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

2015 MICHIGAN AIS AND BOATING SURVEY FINAL REPORT

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

Final Report

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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!™ Clean Boats, Clean Waters*, and *Be a Hero, Transport Zero* match logos and slogans with information on specific AIS-prevention actions.

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) were similar (33% for Message 1 and 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. Subjective and injunctive norms associated with law enforcement officers than for family, friends, and other boaters. Boater 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.

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 Hitchikers!*™ 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 that require boaters to take certain AIS-prevention actions.

Public outreach and education programs have included *Stop Aquatic Hitchhikers!*™, *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!*™ 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 the secondary spread of AIS (Wildlife Forever 2013) although some messages have included additional or alternate description of actions.

The *Stop Aquatic Hitchhikers!*™ 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!*™ 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 A) 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 A). 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.

Questionnaire

The questionnaire was adapted from the Michigan 2012 Aquatic Nuisance Species and Boating Survey jointly conducted by the Michigan State University and Michigan Sea Grant Program (Lee et al. 2012). The questionnaire also included additional questions that asked about environmentally conscious boating behaviors and the effectiveness of outreach activities related to the protection of aquatic natural resources. The questionnaire mainly addressed the following six topics: 1) boating activity, 2) perceptions of AIS, 3) awareness of AIS laws, 4) engagement in AIS prevention and other environmentally responsible behaviors, 5) attributes of outreach messages, and 6) demographics.

Statistical Analysis

Each individual respondent was provided with only one of the three messages. Respondents were then asked to read the message before answering questions specific to their message (see Appendix B for full questionnaire). The first question (Q16) asked respondents' level of agreement regarding the effectiveness of the message. The second (Q17) asked the level of respondents' agreement on message attributes. The third (Q18) asked the level of respondents' willingness to take actions that can prevent the spread of AIS during the 2014 boating season. All of the questions were asked using a 5-point Likert scale (i.e., Strongly Disagree = 1, Strongly Agree = 5 for Q16 &17 and Never = 1, Always = 5 for Q18).

Attributes and effectiveness of the three messages were compared using Kruskal-Wallis (K-W) tests. The K-W test was conducted instead of the analysis of variance (ANOVA), which is commonly used to analyze group differences (Field 2009). To conduct ANOVA the assumption of normality needs to be satisfied. However, normality tests, including visual inspection of distribution (histogram, Q-Q plot) and Kolmogorov-Smirnov test (K-S test,) showed that the data did not meet to the normality assumption. The K-W test can only indicate a significant difference for a given question across the three groups but does not specify which groups are different. Post-hoc χ^2 analyses were conducted to identify which pairs of groups were statistically different from one another. Bonferroni's correction was used to avoid compromising our chosen level of significance ($\alpha = 0.05$).

While outreach messages may play role in influencing boater adoption of AIS-prevention behaviors, boaters also may be more likely to engage in behaviors that they believe to be

required by law. Before respondents viewed messages, they were asked if each of the six specified AIS-prevention actions are required by law (Q14). Results from this question were used to separate boaters into two groups for each AIS-prevention action: those that believed the action was required by law and those that did not. Mann-Whitney *U* tests (Field 2009) were conducted to examine the effect of this belief on intent to perform each specified AIS-prevention action (Q18). Boaters who received Message 3 were excluded from this analysis because this more comprehensive message described which actions were, in fact, required by law. Boaters who received the other messages were not provided with specific information regarding required actions and therefore only relied upon their prior understanding of AIS laws when answering Q18.

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.

Boating Activity

In the first section, respondents were asked about their boating experience. The average boater had 34.7 years of boating experience (Table 1) and the vast majority of registered boaters (96.3%; N = 433) reported that they owned their own boats (Table 2). In Michigan, registered boaters are required to notify the Secretary of State and surrender their Certificate of Number within 15 days of vessel destruction, abandonment, or transfer of ownership so it was expected that ownership would be close to 100%.

Table 1. Years of boating experience (Q1).

Years	N	Percentage (%)
1-10	50	11.8
11-20	52	12.3
21-30	93	22.0
31-40	79	18.7
41-50	86	20.3
51-60	51	12.1
Over 61	12	2.8
Total	423	100

The majority (87.5%) of respondents (N = 417) reported that they had used their boat during the 2013 season and only 12.5% said they had not. Those who boated during 2013 were asked about patterns of boating activity (Table 2). Nearly half (48.1%; N = 318) of boaters visited the Great Lakes including bays, Lake St. Clair, and St. Clair, St. Mary's and Detroit rivers at least once during 2013. The average Great Lakes boater took 18.4 trips (S.D. = 17.2) on Great Lakes waters in 2013 (Table 2). Rivers, rivermouth lakes and inland lakes accessible by boat from Great Lakes waters were visited by 42.1% of active boaters (N = 299) at least once and an average of 15.1 times (S.D. = 22.7) during the 2013 season. Inland waters not accessible by boat from the Great Lakes accounted for the heaviest use, with 85.8% of boaters (N = 344) visiting these disconnected waters at least once and an average of 26.9 times (S.D. = 28.0 times) during 2013. In-state waters were visited by 87.6% of boaters (N = 322) while out-of-state waters were visited by 18.3%. Boaters who took trips on in-state waters in 2013 averaged of 31.5 trips (S.D. = 31.7) in 2013, and those who boated on out-of-state waters averaged 8.0 trips (S.D. = 8.4) in 2013.

