decisions (e.g., about agency spending) to politicians and senior decision makers. Also mentioned was the need to demonstrate the economic value of the fishery to local communities. Said one respondent:

We are constantly being faced with . . . justifying . . . the value of the fishery [. . . and] the jobs associated with the fishery . . . [so we can] put it on a footing–an economic footing–[and help politicians] if they are going to make a tough decision.

We very often… need to justify how we spend our resources. If [our Great Lake] is the third most fished water in [our state] you can also rank how resources are distributed in relation to how people are fishing. It's useful in that respect.

Social information, such as user values, can also be used to demonstrate the value of fisheries to decision makers by showing public interest in fishing.

Surveys tell us very clearly and in a quantified manner what our public wants and how diverse the public [opinions]are. And we've been able to take those surveys to the legislature … and say 'look we know our public now because we are investing in these surveys and this is what these surveys are telling us.' They've been hugely valuable to our divisions. They've really saved us politically on many issues.

Although these sentiments do not reveal the extent to which - and precisely how - managers use angler attitudes to justify or override their own opinions, they do suggest that managers understand the link between legislative pressures and stakeholder goals and, thus, use such knowledge to make management decisions more defensible.

Managers Experience with HD Information

A number of managers and supervisors were aware of HD data collection in the past, sometimes within their own agency. This information included economic studies, data on user patterns, expectations and concerns, user and public knowledge and understanding about fisheries, local ecological knowledge, and users' views on current management performance.

Previously collected HD information, however, seems to have been gathered infrequently and in an ad-hoc manner. User concerns, for example, were often received informally through comments by users or by "*sitting face to face in a bar*", informal talks, phone calls, and letters to managers. One could question if this counts as valuable and reliable HD information since it provides only individual or anecdotal insights to management. Workshops and round tables provided more systematic means to elicit user expectations and concerns. They were seen as valuable venues to hear different groups' voices at the same time, and to have two-way discussions, thereby making the management process more transparent. Harvest allocation expectations were discussed more frequently in direct negotiations among tribal fishers, non-tribal commercial fishers, and anglers. Information on user patterns was mainly based on catch rates collected in annual creel surveys, which are admittedly somewhat ad hoc in their protocols. Some additional information that has been collected infrequently included angler profiles and demographics, motivation to engage in fishing, and angler satisfaction.

Managers, for example, have elicited anglers' expectations about the fishing experience, desired fish species, and preferred regulations. Managers have also collected some HD information on expectations for management objectives. Information on user concerns included concerns about rules and regulations (e.g., catch quotas, proposed regulation change, gear regulations), concerns about impacts of regulations on fishers' livelihoods, concerns about management approaches

(e.g., physical barriers such as dams that affect fish populations), and concerns about external factors affecting fishing participation (e.g., fuel price).

Respondents have also collected user perceptions of about fishery management issues, such as invasive species. Canadian participants in particular mentioned local and traditional ecological knowledge, which involves understanding of the resource through daily interaction with the fishery (e.g., commercial fishers) and familiarity with a particular location (e.g., anglers' knowledge about a specific watershed) as they are "*out there on the water every day*" and thus might know firsthand "*what the fishery is like*" and "*what the ecosystem is doing*".

Participants also mentioned data collection focusing on direct and indirect economic benefits from recreational and commercial fisheries. Examples included anglers' expenditures; income to local businesses from expenditures on fishing gear and other equipment; gas, food, and lodging; and economic valuations of the local bait industry, which was calculated to be "*a multi-million dollar industry*". In addition, there was an interest in economic studies on economic sectors that are related to fisheries such as the shipping industry and the economic impacts of invasive species that are affecting Great Lakes fisheries (e.g., "*we need sea lamprey control, it costs $20 million but the $7 billion fishery would not exist in the absence of sea lamprey control…*").

Only one participant mentioned the economics of non-market values. The respondent mentioned the collection of information by Fisheries and Oceans Canada on "*how much would [the public] basically be willing to pay to support the recovery of species at risk*". Overall, it seems that HD information was usually collected infrequently and not systematically across the basin or even a whole lake. The information might therefore provide only limited insights for management, which could be one of the reasons why data is often collected but not actually applied to management.

