

Aquatic Invasive Species in Mississippi

A survey on what people in Mississippi know about aquatic invasive species, where they learned about them, and what they are willing to do to stop their spread

By Kristina Alexander

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Cover: Silver carp based on a photograph by the U.S. Fish and Wildlife Service as altered by the author.

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Executive Summary

One of the Mississippi-Alabama Sea Grant Legal Program's (MASGLP) core missions is a healthy coastal ecosystem. As part of that effort, MASGLP conducted a survey to learn what Mississippians know about aquatic invasive species (AIS), where they learned that information, and what steps they are willing to take to avoid spreading AIS. The survey was funded by a grant from the Mississippi Department of Environmental Quality (MDEQ) and the U.S. Fish and Wildlife Service. The results of the survey will be used to help the State of Mississippi's AIS policies and programs as managed by the MDEQ and the Mississippi Department of Marine Resources (MDMR).

Of the 172 respondents to the survey, most had a connection to fishing. 63% have Mississippi fishing licenses, and 55% own or live with someone who owns a boat. Only 27% had neither a fishing license nor a boat.

Respondents were reasonably knowledgeable about fish AIS, even though they did not consider themselves so. Just 24% of all respondents considered themselves knowledgeable about AIS in general. However, almost 70% of the respondents correctly identified three invasive fish when given multiple choices. Fewer were knowledgeable about plant AIS, however. Respondents correctly identified 33% plant AIS on average. An average of 88% respondents correctly identified certain actions as legal in Mississippi, and an average of 42% misidentifying actions as illegal when they were not.

One key finding is that State messaging on AIS by the MDEQ and the MDMR is not reaching its intended audience. When respondents were given a choice of 15 sources of where they learned about AIS, the most popular source (15%) was *social media (not of MDEQ or MDMR)*, with *friend* being chosen next often (12%). The least picked were *MDEQ or MDMR employee* (2%) and *MDEQ or MDMR sticker, sign, or handout* (1%). Yet when asked how to inform Mississippians about AIS, a plurality of respondents chose placing *signs with photos at boat ramps*, which is where many MDEQ and MDMR stickers, signs, or handouts are located.

Almost all respondents (98%) were motivated to reduce the spread of AIS, indicating that a healthy environment is important to them. When asked which specific steps they take to help limit the spread of AIS, however, participation dropped. This could be attributed to a lack of knowledge about what steps to take, but it also could be attributed to a lack of facilities at boat landings. The survey bore this out. The two reasons most frequently given for not taking actions at boat landings to limit the spread of AIS were *don't know what to do* (23%) and *no facilities to do it* (20%).

The survey sought to determine who respondents believe should be responsible for controlling AIS. The answer largely depended on who the respondent was. Among those who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways, 100% *strongly agree* or *somewhat agree* that the State is responsible for controlling AIS. Just 25% of that cohort agree (strongly or somewhat) that individuals are responsible. In contrast, respondents as a whole believe that the responsibility should be shared equally: 74% agree (strongly or somewhat) that the State is responsible and 70% agree (strongly or somewhat) that the individual is responsible.

Additionally, despite a general perception that Mississippians are against government regulation, more than 80% of respondents agree that the State should spend to control AIS and that the State should spend at higher levels than are currently funded. Over 85% of respondents support spending more than \$1 million a year annually to control AIS. Among those who believe that AIS have reduced their enjoyment of Mississippi's waters, 42% support spending more than \$15 million annually. Notably, over 23% of respondents identified *not enough rules to protect the environment* as one of the top two issues they think are important. While only 10% said there were *too many rules about fishing*.

One significant reason for the respondents' views appears to be concern for the preservation of native fish and the habitats that nurture them. When asked to rank what is important to them, half of all respondents placed *loss of fish habitat* first or second.

Key Findings

- ! Fishers and boaters support the State spending more than \$1 million annually to control AIS, and almost half support spending more than \$5 million annually.
- ! Fishers and boaters are willing to take steps to reduce the spread of AIS, but do not believe they are informed about AIS.
- ! The lack of facilities to rinse boats before leaving the landing hampers boaters' ability to take the necessary steps to limit the spread of AIS.
- ! Current State education and outreach efforts are not reaching fishers and boaters to inform about aquatic invasive species and/or practices to limit their spread.
- ! Loss of fish habitat is a top concern of respondents.

Recommendations

- ★ Placing rinse stations at more boat landings would lead to more boaters rinsing their boats and gear.
- ★ State information efforts should focus on enhancing State websites by identifying species with photographs and including a state map showing where AIS are present.
- ★ In its outreach efforts, the State should describe actions for boaters to take at boat landings to prevent the spread of AIS.
- ★ Enhanced use of social media by the State to inform Mississippians about AIS prevention would likely increase the number of boaters and fishers who took protective steps at boat landings.
- ★ The State should spend more money on management and control of aquatic invasive species.

Introduction and Methodology

In April 2022, a link to the Aquatic Invasive Species Survey was sent to approximately 1,200 email addresses associated with the names and addresses of registered boaters provided by the State of Mississippi, as well as to approximately 100 email addresses from other sources not explicitly related to fishing or boating, such as community colleges and not-for-profits. The email addresses were gathered by entering names and cities into publically available databases. The databases produced an email address for approximately 20% of the names. More than half of the emails bounced back as having invalid email addresses.

The email described the survey and its purposes and explained that \$25 Amazon gift cards would be awarded at random. Only six responses were received from the approximately 600 people who received the email. Subsequent efforts using the same sources for emails had better response rates when the survey offered a \$25 Amazon gift card to the first X number of people who responded. Approximately 70 responses were gathered using this method. Of the initial responses, 6 respondents were affiliated with the Mississippi Department of Environmental Quality or the Mississippi-Alabama Sea Grant Legal Program, and those responses were excluded from the results.

In October 2022 a paid advertisement was posted on Facebook focusing on people in Mississippi who indicated in interest in fishing. The ad offered \$25 Amazon gift cards to the first X people who completed the survey. More than 100 responses were received, and the survey was closed. A total of 172 responses were tallied after excluding those who had a perceived conflict of interest and the few who responded to a question designed to eliminate bot responses. Participation in the survey decreased for questions later in the survey which took approximately 15 minutes to complete.

No demographic questions were asked such as race, gender, age, or income. The State's goal is to design a management program that is appealing to the most fishers and boaters regardless of demographic group. The software used for the survey was Qualtrics.

Initial questions sorted respondents based on whether they had a fishing license in Mississippi and whether they or someone they lived with own a boat. Several questions were targeted to only licensed fishers or boat owners.

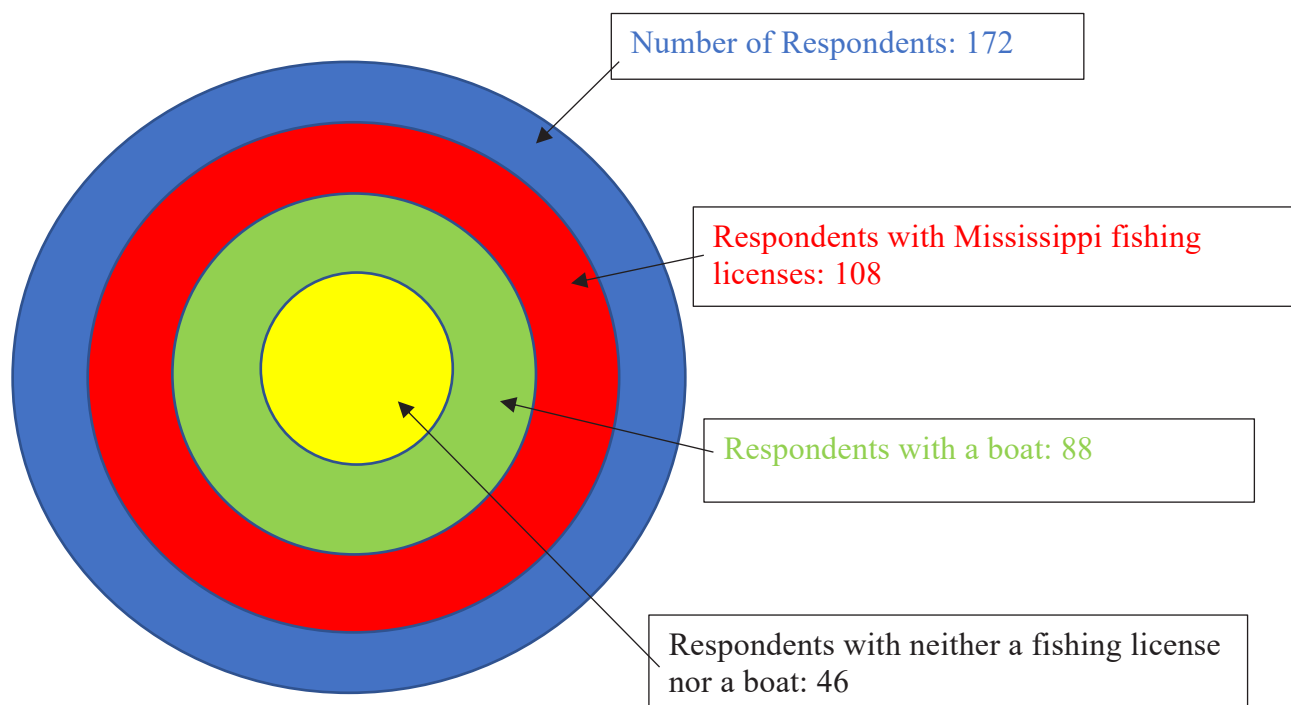
Several cohorts within the respondents as a whole were identified based on responses to particular questions, such as respondents who have neither a fishing license nor own a boat, respondents who strongly agree that a healthy environment is important, and respondents who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways. Responses from the cohorts should assist the State in its policy choices. For example, those who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways did better identifying species, chose higher amounts for the State to pay to control species than the respondents as a whole, but were just as likely not to recognize one of the State's key AIS handouts.

This report groups responses in the following categories: Boating and Fishing Experience; Opinions on Environment; Knowledge of Aquatic Invasive Species; Sources of Information;

Practices; and Respondent Comments. Appendices provide additional discussion summarizing research on nationwide AIS management and enforcement.

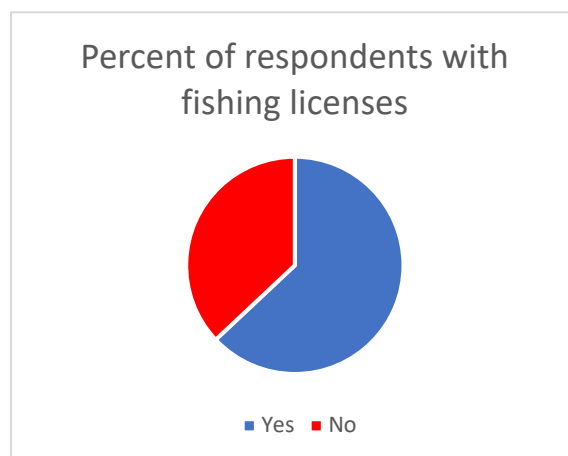
Boating and Fishing Experience

Of the 172 people who took the survey, 63% responded that they had Mississippi fishing licenses, and 55% own a boat or have one in their household, with 41% having both a fishing license and a boat. Forty-six people (27%) had neither a Mississippi fishing license nor a boat. Separately, 37% of all respondents did not have a fishing license, and 45% of respondents did not have a boat.

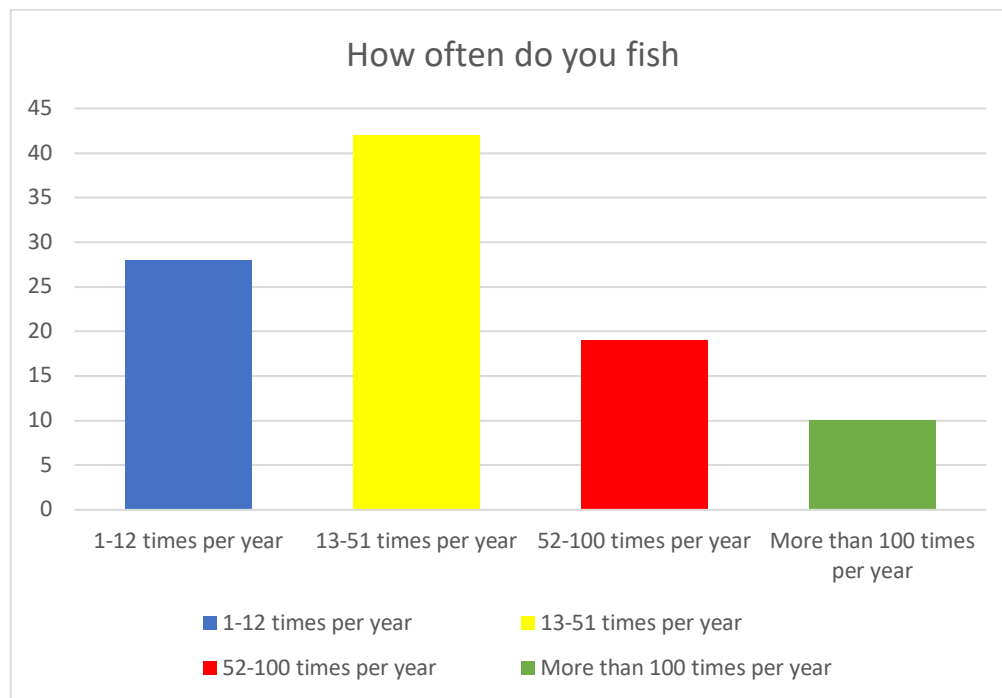


Fishing License

An initial question asked whether respondents had a fishing license. Nearly 63% said *yes*.

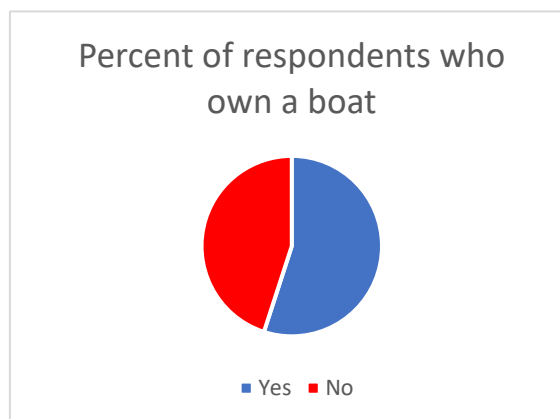


Respondents who indicated they had a fishing license were asked *how often do you fish*. Of those respondents (108 out of 172), 19% fish at least once a week. 42% fish more than once a month but less than once a week. And another 28% fish between 1-12 times a year.

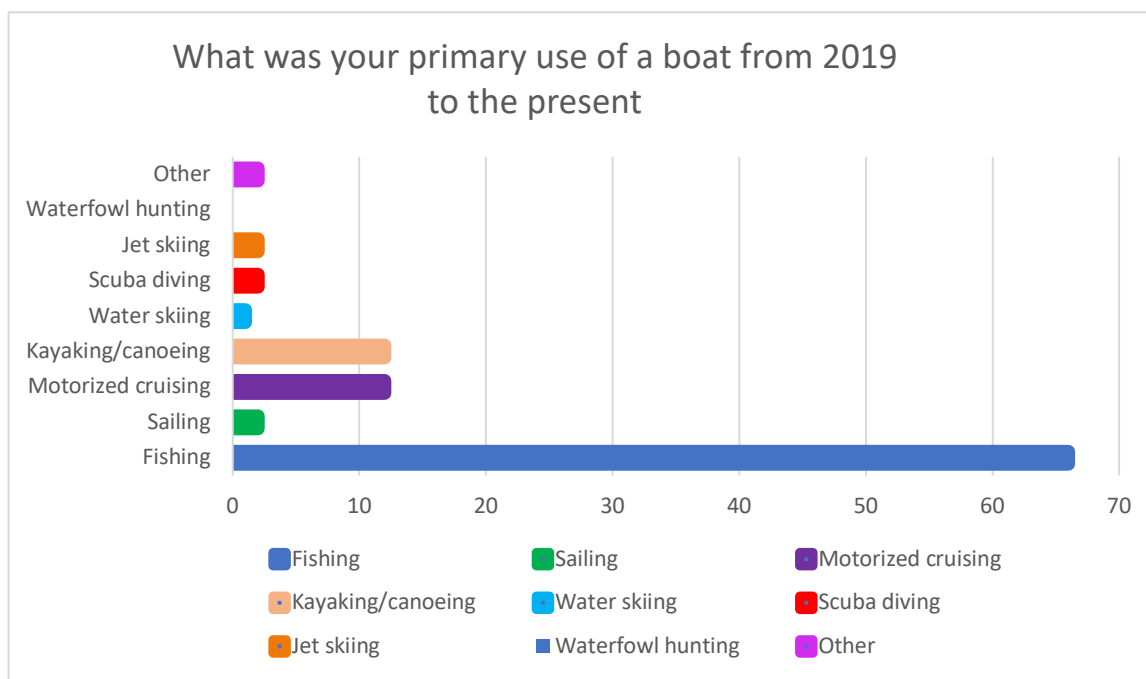


Boat Ownership

Respondents were asked whether they or someone in their household own a boat. Just over 55% have a boat.



Respondents who answered *yes* to having a boat were asked the primary use of the boat for the past several years. Not surprisingly, of the respondents who own a boat, more than 68% described the primary use of the boat as *fishing*. An equal percentage of boaters identified the primary type of boating as *kayaking/canoeing* (12%) as chose *motorized cruising*.



Opinions on the Environment

After gathering general information about fishing and boating activities, the survey focused on respondents' attitude toward the environment. Are there people who can be convinced to do more to help protect resources they enjoy? Presumably, those who already take some steps to protect nature would be interested in expending some effort to help reduce the spread of aquatic invasive species.

General Opinions and Behavior

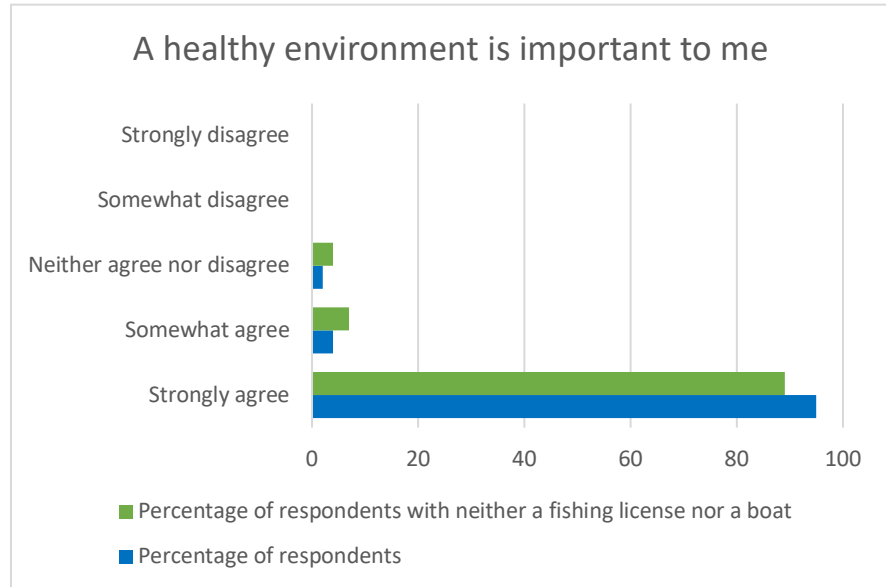
The first such question asked respondents to rate whether they agreed with the statement *a healthy environment is important to me* on a 5-point Likert Scale from *strongly agree* to *strongly disagree*. The questions seeking opinions on the environment were designed to identify those who take small, daily steps to improve the environment, rather than more substantial (and often expensive) efforts such as having an electric car.

More general questions assessing respondents' opinions on the environment were compared to results from the specific questions in the *Practices* section to see if there was a correlation. Those who answered that they *strongly agree* were put into a cohort, and in later questions

their responses were compared to answers on what actions those respondents were willing to take to protect the environment to see if there was consistency.