Boaters who used their boats(s) during 2013 were also asked whether they transported boat(s) between the Great Lakes and Michigan inland lakes during the 2013 boating season. Out of 378 respondents, 19.8% respondents stated that they had transported boat(s) and 80.2% stated that they had not transported boat(s). Those respondents who had transported boat(s) did so an average of 9.1 times (S.D. = 13.8) during 2013. Although the majority of registered Michigan boaters did not move boats between the two types of water bodies, a small fraction (3.6%) did so more than 10 times and up to 75 times per season.

Table 2. Number of trips taken by Michigan boaters on different types of water bodies during the 2013 season (Q3A, Q3C).

	Great Lakes*		Connected**		Inland***		In-State		Out-of-State	
Trips	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
0	165	51.9	173	57.9	49	14.2	40	12.4	223	81.7
1-10	78	24.5	77	25.8	103	29.9	78	24.2	39	14.3
11-20	35	11.0	23	7.7	81	23.5	71	22.0	8	2.9
21-30	22	6.9	10	3.3	41	11.9	43	13.4	2	<0.1
31-40	3	0.9	8	2.7	15	4.4	23	7.1	1	<0.1
41-50	6	1.9	6	2.0	21	6.1	22	6.8	0	0
51-60	6	1.9	0	0.0	7	2.0	13	4.0	0	0
61-70	0	0.0	0	0.0	0	0.0	4	1.2	0	0
Over 71	3	0.9	0	0.7	27	7.8	28	8.7	0	0
Total	318	100	299	100	344	100	322	100	273	100

*Great Lakes waters include bays, Lake St. Clair, and St. Clair, St. Mary's and Detroit rivers
**Connected waters include rivers, rivermouth lakes, and inland lakes accessible by boat from Great Lakes
***Inland waters include all waters not accessible by boat from Great Lakes

Boaters (N = 426) were asked to indicate their primary activity while boating in Michigan waters during 2013. The most common response was recreational fishing (46.0%), followed by pleasure cruising (27.0%), sightseeing (15.5%), and water skiing or tubing (5.4%). Other activities listed by less than 3% of boaters as their primary activity included sailboat racing, commercial use, transportation, duck hunting, scuba diving, tournament fishing, yacht racing, and "swimming in the middle of the lake." When boaters (N = 425) were asked to report their level of commitment to boating, most (67.5%) self-reported as "casual boater" and only 6.4% reported as "committed boater." The remaining 26.1% classified themselves as active boaters.

Table 3. Number and percentage of boaters engaging in environmentally conscious boating behaviors (Q6).

	Never N (%)	Seldom N (%)	Some-times N (%)	Often N (%)	Always N (%)
A. Keep oil-only absorbent pillows or socks in my bilge.	340 (83.5)	19 (4.7)	10 (2.5)	10 (2.5)	28 (6.9)
B. Recycle my used boat oil and filters.	160 (39.6)	12 (3.0)	17 (4.2)	31 (7.7)	184 (45.5)
C. Do major boat maintenance or cleaning.	64 (16.8)	39 (10.3)	93 (24.5)	93 (24.5)	91 (23.9)
D. Remove aquatic plants from boats, boating equipment, and boat trailers before launching or placing in the water.	110 (27.4)	27 (6.7)	27 (6.7)	70 (17.5)	167 (41.6)
E. Use cleaning substitutes-such as vinegar, baking soda, "eco-cleaners," etc. to clean my boat.	212 (51.0)	56 (13.5)	55 (13.2)	48 (11.5)	45 (10.8)
F. Buy and use phosphorus-free biodegradable soaps for my boat sink and showers.	250 (64.3)	28 (7.2)	30 (7.7)	28 (7.2)	53 (13.6)

Total N: A=407; B=404; C=441; D=401; E=416; F=389

Respondents were asked about two different types of environmentally responsible behaviors (ERB): environmentally conscious boating behaviors and behaviors related to protecting aquatic natural resources. Most environmentally conscious boating behaviors showed relatively low mean values. On a scale of 1 = Never to 5 = Always, the highest mean value was reported for the only AIS-related behavior (Table 3). Boaters rarely performed behaviors related to purchasing particular products such as absorbent pillows and phosphorus-free biodegradable soaps. Conversely, the majority of boaters (64.4%) would always or often pick up litter at a boating access site and 46.0% would always or often encourage others to do so. With respect to

other behaviors related to protecting aquatic natural resources, most showed relatively low compliance (Table 4).

Table 4. Number and percentage of boaters engaging in behaviors related to protecting aquatic natural resources (Q7).

