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Identifying useful climate change information needs of Great Lakes fishery managers

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ABSTRACT

There is mounting evidence that climatic changes have altered physical conditions in the Laurentian Great Lakes and will continue to do so. In the face of this challenge, fishery managers require useful information to support decision making. We utilized a mixed methods approach, including an email survey and focus groups with fishery managers, to identify information gaps in understanding the impacts of climate change on fishery management. The fishery managers perceived climate change to be a threat to the fishery and identified specific climate change information that would be most useful for their work. This includes information on how climate change will affect fish populations, trophic interactions, and habitat conditions, as well as how climate change will interact synergistically with other management concerns. Our findings indicate that future research efforts should focus on species of commercial or recreational interest and species for which restoration plans already exist. Although modeling efforts that incorporate both biotic and abiotic factors may be useful to fishery management stakeholders, to enhance utility for managers, researchers should work with the information users to understand the pertinence of various temporal and spatial scales when designing studies and presenting information. Many fishery managers believe that valuable information related to climate change, particularly long-term datasets, already exists but has not been made easily accessible or brought to their attention. Finally, in order to increase the awareness and use of their climate research, researchers should present at relevant meetings in addition to just emailing reports and publishing scientific manuscripts.

Introduction

Globally, climate change is expected to have far-reaching consequences for freshwater ecosystems (IPCC, 2007), including the Laurentian Great Lakes and their associated fisheries (Kling et al., 2003; Cruce and Yurkovich, 2011). In order to proactively address implications from climate change, resource managers need to identify, collect, and be provided with the appropriate research findings and data to address management concerns. Additionally, resource managers are faced with high degrees of uncertainty (e.g., Angel and Kunkel, 2010) in understanding impacts from climate change on the Great Lakes in their decision making. Accordingly, there is a need for researchers to explain reasons for uncertainty and to translate uncertainty within the context of management decisions (McNie, 2007). To best identify the research and data needs of Great Lakes fishery managers concerning climate change, we utilized a mixed methods approach (Morse, 2003) that included an email survey sent to policy and decision makers participating in the Great Lakes Fishery Commission (GLFC) and focus groups with participants in GLFC lake technical committees.

While several studies have addressed the effects of climate change on abiotic conditions in the Great Lakes, the cumulative and likely far-reaching implications of these changes on Great Lakes fisheries remain unclear. Previous studies suggest that changing conditions associated with climate change may lead to an increase in fish production in the Great Lakes (e.g., Kling et al., 2003; Magnuson et al., 1997), but that species composition of fish communities will change (e.g., Magnuson et al., 1990; Meisner et al., 1987). Possible changes in water basin levels (e.g., Lofgren et al., 2011; UGLSB, 2012), reduced winter ice cover (e.g., Assel et al., 2003; Austin and Colman, 2007), changes in thermocline depth, and increased duration of summer stratification and hypolimnetic hypoxia (e.g., Lehman, 2002; Magnuson et al., 1990; Scavia et al., 2014) are expected to affect Great Lakes fisheries through direct impacts on the fish themselves, as well as various indirect impacts including, prey availability (e.g., Lehman, 2002; Magnuson et al., 1997), habitat (Mortsch, 1998), and the type and number of invasive species that successfully establish and compete for resources (e.g., Mandrak, 1989; Rahel and Olden, 2008).

Relevance to decision makers

Currently, despite the prevalence of climate change evidence and predicted impacts, climate change considerations are not explicitly

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incorporated into governance decisions of the Great Lakes Fishery Commission (GLFC) although they are called for in some of the research priorities identified by the GLFC. Despite its current lack of incorporation, in general, there is a call for natural resource governance to use science to understand the effects of human activities, including those that result in climate change, on an ecosystem-wide level, and to incorporate that understanding into governance decisions (NRC, 2009). This call for more effective integration of science into natural resource decision making is not new and is commonplace across environmental disciplines (Liu et al., 2008); however, integrating science into governance decisions is easier said than done. Managers of Laurentian Great Lakes fisheries have identified and emphasized a need for climate change research across multiple spatial and temporal scales in order to increase their ability to incorporate the knowledge into fishery governance (e.g., Rutherford et al., 2007). However, little is known about the information needs of Great Lakes fishery managers with respect to climate change. Additionally, little is known about how to provide information in a usable format compatible with their existing models or that is easily understood in terms of relevance to their work.