The application of HD information to fishery management is sometimes lacking

Despite the awareness of the potential contribution of HD information to fishery management and the collection of previous HD data, the actual application of such information to fishery management seems limited. Few managers mentioned that they actually used HD information to help make decisions. The most common challenges relate to the attitudes of management staff, perceived data quality and relevance, and difficulties to integrate HD information with ecological and biological information.

Management staff and resources

Even though most managers were aware of the need to understand HD of fisheries in order to address current fishery management challenges, multiple challenges to actually integrate HD information into fishery management were mentioned. A key barrier to integrate HD information into fishery management related to the expertise of management staff. Most fishery managers and staff in our study were trained ecologists or biologists with little expertise in social science basics or their applicability to fishery management. A lack of training in social science methods lead to negative perceptions and beliefs about the quality and applicability of social science information:

I think one of the biggest challenges that I've seen so far is internal staff. The internal staff that are trained, that went to school ...20 years ago ... didn't have any social science classes. They're trained in the biological sciences...they have botany and zoology--but they didn't take any social science classes ... We're all kind of learning this at the same time. That's probably the biggest challenge that I see right now.

You just don't understand how the information was collected and you don't necessarily see the value always in the way that other people do things.

A lower perceived value of HD information compared to natural science information also means that the collection of HD information is cut in times of limited human and financial resources:

Under tough economic budget times we tend to get back to just core data that we need, typically the biological data ... We know that social data is important, and we try to get there at some point, but I feel like every time we try to take a step in that direction we take a step back when budgets become bad.

Data Quality, Applicability, and Integration

Participants were sometimes skeptical about the quality of some forms of social science data, particularly the representativeness of qualitative data

I think the biggest challenge that I see in using that [qualitative] type of information is that you typically get a non-representative sample of the angling public. ... Typically you're going to get people who are most passionate about the resource who typically are the ones advocating strongly anyway.

Managers also point out that data can be biased, or driven by a personal agenda and that "*you can tailor the socioeconomic data to reach the conclusion that you want.*" Again, this point reflects an inherent distrust towards social science data among some participants, which seems to challenge the integration of HD information into fishery management despite a recognized need to integrate social and natural science information.

Sometimes you have to take their information with a grain of salt because they may say that the fish are much smaller than they were and our data says they're not. It is what it is, so we listen to it and try to make sense of it. ... Another good example would be that perhaps the walleye fishery may be down in a specific area and the anglers will immediately assume that the tribal fishing took all the fish. So they might make accusations against another group that are untrue.

Another major challenge was the integration of different sources of data into decision making. Previous attempts to incorporate social science and natural science information were challenges and often failed due to a lack of skills on how to actually integrate and weight different types of data in the decision-making process.

I think in many cases [managers] don't know how to use the data and how to incorporate that into a management decision. And I would hope that the fisheries manager would be making the decision primarily on 'this is what the resource can produce so here is the

harvest' and then the socioeconomic decision data would come in on how they can best harvest, how they can best use that harvest.

Suggestions to Facilitate Integration of HD Information into Great Lakes Fishery Management

Based on the above challenges, respondents identified multiple criteria that would improve the use of HD information in fishery management in the future.

Expertise in Social Sciences

Participants emphasized the need to engage social scientists within or outside agencies for data collection and analysis. Ideally these people should have both social training and an understanding of biology or, even better, "*have a good solid fisheries background*". Added a manager:

> *You either hire the staff internally to have social scientists on staff, or you have them available at some place … where we can contract with them and get it done.*

Some respondents would prefer the involvement of scientists that are not part of any management agency, since they perceive them to be more "*neutral on the topic*" compared to staff within agencies. Involving experts that are not part of management agencies was also seen as a way to increase the credibility of results. Another suggestion was a peer-review process to ensure that data is credible and "*removed from the politics*". Such an approach "*takes us [the agency] out of the equation… and any biases that they feel we might have towards the data that is removed when we have an independent person provide that analysis.*"

Participants suggested interdisciplinary teams that consist of "*credible fisheries researchers and credible social scientists*". Such an approach should improve the integration of different kinds of data and ensure that fishery research becomes more holistic.

Participants also mentioned that fishery scientists still have difficultly judging the quality and applicability of HD research. This in turn, diminishes trust in and value of HD findings. More exposure of fishery scientists to the rigors of social science should deepen the perceived value and applicability of such information. Understanding the application of HD research findings is particularly crucial since managers thought that the applicability to management is the most important criterion by which to judge HD research.

