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OSMB Final Report: Task 6. Tenmile Lake Boat Wash Effectiveness Monitoring

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OSMB Final Report: Task 6. Tenmile Lake Boat Wash Effectiveness Monitoring

**Final Report submitted by:
Sam Cimino and Angela Strecker
for Oregon State Marine Board
funded by Aquatic Invasive Species grant
to Portland State University**

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Abstract

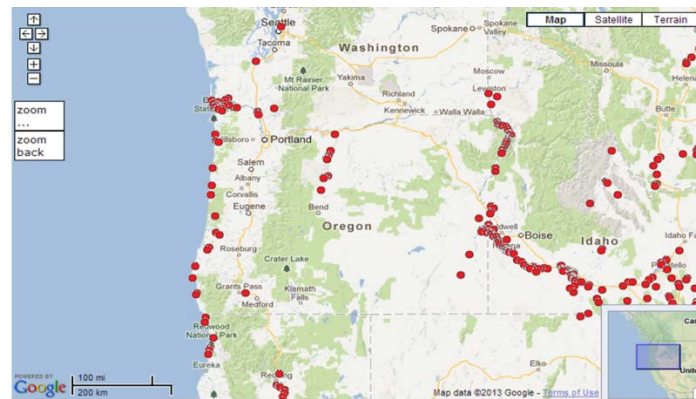
Public awareness of aquatic invasive species and proper boat cleaning procedures may prove to be beneficial in reducing the transport and establishment of aquatic invasive species like New Zealand mud snails and zebra and quagga mussels as well as hydrilla and Eurasian watermilfoil. The primary objectives of this research project were to observe the use and determine the efficacy of a public boat wash station as well as increase the public's awareness of proper boat cleaning procedures and aquatic invasive species. The Tenmile Lakes Basin Partnership, Oregon State Marine Board, and the United States Forest Service (USFS) have undertaken an initiative to increase public awareness of invasive species and proper cleaning procedures by building a boat wash station at the Tenmile Lake public boat launch. In the summer of 2012, 199 qualitative human subject surveys were administered at Tenmile Lake in Lakeside, Oregon to boaters on their boating habits and knowledge of invasive species prior to building the boat wash ("pre-boat wash"). An extension of the 2012 study was conducted in the summer of 2013 on 200 boaters after the completion of the Tenmile Lake boat wash station ("post-boat wash"). Comparisons were made on the observations and answers of boaters prior to and after the boat wash installation. Of the boaters surveyed in the pre-boat wash field season, 75.9% of boaters claimed they would use a boat wash station at Tenmile Lake. The actual use of the boat wash station based on observations made by the field researcher during the post-boat wash field season indicated only 38.5% of surveyed boaters used the station. Furthermore, more than 20% of boaters could not verbally identify an invasive species in either field season when asked their awareness of aquatic invasive species. However, the majority of boaters surveyed at Tenmile Lake in the pre-boat wash field season (63.3%) and post-boat wash field season (66%) were aware of the phrase "Clean, Drain, Dry". These results identify a disconnect in what boaters say and what boaters do and the knowledge gaps boaters have on aquatic invasive species, but these results also identify a growing awareness of proper boat cleaning procedures.

Introduction

Public awareness, more specifically boater awareness, of aquatic invasive species (AIS) and proper boat cleaning procedures, may prove to be highly beneficial in reducing the transport and establishment of nonindigenous aquatic invasive plant species like the Eurasian watermilfoil (*Myriophyllum spicatum*) and hydrilla (*Hydrilla verticillata*) and aquatic invasive invertebrate species like the New Zealand mud snail (*Potamopyrgus antipodarum*), the zebra mussel (*Dreissena polymorpha*), and the quagga mussel (*Dreissena rostriformis bugensis*). Studies on AIS spread have exposed that the movement of recreational boaters between lakes is potentially the most important pathway of overland dispersal for the majority of aquatic organisms including invasive invertebrates as well as various macrophytes (Buchan and Padilla 1999, Leung et al. 2006, Vander Zanden & Olden 2008). Surveys have indicated that more than two-thirds of boaters do not take proper steps to clean their boats (Rothlisberger et al. 2010). Furthermore, controlled experiments have shown that visual inspection and hand removal can reduce the amount of invasive macrophytes on boats by 88% and high-pressure washing can remove small-bodied organisms at an efficiency of 91% (Rothlisberger et al. 2010).

The primary vector for the transport of the New Zealand mud snail is indirect conveyance from the attachment to boats and angling gear like waders or fishing nets (Loo et al. 2007b). A current

known dispersal of the New Zealand mud snail in the Pacific Northwest (Figure 1) indicates their presence along the Oregon Coast in numerous lakes and estuaries. The dispersal of zebra mussel and quagga mussel in the United States (Figures 2 & 3) has not yet reached Oregon; however, the invasion appears imminent with current expansion trends (McMahon 2011). Although zebra and quagga mussel are not currently in Oregon, it is anticipated that these mussels will disperse westward via boater movement, and water bodies most at risk of invasion will be popular boater recreation sites like the quagga invasion witnessed in Lake Mead, Nevada first observed in January of 2007 (McMahon 2011).



Suggested citation: Benson, A. J. 2011. New Zealand mudsnail sightings distribution. Retrieved 4/28/2013 from newzealandmudsnaildistribution.aspx.

Figure 1: A detailed map of the known distribution of New Zealand mud snail in the Pacific Northwest based on the USGS database.

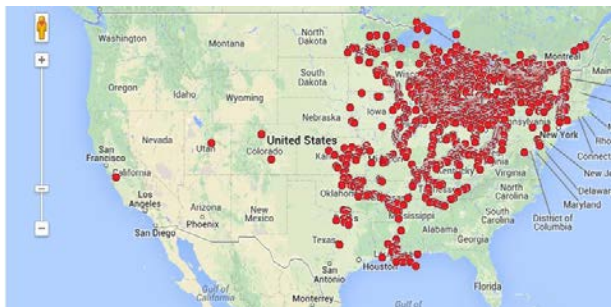


Figure 3: A detailed map of the known zebra mussel distribution in the United States based on the USGS database. Benson, A. J. 2013. Zebra mussel sightings distribution. Retrieved 12/9/2013 from <http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/zebramusseldistribution.aspx>

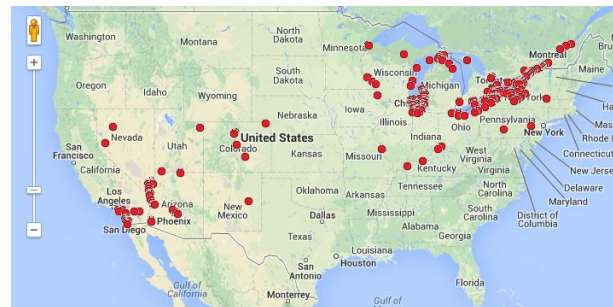


Figure 2: A detailed map of the known distribution of quagga mussel in the United States based on the USGS database. Benson, A. J. 2013. Zebra mussel sightings distribution. Retrieved 12/9/2013 from <http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/zebramusseldistribution.aspx>

At public boat ramps across the state of Oregon, signs have been posted with pictures of common invasive species and how they can be transported via attachment to trailers and engines (Figure 4) as well as transportation of aquatic invasives by the process of back-flushing (Figure 4). Back-flushing is the process of cleaning out one's engine after boating in saltwater by running it in a freshwater system. The Oregon Department of Fish and Wildlife (ODFW) has also displayed signs on how to properly check one's boat for attached invasive species known as "hitchhikers". In addition to educational signs, an Oregon state law was passed that prohibits

launching a boat that has an invasive species on it, and state regulations have been adopted regarding the use and movement of baitfish and crayfish (Reesman et al. 2012).

