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The role of anglers in preventing the spread of aquatic invasive species in the Great Lakes region

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ABSTRACT

The spread of aquatic invasive species (AIS) is an ongoing challenge in the Great Lakes region. Anglers play a pivotal role in preventing or contributing to the spread of these organisms. Anglers in the Great Lakes region were surveyed by mail during fall 2013 to assess their AIS-related awareness, knowledge, and concern as well as the actions they took to prevent the spread of AIS. Many anglers were aware of AIS, knowledgeable and concerned about them, and taking some actions to prevent their spread. However, certain actions, such as drying and disinfecting or rinsing equipment with hot water, were more difficult and were reported less frequently. Because many anglers already recognize the importance of taking action to prevent the spread of AIS, future outreach efforts may be able to deemphasize communication about the importance of taking action and focus more on strategies that will enable anglers to take these actions.

Introduction

The spread of aquatic invasive species (AIS) is an ongoing challenge in many places in North America, including the Great Lakes region. Large freshwater lake systems are particularly susceptible to AIS invasions because there are multiple pathways for introduction, including ballast water from large ships, disposal of unwanted baitfish, and movement of equipment by recreational users.

Recreational users can distribute AIS in multiple ways. For example, Jacobs and MacIsaac (2007) found that fishing line fouled with diapausing eggs of fishhook waterflea *Cercopagis pengoi*, which can remain viable for weeks, was a potential source of introduction of this species to non-invaded lakes if the fishing line was not cleaned. Kelly et al. (2013) found that recreational boaters traveling into Lake Simcoe, Ontario, Canada could transport zooplankton (both native and invasive) in water-holding compartments in their boats as they moved to different locations within this large lake. They recommended frequent drainage of standing water in the boat to prevent AIS movement from one part of a waterway to another. Leung et al. (2006) developed models to show how movement of recreational boaters between lakes could result in the transport of AIS between invaded and non-invaded lakes.

Given the potential for AIS to be moved via recreational equipment, anglers can play a major role in the spread of AIS. For example, about half of the anglers surveyed in a southwestern Montana study reported that they only occasionally, rarely, or never cleaned their boots or waders between uses (Gates et al., 2009). In a recent survey in the United Kingdom, Anderson et al. (2014) found that 12% of anglers and 50% of canoeists who move their equipment, including boats, between basins did not either clean or dry them adequately between uses. In Michigan and Wisconsin, mail and in-person surveys of boaters found that more than two-thirds do not always clean their boats when going from one water body to another (Rothlisberger et al., 2010).

Educational efforts have been undertaken throughout the United States, and in some states regulations have been put in place, to encourage anglers to take additional actions to prevent the spread of AIS. The most notable educational program in the Great Lakes region has been the "Stop Aquatic Hitchhikers" campaign (Jensen, 2008; Wildlife Forever, 2013). However, little information is available about the level of awareness generated by multiple efforts across the Great Lakes region and subsequent compliance with AIS recommendations and regulations.

This paper examines anglers' AIS-related awareness, knowledge, concerns, and the actions they take in the Great Lakes region to prevent the spread of AIS. Factors that could influence actions are also examined to assess what factors and messages are most likely to increase angler compliance with the AIS recommendations. Results by state are examined to assess differences in the level of consistency in awareness, knowledge and actions across the region. Based on the research results, recommendations for managers and educators are made about how to refine outreach efforts to increase actions that will help to prevent the spread of AIS.

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The factors explored in this paper that could influence actions were developed based on the Integrated Model of Behavioral Prediction (Fishbein and Ajzen, 2010; Fishbein and Yzer, 2003), which postulates that behavioral, normative, and control beliefs can influence behavior. A series of belief statements were included in the questionnaire on the basis of their potential contribution to compliance with AIS recommendations. A fully executed test of the model was not possible due to questionnaire space constraints, but relationships between each type of belief and AIS-related actions were examined. The behavioral beliefs included in the questionnaire focused on the importance of compliance in order to limit the spread of AIS and protect the resource for future generations of anglers. Normative beliefs assessed the importance of fishing companions in motivating compliance. Control beliefs focused on the presence or absence of situational factors that could enhance or impede compliance with the recommendations. In this case, anglers were asked about the ease, cost, and time required to comply with the recommendations.

Methods

A sample of 1000 licensed anglers likely to have fished the Great Lakes was obtained from each of the six states selected for the study (Illinois, Indiana, Michigan, New York, Ohio, and Wisconsin). Funding constraints limited the survey to six of the nine states/provinces bordering the Great Lakes. Selected states/provinces were chosen to represent diverse regulatory responses to AIS, including fish pathogens. Anglers were defined as any state resident who: (1) bought an annual or short-term (of more than one-day) license that permitted fishing in the most recently completed license year; (2) was 18 years old or older as of September 1, 2013; and (3) resided in a county (or grouping of zip codes covering the majority of the county, if the state did not keep data on counties) bordering the Great Lakes. In Michigan, all adult anglers who resided in the state were included because Great Lakes waters are accessible throughout the state.