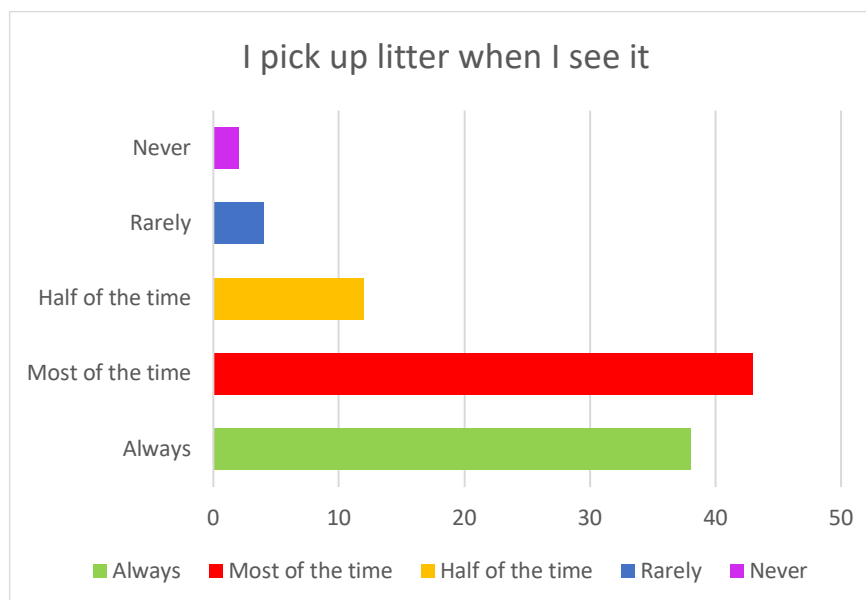
Overall, people taking the survey indicated that the environment was important to them. For example, over 94% of all respondents say they *strongly agree* that a healthy environment is important.

An additional 4% *somewhat agree* that a healthy environment is important to them. Only 2% of takers chose *neither agree nor disagree* as to whether a healthy environment was important to them, and no respondents disagreed that a healthy environment was important to them.



The percentage of those who *strongly agree* that a healthy environment is important was slightly lower in the cohort of respondents who had neither a fishing license nor a boat, 89%. The percentage of that cohort who *somewhat agree* was 7%.

People were also asked if they pick up litter and if they recycle, using a 5-point scale from *always* to *never* for both questions. Of the 166 people answering the questions, 38% said they *always* pick up litter, and 43% said they pick up litter *most of the time*. The responses are similar to those in the cohort who *strongly agree* that healthy environment was important. Granted, that cohort is 94% of all respondents, but of the cohort who strongly agree that a



healthy environment is important, 39% *always* pick up litter and 43% pick up litter *most of the time*.

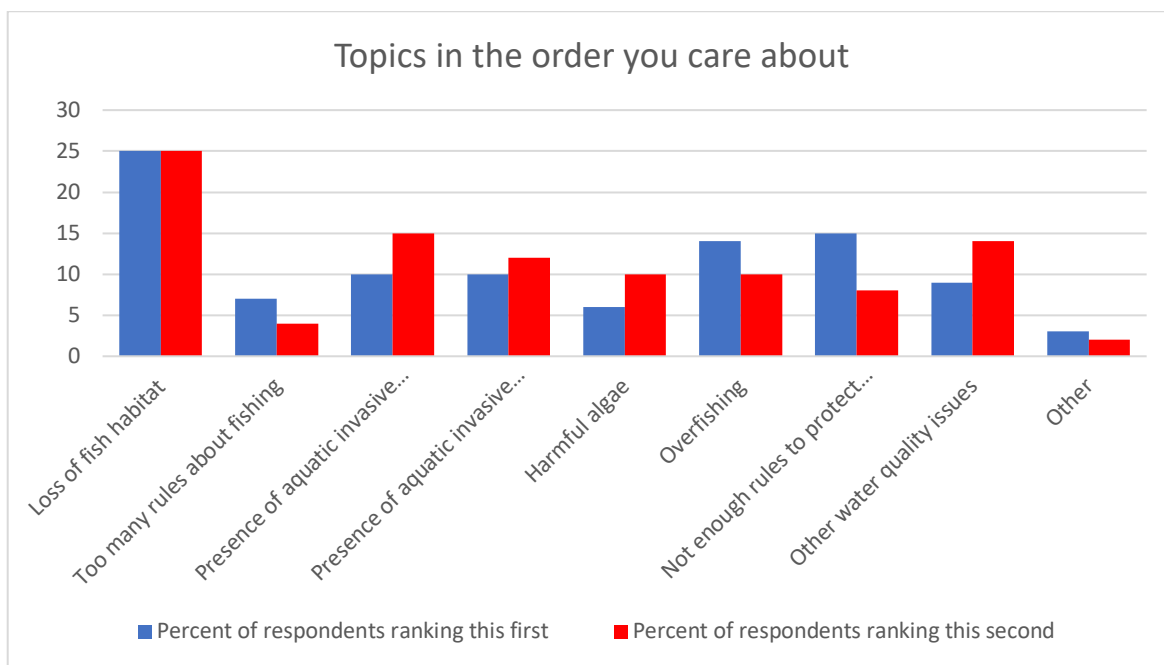
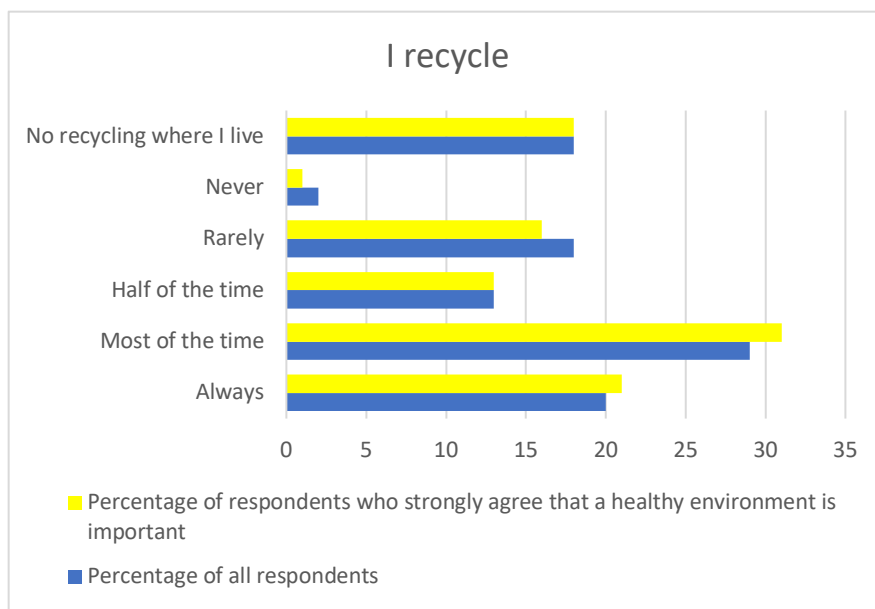
Similarly, the cohort who strongly agree that a healthy environment is important report recycling slightly more than respondents as a whole. Respondents in the cohort who recycle *always* or *most of the time* is 52%

compared to respondents as a whole at 49%.

Topics of Importance to Respondents

Respondents were asked to rank 9 environmental topics. The top issue that respondents identified as being important to them was *loss of fish habitat* with 50% of respondents ranking it first or second. 54% the cohort who strongly agree AIS have reduced their enjoyment of Mississippi's waters

(identified in a later question) ranked it first or second. While not shown on the graph below, loss of fish habitat was also the top issue chosen by the cohort of respondents with neither a fishing license nor a boat, who placed it first or second 52% of the time.

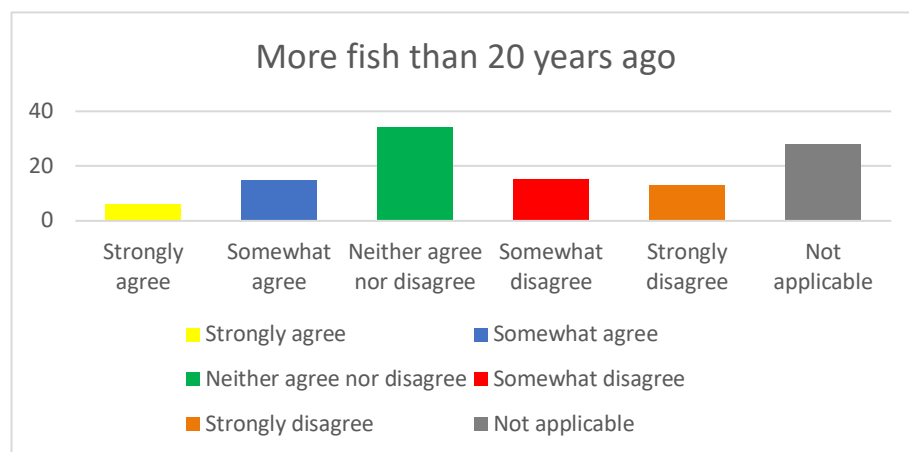


More respondents found the *presence of aquatic invasive plants* to be more important than the *presence of aquatic invasive animals* with 26% ranking invasive plants first or second, and 22% ranking invasive animals first or second. The topic most respondents ranked at the bottom was *other* with 5% choosing that as being most important to them.

Two of the choices tested how respondents feel about regulations that impact fishing and the environment. Respondents ranked *too many rules about fishing* as one of their lowest priorities: 10% ranked it as being of first- or second-most importance to them. Conversely, respondents ranked *not enough rules to protect the environment* as their first or second choice 23% of the time. Although not shown on the chart, the cohort with neither a fishing license nor a boat ranked *not enough rules to protect the environment* first or second 47% of the time.

Observations

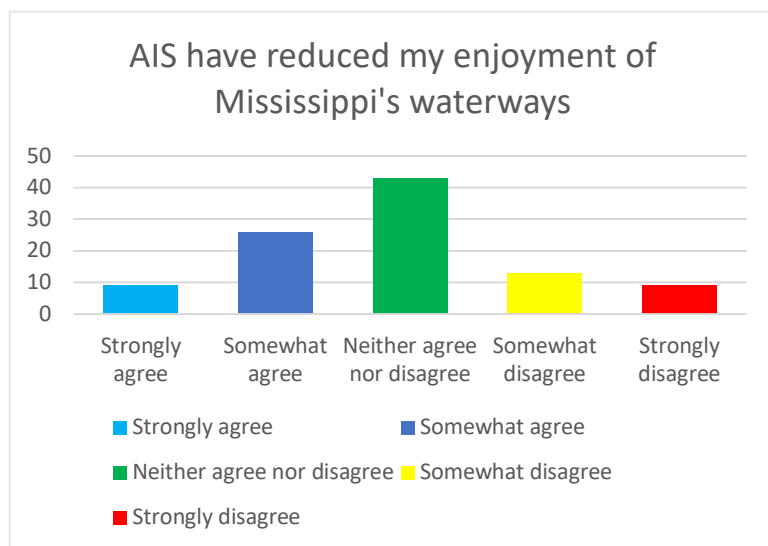
Respondents who self-identified as having fished for at least 20 years were asked whether they agree that *there are more fish in Mississippi waterways than when they started fishing* using a 5-point scale. Many respondents indicated the question did not apply to them (28%). Of those that responded, 21% agreed (strongly or somewhat) there were more fish, and 28% disagreed (strongly or somewhat) that there were more fish now than 20 years ago.



Repondents were asked to rate whether *aquatic invasive species have reduced my enjoyment of Mississippi's waterways* using a 5-point scale from *strongly agree* to *strongly disagree*. (The chart is on the following page.) Responses to this question may show the

State how the public values AIS management. Most of the respondents were neutral on the issue – 43% chose *neither agree nor disagree*. Overall, slightly fewer respondents agreed, choosing *strongly agree* (6%) or *somewhat agree* (15%), compared to those who *somewhat disagree* (15%) or *strongly disagree* (13%). More than a quarter of respondents (28%) selected *not applicable*.

After identifying the extent to which they felt AIS reduced their enjoyment of the State's waterways, respondents were asked to describe the impact of AIS in their own words. While just 34 respondents agreed that their enjoyment was reduced by AIS, 46 people wrote substantive comments about impacts from AIS, primarily describing some form of access limitation or navigation problem due to the presence of aquatic invasive species. (All comments by those with a fishing license and/or a boat are in *Respondent Comments*, at the end of this report.)

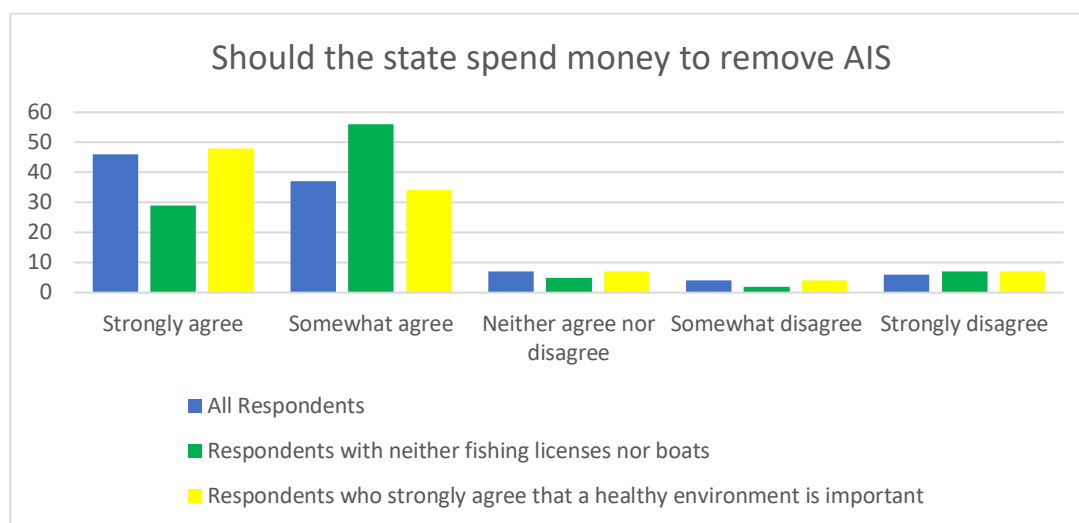


At least 16 comments of the 39 received fell into the category of *Access and Navigation*. For example, one comment was “Unable to move boat through invasive species; unable to get lure/bait through invasive species.” Another comment was “I use artificial bait, and I can no longer fish because the grass has completely taken over all of Pascagoula River bayous and out in the bay. It is now to a point you cannot even run your boats for the grass is so thick.”

At least 9 respondents described *Poor Fishing* as a result of AIS. One such comment was “I believe carp in smaller lakes have decreased the number of bass and bream.” Another comment stated, “Every year the fishing is getting worst. Less fish and bad quality of water on and near the main land.” An additional 7 respondents addressed *Habitat* as an issue, such as this comment, “Chokes out fish habitat.”

The Cost of AIS Management

Respondents were asked whether *the state should spend money on removing aquatic invasive species* using a 5-point scale. A strong majority of respondents agreed: 83% of all respondents *strongly agree* or *somewhat agree*; 84% of respondents without fishing licenses or boats *strongly agree* or *somewhat agree*; and 82% of the cohort who strongly agree that a healthy environment is important *strongly agree* or *somewhat agree* that the state should spend money to remove AIS.

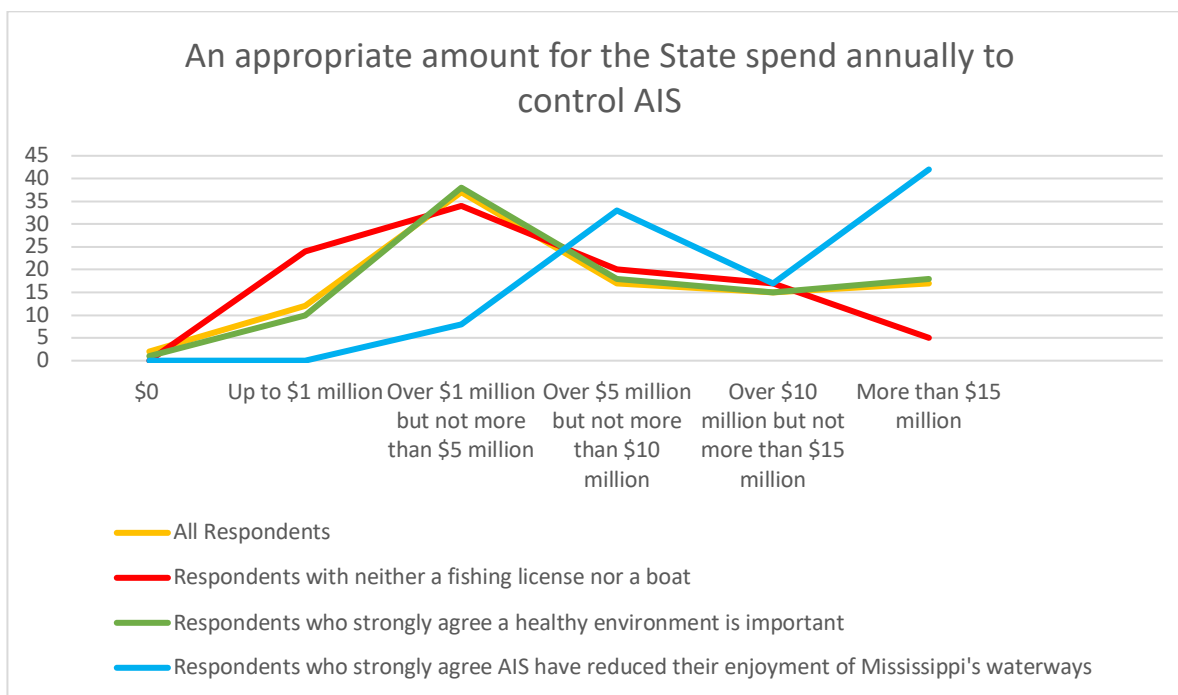
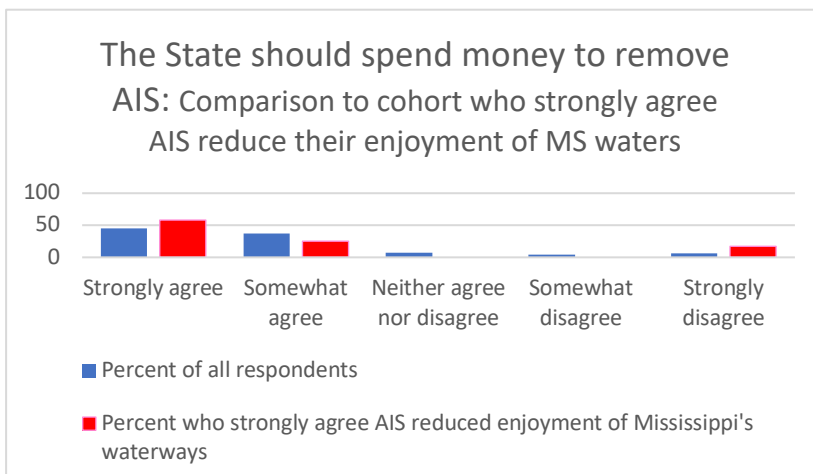


Fewer than 12% of respondents disagreed, either strongly or somewhat. Of the healthy environment cohort 11% *somewhat disagree* or *strongly disagree* that the state should spend

money to remove AIS, which is slightly higher than the percentage of all respondents who disagreed the state should spend money (10%).

A different comparison shows the cohort which strongly agree that AIS have reduced their enjoyment of Mississippi's waterways is more divided than respondents as a whole on the issue of spending. While 58% of the reduced enjoyment cohort *strongly agree* the state should spend money to remove AIS, compared to 46% of all respondents, 17% of the reduced enjoyment cohort *strongly disagree* that the State should spend money, compared to just 6% of all respondents.

Respondents were asked to choose the *appropriate amount for the State of Mississippi to pay to control harmful invasive species every year*. The choices ranged from \$0 to more than \$15 million. More respondents (37%) chose *over \$1 million but less than \$5 million*. More than 48% want the State to spend more than \$5 million, including up to \$15 million, with *over \$5 million but not more than \$10 million* being the second-most popular category chosen by 17% of all respondents. 15% of respondents want the State to spend \$1 million or less, including spending \$0.



Results varied among the cohorts at the highest amounts and the lower amounts. The most significant shift in responses compared to respondents as a whole is by the cohort who strongly

agree that AIS have reduced their enjoyment of Mississippi's waterways. That is the only cohort with 0 responses to the two lower amounts: \$0 or *up to \$1 million*. That same cohort exceeded all other cohorts in the percentage who believe the state should pay *more than \$15 million* annually to control AIS (42%). The next highest response rate choosing that amount (18%) was within cohort who strongly agree that a healthy environment is important.