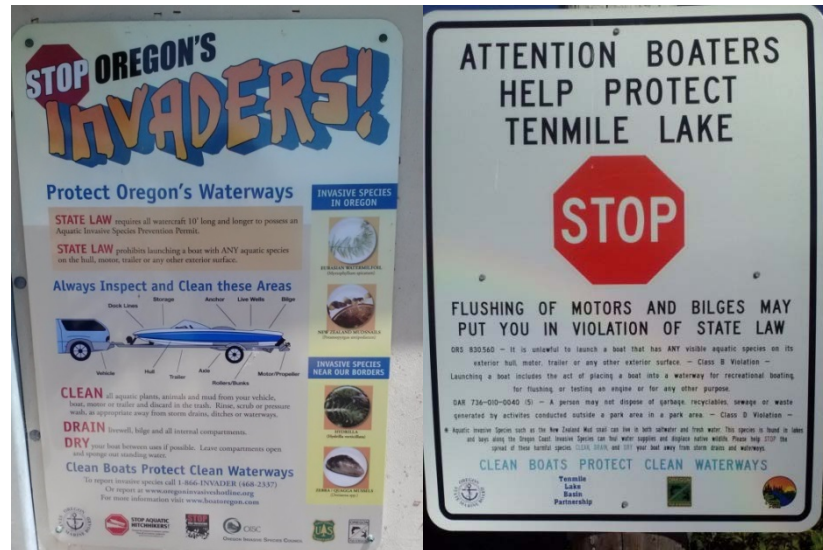


Figure 4: Signs at Tenmile Lake boat ramp instructing visitors on invasive species and proper boat cleaning procedure (left) and warning against back-flushing motors (right). The back-flushing sign (right) was installed in between the 2012 and 2013 field season. Photos were taken by Sam Cimino in the 2013 (post-boat wash) field season.

In 2009, the Oregon Legislature passed House Bill 2220 which created an Aquatic Invasive Species (AIS) Prevention Program and established a new user fee to boaters; “Aquatic Invasive Species Prevention Permit” (Reesman et al. 2012). The AIS Prevention Program is co-managed by the Oregon Department of Fish and Wildlife (ODFW) and Oregon State Marine Board (OSMB) (Reesman et al. 2012). The primary objective of the AIS Prevention Program is to keep Oregon’s waters free of invasive species. These measures stimulated the installment of more useful tools like “boat washing stations” at commonly visited high traffic sites.

With funding to construct a boat wash station, the planning of the Tenmile Lake boat wash station began in 2011 and construction of the boat wash station began in 2012 (Reesman et al. 2012). The boat wash station was completed in the summer of 2013 and operational upon completion. As the Tenmile Lake boat wash station was the first public boat wash station in Oregon, the amount of documented usage and public opinion will likely be the drivers for continued funding at Tenmile Lake and the construction of other stations across the state. These measures are crucial in promoting greater awareness of aquatic invasive species and their transport vectors to the public.

The project objectives were to measure the utilization and effectiveness of the boat wash station, ascertain boaters’ general aquatic invasive species and proper boat cleaning procedure knowledge, as well as determine traffic patterns of boater movement. Pre-boat wash installation data (summer 2012) and post-boat wash installation data (summer 2013) were compared to address the efficacy of the boat wash facility and whether it led to changes in boaters’ behavior and awareness. Additionally, survey data also evaluated the back-flushing occurrences and the effect of the boat wash facility on such behavior.

Methods

Site

Tenmile Lake is a large, eutrophic freshwater lake on the Oregon Coast (Figure 5). It is a popular spot for bass fishing and other recreation with nearly weekly fishing tournaments. It is also surrounded by many other popular recreational freshwater lakes as well as ocean bays like Winchester and Coos Bay. Tenmile Lake's proximity to the ocean makes it a popular destination for boaters wishing to back-flush their engines in freshwater. Located fifteen miles north of the city of Coos Bay and directly off of Highway 101, Tenmile Lake was a prime spot to passively observe and actively survey boaters traveling from within Oregon and those who are visiting from out of state.

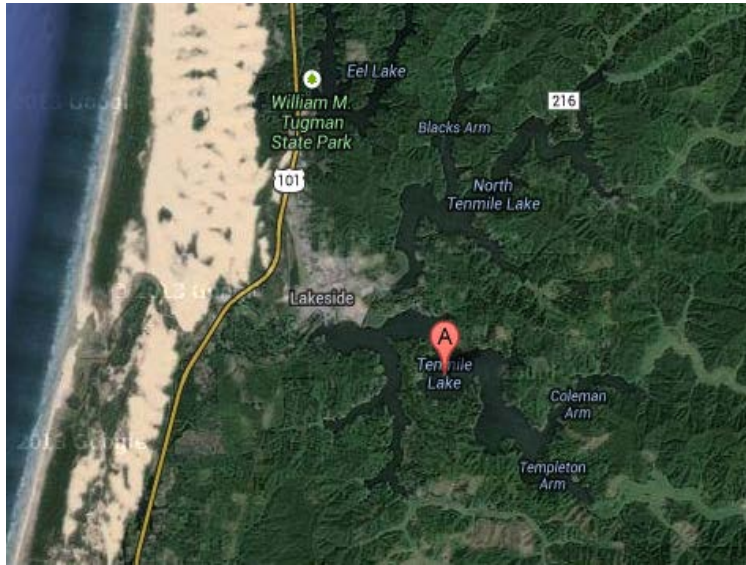


Figure 5: A Google Maps image of Tenmile Lake and its proximity to the coast and Highway 101.

Surveys

In order to obtain a better understanding of boat traffic patterns and public awareness of invasive species, as well as proper boat-cleaning procedure, a human subject survey at Tenmile Lake in Lakeside, Oregon was conducted over the summer of 2012 and the summer of 2013. Tenmile Lake was chosen as the site for these human subject surveys because in the summer of 2013 a boat wash station was installed at the primary public boat ramp of Tenmile Lake. The purpose of the boat wash station at Tenmile Lake is to: 1) prevent invasive species from entering the lake, 2) contain invasive species already present in the lake from being transported out, 3) provide a free and efficient tool for cleaning out one's motor after boating in salt water and before entering freshwater, and 4) increase public awareness of invasive species and proper boat cleaning procedure. These surveys were also useful in identifying local knowledge of AIS and recreationalists' willingness to use a free, non-mandatory boat-washing station.

The human subject surveys were voluntarily submitted and ceased at any time if the surveyed boater felt uncomfortable. In addition, all boaters received contact information verbally and through an informed consent form (Appendix A) and were encouraged to contact the researchers if inclined to learn more about the project. The 2012 pre-boat wash installation surveys were collected on boaters' knowledge of invasive species, their familiarity with proper boat cleaning procedure like the slogan "Clean, Drain, Dry", and the patterns in boater movement to determine

areas of frequent visit and common transportation routes (Appendix B). Post-boat wash installation surveys conducted in the summer of 2013 (Appendix C) 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. The observational survey consisted of passive visual observations of the boater and their use of aquatic invasive species prevention techniques before entering Tenmile Lake and again while exiting Tenmile Lake. Observational notes were only included in the surveys of boaters that participated in the active portions of the survey.

The short form boater survey consisted of quick, simple (typically one-word answer) questions asked to the boater while exiting Tenmile Lake. Short form boater survey questions included where and when they last boated, whether the boater was aware of Oregon state regulations and permits, whether the boater was aware of proper boat cleaning procedures, and their knowledge of aquatic invasive species. The short form boater surveys consisted of twelve questions and took approximately ten to fifteen minutes to complete.

If the boater showed interest in the survey at the completion of the short form survey, in-depth boater survey questions were asked while boaters were exiting Tenmile Lake that provided questions with more detailed answers. The in-depth boater survey asked the boater to elaborate on how aquatic invasive species affect their activities and where or they learned about aquatic invasive species. The in-depth boater survey consisted of six questions and took an additional five to ten minutes to complete. All surveys were filled out and completed by the field researcher, Sam Cimino, by hand and also backed up in an Excel spreadsheet.

Results

Tenmile Lake Use

A total of 399 boaters were surveyed in the two year study at Tenmile Lake, 199 in the first field season of 2012 (pre-boat wash) and 200 in the second field season in 2013 (post-boat wash). The boaters at Tenmile Lake use the lake primarily for fishing and other recreational activities (Figure 6). Most boaters that use Tenmile Lake are frequent recreationalists, the majority boating more than twice a month (Figure 7). Additionally, as would be expected, most of the boaters surveyed last came from waterbodies (freshwater and saltwater) in close proximity to Tenmile Lake (Figure 8); however, boaters surveyed also last boated out of state in places such as Shasta Lake of California, the Snake River of Idaho, and Flathead Lake of Montana (Appendix D). Note that the raw data for all survey questions is included in Appendix E.

