Boater Knowledge and Behavior Regarding Aquatic Invasive Species at a Boat Wash Station

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Abstract

Overland movement of recreational boaters between waterbodies is a significant pathway for spreading aquatic invasive species (AIS). Boater awareness of AIS and proper boat cleaning procedures may prove beneficial in reducing the transport, introduction, and establishment of invaders. Our objectives were to observe the use and determine the efficacy of a public boat wash station, gain a better understanding of boater knowledge on AIS and boat cleaning procedures, and help guide future educational outreach and AIS management. We conducted a three-tier human subjects survey at Tenmile Lake, Oregon over a two-year period in which a boat wash station was installed, allowing comparison of boater behavior and attitudes before and after the station was operational. The survey consisted of an observational survey, a short form (quick answer) survey, and an in-depth survey in which boaters could elaborate on their knowledge of AIS and regulations. The comparison between boaters surveyed before and after the installation of a boat wash station indicated discrepancies between what boaters say they will do and how they behave. While 76% of boaters said they would use a boat wash station prior to its installation, only 39% of boaters were observed using the station after it was installed. Additionally, the surveys identified knowledge gaps of boater AIS awareness, with > 20% of boaters unable to name any AIS. Our research indicates that even with innovative tools and targeted outreach, knowledge of AIS is still limited among the boating community and other education and management techniques need exploration.

Keywords: aquatic invasive species, surveys, boaters, Tenmile Lake, Oregon

Introduction

Effective management of aquatic invasive species (AIS) necessitates continual adaptation depending on the species, introduction vectors, the spatial extent of spread, and the severity of the impact. Models indicate that early in the invasion process the best way to protect uninvaded areas is to allocate resources to preventing spread away from invaded sites (i.e., containment); however, blocking introduction to uninvaded sites (i.e., shielding) is also critical (Drury and Rothlisberger 2008). In addition, determining the type of management needed (i.e., containment versus shielding) involves estimating the suitability of the receiving habitat given the ecological niche of the invader and having an understanding of the connectivity of the managed habitat to other at-risk or invaded habitats (Stewart-Koster et al. 2015). Studies on AIS spread have shown that the movement of recreational boaters between waterbodies is an important pathway of overland dispersal for aquatic organisms (Buchan and Padilla 1999, Johnson et al. 2001, Leung et al. 2006, Vander Zanden and Olden 2008), though other vectors, such as the aquarium trade and recreational activities like fly fishing, are also important (Alonso and Castro-Díez 2008, Strecke et al. 2011).

In addition to selecting effective management strategies, creating more public awareness of AIS and proper boat cleaning procedures may prove to be beneficial in reducing the transport of AIS. Recent studies suggest that managing vectors, such as the overland transport of recreational boats, is a more effective approach to controlling the spread of many invasive species than focusing on specific invasive species (Leung et al. 2006, Peters and Lodge 2009, Rothlisberger et al. 2010). In the Great Lakes region, visual inspection and
hand removal reduced the amount of invasive macrophytes on boats by 88% and high-pressure washing removed small-bodied organisms at an efficiency of 91% (Rothlisberger et al. 2010). However, these simple boat cleaning procedures were only performed by one-third of the boating community (Rothlisberger et al. 2010). Other studies have demonstrated that boaters are more likely to participate in visual inspection and hand removal techniques rather than high pressure washing (Connelly et al. 2016, Seekamp et al. 2016). These factors suggest there is work to be done in getting the public to participate in containing the spread of AIS.

Public education campaigns (i.e., outreach) are an increasingly important tool for creating awareness of AIS and how individuals can help control their spread. Education can come in many forms, including through laws and regulations, newsletters, signage at boat launches, as well as from investing in infrastructure, such as public boat wash stations. If effective, educational campaigns aimed at motivating boaters to take responsibility for inspecting and cleaning their own boat would reduce the expenses of equipment and staff required to clean boats at check stations and boat ramps. However, observations of boater behavior and self-reported data suggest that areas with educational campaigns that have not been augmented with staffed cleaning stations, enforcement, or fines may have low cleaning rates (Rothlisberger et al. 2010). Given that resources for AIS are constrained, it is critical to develop and test cost-effective management tools that can bolster educational campaigns. Our study used interviews with boaters to determine the vulnerability of the system to AIS introductions from boats and the effectiveness of a new management tool, a free public boat wash station. With this knowledge, we aim to guide future educational outreach and management plans for AIS.