Demonstrate and Communicate Academic Rigor

Participants believed that natural and social science should adhere to the same high standards of academic rigor. Based on their training in ecological and biological sciences, participants equaled academic rigor with reliability, repeatability, and quantitative approaches. No participant seemed to be aware of other standards of academic rigor that are common in the social sciences especially when dealing with qualitative data collection and analysis.

Fishery professionals subsequently prefer quantitative data over qualitative information: "*everybody trusts quantitative information a little more*". Quantitative data is seen as more "*scientific*" rather than just "*yeah they liked it*" and is perceived as "*always easier to defend*". This preference seemed to be, to some extent, based on the fact that biologists and ecologists are used to working with numbers and might seek data that is more familiar to them:

> *We tend to lean towards quantitative [data] for obvious reasons; it is what we do and we try to base things on [natural] science . . . I think you would agree, it is far better to have something that is controlled, repeatable, and quantifiable rather than going to a meeting and recording some opinions on a flip chart and summarizing what people said.*

Some participants, however, suggest that the type of data used depends on the question being asked; they recognize the appropriateness of qualitative data or "*having a combination of both*". Yet again, none of these respondents commented on academic rigor or perceived credibility of qualitative information, only the general value of such information to fishery management.

> *Some questions, or some management decisions, are very easily answered by a quantitative decision ...it's nice to have yes or no, black or white, one or two, or one or zero, and those are easy to calculate . . . . But there are many shades of grey, so you need that additional information.*

> *Quantitative is something that people are used to seeing as science, but the qualitative piece is what makes the story for the quantitative piece. You need both to tell the story, otherwise it is just numbers. And the qualitative piece is often the hook that gets you into the numbers; to get you to look at them more deeply.*

Timing is Important

Managers pointed out that social science often comes in too late for a meaningful connection between ecological and social information. One manager said that usually biologists "*work out the best biological option*" and "*then the social comes in at the end out of context*". Some managers reflected that social science needs to be brought into the discussion sooner than it is traditionally, and not as "*an appendage at the end*" just to give it "*sincere attention and importance*". Failure to incorporate the social context and public perceptions into decisions may contribute to poor long term planning.

Areas for Human Dimensions Research in Fishery Management

Fishery managers and biologists interviewed for this paper perceived a lack of interest in Great Lakes fisheries within the HD research community. Although a large body of HD research exists on marine fisheries (especially for commercial fisheries), the Great Lakes region has received less attention. The relative paucity of Great Lakes HD literature points to the need for the research community to take greater advantage of the GLFC's support for more HD research. Moreover, the opportunity also exists for fishery managers to do more to seek to understand the implications of HD research findings on management and for HD practitioners to better design and deliver their research in a manner compatible with manager needs. Paramount is the desire to communicate the need for HD research more widely among the scientific community and to promote the Great Lakes as an exciting area of interest to HD academics.

Based on the semi-structured interviews and on a review of HD literature, the authors identified seven areas for research, organized into three general categories: economics, values, and governance. Under each research area, specific questions related to management priorities (again, informed through interviews and the literature) are provided as the starting points for researchers as they craft their proposals for the GLFC's consideration.

(I) The economic value of Great Lakes fisheries

(1) What is the economic value of the Great Lakes fishery and how does understanding the value relate to fishery management?

- What are direct economic values of fisheries at the lake level and basin-wide and how do they compare to other sectors?

- What is the contribution of fisheries to provincial, regional, and local economies?

- What is the economic value of ecosystem services (e.g., wetlands, habitat restoration, clean, healthy, and more resistant freshwater ecosystem)?

- What is the economic value of non-use values?

- What are costs and benefits of government spending on fisheries compared to generated revenue?

- Which factors influence the economic value of fisheries?

(II) Attitudes, values, and beliefs about Great Lakes fisheries

    (2) What are the values, expectations, and beliefs towards Great Lakes fisheries?

- In what ways do user and non-user groups, as well as municipalities, value Great Lakes fisheries?

- What expectations do stakeholders have related to fishery management?

- What are the public's beliefs about Great Lakes fisheries?