	Never N (%)	Seldom N (%)	Some-times N (%)	Often N (%)	Always N (%)
A. Encourage others to reduce their waste and pick up their litter when they are at boating area.	103 (24.7)	41 (9.8)	80 (19.2)	71 (17.0)	122 (29.3)
B. Pick up litter at boating access site.	38 (9.2)	20 (4.8)	89 (21.5)	112 (27.1)	154 (37.3)
C. Learn more about aquatic natural environment area left by other visitors.	162 (40.9)	72 (18.2)	93 (23.5)	47 (11.9)	22 (5.6)
D. Sign petition in support of aquatic natural area or protected area.	282 (68.3)	47 (11.4)	32 (7.7)	24 (5.8)	28 (6.8)
E. Participate in public meeting about managing aquatic natural environment.	304 (72.7)	52 (12.4)	37 (8.9)	14 (3.3)	11 (2.6)
F. Volunteer my time to projects that help aquatic natural environment.	324 (77.5)	52 (12.4)	22 (5.3)	11 (2.6)	9 (2.2)
G. Write letters in support of aquatic protected areas.	361 (88.5)	28 (6.9)	15 (3.7)	2 (0.5)	2 (0.5)
H. Volunteer to reduce visiting/boating activity in a water body if it needs to recover from environmental damage.	343 (83.9)	28 (6.8)	17 (4.2)	8 (2.0)	13 (3.2)
I. Volunteer to stop visiting/boating activity a favorite water body if it needs to recover form environmental damage.	333 (82.0)	20 (4.9)	21 (5.2)	12 (3.0)	20 (4.9)
J. Contribute donations to ensure protection of aquatic natural environment.	267 (63.7)	39 (9.3)	67 (16.0)	28 (6.7)	18 (4.3)

Total N: A=417; B=413; C=396; D=401; E=413; F=413; G=408; H=409; I=406; J=419

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 (Table 5) 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 AIS had increased dramatically (Table 6). 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 (Table 7). The majority (69.6%) of respondents also indicated that AIS pose a serious or very serious problem to Michigan's economy (Table 8). 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 that they were unaware of AIS (Table 9).

Table 5. Boater perception of AIS abundance in Michigan (Q8).

	N	Percentage (%)
Very rare	2	0.5
Somewhat rare	11	2.5
Intermediate	30	6.9
Somewhat common	101	23.3
Very common	270	62.2
Unsure	20	4.6
Total	434	100.0

Table 6. Boater perception of AIS population trends in Michigan over the past five years (Q9).

	N	Percentage (%)
Increased dramatically	71	16.4
Increased	231	53.3
Stayed about the same	88	20.3
Decreased	8	1.8
Decreased dramatically	3	0.7
Unsure	32	7.4
Total	433	100.0

Table 7. Boater responses regarding the extent to which AIS currently pose problems in Michigan (Q10).

	N	Percentage (%)
Not a problem	3	0.7
Slight problem	10	2.3
Moderate problem	89	20.6
Serious problem	181	41.8
Very serious problem	132	30.5
Unsure	18	4.2
Total	433	100.0

Table 8. Boater perception of the extent to which AIS threaten the future of Michigan's economy (Q11).

	N	Percentage (%)
Not a problem	5	1.2
Slight problem	23	5.3
Moderate problem	85	19.7
Serious problem	147	34.1
Very serious problem	153	35.5
Unsure	18	4.2
Total	431	100.0

Table 9. Level of self-reported boater knowledge regarding AIS (Q12).

	N	Percentage (%)
Not at all	21	4.9
Slightly	100	23.3
Moderately	219	50.9
Very	68	15.8
Extremely	10	2.3
Unsure	12	2.8
Total	430	100

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 10). 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 10. 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

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 11). 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 ore 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 11). 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 11). 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 11. 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 12). Injunctive

norms are defined as “a perception of important people’s approval of given individual’s behavior” (items D, E, & F on Table 12).

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 12. 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 (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 13).

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; χ^2 (2) = 10.172, p = 0.006) and post-hoc analysis indicated that the comprehensive message was more effective (Table 13).

Table 13. 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 *p*
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)

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 (χ^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 14).

Table 14. 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 (%)	Some-times 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

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 AIS in the future.

Regardless of the message, over 80% of 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 15). 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 15). As noted previously (Table 11), boaters do not universally understand which actions are mandatory and which are recommended.

Table 15. 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*	*p*
A. Remove**	Required	196	4.60	5	70.4	6,545	0.008*
	Recommended	56	4.30	5	53.6		
B. Drain**	Required	191	4.57	5	72.3	6,559	<0.001*
	Recommended	53	4.04	4	45.3		
C. Disinfect	Required	73	3.95	4	47.9	7,437	<0.001*
	Recommended	159	3.29	4	24.5		
D. Dispose***	Required	158	4.60	5	72.8	9,511	<0.001*
	Recommended	88	3.76	4	40.9		
E. Wash	Required	60	3.97	4	48.3	7,095	0.001*
	Recommended	184	3.33	3	23.9		
F. Dry	Required	50	4.28	5	56.0	7,114	<0.001*
	Recommended	194	3.22	3	21.1		

*Significant result; α=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).