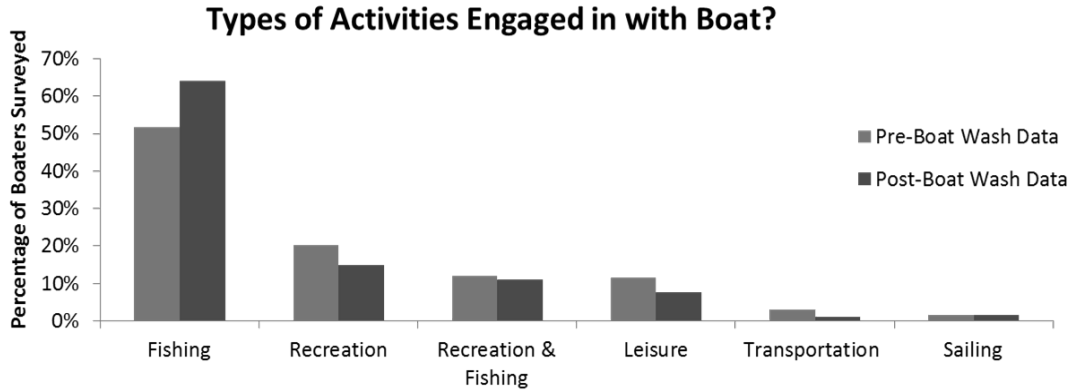


Figure 6: The types of activities engaged in (by percentage) reported by survey participants at Tenmile Lake. Pre-boat wash data (n=199) was acquired in the summer of 2012 and post-boat wash data (n=200) acquired in 2013.

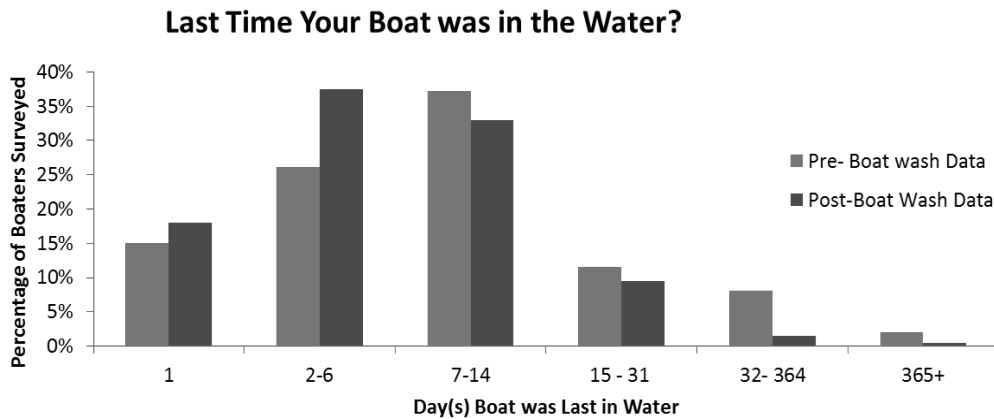


Figure 7: The number of days the surveyed participant last put his or her boat in a waterbody. Pre-boat wash data (n=199) was acquired in the summer of 2012 and post-boat wash data (n=200) acquired in 2013.

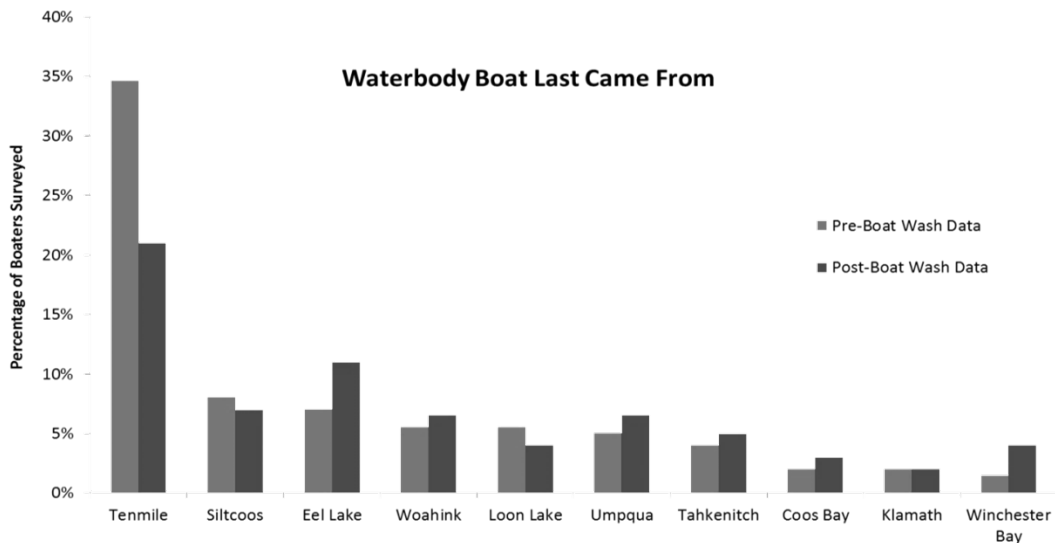


Figure 8: The top ten water bodies surveyed boaters last came from. Pre-boat wash data (n=199) was acquired in the summer of 2012 and post-boat wash data (n=200) acquired in 2013.

Boat Wash Station Use

The pre-boat wash survey in 2012 at Tenmile Lake included a question on whether or not the surveyed boater would use a boat wash station (Appendix B). Of the boaters surveyed, 75.9% of boaters claimed they would use a boat wash station at Tenmile Lake (Figure 9). The Tenmile Lake boat wash station was installed in 2013 thus an amendment to the survey was made to include whether or not boaters were using the boat wash station (Appendix C). The actual use based on the observations made by the field researcher of the boat wash station during the 2013 field season of surveyed boaters was 38.5% (Figure 9). Reasons for not using or wanting to use the boat wash station at Tenmile Lake included: boaters would like better equipment at the station, the station was inconvenient, or boaters didn't deem washing at a boat wash station necessary for their boating frequency or activities (Figure 10). Only boaters who claimed they would not use the boat wash station in the pre-boat wash survey (n=48) and do not use the boat wash station in the post-boat wash survey (n=123) are represented in these survey questions (Figure 10).

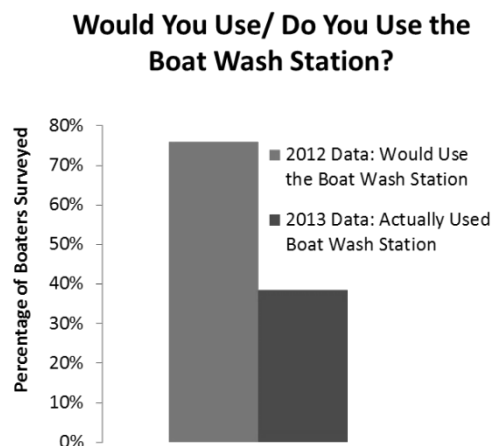


Figure 9: The percentage of boaters claiming they would use a boat wash station in 2012 (75.9%), and the percentage of observed boaters (38.5%) who were observed using the boat wash station in 2013. Pre-boat wash data (n=199) was acquired in the summer of 2012 and post-boat wash data (n=200) acquired in 2013.

