

Informing the Debate

Michigan Applied Public Policy Brief

Improving Public Outreach and Education Programs to Minimize the Spread of Aquatic Invasive Species

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Informing the Debate

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Informing the Debate

MAPPR Policy Research Brief

Improving Public Outreach and Education Programs to Minimize the Spread of Aquatic Invasive Species

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EXECUTIVE SUMMARY

Boating is an important recreational activity in the Great Lakes region. Along with stimulating tourism and contributing to local and regional economies, recreational boating can also have adverse impacts on freshwater environments. When boats are moved among water bodies without taking proper precautions they can introduce unwanted invasive “hitchhikers” into new environments. The risk of spreading aquatic invasive species (AIS) via boating can be reduced if boaters take certain precautions. Public outreach and programs such as *Stop Aquatic Hitchhikers!*TM *Clean Boats, Clean Waters*, and *Be a Hero, Transport Zero* match logos and slogans with information on specific actions boaters should take.

In Michigan, all boaters are required to remove plants from boats and trailers, drain livewells and bilges, and (in most instances) dispose of unused bait. These required actions do not align perfectly with simplified outreach messages used in national campaigns (e.g., “Clean, Drain, Dry”). Required actions also do not include additional AIS-prevention behaviors that are necessary to ensure that boaters do not move live invasive organisms into new environments. State agencies recommend that boaters remove mud in addition to plants and either “Wash, Dry, or Disinfect” all recreational equipment before moving to new water bodies.

The goal of this project is to provide more comprehensive information about Michigan boaters’ awareness of required and recommended AIS-prevention behaviors and willingness to engage in them. The specific project objectives are to: 1) evaluate the effectiveness of AIS regulations and public outreach and education programs, 2) determine the level of boaters’ understanding of AIS regulations and willingness to follow them, and 3) help design more effective outreach and education programs to publicize the regulations and increase boaters’ willingness to engage in other voluntary actions.

Three outreach messages and a survey questionnaire were developed in cooperation with members of Michigan’s AIS Core Team. One message appealed to environmental sensibilities, another stated the economic damages of AIS, and a third message was more comprehensive in its description of required and recommended AIS-prevention behaviors. Out of approximately 1 million registered boaters, a sample of 1,500 boaters was randomly selected and those boaters were randomly assigned one of the three messages. Response rates for each of the three groups (n = 500 per group) was similar (33% for Message 1 & Message 2; 31% for Message 3).

Boaters found the comprehensive message more informative but all three messages were judged to be informative, sensible, useful, believable, convincing, professional, motivating, on-target, and easy to process, understand, and comprehend. All three messages were rated somewhat lower in terms of being enjoyable and imaginative. Future outreach efforts could pair similar messages with more engaging visuals in print or video media to increase overall appeal.

Regardless of the outreach message they were shown, all Michigan boaters reported similar willingness to engage (or not engage) in specific AIS-prevention behaviors. However, boater beliefs regarding the required or recommended nature of a given behavior did have a significant effect. Most boaters (72.3%) who believed that Michigan law requires boaters to “Drain” bilges and livewells always drained. Less than half (45.3%) of those who mistakenly believed that the law does not require boaters to “Drain” always did so. The same trend held for steps that are, in fact, recommended. Over half (56.0%) of boaters who erroneously thought that the law requires them to “Dry” always dried their boats for at least five days. Only 21.1% of boaters who knew that regulations do not require boaters to “Dry” did so whenever they move boats. Outreach messages that clearly state which actions are required by law should help to increase compliance, but unfortunately they may also decrease compliance with recommended behaviors.

Although one-time exposure to outreach materials may have little effect, there has been a cumulative effect of outreach campaigns, new regulations, coverage of AIS issues in mass media, and increasing availability of boat washes. Over the past ten years there has been a general decline in the proportion of Michigan boaters who “Never” engage in AIS-prevention behaviors. This trend was most evident for boat washing. Michigan boaters are now nearly four times as likely to wash their boats (at least occasionally) when moving boats from one body of water to another.

Future efforts should incorporate a balance of outreach, law enforcement, and other activities intended to influence social norms and increase boater adoption of AIS-prevention behaviors in Michigan. The opinions of law enforcement officers were more likely to influence boater behavior than the opinions of family, friends, and other boaters. Boaters expressed a strong intention to abide by boating laws, but many (17.9% to 32.1%) were unclear regarding the required vs. recommended nature of each AIS-prevention behavior. Boat launch signs and boating regulation booklets are among the most effective tools for changing boater behavior and reaching a large audience of boaters. Standardizing a comprehensive message for use on Michigan signs and boater handbook would help to avoid confusion and increase compliance with required actions. Outreach efforts targeting recommended actions should highlight increasing availability of boat washes and alternate steps to take if boat washes are not available.

Summary Recommendations*

1. Pair a comprehensive outreach message with more engaging visuals.
2. Clarify and standardize a comprehensive outreach message for signs and the boater handbook.
3. Provide all registered boaters with the standardized comprehensive message.
4. Expand upon law enforcement office engagement in AIS outreach and education efforts.
5. Enforce Michigan's AIS-prevention laws after increasing outreach efforts.
6. Expand NREPA 324.41325 to cover draining and removal of mussels and mud.
7. Harmonize AIS-prevention laws across Great Lakes region.
8. Coordinate outreach, enforcement, policy, and development of infrastructure.
9. Target diverse audiences using traditional and new media.
10. Conduct follow-up survey in 2020.

OVERVIEW OF THE ISSUE

The introduction of aquatic invasive species (AIS) into new environments often negatively impacts the economy, the environment, and human health (National Invasive Species Council 2006; Ricciardi and MacIsaac 2011). The economy suffers from a reduction of recreational and commercial activities such as industrial water uses and recreational and commercial fishery activities. Total costs of managing aquatic and terrestrial invasive species are estimated at \$137 billion per year (National Oceanic and Atmospheric Administration [NOAA] 2014). Some of the negative environmental effects are manifested in predation, parasitism, competition, introduced pathogens, hybridization, and habitat alterations (NOAA 2014). Also, AIS can negatively affect human and animal health through their role in contributing to harmful algal blooms and outbreaks of diseases such as Type E botulism (Ricciardi and MacIsaac 2011).