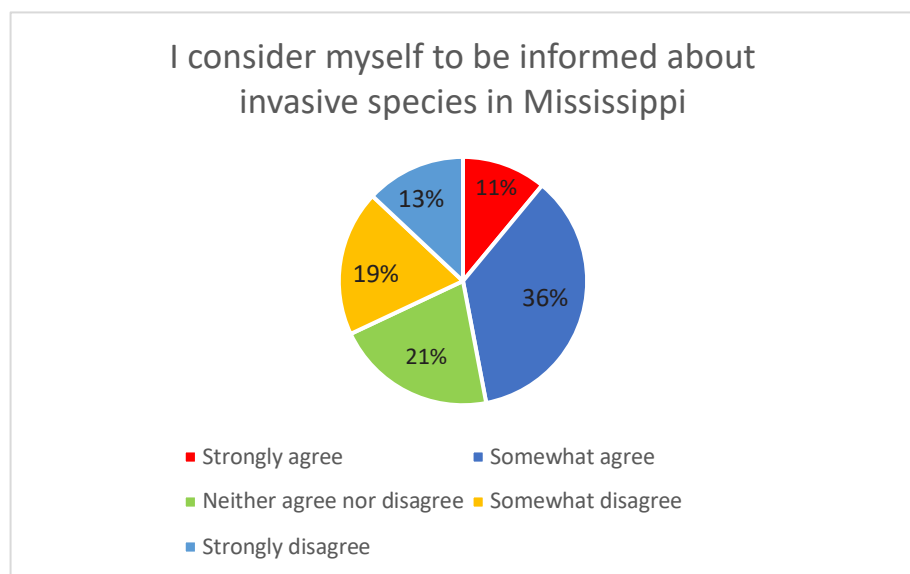
In comparison, respondents with neither a fishing license nor a boat lagged in how much they thought was appropriate for the State to spend at the highest amount of *more than \$15 million* (5%, compared to all respondents at 17%), as well as having significantly more (24%) choosing *up to \$1 million* compared to overall respondents (12%).

Knowledge of Aquatic Invasive Species

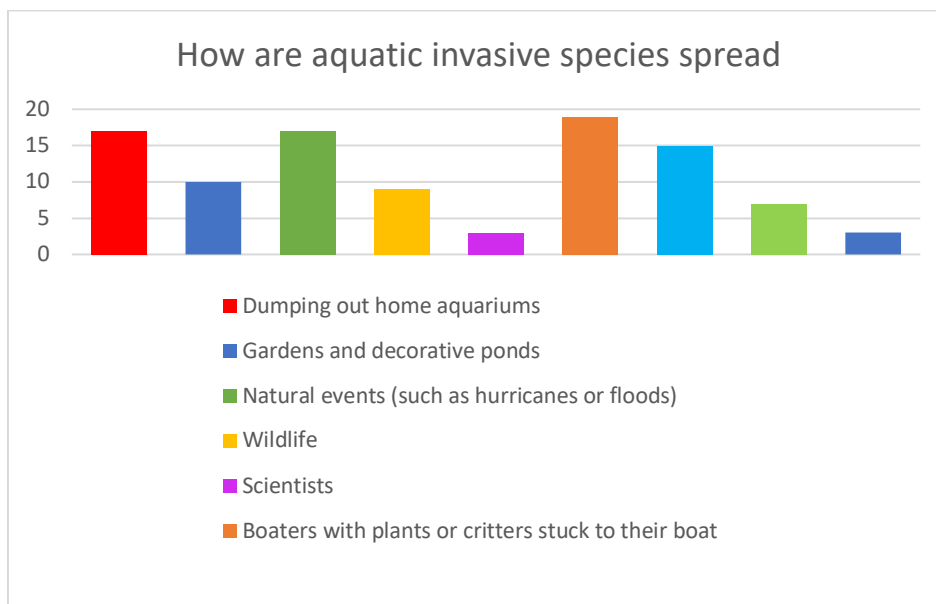
The next questions explored respondents' knowledge of invasive species. These questions investigate what people know and where they got that knowledge in order to help the State improve its education and outreach efforts. It includes a section on invasive species laws to see if people know what actions related to AIS are legal in Mississippi.

Respondents were asked whether they considered themselves informed on aquatic invasive species. Of the 151 people answering, just 11% *strongly agree* that they are informed, 36% *somewhat agree* they are informed about AIS, and more than 13% do not consider themselves informed, selecting *strongly disagree*.

More specific questions sought to investigate where education and information would best improve understanding of AIS. The first such question asks respondents to identify *how aquatic invasive species are spread* by choosing as many options as they think distribute AIS.



Respondents identified three causes as being most responsible for spreading AIS: *boaters with plants or critters stuck to their boat* (19%), *anglers with fish and bait from other water bodies in live wells* (15%), and *natural events (such as hurricanes or floods)* (17%). Few identified *bait* as a nexus (7%). The percentage of respondents who identified *scientists* as a way AIS are spread (3%) was the same as those who chose *I don't know* (3%).



Identifying Aquatic Invasive Plants

Next in the sequence of assessing what people know about AIS, photos of three different



aquatic invasive plants were shown.

Respondents were asked to identify the species from 4 multiple choice answers and *I don't know*. The average correct identification of all three invasive plants was 33%. The cohort of respondents who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways had a higher correct identification rate (54%) than the respondents as a whole.

The first photo was of giant salvinia (*Salvinia molesta*). It was the least correctly identified of the three invasive plants, as well as the least of all

invasive species tested. Just 22% of respondents correctly identified it, and 54% chose *I don't know*. Of the cohort who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways, 50% correctly identified giant salvinia with 33% choosing *I don't know*.

The second photo was of hydrilla (*Hydrilla verticillata*) which was correctly identified by 36% of all respondents, with 49% choosing *I don't know*. Again, the cohort who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways had a higher percentage of correct identification of hydrilla at 50%, with 25% choosing *I don't know*.



The final plant species, water hyacinth (*Pontederia crassipes*), was chosen correctly by the most respondents of the three plant AIS, 42%. Notably, it is also the only photo with a blooming flower and whose common name is a flower, which may have aided some of the identification. *I don't know*, was selected by 44% of respondents – more than who chose a species name. Of the cohort who strongly agree that AIS have reduced their

enjoyment of Mississippi's waterways 64% correctly identified water hyacinth, with 36% of that cohort choosing *I don't know*.

Identifying Aquatic Invasive Animals

After the AIS plant questions, the respondents were asked to identify AIS fish. The respondents did much better identifying fish species than plants. They averaged almost 70% correct responses. Again, more respondents who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways correctly identified the fish (88%) than the group as a whole.

The first photo was of the northern snakehead (*Channa argus*). Respondents identified it correctly the least often of the fish species, 63%, with 26% responding *I don't know*. In the cohort who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways, 91% correctly identified the northern snakehead with just 9% choosing *I don't know*.



The second-highest correctly identified aquatic invasive species – plant or animal – in the survey was the lionfish (*Pterois*). Over 70% of respondents correctly identified this fish from the four choices. Correspondingly, only 14% indicated *I do not know*. Of the cohort of respondents who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways 82% correctly identified lionfish; 9% cohort chose *I don't know*.



The most respondents – 76% – correctly identified the silver carp (*Hypophthalmichthys molitrix*) of any

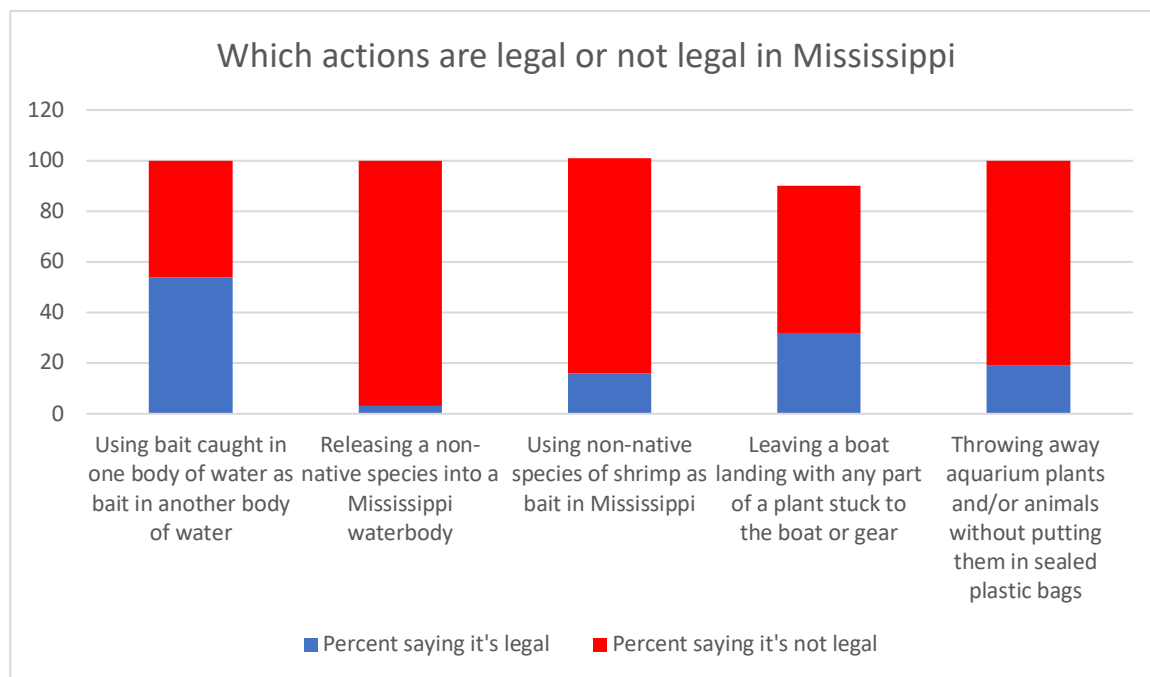
of the invasive species, plant or fish. Only 3% of respondents chose *I don't know*. Once again the cohort who strongly agrees that AIS have reduced their enjoyment of Mississippi's waters exceeded respondents as a whole with 91% correctly identifying the silver carp; 9% chose *I don't know*.

Respondents were asked to identify whether five different activities related to aquatic species were legal in Mississippi or not. Two of the five activities are legal in Mississippi: using bait caught in one



body of water as bait in another body of water; and leaving a boat landing with any part of a plant stuck to the boat or gear.

On the whole, respondents answered the questions correctly: it is illegal to release a non-native species into a Mississippi waterbody (97%); it is illegal to use non-native species of shrimp as bait (85%); and it is illegal to throw away aquarium plants and/or animals without putting them in plastic bags (81%).



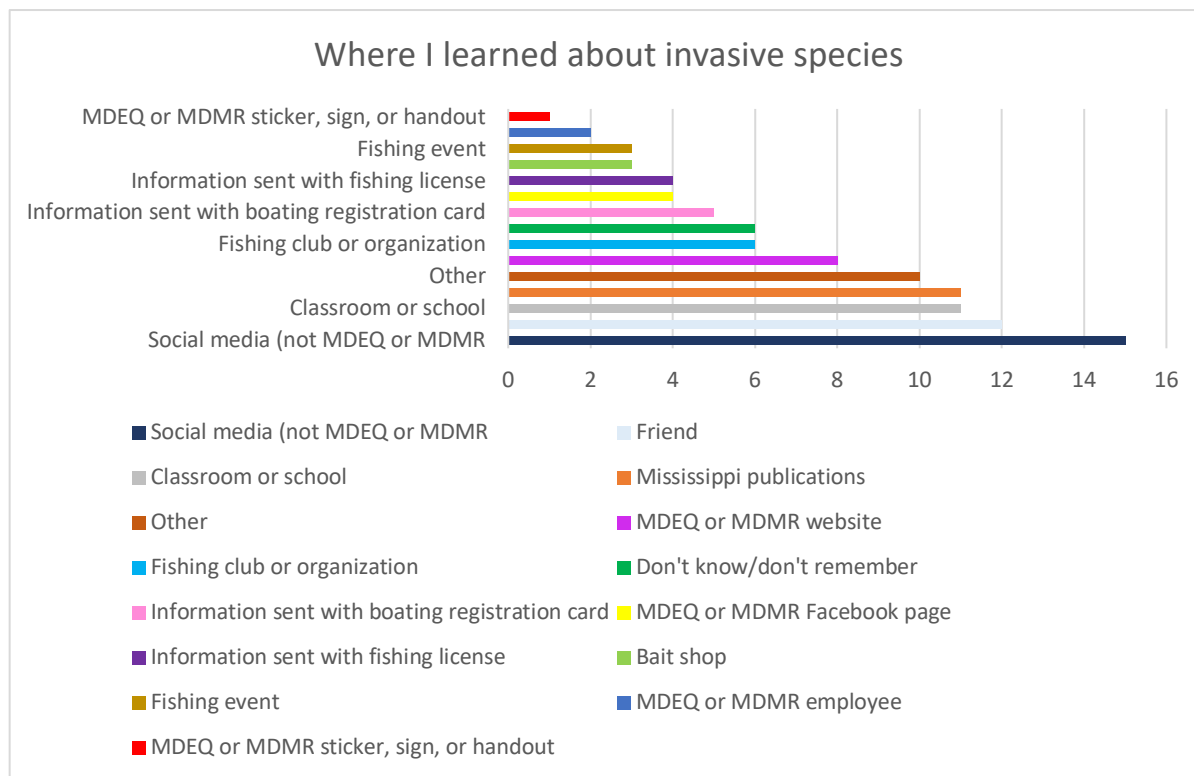
More than 53% of respondents incorrectly indicated that using bait in a different bodies of water was against the law. Just over 32% of respondents incorrectly chose that leaving a boat landing with plant material stuck to the boat or equipment was illegal.

Sources of Information on Invasive Species

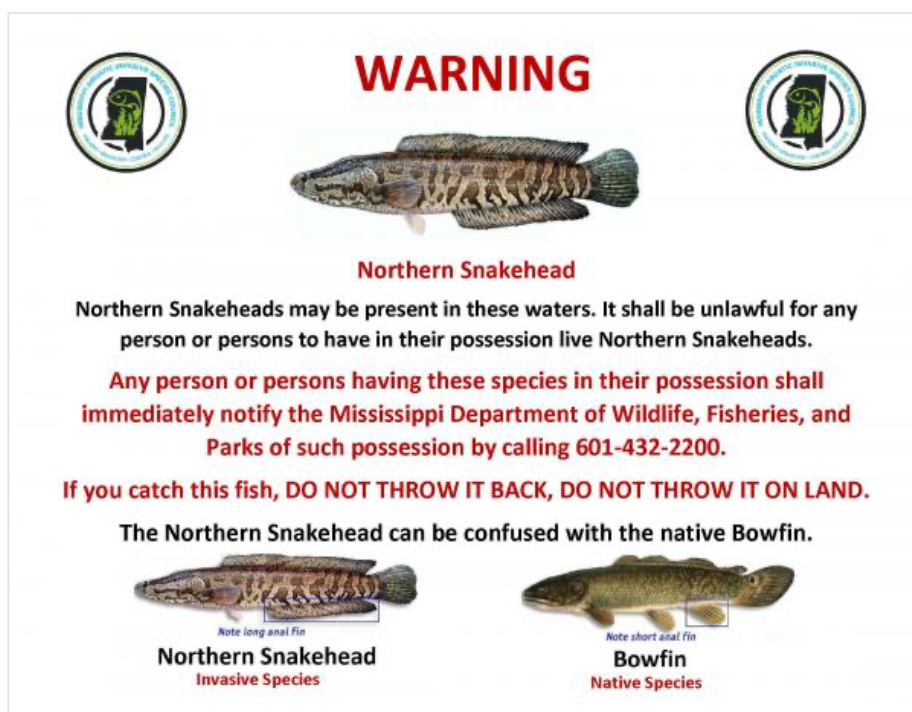
The survey asked respondents to identify where they learned about invasive species to help the State tailor its education and outreach programs to reach the fishing and boating community better.

Respondents were asked to choose from a list of 15 sources of information on AIS, which included *other* and *don't know/don't remember*. Primarily, respondents identified sources other than the MDEQ or the MDMR. More (15%) chose *social media (not MDEQ or MDMR)* as the source, with *friends* being the second greatest source at 12%. The least chosen source of information was *MDEQ or MDMR sticker, sign, or handout*, with 1% of respondents. The three sources of State communication chosen most often were: *information sent with boating registration* (5%); *information sent with fishing license* (4%); or *information from an MDEQ*

or MDMR employee (2%). Notably, more people identified learning from a State employee than from one of its handouts or stickers.



A more specific question sought to measure respondents' awareness of a specific flyer used by



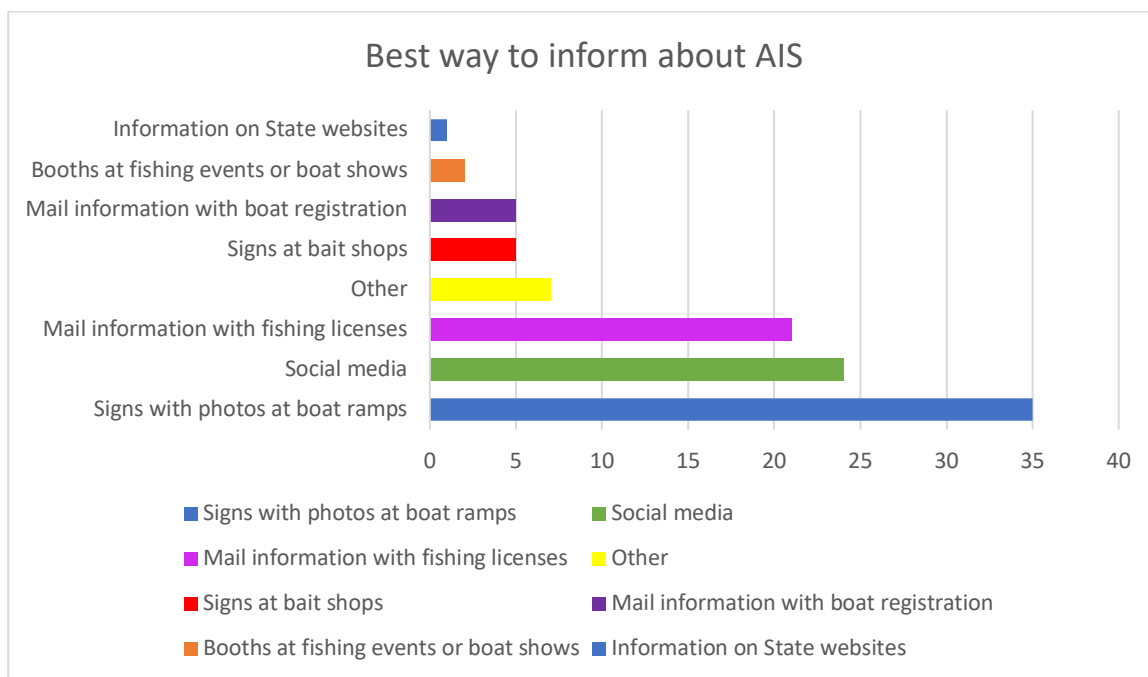
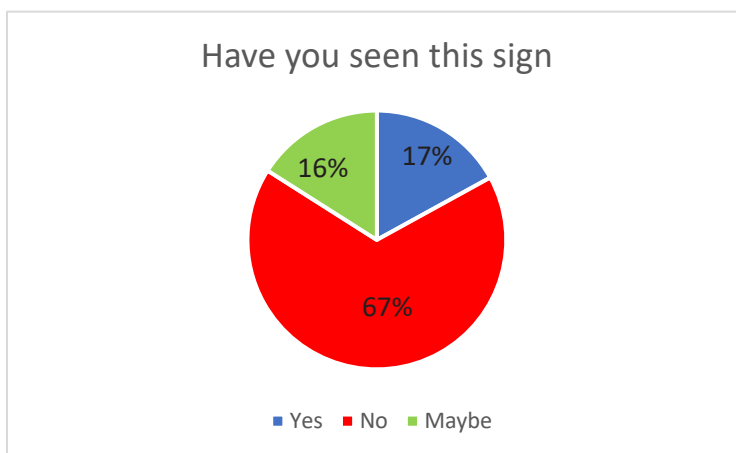
MDEQ for several years warning people about the presence of the identifying the northern snakehead. This handout was posted at boat landings. Respondents were asked *have you seen this sign* and could answer *yes, no, or maybe*.