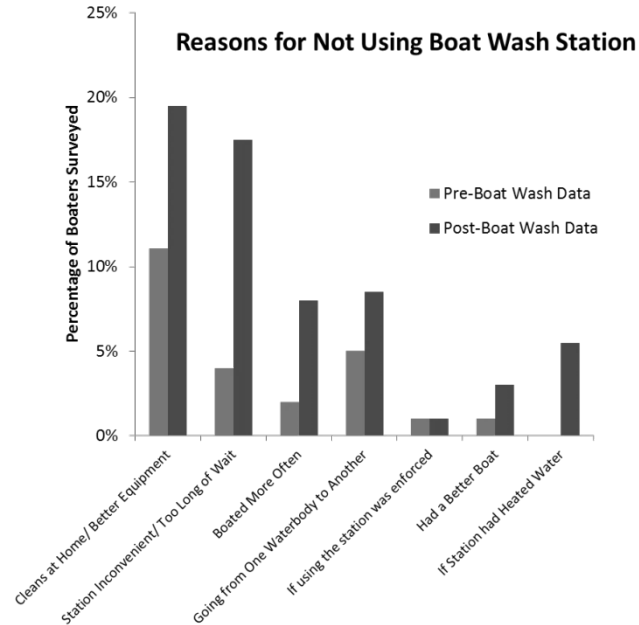


Figure 10: Reasons boaters claimed they would not use the Tenmile Lake boat wash station (Pre-Boat Wash Data) and why they do not use the boat wash station (Post-Boat Wash Data). Pre-boat wash data was acquired in the summer of 2012 (n=48) and post-boat wash data (n=123) acquired in 2013.

Knowledge of Aquatic Invasive Species

The aquatic invasive species that surveyed boaters could most verbally identify was the zebra mussel (*Dreissena polymorpha*) (44.7% of boaters in 2012, 59% of boaters in 2013) (Figure 11). The New Zealand mud snail (*Potamopyrgus antipodarum*) and quagga mussel (*Dreissena rostriformis bugensis*) were also verbally identified by surveyed boaters and were ranked among the top ten most identified aquatic invasive species (New Zealand mud snail: 14.6% in 2012, 17% in 2013; quagga mussel: 6% in 2012, 9.5% in 2013) (Figure 11). However, the second most common answer to whether or not a surveyed boater could verbally identify an invasive species was that they could not (Figure 11). In 2012, 25.6% of boaters could not verbally identify an invasive species and in the 2013 (post-boat wash) field season 23% of boaters could not verbally identify an invasive species (Figure 11).

Surveyed boaters were less informed in 2013 (55%) compared to 2012 (69%) about the Oregon state law prohibiting the launching of a boat with invasive species attachment (Table 1).

Conversely, surveyed boaters were more aware of the state regulations regarding the use and movement of bait fish in 2013 (82%) versus 2012 (63%) (Table 1). Similarly, the awareness of the state regulation regarding the use and movement of crayfish increased from 2012 (60%) to 2013 (62%) (Table 1).

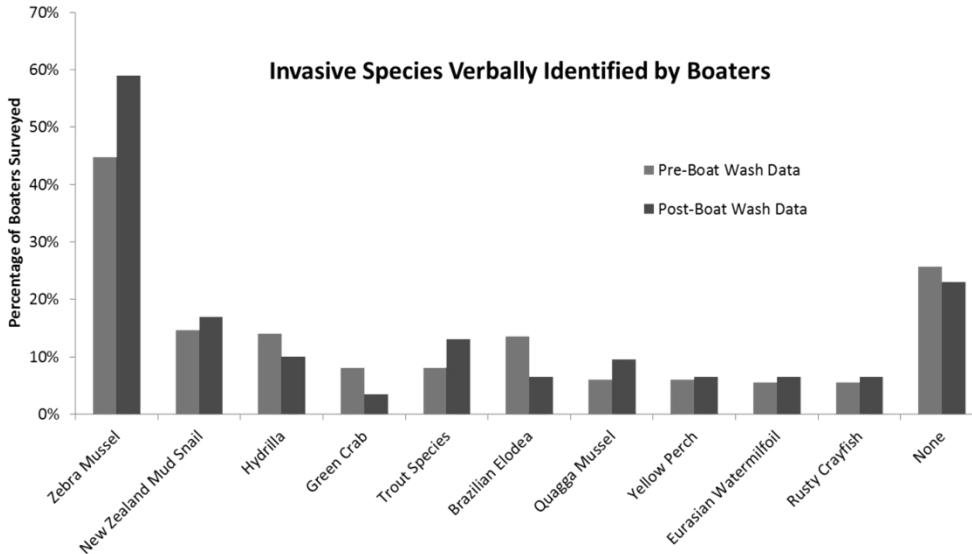


Figure 11: The percentage of boaters surveyed who verbally identified aquatic invasive species. Pre-boat wash data (n=199) was acquired in the summer of 2012 and post-boat wash data (n=200) acquired in 2013.

Table 1: The percentage of boaters surveyed aware of Oregon State laws and regulations regarding aquatic invasive species in the field season of 2012 and 2013. The 2012 results (n=199) were collected during the pre-boat wash installation, the 2013 results (n=200) were collected after boat wash installation (post-boat wash).

Survey Questions	2012		2013	
	Yes	No	Yes	No
Aware of state law that prohibits launching a boat with invasive species on it?	69%	31%	55%	45%
Aware of state regulations regarding the use and movement of bait fish?	63%	37%	82%	18%
Aware of state regulations regarding Crayfish use and movement?	60%	40%	62%	38%

Public Awareness

A minority of surveyed boaters arriving at Tenmile Lake did see signage regarding aquatic invasive species in both the pre-boat wash field season (25.1%) and post-boat wash field season (31.5%) (Figure 12). Even fewer boaters saw signage regarding aquatic invasive species when leaving Tenmile Lake in both the pre-boat wash field season (5.5%) and post-boat wash field season (4.5%) (Figure 12). However, the majority of boaters surveyed at Tenmile Lake in the pre-boat wash field season (63.3%) and post-boat wash field season (66%) were aware of the phrase “Clean, Drain, Dry” (Figure 13). Moreover, 44.7% of pre-boat wash boaters and 59% of the post boat wash boaters always practice the “Clean, Drain, Dry” method (Figure 13). The majority of boaters unaware of the phrase “Clean, Drain, Dry” in the pre-boat wash season and post-boat wash season still practiced this cleaning method at least some of the time (Figure 13).

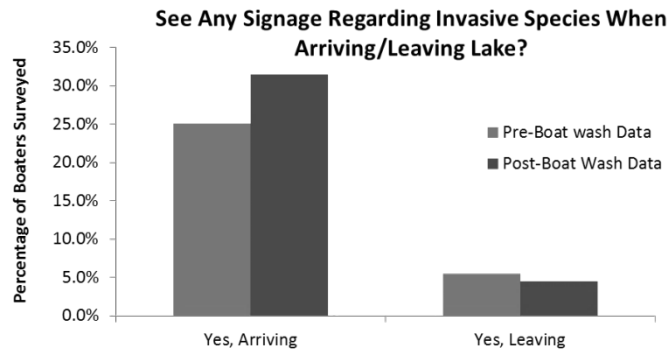


Figure 12: The percentage of boaters surveyed who saw signage regarding aquatic invasive species when arriving at Tennile Lake and leaving Tennile Lake. Pre-boat wash data (n=199) was acquired in the summer of 2012 and post-boat wash data (n=200) acquired in 2013.

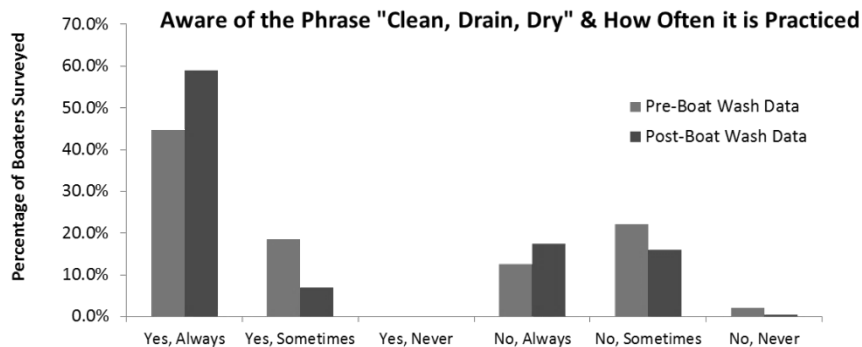


Figure 13: The percentage of boaters surveyed who were aware of the phrase "Clean, Drain, Dry" and how often the surveyed boaters practiced this phrase. Pre-boat wash data (n=199) was acquired in the summer of 2012 and post-boat wash data (n=200) acquired in 2013.