Figure 1. Great Lakes AIS include Zebra Mussel, Round Goby, and *Phragmites* (listed from left to right, image courtesy Michigan Sea Grant).

In the Great Lakes basin, over 180 non-native species have established breeding populations (Mills et al. 1993). These include AIS, such as Zebra Mussel (*Dreissena polymorpha*), Round Goby (*Neogobius melanostomus*) and *Phragmites* (Figure 1). These species have caused significant negative impacts on freshwater ecosystems and resources of the Great Lakes. Total economic costs of all AIS-caused environmental effects are estimated at \$5.7 billion per year in the Great Lakes region (Pimentel 2005).

Primary sources of exotic species introduction to U.S. waters include ballast water and organisms in trade (OIT), while boating activity is an important contributor to the spread of AIS once they become established in U.S. waters (Kelly et al. 2012). According to the National Marine Manufacturers Association (NMMA 2014), of 12.1 million registered boats in the U.S., about 20% are in the Great Lakes states. Further, as 95% of the boats are less than 26 feet long and trailerable, most of them could be transported between disconnected water bodies over the course of a season (NMMA 2014). Unaware of the existence of AIS or knowing too little about them, boaters could unintentionally spread AIS by transporting their boats between unconnected water bodies.



Figure 2. Logo, slogan, and URL for *Stop Aquatic Hitchhikers!*TM campaign.

The prevention of new introductions of AIS via primary vectors is the most effective way to prevent harm (Leung et al. 2002), but once AIS become established limiting the dispersal of AIS via boating and other secondary vectors is a realistic alternative (Vander Zanden and Olden 2008). Boaters' operation and maintenance of their vessels can prevent new invasions (Rothlisberger et al. 2010), so it is important to encourage boaters to implement environmentally responsible boating practices. As a result, government officials and resource managers have recommended a variety of actions to prevent the spread of AIS. These actions have been encouraged using a variety of outreach campaigns and, in some instances, through regulations requiring their implementation.

Public outreach and education programs have included *Stop Aquatic Hitchhikers!*TM, *Clean Boats, Clean Waters*, *Be a Hero Transport Zero*, and *Don't Dump Bait!* and have been implemented to encourage boaters to engage in AIS prevention actions. The *Stop Aquatic Hitchhikers!*TM campaign includes a logo (Figure 2) that has been featured on billboards, in magazines, on television programs, and on a wide variety of other products including regulation pamphlets and boating access site signage. The logo has been used by hundreds of different management agencies, NGOs, and other groups across the U.S. and accounted for over 200 million impressions in 2013 alone (Wildlife Forever 2013). This campaign has included specific recommendations for AIS prevention actions, and the messages tailored to specific actions have changed somewhat over time and varied from product to product and state to state. Recent billboards emphasize "Clean, Drain, Dry" steps for preventing secondary spread of AIS (Wildlife Forever 2013) although some messages have included additional or alternate description of actions.

The *Stop Aquatic Hitchhikers!*TM campaign is a national effort endorsed by the inter-governmental ANS Task Force, but legal requirements for compliance with specific actions varies from state to state. In Michigan, Fisheries Order 245.14 was adopted in 2007 as a response to the spread of viral hemorrhagic septicemia virus (VHSV). This order required boaters to "drain all live well(s) and the bilge" and also established more complex restrictions on the movement of certain VHSV-susceptible fish species between water bodies, including restrictions on the release of bait. These are summarized by the actions "Drain," "Dispose," and "Don't Transfer" that have been used in some prevention messages (see Appendix 1, Message 3).

In 2009, an amendment to Michigan's Natural Resources and Environmental Protection Act (NREPA; Act 451 of 1994) required that boaters shall not place a boat, boating equipment, or boat trailer into state waters if it "has an aquatic plant attached." While this could be generalized to suggest that boaters are now required to "Clean" their boats, NREPA technically does not require cleaning of mud and other debris that may harbor AIS. Specific language following recommendations to "Clean" or "Inspect"

and “Remove” is needed to make the general recommendation conform to Michigan law. Furthermore, recommendations to “Dry” a boat for five days, “Spray” or “Wash” equipment if drying is not feasible, and “Disinfect” live wells and bilges are not required by law in Michigan. Boat washes are not available at most Michigan boat launches, but signs at access sites have been used to inform boaters of risks posed by AIS and measures that boaters can take to prevent their spread (Figure 3)

In 2012, Michigan boaters were surveyed to assess compliance with AIS-prevention behaviors and the effectiveness *Stop Aquatic Hitchhikers!*TM outreach materials (a brochure and winch post sticker) at increasing boaters’ intent to engage in prevention behaviors. The survey found that the majority of boaters rated materials effective and always took action to “Inspect,” “Remove,” “Drain” and “Dispose” when moving boats between water bodies (Lee et al. 2012). However, one-time exposure to the outreach materials had no significant effect on intent to take future action and adoption of prevention behaviors was not universal even when required by law.



Figure 3. Boaters launch at East Bay Access Site on Hubbard Lake.

To minimize the spread of AIS, the goal of this project is to provide more comprehensive information about Michigan boaters’ awareness of required and recommended AIS-prevention behaviors and willingness to engage in them. The specific project objectives are to: 1) evaluate the effectiveness of AIS regulations and public outreach and education programs, 2) determine the level of boaters’ understanding of AIS regulations and willingness to follow them, and 3) help design more effective outreach and education programs to publicize the regulations and increase boaters’ willingness to engage in other voluntary actions.

METHODS

Focus Group

Prior to surveying boaters, the project team invited members of Michigan's AIS Core Team to provide input on survey design and outreach messages. State agencies participating in the AIS Core Team include Michigan Department of Environmental Quality (MDEQ), Michigan Department of Natural Resources (MDNR), and Michigan Department of Agriculture and Rural Development (MDARD). Members of the AIS Core Team were invited to a focus group meeting held at Michigan State University on March 13, 2014. Attendees included AIS Core Team Chairperson Kevin Walters (MDEQ Water Resources Division), MDEQ AIS Coordinator Sarah LeSage, MDNR AIS Coordinator Seth Herbst, MDNR Communications Specialist Elyse Walter, and Kile Kucher of MDNR Wildlife Division. The focus group heard presentations from Chi-Ok Oh (MSU) on survey methodology and sample size constraints that determined the maximum number of outreach messages that could be used as treatments (i.e., three). Dan O'Keefe (MSU Extension) facilitated discussion that led to development of the three messages (Appendix 1) and revision of draft survey questions.