This sign was not recalled by a majority of the respondents taking the survey, with 67% answering *no*.

Just 17% of respondents answered *yes*, and 16% answered *maybe*.

Among the cohort who strongly agrees that AIS have reduced their enjoyment of Mississippi's waters, a slightly higher percentage indicated they had seen the sign (18%). In that cohort 45% chose *no* and 36% chose *maybe*.

Respondents were asked to choose one method that they thought was the best way to inform people about AIS. The results appear to contradict earlier responses that identified sources of learning about AIS. For example, 35% of respondents chose the top way to inform people about invasive species was to post *signs with photos at boat ramps*. However, when asked whether respondents learned about invasive species from *stickers, signs, or handouts from MDEQ or MDMR*, just 2% identified that method, and over 67% failed to recognize one of the top handouts used as a sign by MDEQ at some boat ramps. Also, only 1% of respondents who own boats chose *mail information with boat registration* as the best way.

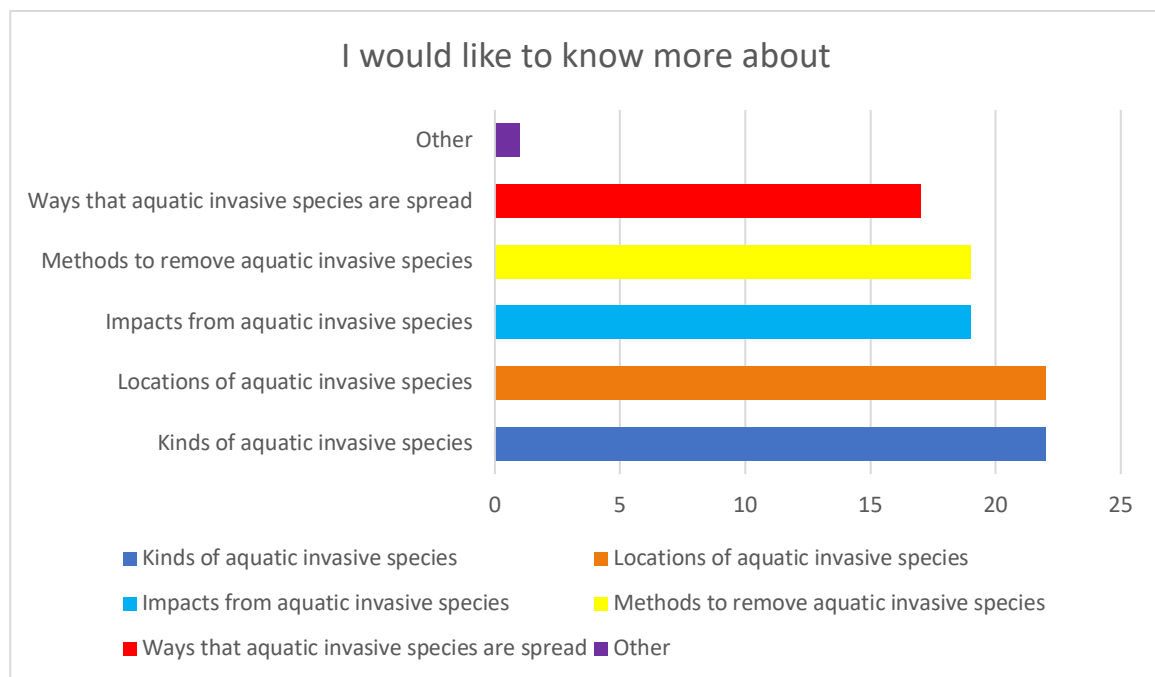


Several respondents suggested ideas for other ways to inform the public about aquatic invasive species. Those comments are:

- TV
- All of the above
- Mail out flyers to everyone (two respondents said this)

- Signs with photos at bait shops, boat ramps, license registration locations, and local recreational fishing piers
- Fishing report groups and promotion by local guides and bait shops/tackle shops
- Bounty on invasive species
- Multiple ways are needed. One source is not effective
- Tiktok

When asked what more they would like to know about AIS, the top two responses were *the kinds of AIS in Mississippi* (22%) and *the locations of AIS in Mississippi* (22%). There was little variation in responses among the cohorts. 20% want to know more on the impacts from AIS; 19% want to know more about the methods to remove AIS; and 17% want to know more about how AIS are spread.



Three written comments were received: “Not sure”; “When is our state going to do something about our rivers here in Jackson County? It's just about too late before our water is over taken by this choking grass”; and “Promoting all of the above.”

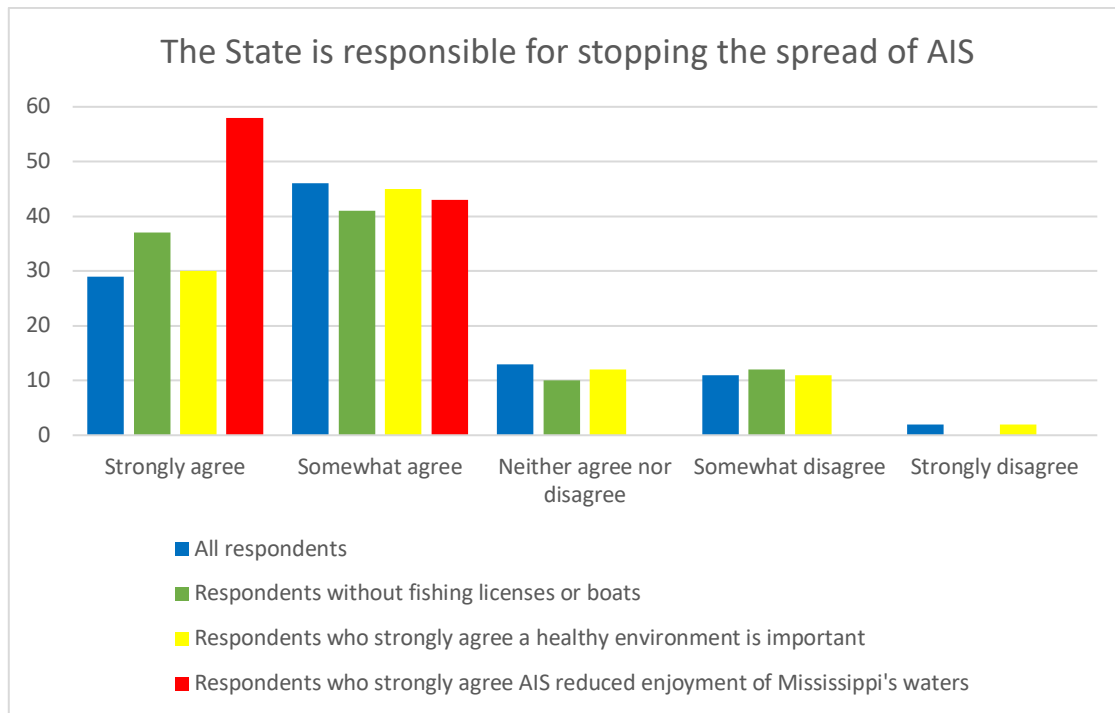
Practices to Limit the Spread of Aquatic Invasive Species

The next category investigates fishing and boating practices and what steps people are willing to take to help reduce the spread of AIS. It includes questions to determine what motivates people to take the actions that they do. Responses should help the State identify which measures are successful as well as what future practices might be more effective. Some responses are compared to those to similar questions in the survey to assess consistency.

Responsibility for Stopping the Spread of AIS: State v. Individual

Respondents were asked to choose the extent they agree that the State of Mississippi is responsible for stopping the spread of AIS. 100% of the cohort who strongly agree that AIS have reduced their enjoyment of Mississippi's waterways *strongly agree* or *somewhat agree* that the State is responsible, compared to 75% of all respondents.

Of respondents with neither fishing licenses nor boats, 78% *strongly agree* or *somewhat agree* that the State is responsible to stop the spread of invasive species. In the cohort of respondents who strongly agree that a healthy environment is important, 75% *strongly agree* or *somewhat agree* that the State is responsible.

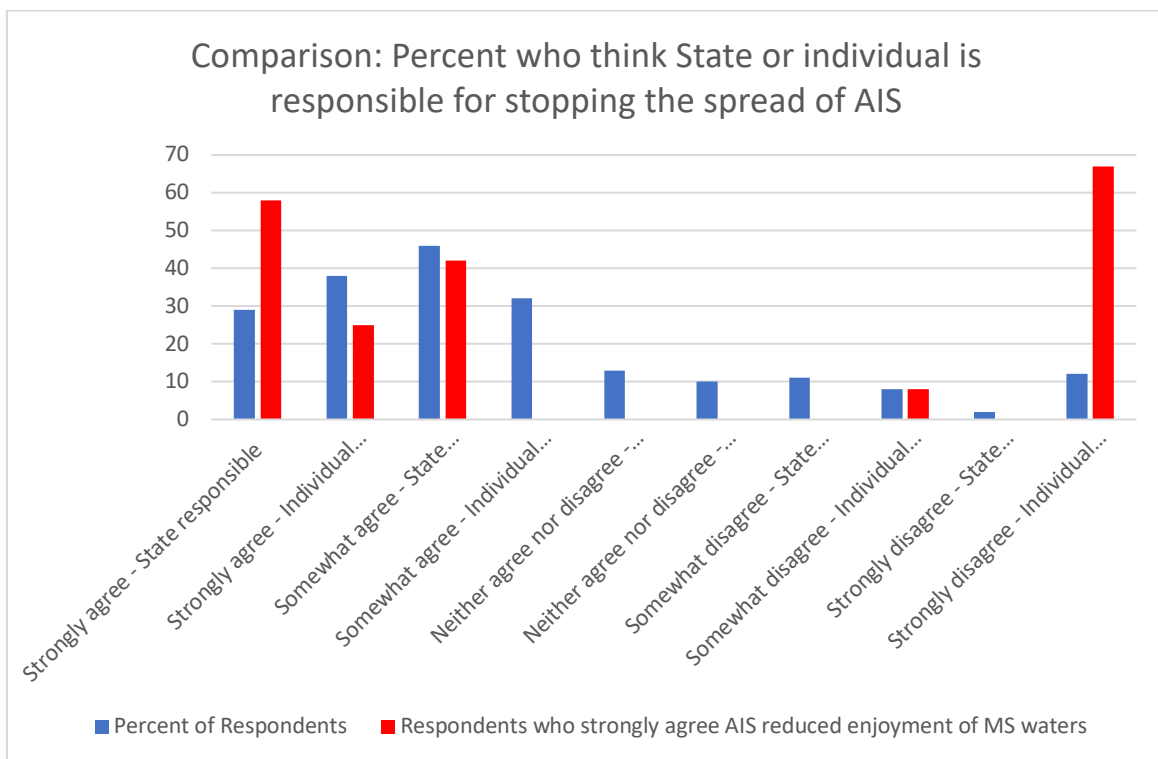
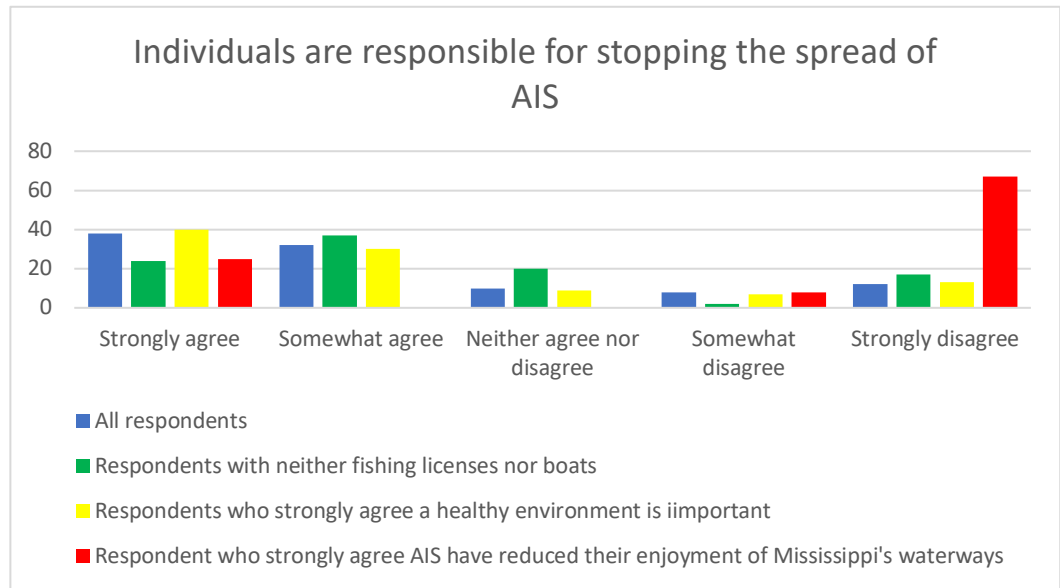


Respondents were also asked whether *individuals are responsible for stopping the spread of aquatic invasive species*. While those who chose *strongly disagree* (12%) outnumbered those who were on the fence (10% *neither agree nor disagree*), a preponderance of respondents *strongly agree* or *somewhat agree* that individuals are responsible for stopping the spread of AIS (70%). The cohort who strongly agree that AIS reduced their enjoyment of Mississippi's

waters was on the other side of the Likert Scale with 67% choosing *strongly disagree* that individuals are responsible.

The results were not so clear within the cohort with neither fishing licenses nor boats. While 61% of the cohort agree that individuals are responsible, 20% chose *neither agree nor disagree*, and 20% chose *somewhat agree* and 20% chose *strongly disagree*.

The data from the two questions were cross-tabulated to compare opinions on State and individual responsibility. The data are shown for the respondents as a whole and for the cohort that strongly agrees AIS have reduced their enjoyment of Mississippi's waterways.



Overall, that cohort more uniformly identified the State as responsible over the individual. In contrast, 74% of the respondents as a whole *strongly agree* or *somewhat agree* that the State is responsible and 70% *strongly agree* or *somewhat agree* that the individual is responsible. Note that the question did not ask respondents to choose between the State or the individual. The positions are not inherently contradictory, and subsequent polling could identify which party people believe is *more* responsible.

While the combined chart shows that a higher percentage of all respondents were likely to agree that someone should be responsible for stopping the spread of aquatic invasive species, on balance, respondents were more likely to pick the State as the responsible party. In contrast, 67% of the reduced enjoyment cohort *strongly disagree* that the individual is responsible. It is worth noting that the cohort consists of 12 respondents, compared to 145 overall respondents for those two questions.

Behaviors

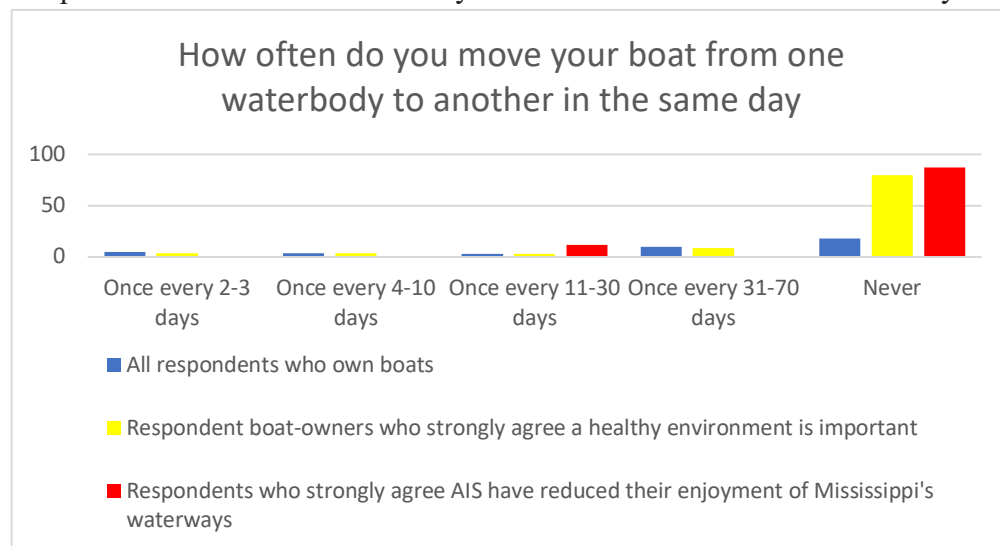
Respondents were asked about common boating and fishing practices that can spread AIS. Some of the questions were asked only to those who own a boat or only to those who have a Mississippi fishing license. The survey sought to investigate what steps respondents are already taking and what steps respondents are likely to adopt to reduce the spread of AIS.

Boat Owners

Respondents who answered *yes* to whether they or someone in their household own a boat were asked three questions related to boat ownership: *how often do you take your boat from one waterbody to another in the same day*; whether they *remove plants and animals from their boat and equipment before leaving the boat landing*; and whether they *wash their boat and gear before leaving the landing*.

The responses of boat-owning respondents as a whole (75 people) were compared to two different cohorts – boat-owning respondents who strongly agree that a healthy environment is important (69 people); and boat-owning respondents who strongly agree that aquatic invasive species have reduced their enjoyment of Mississippi’s waterways (8 people).

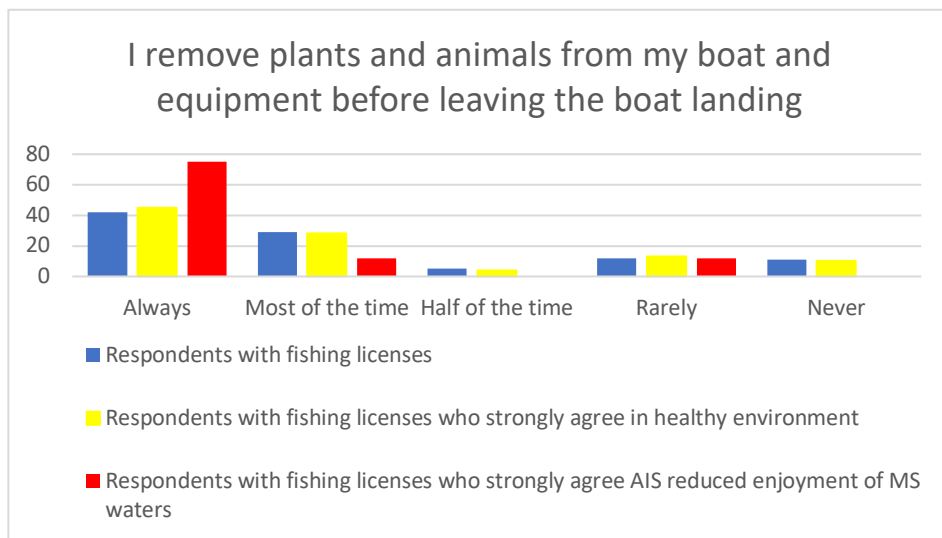
Respondents were asked often they move their boat from one waterbody to another in the same



day, as this is a way that AIS are spread. More respondents chose *never* (78%) over the other four categories combined.

Respondents were asked about removing

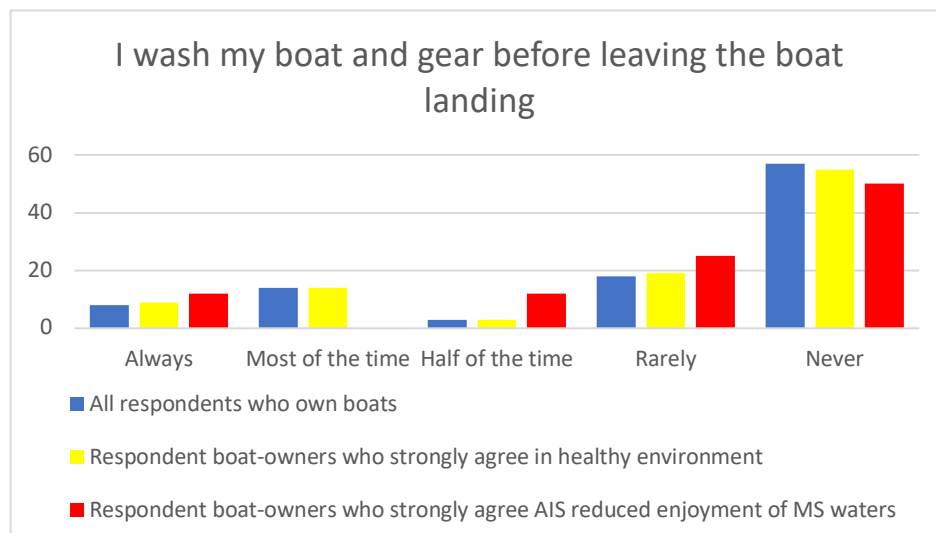
plants and animals from their boats. Boat owners in the reduced enjoyment cohort were more likely to choose that they *always* (75%) remove plants and animals from their boat and



equipment compared to 43% of all boat-owning respondents and 45% of boat owners in the healthy environment cohort. Boat owners chose *rarely* or *never* from 12% to 23%. But of the reduced enjoyment cohort of boat-owners, 0% chose *never*.