Discussion

The zebra mussel (*D. polymorpha*), quagga mussel (*D. rostriformis bugensis*), and New Zealand mud snail (*P. antipodarum*) were all introduced into US waters in the mid to late 1980s and early 1990s (Mills et al. 1987, Bowler et al. 1991, Herbert et al. 1996). The New Zealand mud snail, introduced into the Snake River of Idaho in 1987 (Bowler 1991), was likely transported via an anglers' fishing gear (Loo et al. 2007b). The zebra mussel, introduced into Lake St. Clair just north of the Great Lakes in 1986 (Herbert et al. 1987), and the quagga mussel, introduced into Lake Ontario and Erie Canal in 1991 (Mills et al. 1996), were transplanted likely as the result of a ship's ballast water discharge (Mills et al. 1996).

The New Zealand mud snail as well as the zebra and quagga mussel have been spreading quickly and effectively (Figures 1-3) since their initial establishment in the United States (Loo et al. 2007a, and McMahon 2011). In 2001, in response to the growing threat of invasive species to the state, the Oregon Invasive Species Council (OISC) was created by the Oregon State Legislature (Reesman et al. 2012). The task of the Council was (and still is) to conduct a coordinated and comprehensive effort to keep invasive species from establishing in Oregon and

to eliminate, reduce, or mitigate the impacts of invasive species that are already established (Reesman et al. 2012). Furthermore in 2001, Portland State University (PSU) developed an Oregon Aquatic Nuisance Species Management Plan, which was the first step to outline activities in the state that were needed to address the impacts of aquatic invasive species.

In 2007, the destructive freshwater invasive species the quagga mussel (*Dreissena rostriformis bugensis*) a close relative of the zebra mussel, was detected in Lake Mead, Nevada (McMahon 2011). As a result of this invasion, many western states, including Oregon, implemented programs to protect water bodies against the spread of this and similar highly destructive species (Reesman et al. 2012). Most of these protective efforts focused on establishing recreational watercraft inspection stations and implementing early detection and rapid response strategies (Reesman et al. 2012). Additionally, signs were placed at most public boat ramps in the state of Oregon warning boaters about particular aquatic invasive species and how to properly clean one's boat, as well as the construction of the boat wash station at Tenmile Lake in 2013.

Tenmile Lake Use

The majority of boaters are visiting Tenmile Lake after boating in nearby freshwater and saltwater waterbodies. In addition, the majority of these boaters are boating multiple times a month. Fishing is the most common activity of boaters surveyed at Tenmile Lake and annual fishing tournaments boost the Lakeside community economy. Because of their important involvement with the community it is becoming increasingly essential that fishermen, who may travel to multiple different tournaments throughout the peak fishing season, are well educated on aquatic invasive species identification and proper boat cleaning procedures.

Boat Wash Station Use

Understanding the boat wash station use at Tenmile Lake should also provide a better understanding of recreationalists use and views of Tenmile Lake itself. Results from the two seasons of field surveys indicate that there was disconnect in what boaters said in the human subject surveys and what boaters actually did. In 2012 before the Tenmile Lake boat wash station was installed boaters were asked if they would be willing to use a boat wash station and 75.9% said they would; however, in 2013 after the boat wash station was installed only 38.5% of surveyed boaters were actually observed using the washing station (Figure 9). Boaters appear to like the idea and certainly the benefits of a healthy lake ecosystem, but they may not be inclined to change their daily routines. Responses to why boaters are not using the Tenmile Lake boat wash station indicate that they support maintaining or promoting a healthy lake ecosystem but are not interested in actions that may require more individual preparation and involvement and potentially result in less access to the lake.

There are some caveats to these boat wash station use results. The post-boat wash surveys were administered precisely upon the completion of the boat wash installation in 2013 and even before the grand opening. By the time the post-boat wash surveys were completed, the boat wash had only been installed for approximately a month allowing very little time for word to spread of the station's existence and efficacy. The plan for volunteers to work the station was also not put into effect by the time the post-boat wash surveys were completed. Observing the station's use with volunteers present will potentially provide an even greater understanding of boaters' willingness

to use the boat wash station. Furthermore, boat wash station use was only recorded from surveyed boaters.

Knowledge of Aquatic Invasive Species

Through the information gathered from the boater surveys, a better understanding of recreationalists' knowledge of aquatic invasive species and proper boat cleaning procedure was developed and will continue to be analyzed. Case 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 like 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 lakes' fauna (mostly fish). However, boaters were unaware of some of the major pressures threatening the health of the lake. The most noticeable lack of boater knowledge was in the verbal identification of aquatic invasive species (Figure 11). The second most common answer from surveyed boaters when asked to verbally identify an aquatic invasive species was that they did not know of any (Figure 11). Moreover, bass species, an abundant and stocked invasive species at Tenmile Lake, were not in the top ten verbally identified invasive species possibly due to the economic benefits bass fishing brings to the community (Figure 11).

The majority of boaters surveyed were aware of Oregon's state law that prohibits a boat to launch if an invasive species is attached to it. However, awareness of this state law decreased from 2012 to 2013. The law passed by Oregon Legislature House Bill 2220 created an Aquatic Invasive Species Prevention Program and established a new user fee for boaters in 2009, the "Aquatic Invasive Species Prevention Permit" (Reesman et al. 2012). All licensed boats are paying this user fee, but since the law passed boaters appear to becoming less aware of what this fee actually represents. However, boaters have shown continued awareness of the state regulations regarding the use and movement of bait fish and crayfish throughout the two year boater survey period.

Public Awareness

The visibility of signs used to inform the public, more specifically boaters, on invasive species at Tenmile Lake is low. Location of the signs may be a leading contributor to such a small percentage of surveyed boaters claiming to have seen a sign entering or leaving the lake. The "Aquatic Invaders" sign at Tenmile Lake informing boaters on common and potentially devastating aquatic invasive species as well as how to properly clean one's boat ("Clean, Drain, Dry") was located a substantial distance from the boat ramp (Figure 14). In 2013, signs were put up along the edges of the Tenmile Lake boat ramp to inform boaters they may be in risk of violating state law if caught back-flushing their motors (Figure 14), but this sign only mentions the risk of transporting invasive species in small print (Figure 4). These signs need to be more visible and easier to read at Tenmile Lake. Although signage was commonly overlooked at Tenmile Lake, most boaters were still aware of the phrase "Clean, Drain, Dry" and practiced this method of taking care of their boat.



Figure 14: Tenmile Lake public boat ramp with the "Aquatic Invaders" sign (far left) a distance from the boat ramp and the "Warning of Back-Flushing" sign (near boat ramp). Photo was taken during the 2013 field season (Sam Cimino).

Conclusion

By obtaining recreationalists' knowledge through these the human subject surveys, one can progress, adapt, and move forward in future management plans. Adaptation in future methodology is essential with the Tenmile Lake boat wash station installation and ongoing monitoring of its effectiveness specifically whether the use of the boat wash station is higher when a volunteer at the station is present must be overseen. The human subject survey administered provides only a snapshot of boater knowledge and only reflects a subset of the community's awareness of aquatic invasive species and proper boat cleaning practices. Moreover, visual representations through pictures of common aquatic invasive species while performing the survey may prove to be a more useful technique to gage local and recreational knowledge. However, the ultimate goal remains the same: to increase public awareness of proper boat cleaning procedure and to increase public awareness of aquatic invasive species and their transportation vectors. The installation of the boat wash station at Tenmile Lake promotes this goal by: preventing invasive species from entering the lake, containing invasive species already present in the lake from being transported out, providing a free and efficient tool for flushing boat motors, and most importantly, increasing the public awareness of aquatic invasive species and proper boat cleaning procedure.

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Appendix A

The informed consent form given to all boaters prior to participating in the Tenmile Lake boater survey. Participants were also encouraged to contact via post mail or phone if they had any questions or concerns about their participation in this study.

Department of Environmental Science and Management

Post Office Box 751 503-725-4982 tel
Portland, Oregon 97207-0751 503-725-9040 fax



You are invited to participate in a research study conducted by Professor Angela Strecker from Portland State University, Department of Environmental Science and Management. These researchers hope to learn about boater behavior and attitudes on aquatic invasive species. You were selected as a possible participant in this study because you are a boater here at Tenmile Lake.