- What are the drivers of values, expectations, and beliefs?

    (3) What are the larger socio-demographic trends in the Great Lakes region and how will change affect values, expectations, and fishery management?

- What are the current patterns of fishing and other recreation?

- What are the projected changes in these patterns?

- How are these changes likely to affect stakeholder distribution and their engagement and expectations for Great Lakes fishery management?

    (4) How can traditional and local ecological knowledge inform fishery management?

- What contributions can local and traditional ecological knowledge make to Great Lakes fisheries management (e.g. policy making, decision making)?

- How can local and traditional knowledge be better integrated into fishery policy and decision making (e.g. improve sharing of information and increase trust and application of this knowledge into fishery management)?

- What are the barriers to doing so and how can they be overcome?

(III) Governance and institutions

    (5) How to engage a broader stakeholder community effectively in the planning and management of fisheries?

- How can managers elicit the opinions of vocal and non-vocal stakeholder groups?

- What is the best way to sustain relationships between stakeholder groups and managers?

- How can poorly organized groups increase their participation and/or influence in the decision-making process?

- Can increased stakeholder involvement in management actions lead to increased agency capacity?

- What are key changes in stakeholders anticipated in response to socio-demographic change?

(6) Who should pay for (and have a voice in) fishery management?

- What funding mechanisms would be more equitable and capable of distributing costs of fishery management among the general public?

- How would a change in funding strategy or other payment mechanisms affect governance and management?

(7) Is Great Lakes fishery management effective and how should effectiveness be assessed?

- How do HD vision statements translate into management objectives?

- Which measurable criteria and indicators can be used to assess effectiveness of fishery management?

- How does management perform vis-à-vis these indicators?

Synthetic Questions and Advice for Researchers

To guide their projects, researchers are encouraged to propose "synthetic" research questions; that is, questions that cut across more than one of the seven HD research areas presented above. Proposals that are too broad or too narrow in scope will not be well-received by the proposal review board (Board of Technical Experts; BOTE). Synthetic questions should be designed to reflect the researcher's creativity, strengths, and interests and, thus, are not presented here. Two example synthetic questions are:

How will attitudes (HD research area 2) *and participation* (3) *shift/differ between traditional 'users' and broader 'stakeholders'* (4)*?*

How will trends in participation (3) *affect economic value of Great Lakes fisheries* (1) *and what are the implications for changing funding structure* (6)*?*

Research proposals should address clear aims and objectives, demonstrate and effectively communicate academic rigor in methods, indicate how the data relate to fishery management in the Great Lakes, and outline potential application of the information.[1] Research proposals are evaluated based on the scientific merit of proposals, rationale, innovativeness, budget, logistics,

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[1] See www.glfc.org/science for details and instructions

and qualifications of the principal investigators. Proposals will have also have a high priority for funding if they directly relate to a research theme (such as expressed here) and/or to research priorities identified by the management agencies.[2] HD researchers should consider consulting a fishery manager during the research design and consider including a manager on the research team.   Researchers also should follow the pre- and full proposal templates[3] carefully and develop a rigorous research design that:

- States clearly the rationale for the proposed project, linking the proposal to the HD theme.

- Presents a synthetic research question or questions and explains carefully the research objectives.

- Explains the methods used to achieve each of the objectives.

- Describes why the particular methodologies and methods were selected.

- Describes how the data will be analyzed.

- Explains how the methods will address the research question(s) and how the methods will ensure the proposed objectives are met.

- Addresses all "reliability" and "validity" issues and describes the steps taken to increase both to the greatest extent possible.

- Acknowledges any limitations of the proposed study.

- States how the study relates to GLFC priorities.

- Presents a reasonable budget.

- Lists the expected output from the study (e.g., journal articles, a PhD student).

Research also should provide information for current management or be relevant in the future (e.g. for monitoring or adaptation purposes), indicate a clear geographic scale (e.g. lake vs. basin wide), and address a targeted species or community, or larger ecosystem considerations.

Discussion

Human dimensions-related issues are interwoven into most fishery management decisions. Our study for example found that most management challenges in Great Lakes fisheries were human related and thus need to be addressed with information on Human Dimensions of fisheries in the

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[2] See www.glfc.org/research/FRclc.php
[3] See www.glfc.org/research/sp.php

Great Lakes. Yet, despite this apparent need to integrate HD information, the actual integration of such information seems to fall short.