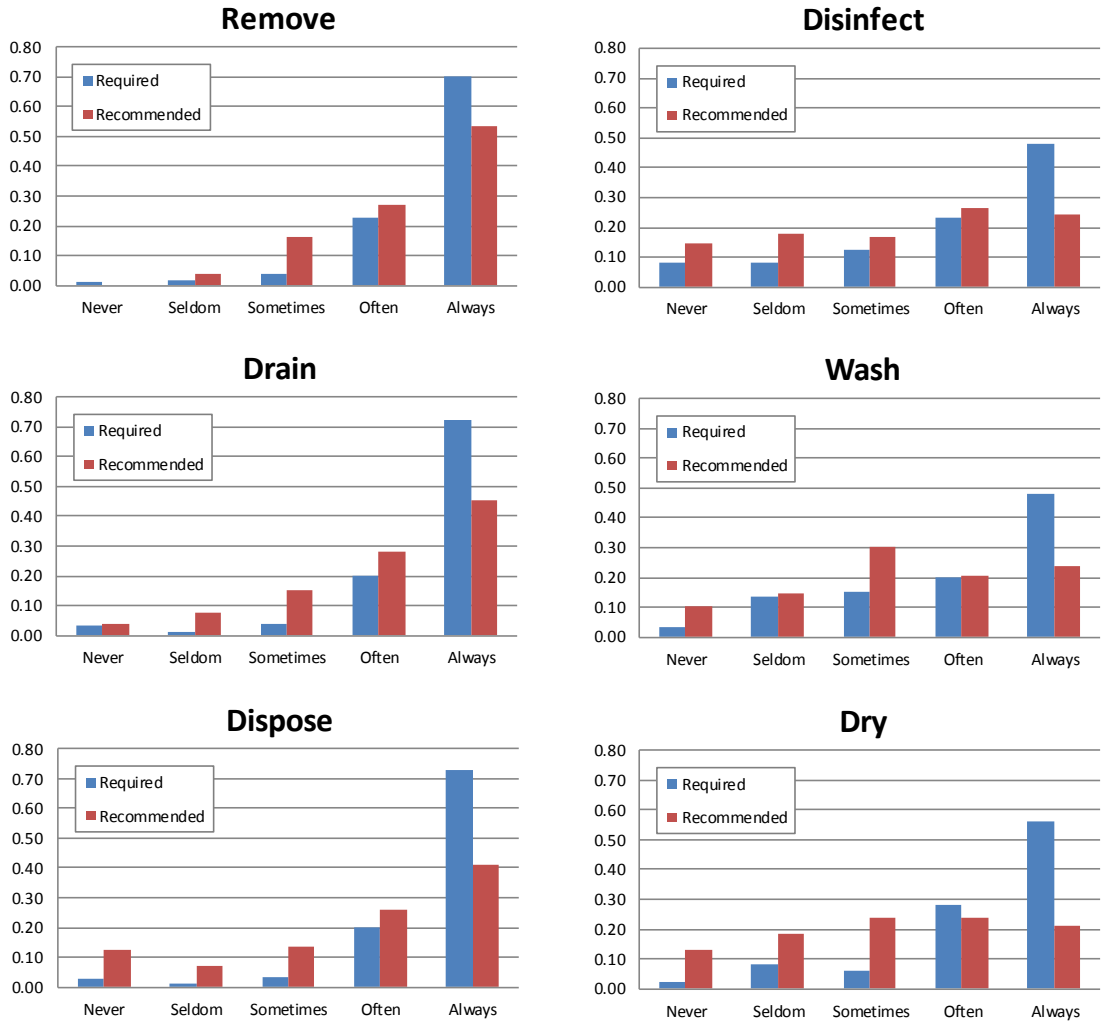

Figure 4 . Distribution of boater responses when asked if they intend to comply with six AIS-prevention actions during their next boating season. Actions that are generally required by Michigan law are shown on the left while actions on the right are not required by law; bars indicate boater belief that 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.