In environmental governance, research will not necessarily contribute to addressing impacts from climate change if it has not been developed to consider the needs and objectives of those tasked with making decisions and developing policies to deal with climate change (Sarewitz and Pielke, 2007). Additionally, Kirchhoff et al. (2013) found that the use of climate science in environmental decision making has still not been optimized despite advancements in modeling interactions between society and scientists. In environmental governance in general, many policy makers are frustrated and feel that the information needed to make scientifically appropriate decisions is insufficient or unavailable (Liu et al., 2008; McNie, 2007), and many scientists are discouraged by feelings that their information is not being integrated into management decisions (Liu et al., 2008). Sarewitz and Pielke (2007) define this problem as an issue of "reconciling supply and demand of scientific information" and illustrate this concept through a "missed opportunity matrix." Their work argues that science portfolios would be improved through increased transactions and engagement between researchers to reconcile differences in perception between researchers and decision makers regarding appropriate information needs.

Useful information is that which enables policy makers to achieve their desired outcomes by expanding alternatives and clarifying choices in the decision making process. This means that information is perceived by the users as salient, credible and legitimate and that it requires just as much attention to the research process as it does to the content of research (Dilling and Lemos, 2011; McNie, 2007, 2013; Sarewitz and Pielke, 2007). In response to this need, a number of boundary organizations have been formed to span the gaps between researchers and decision makers. As an example, in the Great Lakes, the Great Lakes Integrated Sciences and Assessment Center (GLISA) is a boundary organization that connects a number of Great Lakes environmental decision makers with researchers producing climate change (and other subjects) information (Lemos et al., 2014).

In climate policy, there are a number of specific concerns that affect the usefulness of information. One such issue is spatial scale. Considerable resources are being invested in the production of global climate models, but these global models can rarely be used by policy makers making local or regional decisions. Global climate models that produce information generalized across the whole world or even the whole country may not be able to provide information that has any regional or local significance to those faced with making policy decisions (McNie, 2007). Even models at more localized levels can be challenging to utilize as natural resource managers must understand the models themselves, evaluate which models are relevant, and determine which assumptions and levels of uncertainty to accept. This scaling problem leads to challenges for researchers who must struggle with the tradeoff of ensuring that the models are complex enough to be credible but simple enough to be understood by decision makers (Liu et al., 2008).

Because natural resource managers work on time-sensitive issues, often with budget and staffing limitations, they may not use climate data because they are suffering from information overload and do not have the time or capacity to sort through tremendous amounts of information. Climate models, especially integrated models, have the capacity to output tremendous amounts of data. In order for information to be useful it must be pared down into a more consumable quantity of the most important types of information rather than providing an overwhelming deluge (Dilling and Lemos, 2011). For example, in the 2003 Intergovernmental Panel on Climate Change guidelines for using climate scenarios, the authors noted that although there are increasing technological capabilities to generate information at the right scales, it is not always clear which down-scaling techniques are appropriate or if that type of information is required for approaching decisions (Mearns et al., 2003).

Another barrier in usefulness of climate change information identified by Lorenzoni et al. (2007) is appropriate access to information. These barriers include issues with the format in which the information is presented, ability to access that information, information overload, or confusing information. Decision makers may have trouble accessing relevant scientific data because it is not made publicly available or is not easily accessible, e.g., if the only place results are shared is in the academic or scientific literature or at scientific conferences (Lahsen and Nobre, 2007).

Research relevance

We utilized focus groups and surveys to engage fishery decision makers in the identification of useful climate change information for managing Great Lakes fisheries as a first step towards reconciling the supply and demand of climate change information. It investigates the Great Lakes fishery managers' perceptions of the impacts climate change on Great Lakes fishery management and remaining research gaps for addressing those impacts. Additionally, we identified which climate change data outputs would be most important to Great Lakes fishery managers, so as to not overburden them with unnecessary or unhelpful data, and assessed how they prefer to receive information. Our research centered on four main research questions:

1) Do Great Lakes fishery managers consider climate change to be a threat to the immediate and/or long-term stability of Great Lakes fisheries?
2) What research gaps remain for addressing climate change impacts on Great Lakes fisheries?
3) What kinds of climate change data are the most useful to Great Lakes fishery managers?
4) How can climate change information be delivered to be most useful to Great Lakes fishery managers?

Methods

We used a mixed-methods approach to examine our research questions (Morse, 2003), incorporating results from 1) an email survey sent to participants in the Joint Strategic Plan for Management of Great Lakes Fisheries (participants in the GLFC, the GLFC's lake committees, and the GLFC's lake technical committees GLFC, 2007); and 2) focus group interactions with participants in the GLFC lake technical committees. Through the increased number of research strategies employed, mixed-methods approaches allow for a broadening of dimensions and scope in a project (Morse, 2003). The questions, both open-ended and set-answer, were developed by an interdisciplinary team of researchers from Purdue University and were pilot tested with former GLFC lake committee and technical committee participants. The GLFC is a binational, inter-jurisdictional organization that facilitates the coordination of Great Lakes fishery governance by the eight states, one province, two tribal authorities and two national governments which operate