Sampling Frame

Out of approximately 1 million boaters registered in the State of Michigan during 2013, a sample of 1,500 boaters was randomly selected and provided by the Michigan Department of State Information Center in April of 2014. Boat registrations are valid for three years and expire on March 31 in the third year of issuance, so the sampled population included boaters who registered a watercraft as early as 2011. The 1,500 sampled boaters were randomly assigned to one of three different groups. Thus, groups 1, 2 and 3 contained 500 boaters each and each group received the same survey questionnaire except for a message. Message 1 included language appealing to environmental values and sense-of-place, Message 2 focused on economic rationale for AIS prevention, and Message 3 provided more comprehensive instructions regarding required and recommended AIS prevention options than other messages (see Appendix 1). In Michigan, "Clean," (i.e., "Inspect" and "Remove"), "Drain," and "Don't Transfer" are required by law under most circumstances while "Disinfect," "Wash" and "Dry" are recommended.

Survey questionnaires were sent to these boaters by first-class mail. The research teams used a modified Dillman Tailored Design Survey (Dillman et al. 2008) with a total of three mailings. The initial mailing was sent on April 22 and included a personalized cover letter, survey questionnaire and postage paid business reply envelope. The second mailing (May 1) consisted of a postal reminder and thank you note. To increase a response rate, the third mailing (May 13) was sent only to those who had not yet responded and included another cover letter, questionnaire and postage-paid business-reply envelope.

RESULTS

Response Rate

Of the 1,500 questionnaires mailed out, 441 questionnaires were returned for a raw response rate of 29.4%. After deleting 142 non-deliverables, the effective response rate was 32.5%. Each outreach message was sent to one group of 500 respondents. Returns for each message were similar; 153 for Message 1, 146 for Message 2, and 142 for Message 3. The effective response rates were 33, 33 and 31%, respectively.

Boater Perceptions of AIS

Five questions related to respondents' perceptions of AIS were asked. The majority of respondents (85.5%) believed that AIS were somewhat or very common in Michigan and only 3% believed that AIS were somewhat or very rare. Over half of respondents (53.3%) believed that the populations of AIS had increased and 16.4% believed that had increased dramatically. When they were asked about the extent to which AIS pose problems in Michigan, 72.3% of boaters indicated that AIS are a serious or very serious problem. The majority (69.6%) of respondents also indicated that AIS pose a serious or very serious problem to Michigan's economy. About two-thirds (66.7%) of boaters self-reported that they were moderately knowledgeable or very knowledgeable about AIS, and only 4.9% of respondents indicated they were unaware of AIS.

When asked about their level of agreement with a series of statements regarding AIS, Michigan boaters tended to disagree with statements that expressed positive attitudes and agree with statements that reflected negative attitudes toward AIS (Table 1). For example, over 90% of respondents either disagreed or strongly disagreed that AIS have the right to live in Michigan waters and that AIS have an equal right to exist relative to native plants and animals. Conversely, over 90% agreed or strongly agreed that AIS are a personal concern and should be controlled where they damage native species.

Table 1. Boater attitudes toward AIS (Q13).

	Strongly Disagree N (%)	Disagree N (%)	Neutral N (%)	Agree N (%)	Strongly Agree N (%)
A. I feel that aquatic invasive species have the right to live on water bodies in Michigan.	290 (67.4)	111 (25.8)	25 (5.8)	3 (0.7)	1 (0.2)
B. Aquatic invasive species have as much right to exist on water bodies in Michigan as native plants and animals.	290 (67.6)	108 (25.2)	24 (5.6)	6 (1.4)	1 (0.2)
C. Aquatic invasive species should be controlled where they do damage to native species.	22 (5.2)	7 (1.6)	10 (2.3)	133 (31.2)	254 (59.6)
D. Aquatic invasive species on water bodies in Michigan are a concern to me.	9 (2.1)	6 (1.4)	26 (6.1)	203 (47.4)	184 (43.0)
E. Control of some wildlife is necessary to conserve the natural ecosystem of water bodies in Michigan.	12 (2.8)	9 (2.1)	57 (13.3)	197 (46.1)	152 (35.6)
F. Native plants and animals are more important to an ecosystem than non-native plants and animals.	11 (2.6)	8 (1.9)	49 (11.4)	169 (39.3)	193 (44.9)

Total N: A=430; B=429; C=426; D=428; E=427; F=430

Social Norms and Awareness of AIS Laws

Most boaters were aware of which AIS-prevention actions are required by law and which were recommended, but understanding of Michigan AIS laws was far from universal (Table 2). Most (82.1%) respondents were aware that “Removing aquatic plants from boats, boating equipment, and boat trailers before launching or placing in the water” is required by the law and more than three-quarters (78.8%) of respondents were aware that “Draining livewells, bilges and all water from boats before leaving the access site.” The majority (63.9%) answered that “Disposing of unused bait on the land or in the trash” is required by law, and this is generally true for fish species listed as VHSV-susceptible under Fisheries Order 245 (Table 2). Most respondents were also aware that other actions are not required by law. The majority answered that “Disinfecting livewells and bilges with a bleach solution” (67.9%), “Power washing boats and trailers” (73.1%), and “Drying boats for at least five days before launching in other waters” (81.6%) are not required under Michigan law (Table 2). Although the majority of boaters were correct regarding the legality of each AIS-prevention measure, at least 17.9% of boaters were incorrect for each action.

Table 2. Boater response when asked if six AIS-prevention actions are required by law in Michigan (Q14).