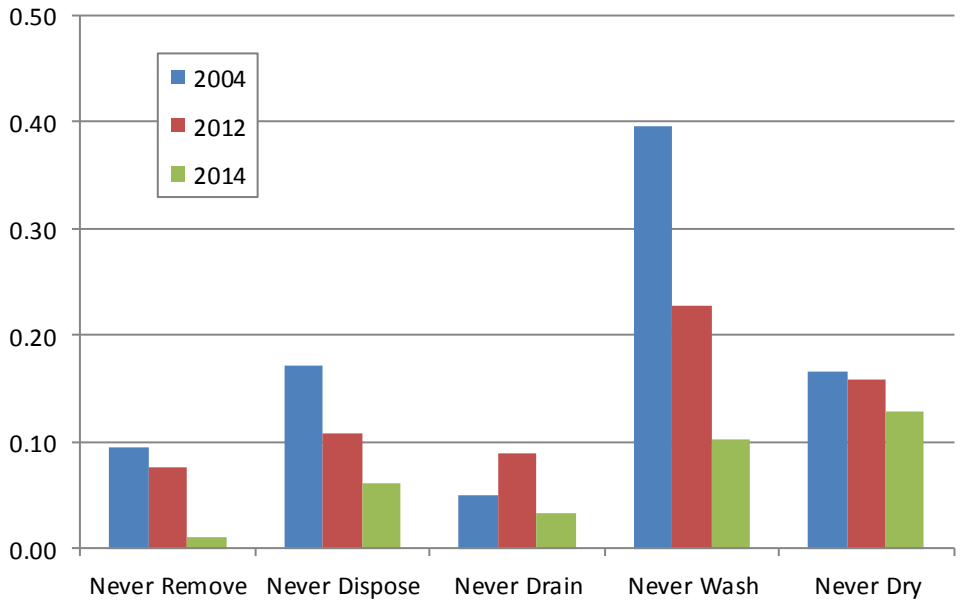

Figure 5. Proportion of Michigan boaters who reported "Never" taking AIS-prevention actions in 2004, 2012, and 2014 surveys.

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 A, 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 (Table 16). 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%).

Table 16. Demographic characteristics of respondents (QA-QF).

		N	%	Total N
Region (Clare, MI as center point)	Southeast	188	46.9	402
	Southwest	110	27.4	
	Upper Peninsula	18	4.5	
	Northwest	37	9.2	
	Northeast	31	7.7	
Age	18-24 yrs	3	0.7	414
	25-29 yrs	3	0.7	
	30-39 yrs	14	3.3	
	40-49 yrs	54	13	
	50-59 yrs	117	28.4	
	60-69 yrs	133	32.1	
	70 or older	90	21.7	
Gender	Female	50	12.0	417
	Male	367	88.0	
Income	Less than $19,000	19	5.3	357
	$20,000 - 39,999	59	16.5	
	$40,000 - 59,999	71	19.9	
	$60,000 - 79,999	57	16.0	
	$80,000 - 99,999	41	11.5	
	$100,000 - 119,999	38	10.6	
	$120,000 - 139,999	11	3.1	
	$140,000 and above	61	17.1	
Education	Some high school or less	14	3.4	416
	High school graduate	71	17.1	
	Some college/ Technical school	151	36.3	
	University graduate	101	24.3	
	Post graduate school	79	19.0	
Employment	Homemaker	6	1.4	415
	Unemployed	9	2.2	
	Student	1	0.2	
	Retired	178	42.9	
	Employed, part time	20	4.8	
	Employed, full time	155	37.3	
	Self-employed	42	10.1	
	Other	4	1.0	

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 (Lee et al. 2012) recently found no difference in willingness to engage in AIS-prevention behaviors between those who were and were not mailed outreach materials (Appendix C; Appendix D).

Even though boaters responded favorably to outreach messages and materials when asked specific questions regarding message attributes and effectiveness, this experimental approach to evaluating outreach messages suggests that a single exposure to outreach products has no demonstrable effect on intent to perform specific AIS-prevention actions. Other surveys conducted online or in person at boat shows or launch sites have typically used a before-and-after approach that involves asking individual respondents about their intention to perform actions twice. The focus group we convened with members of Michigan’s AIS Core Team expressed a desire to avoid asking respondents about intended behaviors both before and after exposure to

the outreach message. This eliminated the possibility of social desirability bias on the part of respondents who may have had a high need for approval with respect to demonstrating their own improvement in adopting socially desirable behaviors. Social desirability bias is always an issue when dealing with illegal, undesirable, or controversial behaviors (Phillips and Clancy 1972) and may have affected the reported frequency of AIS prevention actions in this study and in our previous study (Lee et al. 2012). However, our avoidance of before-after questioning ensured that all treatments (i.e., different messages, including the no message treatment in 2012) were equally influenced by any social desirability bias.

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!*™ (*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.

In Michigan, access site signs incorporating both the *SAH!* logo and language describing required and recommended actions were developed in 2011 (language similar to Appendix A, Message 3). Wisconsin uses similar signs with language tailored to their state regulations (Witzling and Shaw 2014). However, *SAH!* billboards and other outreach materials have utilized simpler (i.e., “Clean, Drain, Dry”) language with no detailed instructions or notes on legal requirements. The *Handbook of Michigan Boating Laws and Responsibilities* (Michigan DNR 2014) also incorporates the *SAH!* logo but includes instructions for AIS-prevention actions in the section on “Protecting the Environment” as opposed to "It’s the Law.” The handbook, which is a highly effective tool for reaching boaters and influencing behavior change, does not explicitly state which actions are required as opposed to recommended.

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 (Steve Huff, Michigan DNR, personal communication). Conflicting or unclear messaging could be partially responsible for Michigan boaters’ confusion regarding actions required by law, while minimal 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. Our results suggest that boaters are more influenced by law enforcement officers than by social norms expressed by other boaters, families, and friends. Wisconsin DNR's AIS Warden Team Events and Water Guard Program exemplify understanding of the influence that law enforcement officers can have on both knowledge of the law and social norms.