When asked whether they wash their boat and gear before leaving the boat landing, most

respondents who own boats (75%) *rarely* or *never* wash their boat and gear before leaving the boat landing. While 75% of the cohort of boat owners who strongly agree AIS have reduced their enjoyment of Mississippi's waterways *rarely*



or *never* wash their boat and gear. 12% of that cohort *always* wash their equipment, compared to 8% of boater owners in general.

Responses to a subsequent question in this survey reveal that 20% of all respondents (regardless of boat ownership) identify the reason they do not wash and drain their equipment is because there are *no facilities to do it*. 23% chose they *do not know what to do*, and 24% chose *other*. Additionally, two people who chose *other* wrote comments such as “lack of hoses at boat ramps prevent rinsing off equipment.”

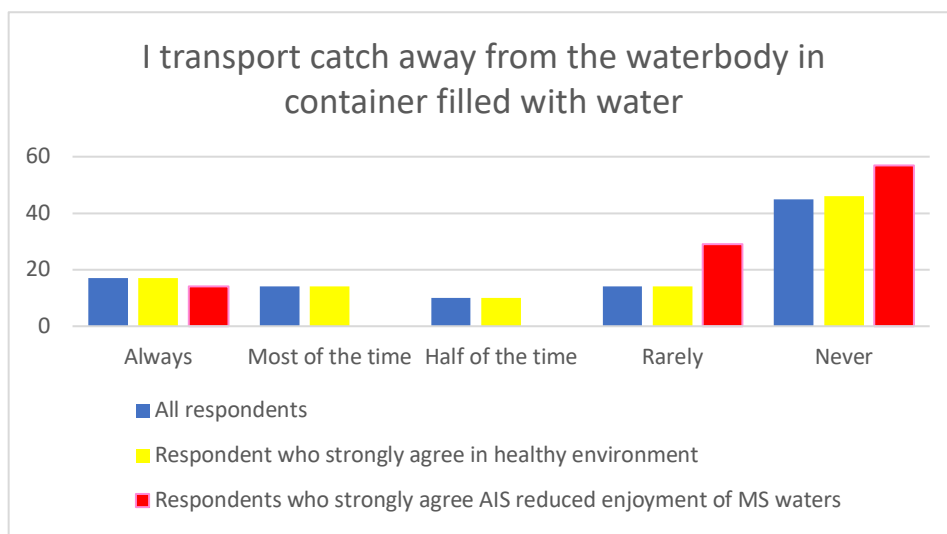
Fishers

Respondents who identified that they had a Mississippi fishing license were asked about common practices that contribute to the spread of AIS such as moving catch away from the

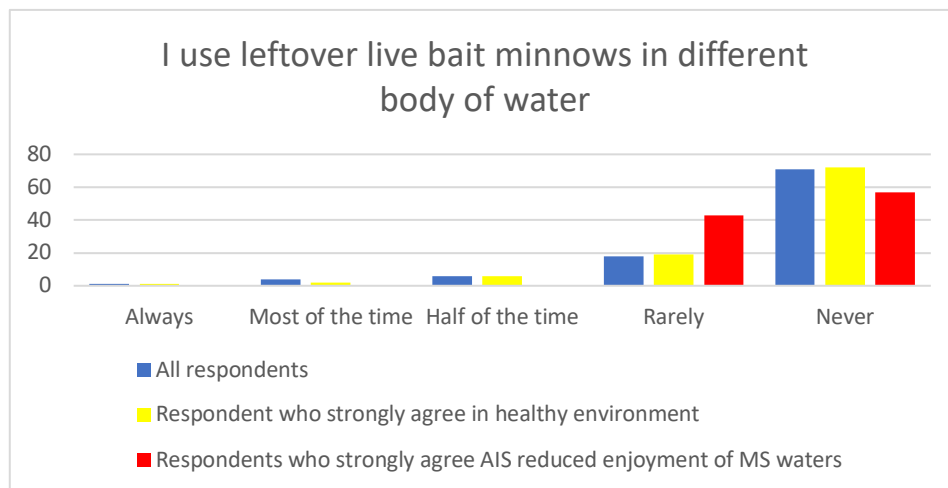
waterbody in a container filled with water and using *leftover live bait minnows on a different body of water*. Responses to both questions were based on a 5-point scale from *always* to *never*.

The responses were compared to two different cohorts – those respondents (with fishing licenses) who strongly agree that a healthy environment is important, and those respondents (with fishing licenses) who strongly agree that aquatic invasive species have reduced their enjoyment of Mississippi’s waterways.

The survey revealed that the licensed fishers follow safe practices most of the time. Of the respondents with fishing licenses, the majority of all groups say they *rarely* or *never* transport their catch from the waterbody in a container filled with water: 59% of the respondents as a



whole; 60% of the cohort who strongly agrees in a healthy environment; and 86% the cohort who strongly agrees AIS have reduced enjoyment in Mississippi’s waterways. 17% report that they *always transport their catch using a livewell, bucket, or other container filled with water*. One respondent wrote that their “catch is always on ice.”

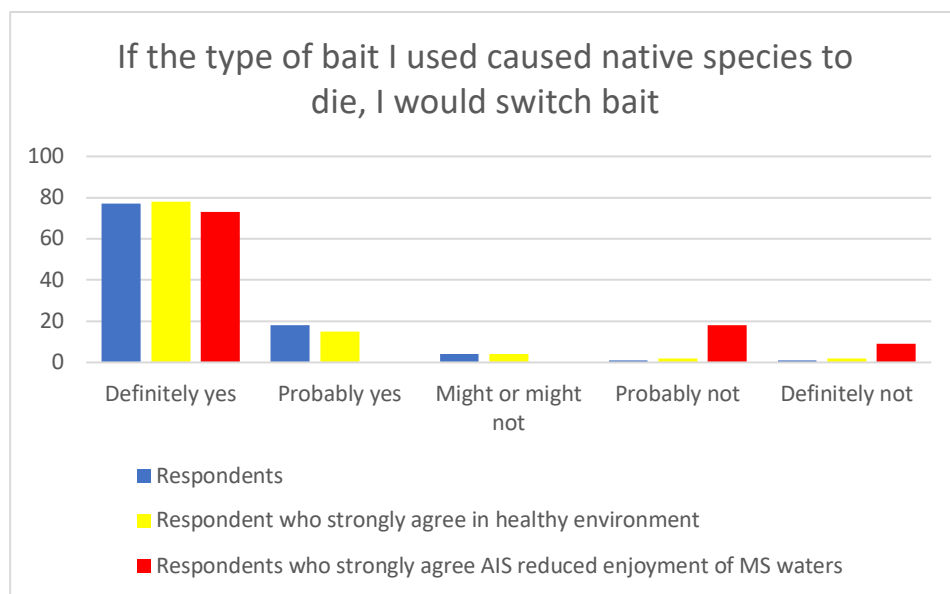


When those with fishing licenses were asked whether they brought leftover minnows to a different body of water, the majority of respondents chose *never* (71%), as did the majority of the cohort who strongly agree a healthy

environment is important (72%) and the cohort who strongly agree AIS have reduced their enjoyment of Mississippi’s waters (57%). An additional 18%, 19%, and 43% of those groups, respectively, say they *rarely* transport their leftover minnows to other bodies of water. In the comments section to a later question, one respondent wrote that “Fish would be wasted.”

All Respondents

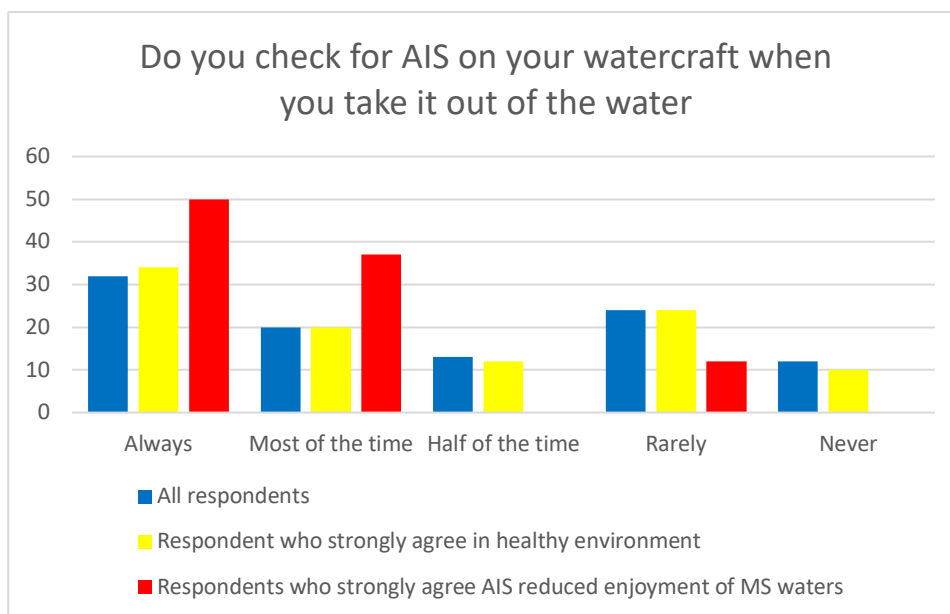
All respondents were asked questions about what steps they take or will take to prevent the spread of AIS. These questions were asked regardless of having a boat or fishing license to get a broader spectrum of responses – such as from those who use other people’s boats.



All respondents were asked *if the type of bait I used caused native species to die I would switch bait*. The cohort who strongly agree in a healthy environment selected *definitely yes* more than any group, 78%, while respondents as a whole selected *definitely yes* 77% of the time. The

reduced enjoyment cohort selected *definitely yes* 73% of the time. 27% of that cohort chose *probably not* or *definitely not*, which was higher than any other group.

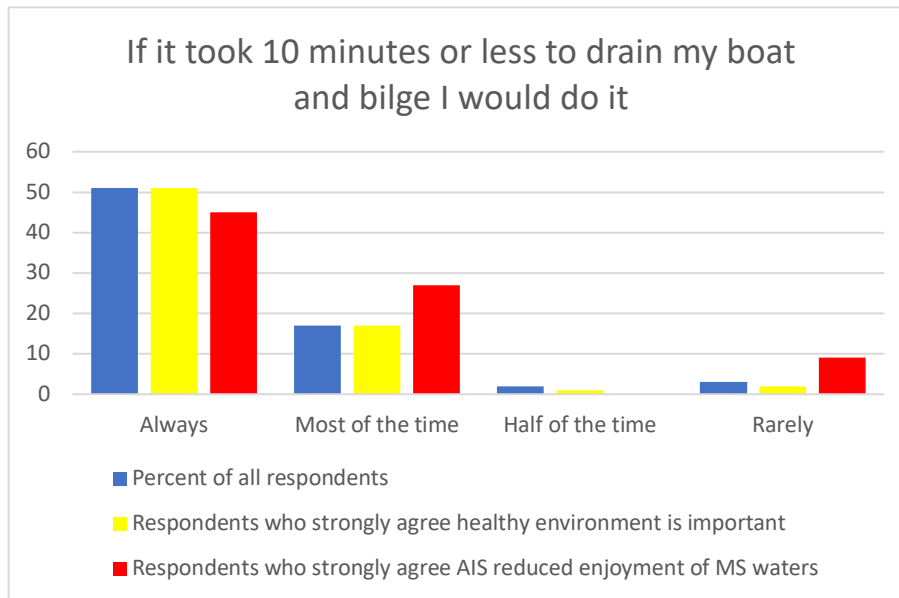
Respondents were asked if they check for AIS on their watercraft when they take it out of the water. Of all respondents, 51% chose *always* or *most of the time*, compared to 53% of the healthy environment cohort and 87% of the reduced enjoyment cohort.



However, in an earlier question posed only to boat owners (see above) 71% said they remove plants or animals before leaving the boat landing *always* or *most of the time*. This could show that a significant number of boat owners do not associate removing plants and animals from their boating equipment as the same as checking for aquatic invasive species. This suggests an opportunity for the State to educate boaters that good boating practices are also good for reducing the spread of AIS.

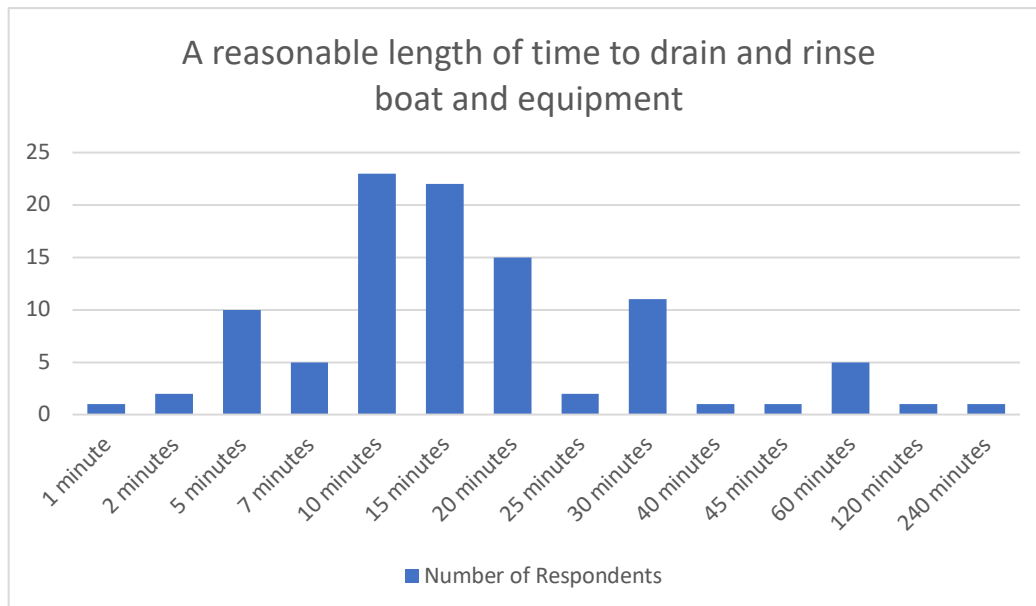
All respondents were asked *if it took 10 minutes or less to drain my boat and bilge I would do it*. Most, 68%, said they would do this *always* or *most of the time*. The healthy environment cohort chose *always* or *most of the time* 78%. The reduced enjoyment cohort chose *always* or

most of the time 73%. A higher percentage of the cohort of boat owners, 82%, chose *always* or *most of the time* than the average of the cohorts shown on the chart, 69%.



Respondents were asked to choose how long they felt was *a reasonable length of time to drain and rinse boat and equipment*. More respondents wrote times of 10

minutes (23 respondents), 15 minutes (22 respondents), and 20 minutes (15 respondents) than of other times. The second largest category was of respondents who wrote they were *not sure/not applicable* with 14 respondents choosing that.

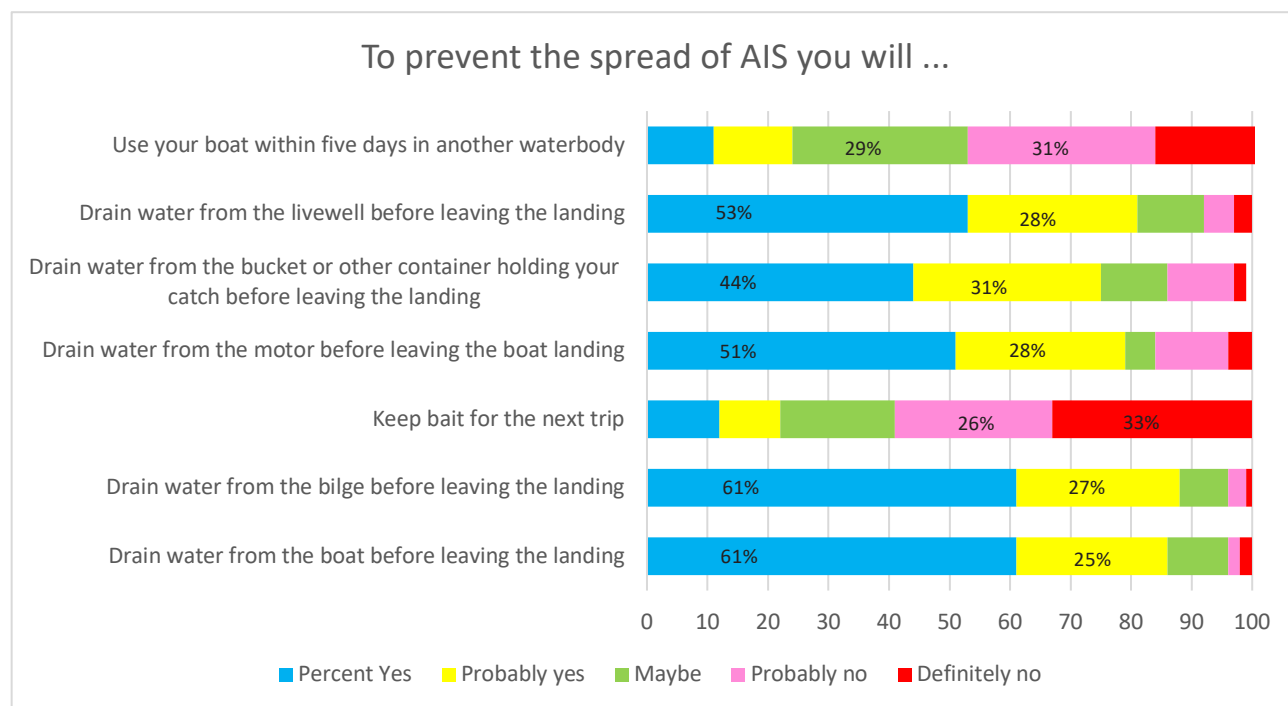


A few wrote comments. One person wrote that the reasonable time is “until it is done. If you don’t have time to take care of your boat or gear, you shouldn’t have them.”

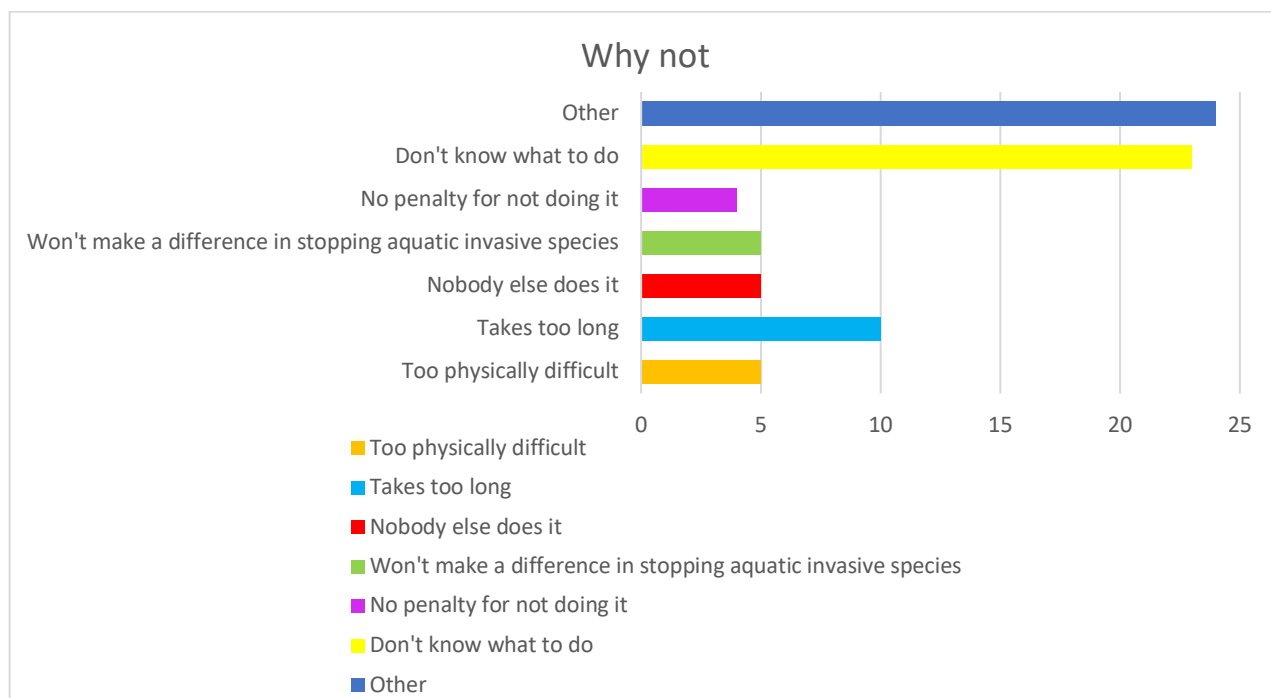
One person wrote “I wash my boat inside and out and flush my motor every time after I use it at my house on my driveway because where I fish has no place to wash down.” Another wrote that a reasonable time is “10-20 minutes if there is a washing area and no line waiting ahead of you.” The last two comments speak to an important management issue – the availability of adequate facilities to wash and drain boats and gear at landing areas.