The questionnaire included items measuring awareness and knowledge about AIS, including fish pathogens, such as the viral hemorrhagic septicemia virus. Items also measured awareness of AIS regulations and recommendations, concern about AIS, factors potentially influencing compliance with the regulations and recommendations, and actions taken to respond to AIS.

A behavioral response score was created for anglers based on their self-reported frequency of taking five actions to prevent the spread of AIS. These actions included inspecting their fishing and boating equipment, removing plant or animal material, draining water-holding compartments on boats, drying equipment, and disinfecting or rinsing equipment with hot water. The AIS behavioral response score summed each angler's response to all items where 0 = never engaged in the action, 1 = engaged some of the time, 2 = engaged most of the time, and 3 = always engaged in the action, and ranged from 0 to 15.

The mail survey was implemented in September 2013. After the initial mailing, up to three follow-up mailings were sent to non-respondents over the course of the next 4 weeks to encourage their response.

Telephone follow-up surveys of 300 non-respondents (50 per state) were implemented approximately 2 months after the first survey mailing to assess how and to what degree non-respondents differed from respondents. Only key questions from the mail survey were asked over the telephone. The questions most relevant to the analysis presented here focused on awareness of AIS and concerns about AIS within the Great Lakes region. Respondents and non-respondents were also compared using information available from their fishing licenses, including year of birth (for five of the six states) and gender (for two of the six states).

Data from returned mail questionnaires were analyzed using SPSS (IBM SPSS Statistics 20). Chi-square, ANOVA and Scheffe's tests were used to test for statistically significant differences at the $P \leq 0.05$ level. All reported differences were significant at this level.

Data reported by state are unweighted and reflect the number of people who responded to the survey from that state. However, because equal sample sizes were drawn from each state, respondent data were weighted proportionate to the population of licensed anglers in the portions of each state from which the sample was drawn to make statements about the population of anglers in the 6-state region as a whole.

Results

Mail survey response and non-response bias analysis

Of the 6000 questionnaires mailed to anglers, 532 were undeliverable, and 1487 completed questionnaires were returned, for an adjusted response rate of 27%. The response rate varied from 31% in Michigan to 20% in Indiana. Although respondents were more likely to know something about AIS than non-respondents (74% versus 62%), the two groups did not differ in level of concern about AIS in the Great Lakes region. Respondents did not differ from non-respondents based on gender in the two states where this information was available from the fishing license. However, respondents were on average 9 years older than non-respondents in the five states where this information was available.

Awareness, knowledge, and concern about AIS

Three-quarters (74%) of responding anglers indicated they had both heard of AIS and knew something about them, 21% indicated they had heard of AIS but did not know much, and fewer than 5% had never heard of them. The level of awareness is likely somewhat lower across the entire angler population in the Great Lakes region based on the non-respondent analysis, in which 62% of non-respondents indicated they knew something about AIS.

Respondents were concerned about AIS. Almost all anglers who were aware of AIS thought AIS could hurt native fish populations (95%) and reduce the number of fish available for them to catch (90%). In addition, more than 90% of the anglers who were aware of AIS were moderately or very concerned about having AIS in the Great Lakes region. Nearly two-thirds (65%) of them were very concerned.

Actions taken in response to the presence of AIS

Anglers can take action to prevent the spread of AIS by following regulations and recommendations for inspecting and cleaning their fishing and boating equipment. The survey asked about five actions anglers could take to prevent the spread of AIS (Table 1). The action most likely to be taken by anglers was draining all water-holding compartments including live wells, bait wells, and bilge areas. Almost three-quarters of anglers indicated they always took this action when moving from one water body to another. Roughly half of all anglers reported that they always inspected fishing and boating equipment for attached aquatic plants and animals, and removed any visible mud, plants, fish or animals before transporting fishing or boating equipment. Fewer anglers always dried their boats, trailers and all fishing or boating equipment before use in another water body. One-quarter never engaged in this activity. Even fewer anglers disinfected or rinsed with hot water anything that came into contact with water before reuse; three-quarters of anglers never took this action. Some recommendations suggest taking one but not both of these actions (i.e., either dry or disinfect/rinse), so the proportion who always took at least one of these actions was calculated. This proportion was still less than 50%. Ten percent of anglers never took any of the five actions, and 5% always took every action.

A behavioral response score was calculated by summing the frequency with which the actions were taken. The average score was 8.3, with a range of 0 to 15. Moderate to high scores could indicate

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