In Michigan, funding challenges led to short staffing of Conservation Officers prior to 2014. Increased funding due to hunting and fishing license fee revisions should lead to increase resources for conservation law enforcement activities in the near future. Although law enforcement funding issues are beyond the influence of outreach programs, it is important to recognize the complementary roles of outreach and enforcement.

Boaters' incomplete understanding of Michigan's AIS-prevention laws results in reduced compliance with actions required by law, but our results also suggest that misunderstanding leads to increased compliance with actions that are *not* required by law. This poses a challenge for outreach messaging that seeks to create a change in environmental conditions (i.e., slow the spread of AIS) by changing boater behavior through honest, clear, and compelling communication. It is unlikely that recommended actions ("Disinfect," "Wash," and "Dry") will ever be required by law, in part due to challenges from a law enforcement perspective. It is often impossible for officers to determine if these steps have been taken.

While outreach may play a role in encouraging adoption of these recommended behaviors 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.

Voluntary behaviors are particularly likely to diffuse to others if they are perceived as the norm and outreach activities can take advantage of these high-profile sites to give the impression that boat washing is a normal and expected behavior for boaters (McKenzie-Mohr 2011). It is also possible that increased adoption of required actions could ultimately result in increased adoption of voluntary actions because people often demonstrate "spillover" behaviors that have similar underlying motivations. This is particularly true for environmentally responsible behaviors (Thogersen and Olander 2003).

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 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. More detailed recommendations can be found in the accompanying policy brief (O'Keefe et al. 2015).

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Appendices


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)

Message 3

Appendix B. 2014 Survey

2014 MICHIGAN AQUATIC INVASIVE SPECIES AND BOATING SURVEY

Michigan State University
Department of Community Sustainability
Natural Resources Bldg.
480 Wilson Rd., Room 151, East Lansing, MI 48824

In cooperation with
Michigan Sea Grant Program

Section 1 - The following questions will help us know about your boating experience. BOATS are defined as canoes, kayaks, duck boats, sailboats, personal watercraft, fishing boats, and recreational watercraft.

1. How many years have you been boating? ( ) YEARS

2. Do you own your boat(s)? ❒ YES ❒ NO

3. Did you use boat(s) ***during the 2013 boating season***?

❒ YES (***If Yes***, please answer the following Questions from 3A through 3C)
❒ NO (***If No***, please skip ahead to Question 4)

3A. How many times have you gone boating in following Michigan water bodies during the 2013 boating season?

(1) Great Lakes, including bays, Lake St. Clair, and St. Clair, St. Mary's and Detroit rivers _____TIMES
(2) Rivers, rivermouth lakes, and inland lakes accessible by boat from Great Lakes waters _____TIMES
(3) Inland lakes and rivers not accessible by boat from Great Lakes waters _____TIMES

3B. Did you transport your boat(s) between the Great Lakes and Michigan inland lakes during the 2013 boating season?

❒ YES: ***If Yes***, how many different times did you transport boat(s) between the Great Lakes and inland lakes? _____TIMES

❒ NO: ***If No***, please skip ahead to Question 3C.

3C. How many times have you gone boating in and outside of the state of Michigan during the 2013 boating season?

(1) Water body IN the state of Michigan ____TIMES
(2) Water body OUTSIDE the state of Michigan ____TIMES

4. ***During the 2013 boating season***, what was your primary activity while boating in Michigan water bodies? *(Check one)*

❒ Sightseeing
❒ Recreational fishing
❒ Pleasure cruising
❒ Water skiing/tubing
❒ Exercise/fitness
❒ Transportation
❒ Commercial/industrial
❒ Other (please specify)_____

5. As a boater, which of the following best describes you? *(Check one)*

❒ **A CASUAL BOATER**: a person whose boating is incidental to other outdoor interests, who may not belong to a formal boating club, who may read an article on boating in a local newspaper or on the web but does not subscribe to any boating magazine, and for whom boating is an enjoyable yet infrequent activity.
❒ **AN ACTIVE BOATER**: a person who travels infrequently away from home specifically to boat, who may or may not belong to a local boating club, who subscribes to general interest boating magazines, who participates in but does not present seminars, and for whom boating is an important but not exclusive activity.
❒ **A COMMITED BOATER**: a person who travels frequently away from home specifically to boat, who subscribes to boating magazines that focus on skills or equipment, who leads local boating clubs, who purchases ever-increasing amounts of boating equipment, and for whom boating is a primary activity.