	Yes N (%)	No N (%)
A. Removing aquatic plants from boats, boating equipment, and boat trailers before launching or placing in the water.*	339 (82.1)	74 (17.9)
B. Draining livewells, bilges and all water from boats before leaving the access site.*	323 (78.8)	87 (21.2)
C. Disinfecting livewells and bilges with a bleach solution.	128 (32.1)	271 (67.9)
D. Disposing of unused bait on the land or in the trash.**	260 (63.9)	147 (36.1)
E. Power washing boats and trailers.	109 (26.9)	296 (73.1)
F. Drying boats for at least five days before launching in other waters.	75 (18.4)	332 (81.6)

Total N: A=413; B=410; C=399; D=407; E=405; F=407

*These actions are in fact required by law in Michigan

**Release of certain VHSV-susceptible species into Michigan waters is prohibited

Respondents were asked to indicate the level of their agreement with statements related to compliance with AIS laws in Michigan. Except for item G, which asked respondents' intention to follow the AIS laws, the rest of items were related to respondents' subjective and injunctive norms. Subjective norms are "individual's perceptions of important others' expectation for a given individual's behavior" (Park and Smith 2007). In other words, subjective norms are perceived as social pressure to perform or not to perform the behavior (items A, B, & C on Table 3). Injunctive norms are defined as "a perception of important people's approval of given individual's behavior" (items D, E, & F on Table 3).

The vast majority (95.3%) of boaters agreed or strongly agreed that they intend to follow the laws when boating (Table 12). This behavior may be influenced by injunctive norms that were strongest for law enforcement officers ($\bar{x} = 4.2$ on 5-point Likert scale; Strongly Disagree = 1, Strongly Agree = 5). Injunctive norms from other boaters and family/friends were less important ($\bar{x} = 3.1$, $\bar{x} = 3.2$, respectively). The same held true for subjective norms, which were stronger for law enforcement officers ($\bar{x} = 4.2$) relative to boaters and family/friends ($\bar{x} = 3.9$ for both).

Table 3. Boater response to statements related to subjective and injunctive norms and compliance with AIS laws in Michigan (Q15).

	Strongly Disagree N (%)	Disagree N (%)	Neutral N (%)	Agree N (%)	Strongly Agree N (%)
A. Family and friends think I should comply with aquatic invasive species laws.	6 (1.4)	5 (1.2)	112 (26.5)	199 (47.0)	101 (23.9)
B. Law enforcement officers think that I should comply with aquatic invasive species laws.	5 (1.2)	6 (1.4)	63 (14.9)	194 (46.0)	154 (36.5)
C. Other boaters think I should comply with aquatic invasive species laws.	4 (1.0)	9 (2.2)	114 (27.5)	205 (49.4)	83 (20.0)
D. When boating, I want to do what family and friends think I should do.	41 (9.8)	76 (18.2)	118 (28.2)	137 (32.8)	46 (11.0)
E. When boating, I want to do what other boaters think I should do.	40 (9.6)	76 (18.3)	135 (32.5)	127 (30.6)	37 (8.9)
F. When boating, I want to do what law enforcement officers think I should do.	8 (1.9)	6 (1.4)	43 (10.2)	202 (47.9)	163 (38.6)
G. I intend to follow the laws the next time I boat.	1 (0.2)	1 (0.2)	18 (4.3)	196 (46.6)	205 (48.7)

Total N: A=423; B=422; C=415; D=418; E=415; F=422; G=421

Comparison of Messages

Boaters were asked if they agreed or disagreed with three statements related to the effectiveness of the message they were shown. The first statement was “I feel that by following behaviors that prevent the spread of aquatic invasive species, I can make a difference.” Boaters reported a very high level of agreement with this statement (\bar{x} = 4.2 on 5-point Likert scale; Strongly Disagree = 1, Strongly Agree = 5) regardless of the message they were shown (Kruskal-Wallis [K-W] test; χ^2 (2) = 0.234, p = 0.890).

Boaters also reported a high level of agreement (\bar{x} = 3.9) with the second statement, “I feel that I know how to go about preventing spread of aquatic invasive species.” The message shown did have an effect on boater agreement with the second statement (K-W test; χ^2 (2) = 13.249, p < 0.001) and post-hoc analysis indicated that the more comprehensive message (Message 3) was more effective than the other two message in educating boaters regarding methods of AIS prevention (Table 4).

Table 4. Boater responses to three questions were influenced by the outreach message they were shown. Kruskal-Wallis tests and post-hoc analyses indicated that the more comprehensive message (Message 3) scored higher on a 5-point Likert Scale for each question.

	Message	N	Mean	S.D.	K-W Test <i>p</i>
16B. By following behaviors that prevent the spread of AIS I can make a difference.	1	145	3.86 ^a	0.833	0.001*
	2	140	3.72 ^a	0.982	
	3	138	4.11 ^b	0.722	
16C. I know how to go about preventing the spread of aquatic invasive species.	1	146	3.86 ^a	0.802	0.006*
	2	140	3.76 ^a	0.975	
	3	136	4.08 ^b	0.770	
17A. Level of agreement that the message was “Informative.”	1	144	3.86 ^a	0.802	<0.001*
	2	141	3.94 ^a	0.725	
	3	135	4.14 ^b	0.784	

*Significant result; α =0.05

^{a,b} Different letters among messages for a given question denote significant differences indicated in pairwise post-hoc χ^2 analysis (p <0.05/3)

The third statement related to message effectiveness, “I believe that I know what steps I should take to prevent the spread of aquatic invasive species,” also found a high level of agreement ($\bar{x} = 3.9$). As with the second statement, there was an effect of message (K-W test; $\chi^2 (2) = 10.172, p = 0.006$) and post-hoc analysis indicated that the comprehensive message was more effective (Table 4).

Table 5. Responses of boaters asked how often they would take AIS-prevention actions when moving boats between waters during their next boating season (Q18).