If you decide to participate, you will be asked to verbally answer questions. The first part of the survey will last approximately 10 minutes. If you agree to answer the more in-depth questions, this second part of the survey will last approximately 15 minutes. While participating in this study, it is possible that you will feel some embarrassment or discomfort, at which point the interviewer will disregard your responses or will terminate the interview. You may not receive any direct benefit from taking part in this study, but the study may help to increase knowledge which may help others in the future. To encourage participation, we will enter your name in a draw for a \$50 gift certificate from a local vendor.

Any information that is obtained in connection with this study and that can be linked to you or identify you will be kept private and will not be shared. This information will be kept private by storage at Portland State University in a password-protected computer file. Paper copies will be kept in a locked filing cabinet.

Your participation is voluntary. You do not have to take part in this study and you may withdraw from this study at any time.

If you have questions or concerns about your participation in this study, contact Angela Strecker (strecker@pdx.edu, 503-725-2427) at PO Box 751, Portland State University, Portland OR 97201. If you have concerns about your rights as a research subject, please contact Human Subjects Research Review Committee, Research and Strategic Partnerships, PO Box 751, Portland State University, Portland OR 97201 (hsrrc@lists.pdx.edu, 1-877-480-4400).

Please indicate to the researcher that you have read and understand the above information and agree to take part in this study. The researcher will provide you with a copy of this form for your own records.

Appendix B

Boater survey questions from the 2012 pre-boat wash installation field season. The boater surveys included a three step process: Step 1 an observational survey, Step 2 a “short form” boater survey, and Step 3 an in-depth boater survey.

Step 1: Observational Survey (to be filled out by researcher)

1. Coming from in state/out of state? _____ If out of state, name: _____
2. Kind of boat (motorized, non-motorized, canoe, fishing): _____
3. Details about the day (fishing tournament, etc): _____
4. Did the boat launch clean (no vegetation or invertebrates)? _____
5. Did the boat leave clean? _____
If not, what was on it (vegetation, invertebrates)? _____
6. Was there any effort to remove the fouling organisms? _____
Drain bilge/live well? _____

Step 2: Boater Survey (to be filled out by researcher)

1. When was the last time your boat was in the water? _____
2. What waterbody did you and your boat come from? _____
What waterbody are you visiting next? _____
How many waterbodies have you visited in the last month? _____
3. Do you know about the invasive species prevention program permit? ___yes ___no
 - a. Have you ever been asked to show your permit? ___yes ___no
4. Are you aware of the phrase “clean, drain, dry”? ___yes ___no
 - a. Have you done this before? ___always ___sometimes ___never
 - b. Do you know which parts of the boat might be susceptible to invasive species attachment? ___yes ___no
5. Have you ever been through a boat inspection station?
 - a. Oregon
 - b. other: _____
6. Would you use a boat wash station at a boat ramp? ___yes ___no
 - a. If no, what would it take for you to change your behavior?

7. Are you aware of a state law that prohibits launching a boat that has invasive species on it?
___yes ___no
8. * Have you ever backflushed your motor in a lake after boating in salt water?
___always ___sometimes ___never
 - a. * Do you know anyone who has? ___yes ___no
9. * Are you aware of the state regulations regarding the use and movement of baitfish?
___yes ___no
 - a. * What about crayfish? ___yes ___no
10. Do you know how to report a suspected invasive species? ___yes ___no
 - a. Would you be able recognize or name an invasive species? ___yes ___no

11. * What types of activities do you engage in with your boat (e.g., sailing, fishing, recreation)?

12. Did you see any signage regarding invasive species when you arrived at the lake?
___yes ___no
Left the lake? ___yes ___no

Step 3: In-Depth Boater Survey (to be filled out by researcher)

1. * How do invasive species affect you and your activities?
 - a. * Do they change your experience at the lake?
2. How important are invasive species as an issue in Oregon?
 very somewhat not at all
3. * Where did you see or hear the information regarding aquatic invasive species?
4. * If you do not wash your boat (clean, drain, dry), what would motivate you to do so?
5. * What invasive species are you aware of?
6. Have you heard of Hydrilla? Eurasian watermilfoil? Brazilian elodea?
7. † Do you know that Eurasian watermilfoil has been found in this lake?
 yes no
8. † How informed are you regarding aquatic weed control options?
 very informed somewhat informed uninformed
9. † In your experience, have aquatic plants negatively impacted your use of a waterbody?
 yes no no opinion
10. † Are you in favor of controlling Eurasian watermilfoil here? yes no no opinion

* These questions will **not** be asked of survey participants at Central Oregon Lakes (Crane Prairie Reservoir, Haystack Reservoir, East Lake and Suttle Lake).

† These questions will **only** be asked of survey participants at Central Oregon Lakes (Crane Prairie Reservoir, Haystack Reservoir, East Lake and Suttle Lake).

Appendix C

Boater survey questions from the 2013 post-boat wash installation field season. The post-boat wash survey is identical to the 2012 pre-boat wash survey with the addition of question 7 in the “Step 1: Observation Survey” (bold) and a change in question 6 in the “Step 2: Boater Survey” from “Would you use a boat wash station at Tenmile Lake?” (2012) to “Do you use the boat wash station here at Tenmile Lake?” (bold).

Step 1: Observational Survey (to be filled out by researcher)

1. Coming from in state/out of state? _____ If out of state, name: _____
2. Kind of boat (motorized, non-motorized, canoe, fishing): _____
3. Details about the day (fishing tournament, etc): _____
4. Did the boat launch clean (no vegetation or invertebrates)? _____
5. Did the boat leave clean? _____
If not, what was on it (vegetation, invertebrates)? _____
6. Was there any effort to remove the fouling organisms? _____
Drain bilge/live well? _____
7. **Did the boater use the boat wash station?** _____
If yes, was the station staffed by a volunteer at the time? _____

Step 2: Boater Survey (to be filled out by researcher)

1. When was the last time your boat was in the water? _____
2. What waterbody did you and your boat come from? _____
What waterbody are you visiting next? _____
How many waterbodies have you visited in the last month? _____
3. Do you know about the invasive species prevention program permit? ___yes ___no
 - a. Have you ever been asked to show your permit? ___yes ___no
4. Are you aware of the phrase “clean, drain, dry”? ___yes ___no
 - a. Have you done this before? ___always ___sometimes ___never
 - b. Do you know which parts of the boat might be susceptible to invasive species attachment? ___yes ___no
5. Have you ever been through a boat inspection station?
 - a. Oregon
 - b. other: _____
6. **Do you use the boat wash station here at Tenmile Lake?** ___yes ___no
 - a. If no, what would it take for you to change your behavior?

7. Are you aware of a state law that prohibits launching a boat that has invasive species on it?
___yes ___no
8. * Have you ever backflushed your motor in a lake after boating in salt water?
___always ___sometimes ___never
 - b. * Do you know anyone who has? ___yes ___no
9. * Are you aware of the state regulations regarding the use and movement of baitfish?
___yes ___no
 - b. * What about crayfish? ___yes ___no
10. Do you know how to report a suspected invasive species? ___yes ___no
 - a. Would you be able **to visually** recognize or name an invasive species? ___yes ___no

Name: _____

11. * What types of activities do you engage in with your boat (e.g., sailing, fishing, recreation)?

12. Did you see any signage regarding invasive species when you arrived at the lake?

____yes ____no

Left the lake? ____yes ____no

Step 3: In-Depth Boater Survey (to be filled out by researcher)

1. * How do invasive species affect you and your activities?

a. * Do they change your experience at the lake?

2. How important are invasive species as an issue in Oregon?

____very ____somewhat ____not at all

3. * Where did you see or hear the information regarding aquatic invasive species?

4. * If you do not wash your boat (clean, drain, dry), what would motivate you to do so?

5. * What invasive species are you aware of?

6. Have you heard of Hydrilla? Eurasian watermilfoil? Brazilian elodea?

7. † Do you know that Eurasian watermilfoil has been found in this lake?

____yes ____no

8. † How informed are you regarding aquatic weed control options?

____very informed ____somewhat informed ____uninformed

9. † In your experience, have aquatic plants negatively impacted your use of a waterbody?