6. As a part of your boating activity during the 2013 boating season, how often did you perform the following behaviors?

		Never	Seldom	Sometimes	Often	Always
A.	Keep oil-only absorbent pillows or socks in my bilge.	1	2	3	4	5
B.	Recycle my used boat oil and filters.	1	2	3	4	5
C.	Do major boat maintenance or cleaning.	1	2	3	4	5
D.	Remove aquatic plants from boats, boating equipment, and boat trailers before launching or placing in the water.	1	2	3	4	5
E.	Use cleaning substitutes-such as vinegar, baking soda, "eco-cleaners," etc. to clean my boat.	1	2	3	4	5
F.	Buy and use phosphorus-free biodegradable sops for my boat sink and showers.	1	2	3	4	5

7. During the 2013 boating season, how often did you perform the following behaviors?

		Never	Seldom	Sometimes	Often	Always
A.	Encourage others to reduce their waste and pick up their litter when they are at boating area.	1	2	3	4	5
B.	Pick up litter at boating.	1	2	3	4	5
C.	Learn more about aquatic natural environment area left by other visitors.	1	2	3	4	5
D.	Sign petition in support of aquatic natural area or protected area.	1	2	3	4	5
E.	Participate in public meeting about managing aquatic natural environment.	1	2	3	4	5
F.	Volunteer my time to projects that help aquatic natural environment.	1	2	3	4	5
G.	Write letters in support of aquatic protected areas.	1	2	3	4	5
H.	Volunteer to reduce visiting/boating activity in a water body if it needs to recover from environmental damage.	1	2	3	4	5
I.	Volunteer to stop visiting/boating activity a favorite water body if it needs to recover form environmental damage.	1	2	3	4	5
J.	Contribute donations to ensure protection of aquatic natural environment.	1	2	3	4	5

Section 2 - The following questions will help us know about your perception and experience about aquatic invasive species. AQUATIC INVASIVE SPECIES (AIS) are plants, animals, or pathogens that enter places where they have NOT always lived. AIS can be harmful to fish and wildlife, and to commercial and recreational water uses.

8. How common do you think aquatic invasive species are in Michigan?

❒ Very rare ❒ Somewhat rare ❒ Intermediate ❒ Somewhat common ❒ Very common ❒ Unsure

9. Over the past five years, how do you believe the abundance of aquatic invasive species in Michigan has changed?

❒ Increased dramatically ❒ Increased ❒ Stayed about the same ❒ Decreased ❒ Decreased dramatically ❒ Unsure

10. To what extent do you believe aquatic invasive species are currently a problem in Michigan?

❒ Not a problem ❒ Slight problem ❒ Moderate problem ❒ Serious problem ❒ Very serious problem ❒ Unsure

11. To what extent do you believe aquatic invasive species pose a threat to Michigan's economy in the future?

❒ Not a problem ❒ Slight problem ❒ Moderate problem ❒ Serious problem ❒ Very serious problem ❒ Unsure

12. How knowledgeable do you consider yourself regarding aquatic invasive species?

❒ Not at all ❒ Slightly ❒ Moderately ❒ Very ❒ Extremely ❒ Unsure

13. Please share your opinion with the following statements about aquatic invasive species.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A.	I feel that aquatic invasive species have the right to live on water bodies in Michigan.	1	2	3	4	5
B.	Aquatic invasive species have as much right to exist on water bodies in Michigan as native plants and animals.	1	2	3	4	5
C.	Aquatic invasive species should be controlled where they do damage to native species.	1	2	3	4	5
D.	Aquatic invasive species on water bodies in Michigan are a concern to me.	1	2	3	4	5
E.	Control of some wildlife is necessary to conserve the natural ecosystem of water bodies in Michigan.	1	2	3	4	5
F.	Native plants and animals are more important to an ecosystem than non-native plants and animals.	1	2	3	4	5

14. Which of the followings are required by laws in Michigan? (*check all that apply*)

		Yes	No
A.	Removing aquatic plants from boats, boating equipment, and boat trailers before launching or placing in the water.	❒	❒
B.	Draining livewells, bilges and all water from boats before leaving the access site.	❒	❒
C.	Disinfecting livewells and bilges with a bleach solution.	❒	❒
D.	Disposing of unused bait on the land or in the trash.	❒	❒
E.	Power washing boats and trailers.	❒	❒
F.	Drying boats for at least five days before launching in other waters.	❒	❒

15. Please provide your opinion with the following statements about aquatic invasive species laws in Michigan.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A.	Family and friends think I should comply with aquatic invasive species laws.	1	2	3	4	5
B.	Law enforcement officers think that I should comply with aquatic invasive species laws.	1	2	3	4	5
C.	Other boaters think I should comply with aquatic invasive species laws.	1	2	3	4	5
D.	When boating, I want to do what family and friends think I should do.	1	2	3	4	5
E.	When boating, I want to do what other boaters think I should do.	1	2	3	4	5
F.	When boating, I want to do what law enforcement officers think I should do.	1	2	3	4	5
G.	I intend to follow the laws the next time I boat.	1	2	3	4	5

Section 3 - The following questions will help us know about your perception of the message we provide, and improve the effectiveness of the message to protect waters from aquatic invasive species. Please carefully read the message below, and we would like to ask you to answer the following questions 16 through 18.

Please read the message below.