	Never N (%)	Seldom N (%)	Sometimes N (%)	Often N (%)	Always N (%)
A. Remove aquatic plants from boats, boating equipment, and boat trailers before launching or placing in the water.	4 (1.0)	7 (1.7)	21 (5.2)	94 (23.4)	275 (68.6)
B. Drain livewells, bilges and all water from boats before leaving the access site.	13 (3.3)	11 (2.8)	20 (5.1)	81 (20.7)	266 (68.0)
C. Disinfect livewells and bilges with a bleach solution.	45 (11.9)	47 (12.5)	73 (19.4)	87 (23.1)	125 (33.2)
D. Dispose of unused bait on the land or in the trash.	24 (6.1)	15 (3.8)	30 (7.7)	76 (19.4)	246 (62.9)
E. Power wash boats and trailers.	40 (10.3)	52 (13.3)	104 (26.7)	80 (20.5)	114 (29.2)
F. Dry boats for at least five days before launching in other waters.	50 (12.8)	56 (14.4)	84 (21.5)	87 (22.3)	113 (29.0)

Total N: A=401; B=391; C=377;
D=391; E=390; F=390

Boaters rated each of fourteen message attributes using a 5-point Likert scale (Strongly Disagree = 1, Strongly Agree = 5). Across all SAH! messages the boaters reported a relatively high level of agreement that messages were informative ($\bar{x} = 4.0$), sensible ($\bar{x} = 4.1$), memorable ($\bar{x} = 3.7$), enjoyable ($\bar{x} = 3.5$), useful ($\bar{x} = 4.1$), imaginative ($\bar{x} = 3.4$), believable ($\bar{x} = 4.0$), convincing ($\bar{x} = 4.1$), professional ($\bar{x} = 3.7$), motivating ($\bar{x} = 3.8$), and on-target ($\bar{x} = 3.9$) as well as being easy to process ($\bar{x} = 4.1$), understand ($\bar{x} = 4.1$), and comprehend ($\bar{x} = 4.1$). Only one attribute, “Informative”, showed statistical

differences among three messages ($\chi^2 (2) = 20.063, p < 0.001$). Post-hoc analysis indicated that the more comprehensive message (Message 3) was considered more informative than the other two messages (Table 5).

After reading the message included in the survey, respondents were asked whether they would comply with AIS prevention actions when moving boats between waters during the 2014 boating season (Table 15). The outreach message had no effect on boater intent to “Remove” (i.e., “Clean”), “Drain,” “Disinfect,” “Dispose,” “Wash,” or “Dry” (K-W tests; $p = 0.150, 0.536, 0.848, 0.794, 0.661, 0.788$, respectively). Thus, although boaters judged the more comprehensive message (Message 3) to be more informative and effective it did not have a measureable effect on their intent to take specific actions to prevent the spread of aquatic invasive species in the future.

Regardless of the message, over 80% of the survey’s respondents reported that they would often or always “Remove” (92.0%), “Drain” (88.7%), and “Dispose” (82.3%). This indicated that most of respondents would abide by actions required by the law (Table 6). Around half of respondents also replied that they would often or always “Disinfect” (56.3%), “Wash” (49.7%), and “Dry” (51.3%), indicating a moderate level of compliance with recommended actions (Table 6). As noted previously (Table 2), boaters do not universally understand which actions are mandatory and which are recommended.

Table 6. Comparison of boaters' intent to comply with AIS-prevention actions according to their belief that a specified action is required by law in Michigan or merely recommended (Q14 & Q18).

	Boater Belief	N	Mean	Median	% Always Comply	U Test p
A. Remove**	Required	196	4.60	5	70.4	0.008*
	Recommended	56	4.30	5	53.6	
B. Drain**	Required	191	4.57	5	72.3	<0.001*
	Recommended	53	4.04	4	45.3	
C. Disinfect	Required	73	3.95	4	47.9	<0.001*
	Recommended	159	3.29	4	24.5	
D. Dispose***	Required	158	4.60	5	72.8	<0.001*
	Recommended	88	3.76	4	40.9	
E. Wash	Required	60	3.97	4	48.3	0.001*
	Recommended	184	3.33	3	23.9	
F. Dry	Required	50	4.28	5	56.0	<0.001*
	Recommended	194	3.22	3	21.1	

*Significant result; $\alpha=0.05$

**These actions are in fact required by law in Michigan

***Release of certain VHSV-susceptible species into Michigan waters is prohibited

Compliance with each AIS-prevention action was strongly influenced by boater belief regarding whether the action is or is not required (Table 15; Figure 4). This was true regardless of whether an action is in fact required by law. Mann-Whitney *U* tests indicated significant differences for each action (Table 15), but interpretation varies somewhat among actions. The Mann-Whitney test compares mean ranks, and a significant result can be interpreted as a significant difference in median values only when the shape of distributions is identical.

Distributions for those who believed an action was required vs. recommended differed somewhat because data were skewed toward “Always” for those who believed an action was required. In some cases, a difference in median values was apparent (Table 15) and in all cases the significant difference between “Required” and “Recommended” distributions was a result of “Recommended” distributions being less skewed toward “Always” (Figure 4). In other words, boaters who believed that an action was required were 16.8% to 34.9% more likely to “Always” comply with that action than those who believed it was recommended (Table 15).