To evaluate boater knowledge and actions, we used responses from in-person surveys conducted both prior to and following the installation of a public boat wash station. Our objectives were to 1) determine the frequency with which boaters visited waterbodies and the traffic patterns of boater movement; 2) measure the utilization of a public boat wash station; and 3) ascertain boaters’ general knowledge of AIS, proper boat cleaning procedure, local laws, and regulations, as well as how they acquired their knowledge.

**Methods**

**Study Area**

Tenmile Lake (43.57° N, –124.17° W) is a large, shallow, eutrophic freshwater lake on the Oregon Coast in Coos County. Several non-native species are present in Tenmile Lake including Brazilian elodea (Egeria densa), largemouth bass (Micropterus salmoides), and yellow perch (Perca flavescens). It is a popular spot for largemouth bass fishing, with nearly weekly fishing tournaments throughout the summer. Tenmile Lake is surrounded by many other freshwater lakes and rivers as well as large estuarine bays (e.g., Winchester Bay, Coos Bay) that are popular with recreationalists. The lake’s proximity to the ocean makes it a convenient destination for boaters wishing to back-flush, the process of running a boat’s motor in freshwater in order to wash out the salt or brackish water in the engine from the saline waterbody most recently visited. Tenmile Lake was chosen as the site for this research because a boat wash station was installed in the summer of 2013 at the primary public boat ramp.

**Surveys**

We conducted a human subjects survey at Tenmile Lake to obtain a better understanding of boat traffic patterns and public awareness of AIS and proper boat cleaning procedure. We surveyed boaters prior to the installation of the boat wash station in July and August 2012 (pre-boat wash survey, n = 199) and again, following the installation of the boat wash station, in July and August 2013 (post-boat wash survey, n = 200). Hereafter, the
surveys will be referred to by the survey year, 2012 and 2013. The purpose of the boat wash station is to 1) prevent additional invasive species from entering a waterbody; 2) contain invasive species already present in the waterbody from being transported elsewhere; 3) provide a free and efficient tool for cleaning motors after boating in saltwater and before entering freshwater; and 4) increase public awareness of invasive species and proper boat cleaning procedure (NOAA Habitat Program 2016). These surveys were also useful in identifying knowledge of AIS and the willingness of boaters to use a free, voluntary boat wash station.

The surveys were voluntarily submitted and all boaters received contact information verbally and through an informed consent form (Supplemental Document S1). Questions included where and when the boater last boated, whether the boater was aware of state regulations and permits, whether the boater was aware of proper boat cleaning procedures, observations of outreach materials at the boat ramp, and their knowledge of aquatic invasive species (see Supplemental Document S2). The 2013 surveys conducted were similar to the 2012 surveys, but also included observations on the pattern of boat wash station use. Both surveys were approved for human subjects research by the Portland State University Institutional Review Board (#122208).

A three-tiered survey was implemented at Tenmile Lake, which included an observational survey, a short-form boater survey, and an in-depth boater survey. For the first part, we visually observed boaters and their use of aquatic invasive species prevention techniques before entering Tenmile Lake and again while exiting the lake. After the boat wash station was installed, an amendment to the survey was made to include our observations of whether or not boaters were using the boat wash station. Surveys conducted in 2013 were administered within a month of the completion of the boat wash station, prior to its official opening. Boat wash station use was recorded from surveyed boaters, with an additional two days spent observing boat wash station use from afar without conducting surveys. For the observational study, it is possible that the boaters could tell that they were being observed, which could bias results. However, the boat ramp was frequently busy during the survey period and the observer was just one of many people in the boat ramp area. The observer made efforts to be inconspicuous. Additional bias could have come from having just finished participation in a survey about invasive species; however, the two days spent observing station use without conducting surveys may elucidate the magnitude of this bias.

The short-form boater survey consisted of quick, simple questions posed to the boaters while exiting the lake. Of the boaters observed and approached to participate in the survey, 67% responded to the short-form boater survey. The short-form boater surveys consisted of twelve questions and took approximately ten to fifteen minutes to complete. Of the boaters who completed the short form boater survey, 32% agreed to participate in a more in-depth boater survey, for an overall response rate of 21%. The in-depth boater survey consisted of six questions and took an additional five to ten minutes to complete. All surveys were completed by the same researcher (S. Cimino) and all survey answers were confidential. All questions and their aggregated responses can be found in Supplemental Document S2 and Supplemental Table S1, (available online); however, due to the large number of questions only a select few that best represented the overarching themes of the paper are discussed below.