____yes ____no ____no opinion

10. † Are you in favor of controlling Eurasian watermilfoil here? ____yes ____no ____no opinion

* These questions will **not** be asked of survey participants at Central Oregon Lakes (Crane Prairie Reservoir, Haystack Reservoir, East Lake and Suttle Lake).

† These questions will **only** be asked of survey participants at Central Oregon Lakes (Crane Prairie Reservoir, Haystack Reservoir, East Lake and Suttle Lake).

Appendix D

Table : All of the waterbodies last visited by surveyed boaters at Tenmile Lake during the 2012 and 2013 field seasons. The percentage is the number of boaters surveyed who last came from that waterbody. Waterbodies outside of Oregon are labeled with the state abbreviation.

Waterbody Boat Came From	Tenmile	Siltcoos Lake	Eel Lake	Woahink Lake	Loon Lake	Umpqua River	Tahkenitch Lake
2012	34.7%	8.0%	7.0%	5.5%	5.5%	5.0%	4.0%
2013	21.0%	7.0%	11.0%	6.5%	4.0%	6.5%	5.0%
Waterbody Boat Came From	Smith River	Coos Bay	Fern Ridge Lake	Klamath Lake	Lake Shasta (CA)	Winchester Bay	Detroit Lake
2012	2.5%	2.0%	2.0%	2.0%	1.5%	1.5%	1.0%
2013	0.5%	3.0%	1.0%	2.0%	0.5%	4.0%	1.5%
Waterbody Boat Came From	Diamond Lake	Mercer Lake	Siuslaw River	Snake River (ID)	Willamette River	Crane Prairie	Columbia River
2012	1.0%	1.0%	1.0%	1.0%	1.0%	0.5%	0.5%
2013	1.5%	2.5%	1.0%	0.0%	0.5%	1.0%	0.5%
Waterbody Boat Came From	Haystack Reservoir	Green Peter Lake	Howard Prairie	Coquille River	Munsel Lake	Dorena Lake	Sutton Lake
2012	0.5%	0.5%	0.5%	0.0%	0.0%	0.0%	0.0%
2013	2.0%	1.5%	1.0%	3.0%	2.0%	2.0%	1.0%
Waterbody Boat Came From	Dexter Lake	Rogue River	Lost Creek Lake	Alesea Bay	Deschutes River	Mayfield Lake (WA)	Suttle Lake
2012	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%
2013	1.0%	1.0%	1.0%	0.5%	0.5%	0.5%	0.5%
Waterbody Boat Came From	Floras Lake	Paddock Valley (ID)	Wickiup Reservoir	Flathead Lake (MT)	Meiss Lake (CA)	Mackenzie River	Riffe Lake (WA)
2012	0.0%	0.0%	0.0%	0.5%	0.05%	0.5%	0.5%
2013	0.5%	0.5%	0.5%	0.0%	0.0%	0.0%	0.0%
Waterbody Boat Came From	Siletz River	Silver Lake (WA)	Timothy Lake	Garibaldi Bay			
2012	0.5%	0.5%	0.5%	0.5%			
2013	0.0%	0.0%	0.0%	0.0%			

Appendix E

Raw data of boater survey answers from the 2012 pre-boat wash field season and the 2013 post-boat wash field season with sample size. All questions are italicized and questions in bold are from the 2013 field season only.

Step 1: Observational Survey (to be filled out by researcher)

1. *Coming from in state/out of state? _____ If out of state, name: _____*
2012 (n=199): Oregon=176, California =13, Washington=5, Idaho=3, Arizona=2
2013 (n=200): Oregon=185, California=5, Arizona=4, Washington=4, Idaho=1, Nevada=1

2. *Kind of boat (motorized, non-motorized, canoe, fishing): _____*
2012 (n=199): Motorized Fishing=151, Motorized Recreation=31, Motorized Luxury=7, Canoe=3, Sail Boat=3, Jet Skis=1
2013 (n=200): Motorized Fishing=146, Motorized Recreation=40, Motorized Luxury=5, Canoe=5, Sail Boat=3, Jet Skis=2, Kayak=2

3. *Details about the day (fishing tournament, etc): _____*
2012 (n=199): No Tournament=118, Tenmile Open=21, Smaller Tournaments= 60
2013 (n=200): No Tournament=146, Tenmile Open=33, Smaller Tournaments=21

4. *Did the boat launch clean (no vegetation or invertebrates)? _____*
2012 (n=199): Yes=75, No/Vegetation attached=2, Did not see boat launch=122
2013 (n=200): Yes=84, No/Vegetation attached=3, Did not see boat launch=113

5. *Did the boat leave clean? _____*
If not, what was on it (vegetation, invertebrates)? _____
2012 (n=199): Yes=172, No/Vegetation=20, No Invertebrates=5, No/Both Invertebrates and Vegetation=2
2013 (n=200): Yes=176, No/Vegetation=22, No Invertebrates=1, No/Both Invertebrates and Vegetation=1

6. *Was there any effort to remove the fouling organisms? _____*
2012 (n=199): Yes, Nothing to Remove=68, Removed Fouling Organism=54, No, but Clean=50, No=23, Yes, Did Not Get All Organisms=4
2013 (n=200): Yes, Nothing to Remove=71, Removed Fouling Organism=68, No, but Clean=37, No=21, Yes, Did Not Get it All=3
Drain bilge/live well? _____
2012 (n=199): Yes= 53, No= 79, N/A=67
2013 (n=200): Yes=124, No=39, N/A=37

7. *Did the boater use the boat wash station? _____*
2013 (n=200): Yes, Leaving Lake=63, Yes, Entering and Leaving Lake=6, No=131
If yes, was the station staffed by a volunteer at the time? _____
2013 (n=0): *Boat wash station was never staffed during the 2013 field season

Step 2: Boater Survey (to be filled out by researcher)

1. *When was the last time your boat was in the water?* _____
2012 (n=199): 1 Day= 30, 2-6 Days=52, 7-14 Days=74, 15-31 Days=23, 32-364 Days=16, 365+ Days=4
2013 (n=200): 1 Day= 36, 2-6 Days=75, 7-14 Days=66, 15-31 Days=19, 32-364 Days=3, 365+ Days=1

2. *What waterbody did you and your boat come from?* _____
2012 (n=199): See Appendix D
2013 (n=200): See Appendix D
What waterbody are you visiting next? _____
2012 (n=199): Don't Know=17, Umpqua River=15, Tenmile Lake=71, Non-descript Bay=3, Woahink Lake=13, Eel Lake=12, Loon Lake=9, Coos Bay=8, Siltcoos Lake=7, Tahkenitch Lake=7, Siuslaw River=4, Fern Ridge Lake=3, Willamette River=3, Lake Shasta=3, Hagg Lake=2, Silutz Lake=2, Lake Washington=2, Detroit Lake=1, Klamath Lake=1, Winchester Bay=1, Coos River=1, Deschutes River=1, Diamond Lake=1, Alsea River=1, Haystack Reservoir=1, Mackenzie River=1, Smith River=1, Snake River=1, Suttle Lake=1, Sutton Lake=1, Charelston Bay=1, Foster Reservoir=1, Green Peter=1, Howard Prairie=1, Timothy Lake=1
2013 (n=200): Don't Know= 19, Alsea Bay=1, Coos Bay=2, Coos River=1, Coquille River=3, Crane Prairie Reservoir=1, Detroit Lake=2, Devils Lake=1, Dorena Lake=4, East Lake =1, Eel Lake=17, Emigrant Lake=1, Fern Ridge=4, Howard Prairie=1, Klamath=3, Lake Billy Chinook=1, Loon Lake=3, Lost Creek Lake=2, Rogue River=2, Siltcoos=18, Siuslaw=7, Smith River=5, Suttle Lake=1, Sutton Lake=3, Tahlenitch Lake=12, Tenmile Lake=57, Umpqua River=7, Willamette River=1, Willow Lake=1, Winchester Bay=5, Woahink Lake=13, Yamhill River=1
How many waterbodies have you visited in the last month? _____
2012 (n=199): 1 waterbody=50, 2=61, 3=53, 4=20, 5=9, 6=6
2013 (n=200): 1 waterbody=19, 2=47, 3=62, 4=39, 5=20, 6=9, 7=3, 10=1