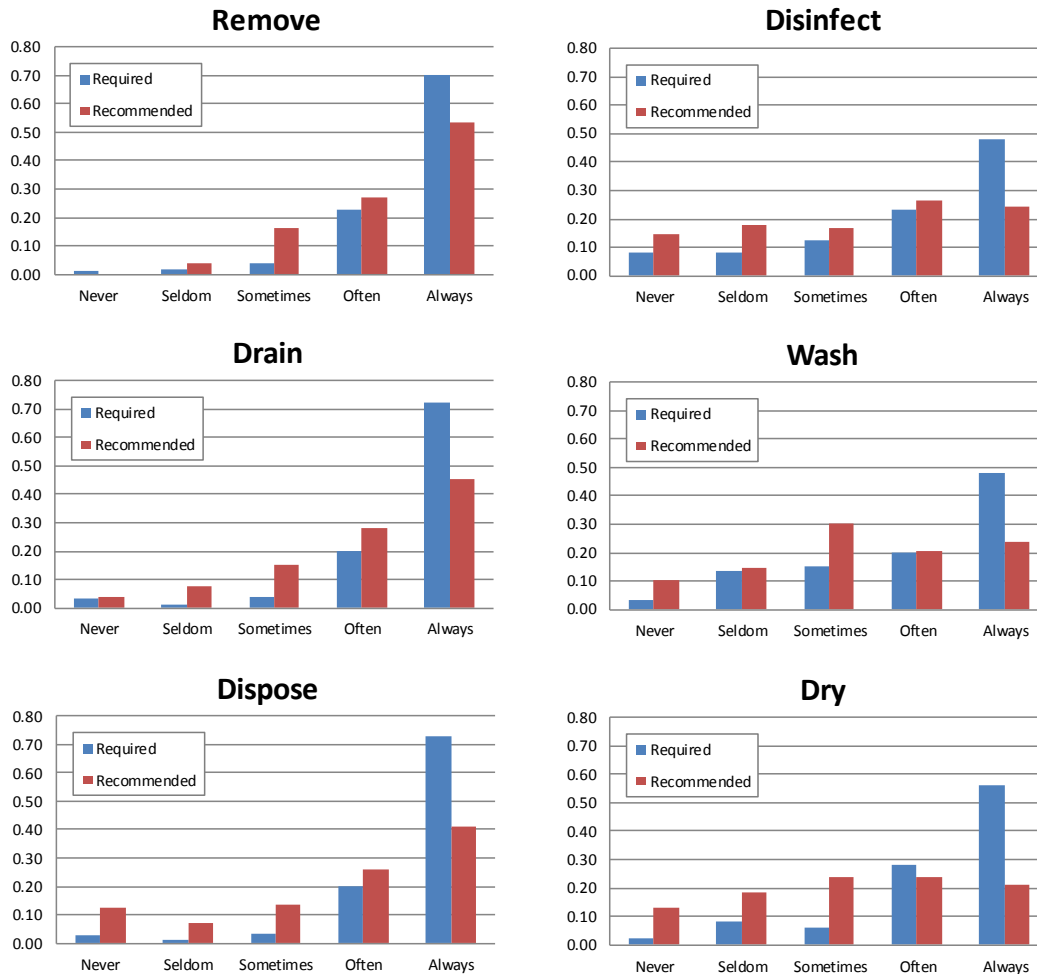


Figure 4 . Distribution of boater responses when asked if they intend to comply with six AIS-prevention actions during their next boating season. Actions that are generally required by Michigan law are shown on the left while actions on the right are not required by law; bars indicate boater belief that a given action is “Required” or “Recommended” (Q14 & Q18).

Comparison with past studies

Although the wording of questions and Likert scales differed somewhat in past surveys of Michigan boaters (Armson 2004; Lee et al. 2012), five of the AIS-prevention actions included in previous surveys were similar to five of the actions included in the present survey and all three surveys included a “Never” category. Comparing results from all three surveys shows a general decline in the proportion of Michigan boaters who “Never” engage in AIS-prevention behavior over the past decade (Figure 5). This trend was most evident for boat washing. Michigan boaters are now nearly four times as likely to wash their boats at least occasionally when moving boats from one body of water to another.

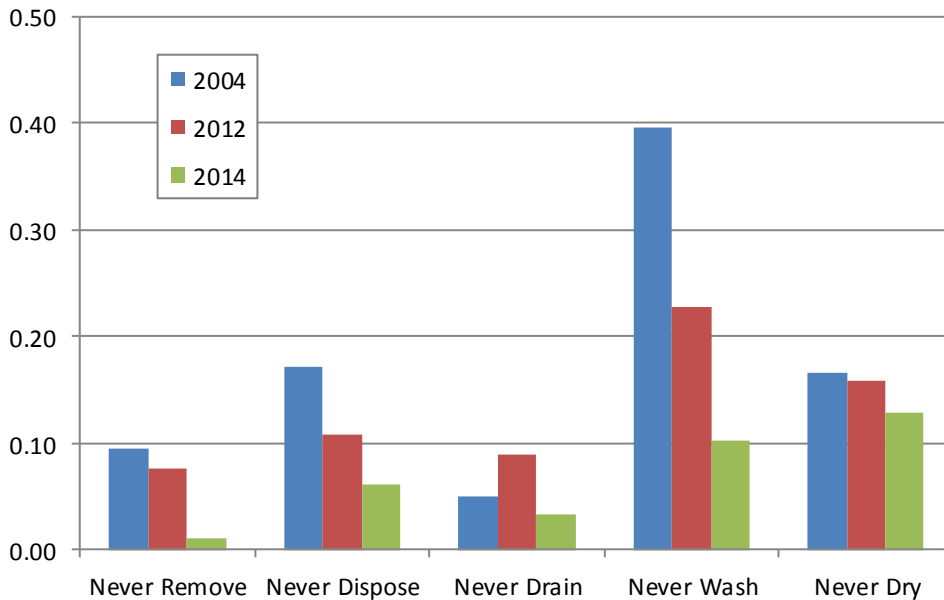


Figure 5. Proportion of Michigan boaters who reported “Never” taking AIS-prevention actions in 2004, 2012, and 2014 surveys.

Recommended actions for Michigan boaters include “Wash” or “Dry” as opposed to “Wash” and “Dry.” This means that complete compliance with individual recommended actions is not advised or expected. In 2012, only 27.0% of boaters “Always” sprayed or washed and 32.2% “Always” dried boats for at least five days; 41.8% would “Always” either “Wash” or “Dry” in 2012. In 2014, boaters were slightly less likely to “Always” either “Wash” or “Dry” with only 37.2% intending to take one of these recommended actions whenever moving a boat. Although “Disinfect” was not mentioned in the 2012 survey, it was listed as an alternate recommended action along with “Wash” and “Dry” in 2014 based on focus group discussions (Appendix 1, Message 3). In 2014, 46.1% of boaters would “Always” take one of these three recommended actions when moving a boat.

Demographics

Almost half of respondents were from the southeast Lower Peninsula of Michigan (46.9%), followed by the southwest (27.4%), northwest (9.2%), northeast (7.7%), and Upper Peninsula (4.5%) regions. Also, a small percentage of respondents were from other states including Ohio (1.5%), Illinois (0.7%), Indiana (0.7%), Wisconsin (0.5%), Maryland (0.2%) and Pennsylvania (0.2%). There was one international respondent from Canada (0.2%).