All respondents – including those without fishing licenses and/or boats – were asked which of 7 practices they were likely to take, based on a 5-point scale from *definitely yes* to *definitely not*. The scale also included *not sure/not applicable*.

The questions were based on practices that lead to the spread of AIS. Of the respondents in this survey 24% indicated *definitely yes* or *probably yes* when asked if they would use their *boat within five days in another waterbody*. However, in an earlier question, 78% of respondents who own a boat answered *never* to *how often do you take your boat from one waterbody to another in the same day*. The State has an opportunity to educate boaters that watercraft need to remain out of water for several days to reduce the risk of spreading AIS.

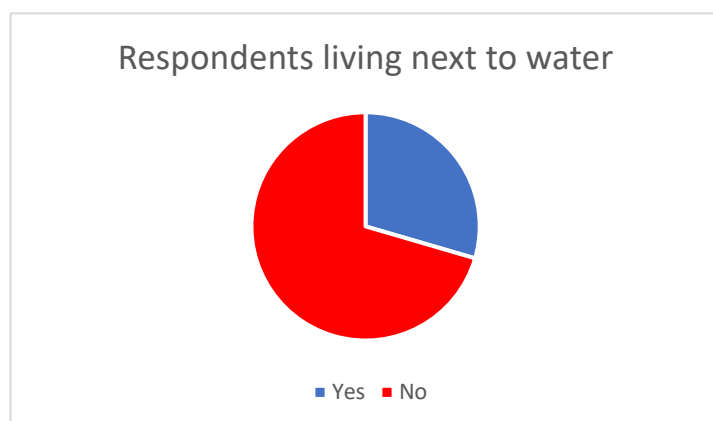


Following that series of questions, respondents were asked to pick all the reasons why they would not take those actions, as well as to write in their own. The responses should help the State identify the publics’ motivations to take steps to help reduce AIS.



Some respondents wrote comments. Here are the responses by respondents who own boats other than kayaks.

- Really not hard to do. Half of the practices also are good boat preservation practices
- I can't promise I won't fish somewhere else within 5 days
- If weather's bad
- I don't use live bait
- Not another body of water I want to fish in
- No facilities to flush motor. Can't wait 5 days in-between fishing trips
- Lack of hoses at boat ramps prevent rinsing off equipment

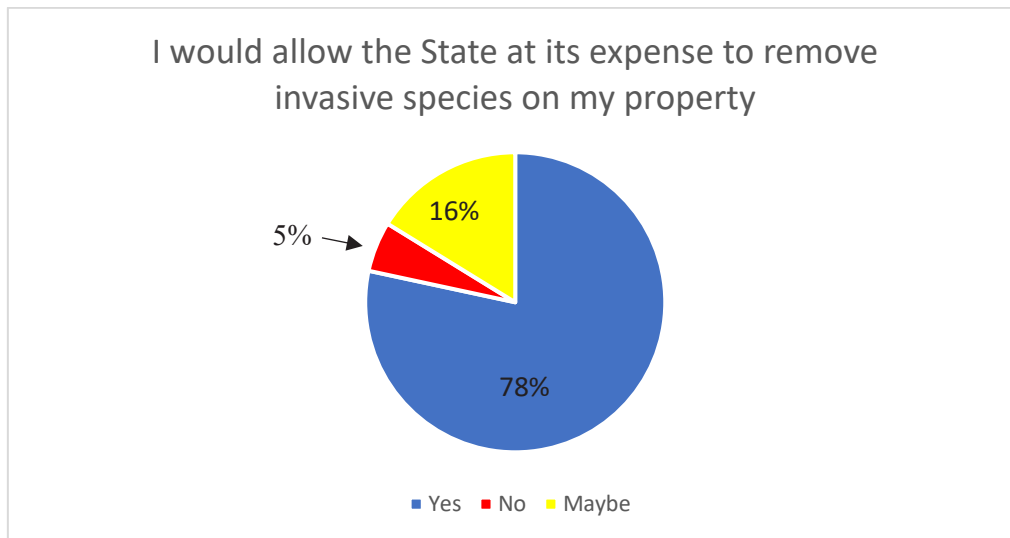


Respondents with property adjoining water

Respondents were asked to identify whether they *own or live on property that touches a river, lake, stream, or other waterbody in Mississippi*.

Understanding the willingness of riparian landowners to allow the State to access their property for that purpose is important to State management of AIS.

Those who answered *yes* were asked whether they would allow a *State agency official to come onto my property to remove invasive species at the State's expense*. A strong majority chose *yes* (78%).



Respondent Comments

Comments on Ways To Make Fishing in Mississippi Better

Respondents were given the opportunity to write anything that they think would make fishing better in Mississippi. The responses, unedited except for clarity, are organized into nine categories: Access to Fishing; Access to Boat Cleaning Facilities; Enforcement and Regulations; Habitat; Information; Invasive Species; Limits; Recreation, Charter, and Commercial; and Personal. These comments include suggestions on how the State could help manage AIS, such as provide rinse stations for boat cleaning, provide a checklist for people leaving the water to remind them to look for invasive plants, improve information by including photographs of species with the regulations, and to do more with social media.

Access to Fishing

- More bank fishing access to those whose don't have boat access
- Provide kayak access at state owned ramps
- Better equipment access at boat ramps around the coast
- More public piers and boat launches plus greater enforcement of littering laws
- Better access points on creeks and rivers for kayakers
- More access
- Opportunity

Access to Boat Cleaning Facilities

- Make sure there is access to facilities for proper boat cleaning and information is accessible to recreational fishermen
- Rinse station for boats coming out of the water
- Equip launch with water source

Enforcement and Regulations

- Stricter enforcement of regulations
- STOP pogy boats from entering between the islands and the mainland. Keep them offshore 20 miles
- Get rid of Pogy Boats in Mississippi Sound they constantly take on water and release from other waters worst polluter in Mississippi
- Not so many rules
- Pop up personnel at launches randomly checking catch limits
- Reasonable enforcement of limits
- More free days without license
- Looser fishing laws
- Less nets
- Offshore shrimping only. More DMR officers checking peoples coolers and looking for gillnetters
- Fish only species required by the law

Habitat

- For Godsakes do someting to stop wave action erosion in the marsh especially Grand Bay where I see the effects
- More artificial reefs (two respondents)
- More habitat for inshore reefs
- Stop spraying the Tenn Tom
- Too many people trash up our waterways. This is the only coastline we have
- Get rid of this grass so we can get in our bayous again to fish and come off of this 12" slot on bass in our rivers thats all that's there
- More emphasis on picking up litter
- Stop dropping the levels in the reservoirs so drastically
- Actually use funds designated for marsh restoration to restore marsh instead of building aircraft hangars, fiber optics, parking lots, ballparks, boardwalk promenades, beaches, on and on ad nauseum. Use the designated funds for conservation and restoration, don't make brothers-in-law rich with it
- Do not dam Pascagoula River to create reservoir
- Clean up public areas

Information

- More facts and fun information via social media regarding the fishery. The state is really missing a big opportunity to taut itself against other gulf states regarding it's fisheries (esp on the inshore saltwater side). We have a healthy fishery. Get the movement involved to take care of what we have. Don't be pushy, just makes sense and be cool about it and people will listen
- Examine Texas Parks and Wildlife Department as they do an excellent job on conservation. However, resident fishing/hunting license is far more than Mississippi
- Continue to improve access to regulations including pictures for learning

Invasives

- A card to fill out on state lakes/coast similar to WMA's with fish caught and question about checking for invasive plants on boat
- Remove invasive species
- Help folks understand the very real impact of invasive species

Limits

- Lower size limits on fish to match surrounding states
- I think we're in pretty good shape but we need to come equal with Louisiana on size limits for trout and reds & leave bag limit where it is

Recreation, Charter, and Commercial

- Charter fishing not be allowed all year and with large quota
- Look for ways that may like using a limited amount of commercial equipment can use without having to comply with all the commercial regulations. Example, allow a sportsman license holder to use a slat box for catfish
- Less charter captains, lower limits, limits on white trout and Southern Kingfish
- No more recreational commercial licenses

Personal

- Catch more fish
- More shade, I am old
- Have fun and take a kid
- Fishermen to take pride in their own waterways to help clean and respect other fishermen while on water
- If only it was my job
- Find me a fishing buddy! I have a boat
- Encourage young children and families to fish to educate children at an early age
- Have less fisherman

Ways AIS Reduce Enjoyment of Mississippi's Waterways

After identifying the extent to which they felt AIS reduced their enjoyment of Mississippi's waterways, respondents were asked to describe how AIS had that effect. The following responses, edited only for clarity, are by respondents who indicated they had a fishing license, owned a boat, or both. The responses are grouped in the following categories: Access and Navigation; Eradication Efforts Hamper Fishing; Habitat; Invasive Carp; Poor Fishing. Many of the comments specifically addressed invasive carp, and those comments were placed in a separate category even when they implicated other issues.

Access and Navigation

- They choke off waterways. I am unable to get into spots I'd like to fish. They steal oxygen from the water and lead to die offs
- You can't get your boat to the good spots
- The presence of Salvinia hinders fishing line

- They choke off waterways and prevent me from getting to where I want to fish. They steal oxygen and cause die offs
- I use artificial bait and I can no longer fish because the grass has completely taken over all of Pascagoula River bayous and now out in the bay where I fish also. It is now to a point you cannot even run your boats for the grass is so thick
- Making it difficult to navigate through water ways. Nuisance when fishing
- Reduced ability to get to spots we used to enjoy on past year's trips!
- My pond is full of grasses making it difficult to fish. Same for streams. Now I haven't been boating in a while so I don't know about larger waterways
- I kayak a lot and certain places aren't paddleable between May and November because of water hyacinth
- Lily pads are restricting fishing lakes
- Water hyacinth blocks surface access making formerly productive areas useless
- Make it hard to fish shorelines
- Choked up rivers where you can't even get a line in the water or will damage your boat motor can often deter Mississippians from fishing
- Unable to move boat through invasive species; unable to get lure/bait through invasive species; invasive species hanging over water
- Too many line snags and overgrowth of fishing areas
- Can no longer access places I've fished for years

Eradication Efforts Hamper Fishing

- Containment efforts to control giant salvinia on Ross Barnett Reservoir made areas off limits

Habitat

- Last year there was an over-abundance of certain water plants in a few fishing areas
- Invasive plants filling shallow water areas and launches
- Algae and plants have made launches dirty and inaccessible
- Thick some times covers the whole area on the pascagoula river and many spots up the 613 area
- Non native plants are encroaching on my marsh grass reducing amount of habitat for shrimp and small fish
- Chokes out fish habitat
- The shallow inlets through the marsh is where trash will build and also the invasive water plant species which hinders me from picking up trash in my kayak and that's my hobby. These invasive water plants steal oxygen from the bayous

Invasive Carp

- You can't run down some rivers without a Asian carp hitting you in the face and killing you. Increased turbidity due to Asian carp
- Asian carp make running a boat dangerous, rough fish seem to be the only thing increasing in population along with the invasives, desired species are reducing
- Asian carp... self explanatory
- Carp populations are way too high
- I believe carp in smaller lakes have decreased the number of bass and bream

Poor Fishing

- Every year the fishing is getting worst. Less fish and bad quality of water on and near the main land
- Harder to find native species
- Competition with game species
- Reduced the amount of native species in certain areas where I fish
- Reducing the presence of native fish
- Certain breeds of fish eat or cause a reduction of other fish that I used to be able to catch
- Fewer fish
- Invasive catfish species make fishing less enjoyable
- Number one there should be stiff fines for anyone dumping these species in our waters Two, they eat native species or effect them in a harmful manner

Conclusion

Management of aquatic invasive species can be divided into two categories – those actions the State takes and those taken by individuals. A high number of respondents surveyed agree that the State is responsible for stopping the spread of AIS, and nearly as many respondents agree that individuals are responsible for stopping the spread of AIS. This suggests that boaters and fishers expect the State to take action but are willing to take steps to mitigate AIS contamination themselves. Other responses indicate support for additional State control and management. Boaters and fishers support the State spending more – in some cases a lot more – to remove AIS, and nearly a quarter of respondents identified a lack of environmental regulation as a priority to them.

The survey reveals that boaters and fishers in Mississippi care about the environment, are aware of many impacts from AIS on fishing and boating activities, and are willing to take some steps to help limit the spread of aquatic invasive species. Two things appear to be holding them back: a lack of information about species, such as where they are located, how they are spread, and what steps to take to stop their spread; and few boat rinsing facilities at boat landings.

Results indicate that the State's current education and outreach efforts are not the primary way people learn about AIS but that enhanced social media and improved information by the State would improve understanding about invasive species. Based on how those respondents who strongly agree that AIS have reduced their enjoyment in Mississippi's waterways support greater spending on AIS removal, performed better in identifying invasive species, as well as reported having boating habits that would limit the spread of AIS, it appears that a more aware boating and fishing public could help reduce AIS in Mississippi.

Appendix A: Research on Enforcement Methods to Control AIS

Clean, Drain, Dry Stations and the Control of Aquatic Invasive Species

By Lauren Wilson

What is Clean Drain Dry

A common way that aquatic invasive species are spread is through the recreational activity of boating and fishing. Boaters who neglect to rid their craft and equipment of invasive species risk spreading the species to new bodies of water. To prevent this from happening, the U.S. Fish and Wildlife Service through the Aquatic Nuisance Species Task Force launched the Stop Aquatic Hitchhikers campaign in 2002 to encourage boaters to use the Clean, Drain, Dry method to prevent the spread of aquatic invasive species.¹ Studies have found that Clean, Drain, Dry stations are effective at reducing invasive species violations and removing remaining water from vessels, even when used for short amounts of time.

The Clean, Drain, Dry Method

The Clean, Drain, Dry method is a three-step routine that is encouraged for boaters to use each time they remove their craft from a water source.² The process goes as follows:

Clean - This step involves removing visible plants, animals, mud, and other debris from the boat and all equipment before leaving the water access. It is recommended that the boater should use very hot water (~140 degrees) to rinse the interior, exterior, and motor of the boat. Most aquatic invasive species are killed at that temperature. However, most commercial water heaters only reach 120 degrees. If access to hot water is limited, boaters are encouraged to remove all visible material and completely dry the boat for five days before reentering a water body.³

Drain - The draining step requires boaters to drain the motor, bilge, livewell, and other devices on the boat that may retain water. This should be done before leaving the water access area. By doing so, boaters will remove water that may hide nearly invisible organisms such as zebra and quagga mussel larvae.⁴

Dry - The last step is to dry the boat. To do so properly, the boat must be thoroughly wiped down with a towel or allowed to air dry for at least five days. Since some organisms can survive for days in very small amounts of water, drying ensures that all biological material is removed. Boaters should consider the area in which their boat is left to dry, staying away from water bodies including streams and rivulets. Warm and dry weather is recommended for optimal drying. Parts of the boat that are not directly exposed to sunlight may take longer to dry.

Efforts and Effectiveness of the Clean Drain Dry Initiatives

The consistent use of Clean, Drain, Dry stations by boaters is estimated to save states money in the long run by reducing the amount of effort needed to alleviate the impacts of invasive species. For the Clean Drain Dry Initiative to work, boaters must 1) know about the initiative and 2) participate.

¹ ANS Task Force, *About Us*, Stop Aquatic Hitchhikers, <https://stopaquatichitchhikers.org/aboutus/>

² ANS Task Force, *Anglers*, Stop Aquatic Hitchhikers, <https://stopaquatichitchhikers.org/prevention/#anglers> . An additional step, *Dispose*, is necessary for those who fish using bait and a hook. Such anglers should dispose of unwanted bait in a trash receptacle, not the water source. Live organisms from one body of water should never be dumped into another.

³ US Fish and Wildlife Service, *Clean, Drain, Dry*, Fish and Wildlife Service, <https://fws.gov/story/clean-drain-dry>

⁴ ANS Task Force, *About Us*, Stop Aquatic Hitchhikers, <https://stopaquatichitchhikers.org/aboutus/>

To encourage boater participation, a non-profit organization in Minnesota, Wildlife Forever, received a grant from the U.S. Fish and Wildlife Service to install several Clean Drain Dry (CD3) Watercraft Cleaning Stations at water access areas across the country. The user-operated stations are equipped with easy-to-follow step-by-step instructions and the necessary tools that boaters will need to perform the steps of Clean, Drain, Dry.⁵ A typical system will have a wet/dry vacuum, a compressed air hose, a brush, a grabber, a universal drain plug wrench and lights. Some are solar-powered. According to Wildlife Forever, the cost of maintaining these stations is relatively low.

The first CD3 stations were installed at five locations in Minnesota in 2017. Software installed in these stations recorded that boaters voluntarily used the stations over 6,500 times during that first year.⁶ Each of these units was placed in a strategic location near substantial boater usage.⁷ Many boaters reported positive feedback after using the stations.⁸

A study was conducted to determine the effectiveness of the station's equipment compared to hand removal of microorganisms. A trained inspector with two seasons of watercraft inspection performed the tests, where invasives were placed on different vessels in likely places, and the inspector was given a time period to remove plants and animals either by hand or using the CD3 station. The results showed that there was no significant statistical difference between hand removal and the CD3 Station's removal.⁹ The study acknowledged that the trained inspector's expertise likely played a role in that success. Additionally, the study found no significant improvement in invasive removal of 90 seconds compared to 180 seconds.

More importantly, the study showed that when used along with signage, and road markings directing boaters to CD3 Stations, the stations reduced invasive species violations by over 70 percent and contributed to behavior change increasing their use.¹⁰ The study revealed the reasons inhibiting boaters from using the stations included a lack of equipment and because boaters did not think their efforts would be effective.¹¹ Overall, the study claimed that CD3 Stations presented an effective solution to increase boater participation in the Clean, Drain, Dry initiative.

Another study found CD3 Systems removed more residual water (water that does not drain) from boats than just removing drain plugs.¹² The study assessed how much water remained in the bilge and live wells of three different types of crafts having different ease of access to those points. Unsurprisingly, the study found that the easier the areas were to access, the more effectively water was removed. This water can contain zebra and quagga mussels. Using the vacuum at CD3 stations led to up to 100% removal of water, once again depending on how hard it was to access the area. Notably, the testers took less than the ten minutes they were given to vacuum the water, even where

⁵ Wildlife Forever, *CD3 Watercraft Cleaning Station*, Wildlife Forever Home,

<https://www.wildlifeever.org/home/invasive-species/cd3-watercraft-cleaning-station/>

⁶ Wildlife Forever, *Waterless Cleaning Stations 2017 Pilot Outcomes*, at 1 <https://www.wildlifeever.org/wp-content/uploads/2017/08/WF-Waterless-Cleaning-Stations-2017-Pilot-Outcomes-1.pdf>

⁷ *Id.* at 2 <https://www.wildlifeever.org/wp-content/uploads/2017/08/WF-Waterless-Cleaning-Stations-2017-Pilot-Outcomes-1.pdf>

⁸ *Id.* at 3 <https://www.wildlifeever.org/wp-content/uploads/2017/08/WF-Waterless-Cleaning-Stations-2017-Pilot-Outcomes-1.pdf>

⁹ Tim Campbell, et. all, *Effectiveness of a CD3 System at Removing Macrophytes and Small-Bodied Invertebrates from Watercraft*, at 4 (July 6, 2020). <http://www.wildlifeever.org/wp-content/uploads/2017/05/Campbell-Bodde-Seilheimer-2020-CD3-System-Removal-Effectiveness.pdf>

¹⁰ *Id.* at 6. <http://www.wildlifeever.org/wp-content/uploads/2017/05/Campbell-Bodde-Seilheimer-2020-CD3-System-Removal-Effectiveness.pdf>

¹¹ *Id.*

¹² Chris Anderson and Nick Phelps, *Preventing the overland spread of aquatic invasive species: Evaluating CD3 System efficacy on the removal of residual water from recreational boats*. Minnesota Aquatic Invasive Species Research Center technical report (2018) (a copy is available from MASGLP).

the vessel was unfamiliar to them. Thus, CD3 stations are more effective at removing potential invasives than a program that simply requires boaters to remove drain plugs when leaving the water.