3. *Do you know about the invasive species prevention program permit?* ____yes ____no
2012 (n=199): Yes=140, No=59
2013 (n=200): Yes=144, No=56
 - a. *Have you ever been asked to show your permit?* ____yes ____no
2012 (n=199): Yes=22, No=177
2013 (n=200): Yes=54, No=146

4. *Are you aware of the phrase "clean, drain, dry"?* ____yes ____no
2012 (n=199): Yes=126, No=73
2013 (n=200): Yes=132, No=68
 - a. *Have you done this before?* ____always ____sometimes ____never
2012 (n=199): Yes/Always=89, Yes/Sometimes=37, Yes/Never=0, No/Always=25, No/Sometimes=44, No/Never=4
2013 (n=200): Yes/Always=118, Yes/Sometimes=14, Yes/Never=0, No/Always=35, No/Sometimes=32, No/Never=1

- b. Do you know which parts of the boat might be susceptible to invasive species attachment? yes no
2012 (n=199): Yes=191, No=8
2013 (n=200): Yes=186, No=14
5. Have you ever been through a boat inspection station?
 a. Oregon b. other: _____
2012 (n=199): No=152, Yes/Arizona=1, Yes/California=17, Yes/Lake Tahoe=1, Yes/Nevada=1, Yes/Oregon=27
2013 (n=200): No=146, Yes/Arizona=3, Yes/California=7, Yes/California and Oregon=2, Yes/Oregon=38, Yes/Washington=4
6. Would you use a boat wash station at a boat ramp? yes no
2012 (n=199): Yes=160, No=39
 a. If no, what would it take for you to change your behavior?
2012 (n=48*): Cleans at Home/Better Equipment=22, Station Inconvenient/Too Long to Wait=8, Boated More Often=4, If Going from One Waterbody to Another=10, If Station was Enforced=2, Had a Better Boat=2
 *9 surveyed boaters claimed they would use the boat wash station only if it had better equipment than their home boat wash equipment
7. Do you use the boat wash station here at Tenmile Lake? yes no
2013 (n=200): Yes=78, No=122
 a. If no, what would it take for you to change your behavior?
2013 (n=126*): Cleans at Home/Better Equipment=39, Station Inconvenient/Too Long to Wait=35, Boated More Often=16, If Going from One Waterbody to Another=16, If Station was Enforced=2, Had a Better Boat=6, If the Station Had Heated Water=11
 *4 surveyed boaters who use the boat wash station only use it if they are going to a different waterbody next.
8. Are you aware of a state law that prohibits launching a boat that has invasive species on it?
 yes no
2012 (n=199): Yes=138, No=61
2013 (n=200): Yes=109, No=91
9. Have you ever backflushed your motor in a lake after boating in salt water?
 always sometimes never
2012 (n=199): Always=1, Sometimes=19, Never=179
2013 (n=200): Always=2, Sometimes=7, Never=191
 a. Do you know anyone who has? yes no
2012 (n=199): Yes=73, No=126
2013 (n=200): Yes=64, No=136
10. Are you aware of the state regulations regarding the use and movement of baitfish?

- a. yes no
2012 (n=199): Yes=126, No=73
2013 (n=200): Yes=163, No=37
- b. *What about crayfish?* yes no
2012 (n=199): Yes=119, No=80
2013 (n=200): Yes=124, No=76
11. *Do you know how to report a suspected invasive species?* yes no
 2012 (n=199): Yes=89, No=110
 2013 (n=200): Yes=84, No=116
- a. *Would you be able to visually recognize or name an invasive species?* yes no
 2012 (n=199): Yes=148, No=51
 2013 (n=200): Yes=154, No=46
- Name:*
2012 (n=148*): Zebra mussel=89, New Zealand mud snail=29, hydrilla=28, green crab=16, trout species=16, Brazilian elodea=27, quagga mussel=12, yellow perch=12, Eurasian watermilfoil=11, rusty crayfish=11, northern pike=10, white flowered lily pads (odorata)=9, shad=8, catfish and bullheads=3, bass=3, swollen bladderwort=3, nutria=2, Asian freshwater clams=1, carp=1, bluegill=1, parrot feather=1, softshell clam=2, terrestrial vegetation=17, terrestrial fauna=7
2013 (n=154*): Zebra mussel=118, New Zealand mud snail=34, hydrilla=20, green crab=7, trout species=26, Brazilian elodea=13, quagga mussel=19, yellow perch=13, Eurasian watermilfoil=13, rusty crayfish=13, northern pike=6, white flowered lily pads (odorata)=4, shad=14, bass=10, nutria=2, Asian freshwater clams=1, carp=5, bluegill=1, parrot feather=5, snakehead fish=4, reed canary grass=5, round goby=2, terrestrial vegetation=30, terrestrial fauna=16
 *Surveyed boaters named one or more species
12. *What types of activities do you engage in with your boat (e.g., sailing, fishing, recreation)?*
2012 (n=199): Fishing=103, Recreation=40, Recreation & Fishing=24, Leisure=23, Transportation=6, Sailing=3
2013 (n=200): Fishing=128, Recreation=30, Recreation & Fishing=22, Leisure=15, Transportation=2, Sailing=3
13. *Did you see any signage regarding invasive species when you arrived at the lake?*
 yes no
2012 (n=199): Yes=50, No=149
2013 (n=200): Yes=63, No=137
- Left the lake?* yes no
2012 (n=199): Yes=11, No=188
2013 (n=200): Yes=9, No=191

Step 3: In-Depth Boater Survey (to be filled out by researcher)

1. *How do invasive species affect you and your activities?*

2012 (n=69): Avoid areas that may have invasives=5, More aware of negative impacts=17, inhibits exercise=1, Invasive species don't affect my activities=9, More permits and checkpoints=8, more rules and regulations to follow=8, Take better care of boat and equipment=22, Invasives have benefitted me=2

2013 (n=57): Avoid areas that may have invasives=12, More aware of negative impacts=5, Invasive species don't affect my activities=10, More rules and regulations to follow=8, Take better care of boat and equipment=21, Invasives have benefitted me=1

a. *Do they change your experience at the lake?*

2012 (n=68): Yes/ Avoid areas=5, Fishing is worse=4, Less Enjoyable=9, No=50,

2013 (n=57): Yes/ Avoid areas=7, Fishing is worse=7, Less Enjoyable=5, No=37, Better fishing=1

2. *How important are invasive species as an issue in Oregon?*

___ very ___ somewhat ___ not at all

2012 (n=69): Very=47, Somewhat=22, Not at All=0

2013 (n=57): Very=30, Somewhat=27, Not at All=0

3. *Where did you see or hear the information regarding aquatic invasive species?*

2012 (n=69*): Education=6, Signage=21, Word of Mouth=21, News=36, ODFW Newsletter=5, Internet=8, No Info seen=3

2013 (n=58*): Education=4, Signage=20, Word of Mouth=22, News=20, ODFW Newsletter=5, Internet=12, Books=3, Permit=1

*Some surveyed boaters provided multiple sources

4. *If you do not wash your boat (clean, drain, dry), what would motivate you to do so?*

2012 (n=68): Boating more often=4, If cleaning was quicker and easier=2, A boat wash station=7, Washes boat=55

2013 (n=57): Boating more often=3, Boating in multiple waterbodies=3, A nicer boat=3, More boat wash stations=2, Washes boat=46

5. *What invasive species are you aware of?*

2012 (n=69): Answers included to the answers from question 11 in Step 2 of the survey.

2013 (n=57): Answers included to the answers from question 11 in Step 2 of the survey.

6. *Have you heard of Hydrilla? Eurasian watermilfoil? Brazilian elodea?*

2012 (n=69): Hydrilla/Yes=27, Hydrilla/No=41, Eurasian watermilfoil/Yes=18, Eurasian watermilfoil/No=50, Brazilian elodea/Yes=13, Brazilian elodea/No=55,

2013 (n=57): Hydrilla/Yes=17, Hydrilla/No=40, Eurasian watermilfoil/Yes=15, Eurasian watermilfoil/No=42, Brazilian elodea/Yes=7, Brazilian elodea/No=50,