The average age of respondents was 60 years old. The minimum age was 20 years and the maximum age was 88. The most common response category was the age interval of 60-69 (32.1%), followed by the age intervals of 50-59 (28.4%) and over 70

(21.7%). The majority of survey respondents were male (88.0%) and only 12.0% were female. The most common income category was between \$40,000 and 59,999 (19.9%) and the median category was \$60,000-79,999. About one-third of respondents (36.3%) had attended some college or technical school while 43.3% had college or postgraduate education. Less than half (42.9%) reported their employment status was “retired” (42.9%) while about one-third of them reported, “employed, full time” (37.3%).

DISCUSSION

Michigan boaters typically express concern regarding threats posed by aquatic invasive species (AIS) and believe that their actions can make a difference in preventing the spread of AIS. Boaters also express a high level of general willingness to comply with boating laws. However, when it comes to specific AIS-prevention actions there is some confusion regarding which actions are required by law. This directly affects compliance with laws intended to prevent the spread of AIS because boaters are more likely to engage in behaviors they believe to be required by law.

One would therefore expect that a more comprehensive outreach message would be more effective at increasing boater intent to engage in required AIS-prevention actions. While boaters who received the more comprehensive outreach message found it more “Informative” than other messages and reported an increased belief in their ability to prevent the spread of AIS, they did not report any increase in their intent to take specific actions in the future. Regardless of the outreach message they were shown, all Michigan boaters reported similar willingness to engage (or not engage) in specific AIS-prevention behaviors. Furthermore, a similar study recently found no difference in willingness to engage in AIS-prevention behaviors between those who were and were not mailed outreach materials (Lee et al. 2012).

Although a single exposure to outreach materials is not enough to influence behavior, multiple exposures over the long term may influence social norms that are precursors to behavior change. Comprehensive messages could have the added benefit of increasing knowledge regarding specific actions required by law. Previous surveys conducted in Michigan and other states have found that boaters rely on a variety of information sources for AIS-prevention information but consistently rate signage at access sites, regulation booklets, television news programs, magazines, and newspapers among the most effective at influencing behavior change (Armson 2004; Lee et al. 2012; Witzling and Shaw 2014). The *Stop Aquatic Hitchhikers!*TM (*SAH!*) logo has been featured in all of these venues and many others, resulting in hundreds of millions of impressions nationally (Wildlife Forever 2013). Over the long term this type of exposure should influence social norms and behavior, but simplification of messages paired with the *SAH!* Logo could also cause confusion regarding required behaviors.

Furthermore, although Michigan boaters have been required to drain bilges and livewells since 2007 and remove plants from equipment since 2009 there has never

been a citation for violation of these regulations (Steven Huff, Michigan DNR, personal communication). Conflicting or unclear messaging could be partially responsible for Michigan boaters' confusion regarding actions required by law, while lack of enforcement gives boaters little incentive to decipher the particulars of Michigan's AIS-prevention laws.

The situation is different in other states. In Wisconsin, Conservation Wardens enforce AIS laws and also participate in outreach at AIS Warden Team Events (Wisconsin DNR 2013). Wisconsin DNR also created the Water Guard Program in 2008; water guards serve as deputy wardens and work full time on AIS education, enforcement, and training during peak boating months (Wisconsin DNR 2013). In Minnesota, 43% of AIS funding is directed toward inspection and enforcement activities (Minnesota DNR 2013). While Michigan has never issued a citation related to AIS-prevention actions, Minnesota issued 405 open water citations in 2013 alone and reported a decrease in violation rate from 18.0% to 13.7% from 2011 to 2013; additional enforcement and higher violation rates occurred at AIS check stations (Minnesota DNR 2014). While citations alone may not be a desirable outcome, they indicate reinforcement of norms that can influence behavior even when penalties are minimal (Tyran and Feld 2002). A better understanding of the relative importance of legal, social, and private norms (Dechesne and Dignum 2011) that govern AIS-prevention behavior may aid in developing policies that efficiently devote resources to an appropriate mix of enforcement and outreach activities.

While outreach may play a role in encouraging adoption of recommended behaviors ("Disinfect, Wash or Dry") over time, access to appropriate facilities could also play an important role in encouraging boat washing and establishing social norms. Michigan boaters are much more likely to engage in boat washing now than they were a decade ago. While determining the cause of this change is beyond the scope of the current study, the construction of permanent boat washes at heavily used access sites such as Higgins Lake State Park and the growing availability of mobile decontamination units could be influential. Lack of boat wash availability was the most common reason boaters expressed for not taking AIS-prevention action when moving boats between waterways in the Kawishiwi Watershed, Minnesota (Jensen 2012). Boat washing is an example of a behavior with relatively low (and historically very low) compliance in Michigan. The availability of boat washes at high-use sites could have an impact far beyond individual sites through influence of social norms.

In conclusion, our study demonstrates that boater compliance with AIS-prevention behaviors has increased over the past decade in Michigan. This is likely due to multiple factors including regulations enacted in 2004 and 2007, coordinated outreach efforts, mass media coverage of AIS issues, and increased availability of boat washes. Taken as a whole these efforts have been effective at reducing, but not eliminating, the risk of secondary spread via boating. Boaters tend to engage in behaviors they believe to be required, but many remain unclear on the specifics of Michigan's AIS-prevention laws. Although a comprehensive outreach message can be more informative than simplistic messages, our previous results suggest that a single viewing of outreach materials has

no effect on intent to engage in AIS-prevention behaviors. Future AIS-prevention efforts should incorporate a balance of outreach, law enforcement, and other activities intended to influence social norms and increase boater adoption of AIS-prevention behaviors in Michigan.

RECOMMENDATIONS

Based on study findings, we offer several recommendations that may help in developing more effective AIS prevention:

Recommendation 1

Pair a comprehensive outreach message with more engaging visuals.

Boaters found the comprehensive message more informative but all three messages were judged to be informative, sensible, useful, believable, convincing, professional, motivating, on-target, and easy to process, understand, and comprehend. All three messages were rated somewhat lower in terms of being enjoyable and imaginative. Although the comprehensive message was informative, it also lacked clear delineation of which actions were required before vs. after boating. Revision of the existing comprehensive message could include creative use of graphic art and clear separation of AIS-prevention actions to be taken before and after boating.

Recommendation 2

Clarify and standardize a comprehensive outreach message for access point signs and the boater handbook.