One barrier to the success of the Clean, Drain, Dry program is getting boaters to participate. To support these necessary behavioral changes, water access areas in Hennepin County, Minnesota were redesigned. Hennepin County added pavement markers to direct boaters to the stations upon leaving the water and signs that encouraged boaters to participate in Clean, Drain, Dry.¹³ A study conducted on the success of the redesign found that the redesigned access area reduced aquatic invasive species violation rates. In fact, violation rates at one access point in Spring Park decreased from 16.5 percent in 2017 to 6.3 percent in 2018.¹⁴

The same study also found that the redesigned areas had better rates of self-inspection and were successful at creating social norms which prompted people to act. Both access areas saw a one-third increase in self-inspections. The access area at Spring Park was observed to have 87 percent of boaters following the new pavement markers. Additionally, the study found that boaters were 57 percent more likely to use the CD3 cleaning station if they had to wait in line to use the system.¹⁵ The explanation for this was that people are more likely to participate in an activity if they perceive it to be a social norm.

Gulf States Clean, Drain, Dry Programs

Most states have laws prohibiting the *intentional* release of invasive plants and animals, but states bordering the Gulf of Mexico are slow to require citizens to comply with actions of the Clean, Drain, Dry initiative. One such state that has legal requirements related to Clean, Drain, Dry practices is Texas. In Texas it is unlawful to possess or transport any aquatic plant or animal listed as harmful, or to fail to remove and properly dispose of harmful aquatic plants or animals. Violators of these laws are subject to fines up to \$500.¹⁶ Texas also requires its boaters to drain all water from their boats and onboard receptacles. Failure to follow this procedure could also result in fines of up to \$500 and 180 days in jail.¹⁷ These laws were put in place to address the aggressive spread of invasive zebra mussels in Texas lakes.¹⁸

Mississippi regulates aquatic invasive species, but does not require vessels to be cleaned, drained, or dried, nor prohibit the disposal of live bait and its water. Currently, it is unlawful for a person to possess or transport certain fish: walking catfish, piranhas, snakeheads, and swamp eels.¹⁹ Additionally, it is illegal for a person to release or cause to be released any nonnative aquatic species.²⁰

Mississippi has made non-regulatory efforts to endorse the Clean, Drain, Dry method. By partnering with Wildlife Forever in 2019, the state was able to install CD3 stations at three access

¹³ Hennepin County Minnesota, *Public Access re-design Observation Summary*, at 1
<https://www.wildlifeever.org/wp-content/uploads/2017/08/CD3-2018-Hennepin-Co-Report.pdf>

¹⁴ *Id.*

¹⁵ *Id.* at 3

¹⁶ Texas Parks & Wildlife, *Possession and Transport of Exotic Aquatic Species*, General Fishing Rules and Regulations, <https://tpwd.texas.gov/regulations/outdoor-annual/fishing/general-rules-regulations/possession-and-transport-of-exotic-aquatic-species>

¹⁷ Mark Haslett, *Boat draining now mandatory at all Texas lakes*, Public Radio of Northeast Texas, July 1, 2014.
<https://www.ketr.org/news/2014-07-01/boat-draining-now-mandatory-at-all-texas-lakes>

¹⁸ Mark Haslett, *New boating rules to combat zebra mussel spread*, Public Radio of Northeast Texas, Nov. 25, 2013.
<https://www.ketr.org/news/2013-11-25/new-boating-rules-to-combat-zebra-mussel-spread>

¹⁹ 40 Miss. Code. R. § 3-1.1A <https://www.law.cornell.edu/regulations/mississippi/40-Miss-Code-R-SS-3-1.1>

²⁰ 40 Miss. Code. R. § 3-1.1D <https://www.law.cornell.edu/regulations/mississippi/40-Miss-Code-R-SS-3-1.1>

points at the Ross Barnett Reservoir near Jackson, MS.²¹ The stations were installed to aid in reducing the spread of giant salvinia, an invasive aquatic plant, which was identified in the reservoir in 2018.²² No studies were found on the use or effectiveness of the stations.

In addition to the stations, Ross Barnett Reservoir requires that any organization that planned to hold a fishing tournament there must submit a boat inspection plan before they could be issued a permit.²³ The Handbook of Mississippi Boating Laws and Responsibilities also features information on aquatic invasive species and the importance of the Clean, Drain, Dry method.²⁴ Lastly, Mississippi includes in its Official Mississippi Boat Education course questions and information on how to stop the spread of aquatic nuisance species.²⁵ This course is required in order to obtain a boating license in Mississippi.

Conclusion

When used correctly and consistently, the Clean, Drain, Dry method has been proven to decrease the spread of aquatic invasive species. Studies conducted in states which have installed CD3 cleaning stations at access areas report success in increasing boater participation in Clean, Drain, Dry and significant reductions in violations. By providing boaters with the tools necessary for them to perform self-inspections, and using pavement markers to direct boaters to the stations, states can effectively address the issues caused by aquatic invasive species in an efficient and cost-effective manner.

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²¹ https://www.google.com/maps/d/u/0/viewer?mid=15jIQQ-YC_h8ZTSRDX0VAn_skpoUs0J&ll=32.39184700000005%2C-89.99893425198763&z=11

²² Pearl River Valley Water Supply District, *Barnett Reservoir to be lowered to level of 295*, Media Release, Nov. 21, 2019. <https://www.therez.ms.gov/Documents/PRVWSD%20Media%20Release%20-%20%20112119%20reservoir%20lake%20level%20lowering%20to%20295.pdf>

²³ <https://www.ms-sportsman.com/fishing/boaters-urged-to-clean-drain-dry/>

²⁴ Boat Ed, *The Handbook of Mississippi Boating Laws and Responsibilities*, boat-ed.com (2016). <https://assets.kalkomey.com/boater/pdfs/handbook/mississippi-handbook-entire.pdf>

²⁵ Boat-ed, Aquatic Nuisance Species, Study Guide for Boating Education, https://www.boat-ed.com/mississippi/studyGuide/Aquatic-Nuisance-Species/10102602_38354/

Lake County, California Quagga/Zebra Mussel Sticker Laws

By Randolph Mikell and Kristina Alexander

Introduction

The State of California mandated that registered recreational watercraft using freshwaters in the state receive a mussel sticker from the Department of Motor Vehicles indicating that the vessel is free from invasive zebra and quagga mussels (of the genus *Dreissena*) beginning in 2014.²⁶ However, the statewide requirement has not prevented water bodies like Pyramid Lake from becoming infested.²⁷ Lake County, California, however, requires a county mussel inspection sticker in addition to the state sticker.²⁸ As of 2022, its waters are invasive mussel-free.²⁹ With the sticker requirement comes enforcement, and Lake County has penalties ranging from a \$100 fine to forfeiture of the vessel.³⁰

Background

Lake County is a 1,327-square-mile county in northern California – more one-third larger than Yazoo County, Mississippi’s largest – located 110 miles northeast of San Francisco.³¹ In addition to being renowned for its landscape suitable for growing wine grapes, Lake County’s economy is based mostly on geothermal power and tourism.³² Lake County has six major public and private water bodies.³³ Lake County’s largest water body, Clear Lake, is the largest lake in the state, covering 68 square miles.³⁴ To protect this economic resource, Lake County enacted the mussel sticker law to keep out the invasive animals.

Mussel Sticker Law

The Lake County Board of Supervisors passed the law requiring stickers in 2008, which cost \$20 for both residents and visitors.³⁵ The resident stickers remain valid for a calendar year, and visitors’ stickers are valid for 30 days.³⁶

²⁶ CALIFORNIA DEPARTMENT OF PARKS AND RECREATION, *Mussel Fee Paid Sticker Requirements for California Registered Vessels* (Jan. 2016), <https://www.parks.ca.gov/pages/28702/files/mussel-paid-sticker-requirements.pdf>.

²⁷ CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE, *New Quagga / Zebra Mussel Discoveries in California* (2022), <https://wildlife.ca.gov/Conservation/Invasives/New-Infestations>.

²⁸ LAKE COUNTY NEWS REPORTS, *County officials say Lake County mussel stickers required for all boats* (May 30, 2014), <https://www.lakeconews.com/news/37000-county-officials-say-lake-county-mussel-stickers-required-for-all-boats>. The county also prohibits the release of live bait or “any liquid which previously contained live bait in a water.” Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-60.

²⁹ Angela DePalma-Dow, personal communication (June 1, 2022).

³⁰ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-61.1 - § 15.61.6.

³¹ LAKE COUNTY, CA, *Lake County at a Glance*, <https://lakecounty.com/explore/lake-county-california-at-a-glance/>.

³² *Id.*

³³ Angela DePalma-Dow, personal communication with Randolph Mikell (June 1, 2022).

³⁴ COUNTY OF LAKE, CA, *Clear Lake* (2017), <http://www.lakecountycalifornia.gov/Government/Directory/WaterResources/ClearLake.htm>.

³⁵ COUNTY OF LAKE, CA, *2021 Resident Quagga/Zebra (Q/Z) Stickers Now Available at All Screening Locations and Water Resources Department* (December 17, 2020), <http://www.lakecountycalifornia.gov/Government/PressReleases/quagga2021.htm>.

³⁶ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-55.1, 15-56.1, respectively.

To obtain a sticker, the vessel owner must be vetted by the County and the vessels have to be screened or sometimes inspected. First, vessel owners must submit an application and an affidavit which are available online.³⁷ Screening is required in three circumstances:

- 1) for residents, annually, prior to the first launch;
- 2) for non-residents, monthly, prior to the first launch in that calendar month; or
- 3) for any trailored vessel that has been launched in a water body outside of the county.³⁸

The County employs screeners to review these applications and determine if further inspection is necessary.³⁹ If, based on screening, the vessel appears to pose an appreciable risk to Lake County water bodies, an inspection is required. The additional process is free of charge.⁴⁰ The inspection will examine bilge pumps, motors, and live wells, bait wells, ballast tanks, bladders, and all areas of standing water to check for invasives. Where it is “possible” the vessel has *Dreissenid* mussels, the vessel is quarantined and may not enter any water until it is decontaminated and re-inspected.⁴¹ Inspections are available in several locations throughout the county such as boat ramps, marinas, and bait shops.⁴²

Once applicants receive stickers, they must affix them to specific areas on their crafts and trailers.⁴³ For registered vessels, the stickers must be placed on the starboard side, six inches closer to the bow than the registration number. For unregistered vessels, the stickers must be placed near the bow and on the starboard side if possible. For classic vessels and seaplanes, inspectors will instruct owners where to attach the stickers.

Enforcement

In 2021, Lake County issued over 21,000 stickers.⁴⁴ With the stickers displayed correctly, vessel owners may launch at any of Lake County’s water bodies. Without the sticker, the vessel may be ordered out of the water.⁴⁵

Without a valid sticker, each launch into a Lake County water body is a violation and may be charged as an infraction for the first two offenses (with fines of \$100 for the first offense, \$200 for the second) and a misdemeanor for subsequent offenses (with fines of \$500 to \$1,000 and up to 60 days in jail).⁴⁶ Additionally, the vessel may be impounded.⁴⁷ If the person is convicted of the offenses, they must pay all the storage fees and “charges incident to the impoundment of said vessel.”⁴⁸ Additionally, upon conviction of a misdemeanor the judge may order forfeiture of the vessel.⁴⁹

³⁷ Angela DePalma-Dow, personal communication (June 1, 2022).

³⁸ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-57.1.

³⁹ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-57.2(a).

⁴⁰ Angela DePalma-Dow, personal communication (June 1, 2022).

⁴¹ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-57.3(g).

⁴² Elizabeth Larson, *Ordinance requires all boats to have inspection stickers*, LAKE COUNTY NEWS REPORTS (May 22, 2008), <https://www.lakeconews.com/news/142-local-government/4288-ordinance-requires-all-boats-to-have-inspection-stickers>.

⁴³ *Id.*

⁴⁴ Terry Knight, *Lake remains quagga mussel-free for now*, LAKE COUNTY RECORD-BEE (February 15, 2022), <https://www.record-bee.com/2022/02/15/lake-remains-quagga-mussel-free-for-now/>.

⁴⁵ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-61.5.

⁴⁶ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-61.1.

⁴⁷ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-61.2.

⁴⁸ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-61.2(c).

⁴⁹ Cnty. of Lake, CA, Code ch. 15, art. IX, § 15-61.6.

Officers authorized to enforce the program include the county sherriff's office and the marine patrol, as well as the police departments in the two municipalities in Lake County.⁵⁰ Additionally, some Lake County officials, like the invasive species program coordinator, may issue administrative citations for violations.⁵¹

Program Success

According to the invasive species program coordinator, Angela DePalma-Dow, the mussel sticker program's success is rooted in prevention instead of punishment. In addition to enforcement personnel at the lakes, most county boat ramps have ramp monitor personnel to check vessels for mussel stickers. These ramp monitors ensure vessels are properly inspected and educate vessel owners about the threat quagga and zebra mussels pose to recreation and the local environment as a whole. Ms. DePalma-Dow believes that the human element of the mussel sticker program is the key to its success.⁵² Unlike mussel sticker machines that some people have suggested for the County, ramp monitors participate in community outreach and education. As a result, the monitors have the opportunity to make a connection during sticker check process, engaging boaters to be part of the program year after year.



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⁵⁰ Angela DePalma-Dow, personal communication with Randolph Mikell (June 1, 2022).

⁵¹ *Id.*

⁵² *Id.*

State Laws Versus Invasive Species

Randolph Mikell

Like the American court system, a well-functioning environment is an adversarial system. Invasive plants and animals disrupt this system. Invasive animals often have no natural predators and outcompete native species for food and resources. Recognizing this rising threat, the U.S. Congress enacted the first anti-invasive species law, the Lacey Act of 1900. Since then, states have followed suit.

Like the federal government, states have enacted their own invasive species laws and take enforcement action against civil and criminal violations of those laws. The laws, explored in more detail as found in state administrative codes, give state conservation officers the power to cite, detain, and even arrest violators. The direct enemy of these state laws are invasive species themselves. Just because invasive species can escape the courtroom, however, does not mean that the humans who possess or transport them can. While many states have laws that make introducing, selling, and/or transporting invasive species illegal, enforcement history is hard to find. Yet, convictions aren't unheard of. For example, in May 2022, an Ohio woman admitted to violating the Lacey Act by selling marbled crayfish in violation of state law. She faces a \$100,000 fine.¹

State Enforcement and Passive Acts

Many of the more publicized convictions related to invasive species involve either zebra or quagga mussels, small invasive mollusks which can rapidly reproduce and wipe out food sources for native species and also adhere to fixtures in water, causing extensive damage such as by clogging water intake structures. Minnesota is one of the states known to hold people accountable for transporting zebra mussels. In 2011, Minnesota conservation officers arrested a man from Fargo, North Dakota for transporting zebra mussels that were on a boat lift.² Notably, the officers had proof that the Fargo man knew that the mussels were present on the lift – after a witness said he told the man there were zebra mussels

on his boat lift – and chose to remove it from a lake and transport it anyway. After officers caught the man, he was charged with a misdemeanor and faced up to 90 days in jail. He pleaded guilty and was fined \$500 and paid \$500 in restitution.³ Fortunately, the man's unlawful act alerted the Minnesota Department of Natural Resources that the lake from which the lift was removed had zebra mussels. The DNR treated the lake to kill the mussels, at a reported \$18,000 price tag.

Another state with a history of mussel-related enforcement is California. There, as with more and more U.S. states, quagga mussels are a threatening invasive species. Some violations of invasive species rules in California are easier to detect. For example, Lake County, in Central California, requires boats to display quagga mussel inspection stickers while on any waterbody in the county. In 2011, a Lake County Deputy Sheriff apprehended a man operating a boat on Clear Lake, arresting the boater for failing to have a mussel inspection sticker on his boat.⁴ In February 2022, the county reported its lakes were still quagga mussel-free, and that it had issued 21,000 inspection stickers in 2021.⁵

State Enforcement of Commercial Violations

Some invasive species crimes result not from the carelessness of the violator but are motivated by the chance to gain a profit. An example of this for-profit phenomenon can be found in a 1986 U.S. Supreme Court case from Maine.⁶ In *Maine v. Taylor*, a bait dealer was indicted under the Lacey Act of 1900 which bans the transportation of fish in interstate commerce when that transportation violates state law. The bait dealer arranged the transportation of over 150,000 golden shiners, nonnative species that can host parasites dangerous to native fish, into Maine in violation of state law. After he was convicted, the dealer appealed, arguing that Maine's statewide ban on importing live baitfish



Credit: Tom Britt

violated the Commerce Clause of the U.S. Constitution, which prohibits the government from discriminating or posing an undue burden on interstate commerce.

Eventually, the U.S. Supreme Court reviewed his claims and rejected his argument, holding that Maine's statute did not violate the Commerce Clause because it served a legitimate local purpose that could not be accomplished in a less discriminatory manner. This case laid a foundation for state enforcement of commercial invasive species crimes by demonstrating that states can constitutionally prohibit the interstate trafficking of invasives.

A more recent instance of transportation and sale of an invasive species occurred in Wisconsin in 2016. Like invasive species laws in many states, Wisconsin law bans the live transport of invasive carp. These fish can quickly overtake waterways, grow up to 80 pounds, and jump 10 feet out of the water, giving the state law strong justification to protect its boaters and natural resources. Reportedly, after a citizen filed a complaint accusing a market of selling

invasive carp, the Wisconsin Department of Natural Resources traced the fish back to a fish dealer.⁷ The dealer was convicted of numerous violations, including the illegal possession and sale of over 9,000 pounds of these fish. This was the state's first conviction related to illegal possession and sale of invasive carp. Yet, had the dealer cut the gills or gutted the fish – thus removing the threat of their invading a waterway – the possession and sale would not have broken Wisconsin law.

Another example of selling live invasive fish occurred in New York in 2011. There, a fish dealer sold a large volume of northern snakehead fish he had imported – nearly 4,000 fish in multiple shipments from China in violation of state law.⁸ Snakeheads are toothy creatures that can devour native fish, reproduce quickly, and even travel short distances on dry land. They have few natural predators in the United States. They are also said to be delicious. Officers arrested the fish dealer for importing the illegal fish. He faced felony charges and up to four years for his crimes.

Difficulty in Enforcement

Ultimately, the list of prosecuted violations of state invasive species laws is short. And surely, violators get away with their crimes. This is due in no small part to the difficulty of enforcing state invasive species laws. There are a variety of factors at play. First, states must have the resources to enforce these laws. Most invasive species crimes, especially in the southeastern United States, likely fall in the wheelhouse of conservation officers, although sheriff departments and municipal police departments also make arrests related to invasive species. For laws to mitigate the spread of invasive species, there must be enough conservation officers to address would-be violators. If law enforcement were the only tool to prevent the spread of invasive species, there would have to be enough officers to check at every boat ramp and fishing hole to see if invasive plants are clinging to a boat or if an invasive species is being used as bait – an impossible task.

However, history shows that a greater number of conservation officers does not mean success in invasive species management. For example, Florida's Fish and Wildlife Conservation Commission employs the largest number of conservation officers of any state in the Union.⁹ Yet, a search of recent news publications and case databases found no reports of Florida prosecutions stemming from its laws and regulations pertaining to invasive species. Perhaps an educated public offers a better way of enforcement.