Results

Tenmile Lake and Boat Wash Station Use

Most boaters that use Tenmile Lake reported that they are frequent recreationalists, the majority boating more than twice a month (Figure 1). The majority of boaters who reported having last launched their boat the previous day (i.e., one day since boat was last in the water), had previously boated in Tenmile Lake (Figure 1). Most boaters surveyed, an average 73% over both years, stated that they last came from waterbodies (freshwater and saltwater) that were within 50 kilometers, traveling by road, of Tenmile Lake (Figure 2). However, 3% of boaters indicated that the last
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waterbody they boated at was in a different state, arriving from places such as Shasta Lake, California, Snake River, Idaho, and Flathead Lake, Montana (Supplemental Table S1). Additionally, 10% of boaters surveyed at Tenmile Lake had boats registered in states other than Oregon (Supplemental Document S2).

Of the boaters surveyed in 2012, 76% of boaters stated they would use a boat wash station at Tenmile Lake (Figure 3). However, we found that only 39% of surveyed boaters actually used the boat wash station based on observations during the 2013 survey (Figure 3). This value is similar to that obtained when observations of boat wash station usage were made from afar and no follow-up surveys were being conducted (i.e., 25 out of 68 boaters [37%] used the station), suggesting that there was little to no observation bias in our study. These results are similar if you exclude responders who last boated at Tenmile Lake: 83% stated that they would use a wash station in 2012, while 35% were observed using the station in 2013. This is concerning, as our observations showed that, on average, 13% of boats left with either aquatic vegetation or invertebrates on their hulls or trailers, and further, on average, 33% of boaters made no effort to remove fouling organisms by hand (Supplemental Document S2). Reasons reported for not planning to use (2012 survey) or not using the boat wash station (2013 survey) included: boaters would like better equipment at the

Figure 1. The number of days since the surveyed participant last put their boat in a waterbody from the survey conducted a) prior to the boat wash installation (2012, \( n = 199 \)) and b) following the boat wash installation (2013, \( n = 200 \)). In both panels, the open bar is for boats that came from lakes other than Tenmile Lake, whereas the solid bar is for boats whose previous launch was at Tenmile Lake.

Figure 2. The road distance (km) to the waterbody last visited by boaters surveyed in 2012 (\( n = 199 \)) and 2013 (\( n = 200 \)).

Figure 3. The percentage of boaters stating that they would use a boat wash station in the 2012 survey (\( n = 199 \)) and the percentage of boaters who were observed actually using the boat wash station in the 2013 survey (\( n = 200 \)).
station (2012 = 46%, 2013 = 32%), the station was inconvenient or wait was too long (2012 = 17%, 2013 = 28%), or boaters did not deem washing at a boat wash station necessary for their boating frequency (i.e., don’t boat often enough: 2012 = 8%, 2013 = 13%; Figure 4).

Knowledge of Aquatic Invasive Species, Laws, Regulations, and Educational Outreach

The AIS that boaters most frequently named was the zebra mussel (Dreissena polymorpha), with 45% of boaters in the 2012 survey and 59% of boaters in the 2013 survey naming this species (Supplemental Document S2). The second most common response was that they could not name any particular invasive species (2012 = 26%, 2013 = 23%; Supplemental Document S2). Other AIS identified by boaters included the New Zealand mud snail (Potamopyrgus antipodarum), hydrilla (Hydrilla verticillata), and rusty crayfish (Orconectes rusticus) (Supplemental Document S2).

Fewer boaters surveyed in 2013 (55%) were informed about the Oregon state law prohibiting the launching of a boat with invasive species attached compared to boaters surveyed in 2012 (69%) (Table 1). Conversely, more surveyed boaters were aware of the state regulations regarding the use and movement of bait fish in the 2013 survey (82%) versus the 2012 survey (63%) (Table 1). The awareness of the state regulation regarding the use and movement of crayfish was similar between the 2012 survey (60%) and the 2013 survey (62%) (Table 1).