Primary barriers to incorporate HD into management appear to stem from within fishery agencies In general, the lack of training in and familiarity with social science methods and data among managers, and a lack of understanding of management structures and processes among HD researchers, hinders such integration. This lack of experience with HD information and how such information is collected exposes a critical need to increase familiarity and understanding among fishery management about social science methods, the applicability and transferability of HD research findings to management, and tools for integrating HD information into planning and decision making. Conversely, HD researchers need to engage managers and include them in proposal development to ensure their objectives address a critical management need, the study design is appropriate to achieve objectives, and the results are provided in a format that allows a seamless integration to management practices. Otherwise, the integration of HD information in the future might not advance despite funded research projects.

There is also the potential for a significant gap in understanding the effects of large scale social trends that may be perceived as "basic" social science information in that such information does not always accrue to any particular management topic. Examples include studies on drivers of social attitudes and motivations that could be transferable to fisheries and provide insights into changes in fishery patterns, attitudes, values, and beliefs. Drivers of change might not be directly related to fishery management, although they are part of the wider context of fishery management (e.g., demographic changes, economic development, or wider beliefs and attitudes that influence values and behaviors towards fishing and fishery management). Managers need to be open to such information to better understand drivers of change, which was of high interest to interview participants in this theme revision. At the same time, social scientists need to design studies and present data in a format that managers can understand and apply.

Many fishery managers appeared suspicious of the academic rigor and credibility of HD data and, thus, seemed reluctant to use such information as a basis for fishery management. To some extent, this perception could stem from the fact that HD data is often received informally (e.g., via user complaints, phone calls, informal meetings) or not collected systematically over a clearly defined geographic area or from a target group. Ensuring that HD information is collected systematically (and communication of this) would likely heighten its credibility and improve it application.

Regarding management and decision-making, the timing of HD data integration is critical. Social science often is considered after ecological information has been collected and analyzed. If decisions were already made based on ecological data and then were challenged as HD information becomes available, natural scientists would perceive decisions as political rather than based on careful consideration of data. HD information, thus, should be integrated from the start and not as an "*appendage at the end*" to increase acceptance of the final decision. A valuable approach to help such integration could be to foster more interdisciplinary research across the natural and social sciences. These studies would logically combine both types of data from the beginning and thereby also facilitate data integration. More transparency of the decision-making process would also add to a better understanding of how a decision has been made.

Increasing the application of HD information is critical to better manage multiple aspects of Great Lakes fishery management

Despite the limited application of HD data to Great Lakes fishery management thus far, interview participants suggested HD research needs for a variety of economic, social, and governance aspects of the fishery. This recognition indicates an understanding among managers of the variety of HD aspects underlying fishery management. Italicized quotations are from interview participants.

The economic value of Great Lakes fisheries: Economics play a prominent role in Great Lakes fishery management. Throughout the interviews for this theme revision, interview participants often couched economic information as "*a common currency for communicating value and benefit*" of fisheries to justify management decisions and money spent. Interview participants noted that if the public, the press, decision makers, and politicians truly understood the economic value of Great Lakes fisheries, stewardship would improve tremendously and greater investment in fisheries (e.g. more public funding) would be justified. The monetary assessment of ecosystem services was judged as important to validate habitat restoration and wetlands conservation.

Managers expressed an interest in better understanding the benefits and costs of decisions and their impact on specific user groups and communities (e.g., trade off analysis of impacts of different catch rate scenarios, or models about the ratio between the costs of fishery management versus its economic value). Economic impact assessments are needed for net values and dollar values of allocations to commercial and recreational fisheries and, in the words of one manager, "*to know what the effect of my decision is or staff's decision is on my stakeholders, in particular on the economic side.*" Moreover, information about tax revenues and impacts of different fisheries on provincial and regional economics would assist management efforts.

Another information need identified is a better understanding among managers of the influence of external socio-economic and environmental factors on economic values. Examples include changes in fuel price and exchange rates, and the influence of societal trends (e.g., the market value of local fish vs. imported fish as society has become more critical about food production and origin, and the impacts of invasive species). Beyond the direct users of the resource, participants also noted the importance of better understanding non-use values, which are perceived as people's willingness to pay for knowing "*that they have a healthy fish community in the river near their house*" or the intrinsic value of "*Great Lakes ecosystems and the fisheries that they support,*" which might be economically more "*important than the shipping industry*".