Boaters expressed a strong intention to abide by boating laws, but many (17.9% to 32.1%) were unclear regarding the required vs. recommended nature of each AIS-prevention behavior. Boat launch signs and boating regulation booklets are among the most effective tools for changing boater behavior and reaching a large audience of boaters. Standardizing a comprehensive message for use on Michigan signs and boater handbook would help to avoid confusion and increase compliance with required actions. Boater safety education materials (i.e., the Boat Michigan course) should also include the standardized outreach message and clearly state which AIS-prevention actions are required vs. recommended.

Recommendation 3

Provide all registered boaters with the standardized comprehensive message.

Boat registrations are renewed on a three-year cycle in Michigan. After boaters renew their registration they receive a watercraft decal by mail from the Secretary of State. This provides an ideal opportunity to enclose a flyer that clearly explains AIS prevention requirements and other recommended actions. The flyer should include the same standardized comprehensive message used in the boater handbook and on access site signage.

Recommendation 4

Expand upon law enforcement officer engagement in AIS outreach and education efforts.

Boaters were more likely to engage in behaviors based on what law enforcement officers think as opposed to family, friends, and other boaters. Even though officers are very important in setting social norms, 17.5% of boaters did not agree that officers “think that I should comply with aquatic invasive species laws.” Conservation officers with MDNR already participate in boating and outdoor shows and often verbally inform boaters of AIS-prevention laws without issuing citations. Formation of an AIS Unit within MDNR’s Law Division could facilitate a strategic approach to expanding upon existing efforts. Targeted outreach to other law enforcement officers (i.e., Marine Units at the county level) could also encourage better understanding of AIS-prevention laws and the role of officers in setting social norms.

Recommendation 5

Enforce Michigan’s AIS-prevention laws after increasing outreach efforts.

Michigan boaters are currently required to “Remove” aquatic plants before launching and “Drain” livewells and bilges before leaving the launch site. However, no citations have been issued for relevant regulations (NREPA 324.41325 [1] and Fisheries Order 245.14 [16], respectively). Immediately increasing the number of citations issued in Michigan would not be a desirable outcome, in part due to the finding that many boaters are currently unclear regarding the required actions. An increase in enforcement activity following a period of time for work on policy and education recommendations would be a more appropriate option. Three years would allow enough time to reach all registered boaters via mail in conjunction with registration renewals.

Recommendation 6

Expand NREPA 324.41325 to cover draining and removal of mussels and mud.

Although Michigan boaters are required to “Remove” aquatic plants before launching, they are not required to do the same for attached mussels or mud and other debris that may harbor small or microscopic invasive species. Expanding NREPA provisions beyond plants would encourage boaters to “Wash, Dry, or Disinfect” as per current recommendations because these additional steps would help to ensure that no mud is present on launched boats. Draining of water is required under F.O. 245, an order that deals mostly with live bait regulations for anglers. Including draining provisions under an amendment to NREPA (or a new act specific to all aspects of boater AIS-prevention) would put all boater requirements under a single legal umbrella.

Recommendation 7

Harmonize AIS-prevention laws across Great Lakes region.

The Great Lakes Council of Governors and Premiers of Ontario and Québec recently agreed upon a list of “Least Wanted” AIS. Some states and provinces subsequently took action to prohibit possession and transport of some of the regionally-recognized species that were not already prohibited. A similar strategy could be used to identify high-priority AIS-prevention actions for all Great Lakes states and provinces. In addition to protection aquatic resources, development of harmonized legislation across the region would have the advantage of making compliance easier for boaters who travel across jurisdictions.

Recommendation 8

Coordinate outreach, enforcement, policy, and development of infrastructure.

While outreach could have an effect on social norms, it is also part of more comprehensive efforts that involve legislation, law enforcement, and development of infrastructure (i.e., boat washes). Future outreach efforts (e.g., Landing Blitz) should leverage efforts in other arenas for maximum effect and changes in policy or enforcement should be accompanied by outreach.

Recommendation 9

Target diverse audiences using traditional and new media.

Traditional media such as television advertising, newspapers, and regulation booklets consistently rank as the most important sources of information for boaters engaging in AIS-prevention while online sources rank much lower. Most Michigan boaters are over 50 years old and may rely heavily on traditional media, but a mix of traditional and new media is recommended to reach more diverse audiences.

Recommendation 10

Conduct follow-up survey in 2020.

Other recommendations (with the exception of Recommendation 5) should be implemented within a five-year time frame. Replicating this survey after the 2020 boating season would give resource managers and outreach professionals an understanding of how boater behavior and beliefs changed in response to implementation of recommendations. Recommendations could be revisited at that time in light of changes in boater compliance with required and recommended AIS-prevention actions.

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APPENDIX 1. Messages



STOP AQUATIC HITCHHIKERS!™

✓ CLEAN ✓ DRAIN ✓ DRY

All Boats and Recreational Equipment

**Michigan laws help keep
our waters world-class.**

www.ProtectYourWaters.net

Message 1



STOP AQUATIC HITCHHIKERS!™

✓ CLEAN ✓ DRAIN ✓ DRY

All Boats and Recreational Equipment

**Aquatic invaders cost us
\$5.7 billion every year.**

www.ProtectYourWaters.net

Message 2



STOP AQUATIC HITCHHIKERS!™

Prevent transport of aquatic invasive species.
Clean all recreational equipment.

www.ProtectYourWaters.net

Required Actions – It's the Law in Michigan!

- **REMOVE** aquatic plants from boats, boating equipment, and boat trailers before launching or placing in the water.
- **DRAIN** live wells, bilges and all water from boats before leaving the access site.
- **DISPOSE** of unused bait in the trash. Do not release bait into the water.
- **DON'T TRANSFER** fish to water bodies other than where they were caught.

Additional Recommended Actions – Protect Our Natural Resources!

- **INSPECT** and **REMOVE** plants and mud from boats and trailers and dry equipment before leaving the access area.
- **POWER WASH** boats and trailers before leaving the access area if possible or at a nearby car wash, AND/OR
- **DRY BOATS** & equipment for at least 5 days before going to other waters.
- **DISINFECT** livewells and bilges with bleach solution (1/2 cup bleach to 5 gallons water)



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