A minority of surveyed boaters saw signage regarding AIS when arriving at Tenmile Lake in both the 2012 (25%) and the 2013 (32%) survey (Supplemental Document S2; see Supplemental Figures S1 and S2 for illustration). Fewer boaters saw signage regarding AIS when leaving Tenmile Lake in both the 2012 (6%) and 2013 (66%) surveys were aware of the phrase “Clean, Drain, Dry”. Moreover, 45% and 59% of the boaters surveyed in 2012 and 2013, respectively, reported always practicing the “Clean, Drain, Dry” method. The majority of boaters unaware of the phrase “Clean, Drain, Dry” in both surveys still reported practicing this cleaning method at least some of the time. See Supplemental Document S2 for responses to additional survey questions.

Discussion

We conducted surveys at Tenmile Lake that identified the movement patterns of recreationalists boating at the lake, and their knowledge of AIS,
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proper boat cleaning procedures, and relevant boating and fishing laws and regulations. Most of the boaters surveyed had boats registered in Oregon and primarily boat locally within the state. However, numerous boaters visited waterbodies outside of the state prior to boating at Tenmile Lake, representing a direct threat of AIS overland transport. Although most of the boaters surveyed report following the “Clean, Drain, and Dry” approach to wash their boats after use, the majority did not actually use the boat wash station at Tenmile Lake. This result is noteworthy because most boaters indicated during the 2012 survey that they would use the boat wash station once installed. The surveys revealed gaps in boater knowledge of AIS as well as inconsistencies in their knowledge of proper boat cleaning procedure and state laws and regulations. Given that current public outreach (e.g., signage, boat wash station) at Tenmile Lake appears to be not entirely effective, efforts that are grounded in research on changing human behavior are needed.

Tenmile Lake and Boat Wash Station Use

The majority of boaters visited Tenmile Lake after boating nearby, and many of these boaters are boating multiple times a month. The large percentage of boaters who had last launched their boats in the prior two weeks (average 84% over both years) is concerning from the perspective of managing the spread of AIS, several of whom can survive for days to weeks outside of water (e.g., New Zealand mud snails; Alonso and Castro-Díez 2008). Fishing is the most common activity of boaters surveyed at Tenmile Lake (Supplemental Document S2), suggesting that it is essential for anglers to be educated on AIS identification and proper boat cleaning procedures. Anglers, who often participate in multiple different tournaments throughout the nation during peak fishing season, are likely a large vector of AIS spread (Buchan and Padilla 1999, Leung et al. 2006, Vander Zanden and Olden 2008). Indeed, Tenmile Lake hosts at least four fishing tournaments a year and our surveys indicated that, on average, 34% of all surveyed lake visitors participated in these tournaments. However, there is also evidence that anglers who use boats are more knowledgeable of AIS and educational campaigns designed to prevent the spread of AIS, as well as feel more personal responsibility for AIS control, compared to non-angling boaters (Seekamp et al. 2016). This suggests that outreach targeting non-angling boaters could have a significant impact on preventing the spread of AIS.

A greater investment in the protection of the environment, such as preventing the spread of AIS and maintaining healthy aquatic ecosystems, will likely require significant changes in the behaviors of anglers and other recreationalists (Kareiva 2008). For instance, results from two seasons of surveys found that there was a disconnect between boater responses to the survey and boater behavior (Figure 3). The majority of boaters appear to like the idea of behaviors that help protect uninvaded lake ecosystems and may even find invasive species to be a very important issue in Oregon (60% over both years, Supplemental Document S2), but fewer appear to be willing to change their behavior. This is referred to as the value-action gap, where pro-environmental values or attitudes of the subjects fail to lead to pro-environmental behaviors or actions (Blake 1999). Studies have suggested that awareness of an environmental issue, as well as attitudes, do not directly influence behavior but rather act as indirect determinants of pro-environmental behaviors (e.g., Bamberg and Möser 2007, Klöckner 2013). Thus, trying to improve boaters’ awareness of invasive species

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TABLE 1. The percentage of boaters surveyed in summer 2012 (pre-boat wash, n = 199) and 2013 (post-boat wash, n = 200) aware of Oregon State laws and regulations regarding aquatic invasive species.