Economic studies, report the fishery managers, would be particularly valuable to demonstrate the direct and indirect economic contribution of fisheries at the local, state, and regional levels. The information could be used to justify management decisions and expenses by fishery management agencies and thereby potentially increase political support and funding for fishery management if the economic value of fisheries is acknowledged. It will be important to not only assess direct economic benefits but also indirect economic impacts to account for the wider economic impacts of fisheries to local communities and regional economies in the basin. Existing economic research also usually emphasizes the value of consumptive use. Yet, additional need exists to assess the value of ecosystem services to better justify expenses for habitat or wetland

conservation and to assess the economic value of non-consumptive values to better reflect the spectrum of HD values attached to fisheries.

Personal values, demographics, and the social dimension of Great Lakes fisheries: Social information helps demonstrate the values that are attached to fisheries and indicated support and interest in having fisheries in the Great Lakes. Examples include non-economic values such as increased quality of life that fisheries provide and that might attract people to the Great Lakes basin; the value of local food, cultural and historic value of fisheries; and the value of ecosystem services. Managers and politicians also need some guidance into how to weigh the various values in relation to the economic benefits from fisheries.

Interview participants were interested in knowing more about angler and commercial fishers' expectations of their fishing experience (catch rates, species and size class preference, and preferred gear types) and expectations for management directions (e.g., how much they think should be invested in the resource to improve and protect it). In line with a broadened understanding of stakeholders, managers are interested in understanding the broader publics' level of knowledge and awareness about GL ecosystem and fisheries. Managers pointed out, for instance, the need to understand the level of support for environmental issues and fishery issues because, in the words of one participant, "*if the general average person doesn't care much then we're not going to have much of a future*".

Beyond knowing the social aspects, fishery managers also expressed an interest in understanding what influences peoples' values, expectations, and beliefs. Examples suggested include demographics, residence, a vested economic interest, education, and cultural background. Interview participants were particularly adamant in pointing out that information seems scarce in terms of participation patterns and motivations. Due to recent declines in recreational fishing participation, managers emphasized the need to better understand the reasons why people fish. This information was perceived as critical to understand underlying demographic factors that are affecting participation in fishing and, thus, was seen as critical to understand, predict, and address changes in user patterns. By understanding which factors influence participation in fishing, managers believe they could do a better job increasing participation. Beyond basic demographic shifts, factors that might influence participation in fishing included (1) the quality of the fishing experience (fish abundance, size, species, quality), (2) personal attributes (time available to go fishing, love of the outdoors, family tradition and upbringing), (3) environmental change (e.g. presence of invasive species), and (4) economic changes (e.g., fluctuation in gasoline price).

Fishery managers, thus, see stakeholder values, expectations, and beliefs about fisheries as important elements in the planning and decision-making process. This information can help to identify points of convergence and divergence between managers and users. Indeed, social science studies on user patterns, values, expectations, attitudes, and local knowledge were mentioned to be most critical in the planning and decision-making stage and should be included early on. This accompanies the fact that fishery management in the Great Lakers is striving towards more integration of stakeholder input into management goals and objectives.

In addition to understanding the users' values and needs, participants emphasized the need to know the values of non-vocal and non-organized stakeholders, as managers felt they only receive

input from a small subset of vocal or organized users. This information need is driven by the fact that government agencies serve the entire public and, thus, must understand not just the values of the most vocal segment of the public, but everyone.

Yet, understanding values, expectations, attitudes, local ecological knowledge, and user patterns is still quite limited, and decisions are often not based on solid HD information that has been collected in a systematic, academic manner. Advancing the collection of HD information that is based on rigorous methods and carefully designed objectives will help to improve the understanding of stakeholders' expectations, attitudes, knowledge, beliefs, and values and would provide valuable insights for planning and decision making. The collection of such data right from the start –and the communication that such data is available--will result in decisions that are based on rigorous natural and social science data and allow informed trade-off analysis and decision making that are defensible, credible, and thus more accepted by fishery management staff and stakeholders alike.