Message 1, 2, or 3

16. After reading the message, how likely do you agree with following statements?

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A.	I feel that by following behaviors that prevent the spread of aquatic invasive species, I can make a difference.	1	2	3	4	5
B.	I feel that I know how to go about preventing the spread of aquatic invasive species.	1	2	3	4	5
C.	I believe that I know what steps I should take to prevent the spread of aquatic invasive species.	1	2	3	4	5

17. Please rate the message you just saw on the following scale from 1 (strongly disagree) to 5 (strongly agree).

	Message Attribute	***Attributes Description***	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A.	Informative	Tells you something new and increases your knowledge.	1	2	3	4	5
B.	Sensible	Presents wise advice that seems reasonable.	1	2	3	4	5
C.	Memorable	Vivid image, fascinating fact, and catchy slogan.	1	2	3	4	5
D.	Enjoyable	Interesting, entertaining, and stimulating message.	1	2	3	4	5
E.	Useful	Valuable information and helpful advice worth remembering.	1	2	3	4	5
F.	Imaginative	Style is refreshing, novel, unique, and clever.	1	2	3	4	5
G.	Believable	Accurate and trustworthy information.	1	2	3	4	5
H.	Convincing	Presents ideas with which you agree.	1	2	3	4	5
I.	Professional	Production quality is high.	1	2	3	4	5
J.	Motivating	Presents influential reasons to prompt change in behavior.	1	2	3	4	5
K.	On-target	Content is personally meaningful and people and situation are used with which you can identify.	1	2	3	4	5
L.	Process	Overall, the message is easy to process.	1	2	3	4	5
M.	Understand	Overall, the message is easy to understand.	1	2	3	4	5
N.	Comprehend	Overall, the message is easy to comprehend.	1	2	3	4	5

18. After reading the message, how often do you expect to follow the behaviors when moving boats between waters during the 2014 boating season?

		Never	Seldom	Sometimes	Often	Always
A.	Remove aquatic plants from boats, boating equipment, and boat trailers before launching or placing in the water.	1	2	3	4	5
B.	Drain livewells, bilges and all water from boats before leaving the access site.	1	2	3	4	5
C.	Disinfect livewells and bilges with a bleach solution.	1	2	3	4	5
D.	Dispose of unused bait on the land or in the trash.	1	2	3	4	5
E.	Power wash boats and trailers.	1	2	3	4	5
F.	Dry boats for at least five days before launching in other waters.	1	2	3	4	5

The following questions will help us know more about you. The information you provide will remain strictly confidential and you will not be identified with your answers.

A. What is your five-digit zip code? _____

B. What year were you born? 19_____

C. Are you: ❒ Female ❒ Male

D. What is your annual household income before taxes?

❒ Less than $19,000 ❒ $20,000 ~ 39,999 ❒ $40,000 ~ 59,999 ❒ $60,000 ~ 79,999
❒ $80,000 ~ 99,999 ❒ $100,000 ~ 119,999 ❒ $120,000 ~ 139,999 ❒ $140,000 and above

E. Which of the following best describes the highest level of education you have completed?

❒ Some high school or less ❒ High school graduate ❒ Some college/ Technical school ❒ University graduate ❒ Post graduate school

F. Which of the following best describes your present employment status?

❒ Homemaker ❒ Unemployed ❒ Student ❒ Retired
❒ Employed, part time ❒ Employed, full time ❒ Self-employed ❒ Other (please specify)_____

G. Is there anything else you would like to share with us?

Appendix C. 2012 Survey (Q17).

When moving boats between waters during the 2012 boating season I expect to…

Actions		Always	Often	Sometimes	Seldom	Never
A.	Inspect watercraft, trailer, and other water-related equipment	1	2	3	4	5
B.	Remove visible plants, animals, and mud before leaving access	1	2	3	4	5
C.	Drain water from boat, bilge, and livewell, and open all draining devices	1	2	3	4	5
D.	Dispose of unwanted bait in trash (skip if you are not an angler)	1	2	3	4	5
E.	Spray/wash boats and equipment with high pressure and/or hot water	1	2	3	4	5
F.	Dry boats and equipment for at least five days	1	2	3	4	5

Appendix D. Results from 2012 Survey.

Table D.1. Results of two sample *t* tests indicated no difference (*p* >0.05) between boaters who received outreach materials (Treatment) and those who did not (Control) when asked about their intent to take specific AIS-prevention actions (Appendix 3) during the next boating season (after Lee et al. 2012).

		N	Mean	S.D.	*t*	d.f.	*p*
A. Inspect	Treatment	104	4.68	0.87	-0.53	188	0.60
	Control	86	4.74	0.71			
B. Remove	Treatment	128	4.59	0.88	-0.41	258	0.68
	Control	132	4.63	0.81			
C. Drain	Treatment	125	4.62	1.04	0.16	252	0.88
	Control	129	4.60	0.91			
D. Dispose	Treatment	107	4.38	1.19	-0.00	212	1.00
	Control	107	4.38	1.17			
E. Wash	Treatment	124	3.07	1.48	-0.31	253	0.76
	Control	131	3.13	1.51			
F. Dry	Treatment	124	3.67	1.36	0.75	251	0.46
	Control	129	3.54	1.34			