<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>2012</th>
<th>2013</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aware of state law that prohibits launching a boat</td>
<td>69%</td>
<td>55%</td>
<td>63%</td>
<td>55%</td>
</tr>
<tr>
<td>with invasive species on it?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aware of state regulations regarding the use and</td>
<td>63%</td>
<td>55%</td>
<td>63%</td>
<td>55%</td>
</tr>
<tr>
<td>movement of bait fish?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aware of state regulations regarding crayfish use</td>
<td>60%</td>
<td>55%</td>
<td>60%</td>
<td>55%</td>
</tr>
<tr>
<td>and movement?</td>
<td></td>
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</tr>
</tbody>
</table>
may have only marginal success with regards to changing behavior. Rather, addressing moral motivations, creating a feeling of self-efficacy, and breaking old habits, in addition to changing attitudes, may all affect changes in behavior (Klöckner 2013).

Knowledge of Aquatic Invasive Species, Laws, Regulations, and Educational Outreach

AIS have spread quickly in the United States (Loo et al. 2007, McMahon 2011). In 2001, in response to the growing threat of invasive species to the state, the Oregon Invasive Species Council was created by the Oregon State Legislature (Reesman et al. 2012). Similarly, many other states have created their own councils to address the growing need of invasive species management. These councils have been effective at providing educational outreach and developing watercraft inspection programs. For instance, the Washington Invasive Species Council reached more than 3,000 people in 2015 through direct communication regarding the impacts of invasive species (Washington Invasive Species Council 2015). Additionally, Idaho’s Invasive Species Watercraft Inspection Program stopped > 195,000 boaters from 2009–2013 (105 vessels were transporting viable zebra and/or quagga mussels; Idaho State Department of Agriculture 2014), suggesting that there is the potential for reaching large numbers of recreationalists.

The majority of boaters (~ 62%) surveyed were aware of Oregon’s 2009 state law that prohibits a boat from launching with an attached invasive species (House Bill 2583, effective January 2010). Boaters showed similar levels of awareness (average ~ 60–70%) of the state regulations regarding the use and movement of crayfish and bait fish over the two-year survey period. However, awareness of the state law prohibiting movement of AIS decreased by 14% from 2012 to 2013. An additional law passed in 2009 by Oregon created an Aquatic Invasive Species Prevention Program and established a new user fee for boaters (House Bill 2220). All licensed boats are paying this user fee, but since the law passed, boaters have appeared to become less aware of state AIS laws. This cannot be easily explained as our survey found that more boaters were asked to show their permit in 2013 (16% increase over 2012) and there were slightly more in-state boaters surveyed in 2013 (4% more than 2012) (Supplemental Document S2), both of which should have increased awareness of state AIS laws. Our best explanation is that boaters’ understanding of the law has faded with time, which is not unexpected, especially for laws with minimal enforcement (e.g., 75% of boaters have never had their boat inspected; Supplemental Document S2). Peters and Lodge (2009) found that inconsistencies among states concerning laws and regulations confuse consumers (in this case, boaters) and reduce the credibility of management agencies. More regional and national regulations, as well as international agreements, need to be developed to restrict the movement of invasive species (Lodge et al. 2006, Drury and Rothlisberger 2008, Vander Zanden and Olden 2008). Indeed, the Western Regional Panel on Aquatic Nuisance Species, which encompasses all of the states and provinces west of the 100th Meridian, has developed a model regulation on watercraft inspection and decontamination that sets the foundation for the adoption of standard protocols and agreements among states (Otts and Nanjappa 2016).

Through the information gathered from boater surveys, we have developed a better understanding of recreationalists’ knowledge of AIS. Other studies have shown that recreationalists have concerns for the environment but may not understand the vast range of ecosystem services provided by a healthy environment, such as clean water (Ryan 2005, Tilt et al. 2007, Kareiva 2008). Similarly, at Tenmile Lake most recreationalists were concerned with the health of the lake and especially the lake’s fish populations. However, boaters were unaware of some of the major threats to lake health, evidenced by the lack of boater knowledge of AIS: 20–25% of surveyed boaters could not name a single AIS (Supplemental Document S2). However, this result may not fully represent the boating community; those more willing to respond to the in-person surveys at the Tenmile Lake may have been more or less informed about AIS compared to other
boaters. To avoid this type of bias, a fully randomized survey would have needed to be conducted at multiple waterbodies throughout the region. By contrast, on average 52% of boaters could name zebra mussels as an invasive species. This value, combined with the absence of either zebra or quagga mussels in Oregon, may actually be a hindrance to invasive species management efforts within the state, as boaters may falsely believe that it is unnecessary to clean their watercraft. This hypothesis remains to be tested.