Mississippi and Alabama Laws

Mississippi and Alabama face gaps in effective invasive species management. For example, both Mississippi and Alabama employ fewer conservation officers than surrounding states.¹⁰ And compared to Maine laws that categorically prohibit importing any live baitfish and smelts, Alabama bans importing only wild caught bait.¹¹ The law allows importing commercially produced baitfish that may carry diseases harmful to native fish. Mississippi bans exporting but not importing wild caught bait,¹² but prohibits releasing non-native species into state waters.

The states have been active in improving their legal battles against invasives. Mississippi and Alabama have issued Aquatic Nuisance Species Management Plans, with Alabama's plan approved in 2021.¹³ The Management Plans focus on aquatic invasives, and they secure the states approximately \$100,000 per year in federal funding to fight invasives.

The Management Plans benefit the states by allowing them to prioritize certain invasives and use federal funds to remove or raise awareness of them, but the actions still depend on effective, up-to-date state laws for enforcement power. Mississippi and Alabama both maintain blacklists of species that are illegal to import. Yet, Mississippi's blacklist remains unchanged since 2011.¹⁴ And while Alabama amended its invasive animal blacklist in 2020,¹⁵ its invasive plant blacklist has been left untouched since 1999.¹⁶

Randolph Mikell was a Legal Intern at the Mississippi-Alabama Sea Grant Legal Program and is a rising third-year law student at the University of Mississippi School of Law.

Endnotes

1. The Guardian, *Ohio Woman Pleads Guilty to Selling Invasive Crayfish Species Across 36 States* (May 12, 2022).
2. Dan Gunderson, *Fargo Man Charged with Transporting Zebra Mussels*, MPR News (Dec. 29, 2011).
3. MPR News, *N.D. Man Sentenced in Minn. Zebra Mussel Case* (March 2, 2012).
4. Lake County News, *Boater Arrested for Invasive Mussel Sticker Violation*, (Aug. 18, 2011).
5. Lake County Record-Bee, *Lake Remains Quagga-Mussel Free For Now* (Feb. 15, 2022).
6. *Maine v. Taylor*, 477 U.S. 131 (1986).
7. Bob McNally, *Wisconsin Fish Dealer Convicted of Illegally Selling, Transporting 9,000-Plus Pounds of Invasive Carp*, Outdoor Life (March 22, 2022).
8. Reuters, *New York Man Charged with Importing Banned Fish from China* (April 28, 2011). While the accused admitted committing the crime, no report was found on his sentence.
9. U.S. Bureau of Labor Statistics, *Occupational Employment and Wage Statistics* (May 2021).
10. U.S. Bureau of Labor Statistics, *Occupational Employment and Wage Statistics* (May 2021).
11. *Ala. Admin. Code* r. 220-2-.162.
12. *40 Miss. Admin. Code* Pt. 3, R. 3.1.G.4.
13. David Rainer, *Alabama Aquatic Nuisance Species Management Plan Approved*, Alabama Department of Conservation and Natural Resources (Feb. 17, 2022). For Mississippi and other Southeastern and Gulf states' management plans, see <https://www.gsarp.org/library-state-ans-plans/>.
14. *2 Miss. Admin. Code* Pt. 1, Subpt 4, Ch. 11, § 104.
15. *Ala. Admin. Code* r. 220-2-.26.
16. *Ala. Admin. Code* r. 220-2-.124.

Appendix B: Selected References on AIS Management

By Conner Linkowski

Clean, Drain, Dry

Caitriona Shannon et al., *The Practical Application of Hot Water to Reduce the Introduction and Spread of Aquatic Invasive Alien Species* (Jan. 15, 2018)
https://eprints.whiterose.ac.uk/131779/14/MBI_2018_Shannon_etal.pdf.

This UK study examines the effectiveness of the “Check, Clean, Dry” method using hot water. Check, Clean, Dry is similar to the Clean, Drain, Dry method in the United States. The results indicate that using hot water for the cleaning process is an effective method of killing invasive plant and animal species, although it is more effective for invasive animal species.

Hennepin County Minnesota, *Public Access Re-design Observation Summary*,
<https://www.wildlifeever.org/wp-content/uploads/2017/08/CD3-2018-Hennepin-Co-Report.pdf>.

This study covers the changes made to public accesses at three lakes in Minnesota. The changes resulted in fewer violations of aquatic invasive species regulations and higher self-inspection rates, among other things.

Kristen Bor, *Clean, Drain, Dry: Prevent the Spread of Aquatic Invasive Species* (Sept. 21, 2022)
<https://bearfoottheory.com/clean-drain-dry-aquatic-invasive-species-prevention/>.

This article emphasizes the importance of and provides information on the Clean, Drain, Dry method. It also adds that stopping at inspection stations is an additional step to prevent the spread of aquatic invasive species.

M. Jake Vander Zanden & Julian D. Olden, *A Management Framework for Preventing the Secondary Spread of Aquatic Invasive Species* (June 25, 2008) <https://cdnsiencepub.com/doi/full/10.1139/F08-099>.

This paper emphasizes the importance of identifying locations vulnerable to damage by invasive species in allocating management efforts, and that requiring boats to be cleaned upon entry and exit at boat launches and denying access to boats at certain locations could be effective in preventing the introduction of invasive species.

Nick Phelps, *Evaluating Boat Cleaning Station Efficacy on the Removal of Residual Water from Recreational Boats* (2018)
<https://maisrc.umn.edu/cleaning-stations>.

This study examines the effectiveness of the Clean-Drain-Dry-Dispose (CD3) Waterless Cleaning Station on removing residual water from boats. The results suggest that the CD3 is an effective method for removing residual water and that it may be useful in reducing the spread of aquatic invasive species.

Noreen E. Kelly et al., *Recreational Boats as a Vector for Secondary Spread for Aquatic Invasive Species and Native Crustacean Zooplankton* (Aug. 10, 2012)
<https://link.springer.com/article/10.1007/s10530-012-0303-0>.

This article examines standing water found in boats of people travelling to Lake Simcoe, Ontario, Canada. Researches found that some of the standing water contained aquatic invasive species. The article recommends prevention methods similar to Clean, Drain, Dry.

Shrisha Mohit et al., *Recreational Watercraft Decontamination: Can Current Recommendations Reduce Aquatic Invasive Species Spread?* (Jan. 8, 2021)

https://www.reabic.net/journals/mbi/2021/1/MBI_2021_Mohit_etal.pdf

This report reviews 37 studies of the effectiveness of air drying, hot water use, pressure washing, and other cleaning products in removing invasive species from recreational watercraft. Most studies were conducted in the United States, and this report includes the mortality rates of various invasive species after being subjected to various decontamination methods.

Shrisha Mohit et al., *Watercraft Decontamination Practices to Reduce the Viability of Aquatic Invasive Species Implicated in Overland Transport* (Nov. 10, 2021)

https://assets.researchsquare.com/files/rs-1021628/v1_covered.pdf?c=1636563913.

This study examines the effectiveness of different variations of the Clean, Drain, Dry method by analyzing the mortality rates of various aquatic invasive species after exposure to different water pressures and temperatures and different amounts of drying time.

Tim Campbell et al., *Effectiveness of a CD3 System at Removing Macrophytes and Small-Bodied Invertebrates from Watercraft* (July 6, 2020)

<http://www.wildlife forever.org/wp-content/uploads/2017/05/Campbell-Bodde-Seilheimer-2020-CD3-System-Removal-Effectiveness.pdf>.

This study compares the effectiveness of the hand-removal and Clean-Drain-Dry-Dispose (CD3) Waterless Cleaning Station methods in removing aquatic invasive species from watercraft.

U.S. Fish & Wildlife Service, *Clean, Drain, Dry . . . In Every Waterbody, Every Time.*,

<https://www.fws.gov/story/clean-drain-dry>.

This resource describes what the Clean, Drain, Dry method is and how it works to prevent the spread of aquatic invasive species.

Wildlife Forever, *Waterless Cleaning Stations 2017 Pilot Outcomes*, <https://www.wildlife forever.org/wp-content/uploads/2017/08/WF-Waterless-Cleaning-Stations-2017-Pilot-Outcomes-1.pdf>.

This resource provides information on the use of Clean-Drain-Dry-Dispose (CD3) Waterless Cleaning Stations by boaters, including statistics on how often they were used and the results of inspections after using a station.

Education/Publicity

Caitriona Shannon et al., *The Effectiveness of e-Learning on Biosecurity Practice to Slow the Spread of Invasive Alien Species* (May 18, 2020)

<https://link.springer.com/article/10.1007/s10530-020-02271-z>.

This study examines the effectiveness of an e-Learning course about invasive alien species and biosecurity practices to increase awareness about these subjects among students and professionals in the field. Awareness among students was increased six months after taking the course.

Eithne Davis et al., *Communications, Outreach, and Citizen Science: Spreading the Word About Invasive Alien Species* (Oct. 29, 2018)

https://www.reabic.net/journals/mbi/2018/4/MBI_2018_Davis_etal.pdf.

This resource examines the effectiveness of outreach regarding invasive alien species through different media. The results indicate that, while messages may reach more people through broadcasts and social media, fewer people actually interact with the message. However, broadcasts and social media can be used to give credibility to events that normally reach fewer people but have higher interaction rates—like workshops and citizen science events—which may contribute to more people interacting with the message through those events.

Elizabeth Golebie et al., *Addressing Barriers to Aquatic Invasive Species Prevention Among Illinois Recreational Water Users* (Oct. 2021)

https://publish.illinois.edu/angler-behavior-and-aquatic-invasive-species/files/2021/10/DNR-report_Final.pdf.

This study examines the factors that may prevent people from engaging in “remove-drain-dry behavior” and the effectiveness of the messages used to provide information on aquatic invasive species prevention.

Erin Seekamp et al., *Effects of Outreach on the Prevention of Aquatic Invasive Species Spread Among Organism-in-Trade Hobbyists* (Aug. 30, 2016)

<https://link.springer.com/article/10.1007/s00267-016-0748-5>.

This study surveys organism-in-trade hobbyists to assess their compliance with the Habitattitude campaign’s recommended behaviors for organism purchase and disposal. Based on the results, the researchers recommend that distributing materials that explain tangible, negative environmental impacts and list specific prevention behaviors could increase aquatic invasive species prevention behaviors.

Erin Seekamp et al., *Exploring the Efficacy of an Aquatic Invasive Species Campaign Among Water Recreationists* (March 16, 2016)

<https://link.springer.com/article/10.1007/s10530-016-1117-2>.

The Stop Aquatic Hitchhikers! (SAH!) campaign is the focus of this report which conducted a survey and focus group research with water recreationists in Illinois and Indiana. The results indicate the campaign had moderate success.

Jenni Lee et al., *Improving Public Outreach and Education Programs to Minimize the Spread of Aquatic Invasive Species (AIS)* (Aug. 2015)

https://repository.library.noaa.gov/view/noaa/38024/noaa_38024_DS1.pdf.

This study examines the effectiveness of AIS regulations and educational outreach programs to evaluate how well boaters understood AIS problems and how willing they were to follow related regulations.

Kyle Gerard, et al., *Evaluation of the Effectiveness of Western States’ Aquatic Invasive Species Public Awareness Campaigns for Eliciting Desired Prevention Behaviors* (Aug. 2022)

https://www.researchgate.net/profile/Gerard-Kyle/publication/363885321_EVALUATION_OF_THE_EFFECTIVENESS_OF_WESTERN_STATES'_AQUATIC_INVASIVE_SPECIES_PUBLIC_AWARENESS_CAMPAIGNS_FOR_ELICITING_DESIRED

[EVALUATION OF THE EFFECTIVENESS OF WESTERN STATES' AQUATIC INVASIVE SPECIES PUBLIC AWARENESS CAMPAIGNS FOR ELICITING DESIRED](https://www.researchgate.net/profile/Gerard-Kyle/publication/363885321_EVALUATION_OF_THE_EFFECTIVENESS_OF_WESTERN_STATES'_AQUATIC_INVASIVE_SPECIES_PUBLIC_AWARENESS_CAMPAIGNS_FOR_ELICITING_DESIRED)

[PREVENTION BEHAVIORS FINAL REPORT/links/633353125d1e2d53d9a0f427/EVALUATION-OF-THE-EFFECTIVENESS-OF-WESTERN-STATES-AQUATIC-INVASIVE-SPECIES-PUBLIC-AWARENESS-CAMPAIGNS-FOR-ELICITING-DESIRED-PREVENTION-BEHAVIORS-FINAL-REPORT.pdf](https://www.researchgate.net/publication/315555555/links/633353125d1e2d53d9a0f427/EVALUATION-OF-THE-EFFECTIVENESS-OF-WESTERN-STATES-AQUATIC-INVASIVE-SPECIES-PUBLIC-AWARENESS-CAMPAIGNS-FOR-ELICITING-DESIRED-PREVENTION-BEHAVIORS-FINAL-REPORT.pdf).

This study gathers information on people's awareness of aquatic invasive species and the Clean, Drain, Dry prevention method. The results indicate that people's understanding of these issues is related to age and how often they engage in recreational water activities. The study also examines what kind of messaging about Clean, Drain, Dry is most effective.

Lushani Nanayakkara et al., *In Lakes But Not in Minds: Stakeholder Knowledge of Invasive Species in Prairie Lakes* (Sept. 25, 2017)
<https://link.springer.com/article/10.1007/s10530-017-1564-4>.

This Canadian study uses a survey to assess people's knowledge of aquatic invasive species and management strategies. The results indicate that, on average, people do not know much about aquatic invasive species management.

Nancy A. Connelly et al., *Roles of Boating Facilities, Bait Dealers, and Angler and Boating Organizations in Preventing the Spread of Aquatic Invasive Species in the Lake Ontario Basin* (Dec. 2014)
<https://ecommons.cornell.edu/bitstream/handle/1813/40352/HDRUReport14-12.pdf;sequence=2>.

This study surveys bait dealers, marina operators, state and local parks with boating access sites, and boating and angler organizations to evaluate their capacity to help with AIS prevention. The results indicate that using these organizations to help with AIS prevention outreach could improve AIS prevention behavior among recreational watercraft users.

Natalie Stafl et al., *Columbia Shuswap Invasive Species Society* (Dec. 2015)
http://columbiashuswapinvasives.org/wp-content/uploads/2014/03/CSISS_Year-End-Report-20151.pdf.

This report shows that efforts to inform people about AIS management strategies can lead to more engagement in the community. The results indicate that there were more requests for informative presentations on these topics after initial engagement. This document also offers information on Clean, Drain, Dry and other prevention methods.

Patrick C. Tobin, *Managing Invasive Species* (October 23, 2018)
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6206619/>.

This article identifies the most feasible invasive species management method as educating the general public about invasive species to raise awareness.

Sam Cimino & Angela Strecker, *OSMB Final Report: Task 6. Tenmile Lake Boat Wash Effectiveness Monitoring* (2014)
https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1035&context=centerforlakes_pub.

This study examines how effective installing a public boat wash station is in raising awareness about the importance of Clean, Drain, Dry and aquatic invasive species.

T. Bruce Lauber et al., *Aquatic Invasive Species Outreach to Boaters and Anglers in the Lake Ontario Basin* (Aug. 2014)
<https://ecommons.cornell.edu/bitstream/handle/1813/40360/HDRUReport14-05.pdf?sequence=2>.

This study examines the messages used by various organizations to promote behaviors among anglers and boaters consistent with AIS prevention. The study also analyzes the messages in an attempt to determine what did or did not make them effective.

T. Bruce Lauber et al., *Assessing Capacity for Aquatic Invasive Species Outreach in Recreational Communities* (May 2015)

<https://ecommons.cornell.edu/bitstream/handle/1813/40340/HDRUReport15-7.pdf?sequence=2>.

This study examines the contributions that local organizations in New York could make to help aquatic invasive species (AIS) outreach programs. The results indicate that increasing the capacity of these local organizations to promote AIS outreach could lead to more information about AIS prevention getting to recreational watercraft users.

University of Wisconsin-Madison Division of Extension, Natural Resources Institute, *Aquatic Invasive Species Prevention: Wisconsin Boaters and Anglers Survey Report* (Nov. 2019)

<https://uwmadison.app.box.com/s/ifu1ov9d7qoa050itnamiiyot6kecgfa>.

This study compares data from a 2013 and 2018 survey of registered boaters in Wisconsin to obtain data on their opinions and behaviors regarding aquatic invasive species (AIS) prevention. The results indicate that awareness of AIS prevention had increased, and people usually gained AIS-related information from signs at boat landings, among other things.

Inspection

Lisa A. DeBruyckere, *Regulatory and Outreach Strategies for Aquatic Invasive Species in Oregon* (2013)

<https://repository.library.noaa.gov/view/noaa/42153>

This study contains data collected from California, Colorado, Idaho, Utah, and Wyoming regarding their boat inspection stations. The data show the number of boats inspected and how many of them fail inspection by year.

Michigan Invasive Species Program, *Michigan's Invasive Species Newsletter – Invasive Species Laws Related to Organism in Trade and Commerce*, at 3, 5 (2018)

https://www.michigan.gov/-/media/Project/Websites/invasives/Documents/Media/IS_Newsletter_Summer_2018.pdf?rev=33477bca181e4e32a0a3a1e623b8f3a6.

This newsletter provides statistics on Michigan's inspection efforts and laws regarding placing a boat, boating equipment, or boat trailer in the water if aquatic plants are attached. The inspection information is focused on live invasive species being intentionally transported more so than on efforts to clean the boats.

Oregon Department of Fish & Wildlife, *Boaters Required to Stop at Aquatic Invasive Species Inspection Stations; Free Inspection Takes Five to 10 Minutes (Images Available)* (May 25, 2021)

https://www.dfw.state.or.us/news/2021/05_May/052521.asp.

This article says that aquatic invasive species inspections are mandatory for watercraft in Oregon. It touches on the Clean, Drain, Dry method, and it offers statistics on the number of inspections done and the number of contaminated watercraft intercepted.

Robert G. Haight et al., *Optimizing the Location of Watercraft Inspection Stations to Slow the Spread of Aquatic Invasive Species* (Aug. 31, 2021)

<https://link.springer.com/article/10.1007/s10530-021-02620-6>.

This study uses a model to allocate scarce inspection resources among lakes. The results indicated that to protect lakes within and outside of the specific county where the study was conducted, locating inspection stations at infested lakes with the most boats departing for un-infested lakes was optimal.

Samantha Tracy et al., *Human Dimensions of Aquatic Invasive Species Transport at Lake Mead National Recreation Area* (July 23, 2021)
https://www.reabic.net/journals/mbi/2021/4/MBI_2021_Tracy_etal.pdf.

This study collect and examines data from inspection stations at Lake Mead and other locations in the western United States to identify boating trends to help organizations adjust their messaging strategy regarding AIS prevention to fit the demographics most responsible for the spread of aquatic invasive species.

Samuel M. Fischer et al., *Managing Aquatic Invasions: Optimal Locations and Operating Times for Watercraft Inspection Stations* (March 13, 2020)
<https://arxiv.org/pdf/2003.06092.pdf>.

This study applies programming techniques in an effort to determine the most optimal locations and operating times for watercraft inspection stations in order to prevent uninspected watercraft from reaching waterbodies still untouched by AIS.

National Sea Grant Law Center, *From Theory to Practice: A Comparison of State Watercraft Inspection and Decontamination Programs to the Model Legal Framework* (April 2017)
<http://nsglc.olemiss.edu/projects/model-legal-framework/files/state-comparison-revised.pdf>.

This study provides extensive information on the watercraft inspection and decontamination requirements of each state as they relate to AIS. It also includes each state's law on the transportation of AIS.

Terri Chase et al, *Behavioral Change Analysis of Aquatic Invasive Species Prevention Strategies for Deep Creek Lake, Maryland* (2020)
<https://www.garrettcountry.org/resources/watershed/pdf/Publications/Deep%20Creek/Behavioral%20Change%20Analysis%20DCL%20Final.pdf>

This source contains case studies that examine the effectiveness of education and inspection efforts to combat AIS and of Clean, Drain, Dry in other locations.

Tim Campbell, *Clean Boats-Clean Tournaments: Best Management Practices to Inspect and Wash Fishing Tournament Boats* (April 2014)
<https://publications.aqua.wisc.edu/download/cleanboatscleantournaments-factsheet-pdf/>.

This article emphasizes the importance of inspecting and cleaning boats for AIS prevention. It provides instructions on how to inspect and clean recreational fishing boats.

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