Governance and institutions: Interview participants noted that research into governance is needed throughout the management process. Managers recognized that public engagement is complicated, but at the same time, they perceived it as the "*recipe for success*" and necessary to increase awareness about why specific management decisions were made. Managers were particularly interested in engaging stakeholders beyond the "*first tier*" of commercial and recreational fishermen in the decision-making process. Interview participants emphasized the actual engagement process, particularly how to engage stakeholders in a balanced fashion and to represent non-vocal and non-organized users/the as opposed to vocal minorities in the decision-making process. Likewise, the stakeholders themselves likely have certain expectations for how they will be involved in management. A better understanding of the process by both the managers and the stakeholders would help in the design of effective structures for engagement.

Managers seemed keen on better understanding and involving non-vocal and non-organized users and stakeholders that may not fish but still have an interest in the Great Lakes and their fisheries. Further stakeholder engagement, however, raised the question of agency capacity. Indeed, while there appears to be an interest in knowing more about user groups and including them in management, agencies are already struggling to deal with significant budget cuts and might not have the capacity to reach beyond their traditional constituents. On this note, the potential for revising the current funding model for fishery management - distributing the costs more widely to the general public and other recreationists - was widely noted. Explicit information needs include research on the implications of changes in tax laws and ways to make agencies base funded rather than dependent on soft money and license sales. Examples included increases in sales tax to fund fishery management efforts, which is perceived, in the words of one manager, as "*a more steady source of income…* [since] *it doesn't fluctuate with users*. Base funding is justified because "*everybody appreciates the Great Lakes, and most people use the Great Lakes from one time or another in every given year . . . whether they are drinking the water from the Great Lakes, or really going out and appreciating them*".

Another critical information needs will be the systematic assessment of management effectiveness, especially of HD management objectives. Results of HD monitoring and evaluation efforts will allow officials to adapt management according to findings and to address critical HD management challenges. Current monitoring and evaluation efforts, however,

emphasize ecological indicators; the regular assessment of social, economic, or governance indicators appears to be missing. A few managers mentioned the use of some vocal stakeholders' opinions as an indication of their satisfaction or dissatisfaction with current management. They, reasonably, were not comfortable with the representativeness of such views. An explanation for the lack of systematic evaluation efforts in the HD realm might be a lack of clearly defined management objectives and targets for HD management goals and a lack of clarity about what management wants to achieve.

In the eyes of managers, assessing and communicating management effectiveness is important to justify decisions and expenses. Moreover, a better appreciation for success would help agencies gain public trust, confidence, and support for fisheries. Evaluation of management is also critical in the political arena. Managers mentioned that *"if you go to legislature and you want that money renewed, you won't get the money if you cannot demonstrate if programs are effective ..."* While some ecological monitoring is undertaken in the Great Lakes, no systematic evaluation exists against management goals and objectives, especially in the case of social science questions described herein. One first step suggested during interviews would be to better define fishery management outcomes, especially HD ones. Comments highlighted that governments and groups *"promote things like vision statements but they don't [try] to translate that into what it means on the ground"* Future research should assess how vision statements translate into management objectives and detailed insights into what fishery management in the Great Lakes is trying to achieve.

CONCLUSIONS

This study used a review of literature and in-depth interviews with managers and practitioners to explore HD information needs for Great Lakes fisheries. This approach was chosen to enhance the relevance of future research to fishery management in the Great Lakes, to bridge the gap between science and policy making, and to strive for a greater balance between advancing scientific knowledge and applied research.

Overall, this theme finds that the application of HD information will not only depend on the supply of HD data and tools to for more transparent decision making, but also on the willingness by fishery managers to apply HD data. The supply of HD information will be become increasingly valuable as trust towards results grows and fishery managers actually integrate the information into management. Currently, many managers still perceive HD information as a luxury and detached from ecological concerns, rather than core to fishery management despite multiple apparent management challenges that are HD based. Such attitudes still conspire against placing HD information on an equal footing with ecological data for fishery management, even though fishery management is ultimately about understanding and managing people as well as fish and the ecological systems they inhabit.

This new theme aims to change the overall status of HD information. The Great Lakes Fishery Commission pledges funds for well-constructed HD research projects that conform to the tenets outlined in this theme. The goal is to help officials integrate the ecological and social aspects of fishery management.

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