At public boat ramps across the state of Oregon, signs have been posted with pictures of common AIS and information on how they can be transported via association to trailers and boats, as well as transportation of AIS by the process of back-flushing (Supplemental Figures S1 and S2). The perceived visibility of these signs at Tenmile Lake was low. These signs were ~30 m from the boat ramp, a distance that may contribute to such a small percentage of surveyed boaters claiming to have seen a sign. In 2013, new signs were put up along the edges of the Tenmile Lake boat ramp warning boaters about the illegality of back-flushing their motors, but this sign only mentions the risk of transporting invasive species in small print (Supplemental Figures S1 and S2). Better use of signage at boat docks and marinas may have considerable ecological benefits. In a 2014 mail-in survey, 55% of boaters in Oregon indicated that they prefer getting information about boating issues through posters or signs, which was the second most common answer given after the preference of getting information from the internet at 70% (Chan et al. 2014). Signs can be an effective educational outreach tool but our results indicate that they need to be more visible, with larger font for key messages (i.e., transporting invasive species is illegal). However, despite the ineffectiveness of signage at Tenmile Lake, the majority of surveyed boaters (65% across both years) were familiar with the “Clean, Drain, Dry” slogan. This result represents a greater recognition of the “Clean, Drain, Dry” slogan than what was found in a similar study of Illinois boaters with recognition of the phrase at only 41%, but a more comparable result to the 59% of Illinois boaters familiar with Illinois’ slogan “Protect Your Waters, Stop Aquatic Hitchhikers” (Cole et al. 2016). The success of the “Clean, Drain, Dry” slogan may be related to the ‘rule of three’ for outreach messages, where three positive claims are the optimal number for persuading a consumer (Shu and Carlson 2014).

Limitations

Our surveys provide a snapshot of boater knowledge and behaviors, and may only reflect a subset of the community. However, surveys remain one of the best tools for measuring the knowledge and attitudes of the general population (Durant et al. 1989, Allum et al. 2008). A caveat of our study is that the 2013 surveys were administered within a month of the completion of the boat wash station. Perhaps with time, boaters will become more aware of the station’s existence and its efficacy for removing AIS from boats. There are future plans for volunteers to work at the boat wash station, which might provide a better understanding of what influences boaters’ willingness to use the station. Furthermore, the presence of a surveyor may have encouraged the surveyed boaters to use the boat wash station more than non-surveyed boaters. However, we found no evidence of observation bias in our study, with similar rates of boat wash station usage from surveyed boaters (39%) vs. boaters observed from afar (37%). Other potential limitations include the willingness of boaters to participate if they were short of time and whether boaters will use the boat wash station if they have to wait in line behind other boaters. Our survey had a good response rate (67%), thus we feel that we did not have under-representation from boaters who did not have time to participate. However, lack of time was one of the reasons stated by boaters who did not use the boat wash station in 2013 (27% in 2013; Supplemental Document S2), suggesting that this may be a limitation of the boat wash station model.

Conclusion

The majority of boaters were familiar with state laws and regulations regarding AIS, but as boaters continue to venture across state borders, more regional coordination, as well as more effective
federal laws, are necessary to prevent invasion and control spread. Without regional regulations concerning AIS transport, there is little external incentive to use free boat wash stations. Adding volunteers to the boat wash station to assist boaters and provide information on the spread of AIS and specific species of concern could be an effective method to encourage more boat wash station use and increase boater knowledge. Additionally, AIS signage at lakes needs to be obvious and prevalent as boats enter and exit a waterbody.

Much of the estimated cost associated with the economic and ecological damages inflicted by invasive species is controlling the density and spread of established invasive species (Pimentel et al. 2005, Stohlgren and Schnase 2006). Boat wash stations aim to prevent AIS from entering the lake, contain invasive species that are already present, provide a safe and effective tool for cleaning boats, and increase public awareness. However, if these tools are not being actively used by the public (i.e., no change in behavior), managers need to adapt, perhaps by changing their outreach strategies or by making boat wash stations more convenient or intuitive to use. Strategies that consider the moral motivations of boaters, create a feeling of self-efficacy (what to do and how to do it), and address ways to break old habits can be effective ways to alter behavior (Klöckner 2013). More research is needed that specifically addresses how to change the behavior of recreationalists with regards to spreading AIS. Successful management of AIS may also require more stringent laws and regulations on a regional scale, especially if these innovative tools remain infrequently used and outreach continues to be ignored or quickly forgotten.

Acknowledgments

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