DEPARTMENT OF NATURAL RESOURCES

Minnesota Department of Natural Resources Aquatic Invasive Species Community-Based Social Marketing Project



Jay Cooke State Park. (Courtesy of the Minnesota DNR via mprnews.org)

Expert Panel Session #1 Summary

February 2019





This document is part of the Minnesota Department of Natural Resources (DNR) Invasive Species Program's Community-Based Social Marketing (CBSM) project. The project aims to better promote the adoption of desirable aquatic invasive species (AIS) prevention behaviors and create positive social norms around AIS prevention in Minnesota.

Tina Wolbers

Minnesota DNR Project Manager tina.wolbers@state.mn.us 651-259-5146

Ken Donnelly Consultant Team Lead ken@beyondattitude.com 902-223-6123



1. Introduction

About the Project

The Minnesota Department of Natural Resources (DNR) delivers the Invasive Species Program with the goals of preventing introductions of new invasive species into Minnesota, preventing the spread of invasive species within Minnesota, and reducing the impacts caused by invasive species to Minnesota's environment, society, and economy.

In August 2018, AZENTIVE, LLC and Beyond Attitude Consulting were awarded a contract to deliver the Aquatic Invasive Species (AIS) Community-Based Social Marketing (CBSM) project for the DNR. The purpose of the project is to apply behavioral psychology techniques to address the human behaviors that contribute to the introduction and spread of AIS in Minnesota waters.

The project is being delivered in two phases: The first phase is focused on the identification and prioritization of target behaviors to most effectively manage AIS in Minnesota and identifying the barriers and benefits to one or more of those target behaviors. The second phase will focus on the development of strategies to foster target behaviors and implementation and evaluation of those strategies. The DNR will use the results to promote the adoption of desirable AIS prevention behaviors and create positive social norms around AIS prevention.

Role of the Expert Panel

The Expert Panel is a group of experienced professionals who bring the most current thinking on AIS and provide a diversity of perspectives that are grounded in real life experiences to the project. The Panel will collaborate with the project team at two points in the project to define and assess behaviors to target (Session #1) and provide advice and recommendations in response to quantitative research being undertaken (Session #2).

Session #1 engaged the Expert Panel in the behavior selection process, as it is outlined in Dr. Doug McKenzie-Mohr's book on Community-Based Social Marketing, *Fostering Sustainable Behavior.* The process evaluates three factors, impact, likelihood of adoption, and market penetration in order to identify the best candidate behavior to pursue. The Session #1 Panel was comprised of 13 respected members of the AIS community including people who represent Canadian provinces, and the states of Washington, Michigan, Wisconsin and Minnesota. Together they represent multiple scales and types of jurisdictions and their expertise includes invasion biology, large-scale AIS program management, risk management, and behavior change.



Purpose of the Expert Panel Summary

This summary provides a record of the Expert Panel Meeting #1 including impact analysis and recommendations for further research.

If you have any questions about the project or the work of the Expert Panel, please contact: Jeff Garkowski, Lead Researcher jeffrey.garkowski@gmail.com 416-895-3632

2. Reviewing the Candidate Behavior List

Overview

Session #1 was held on November 28, November 30 and December 7 to accommodate the schedules of panelists. The purpose of this session was to review the long list of potential behaviors that were identified in previous tasks and to score each behavior for impact, uptake, and market potential. Members reviewed the behaviors and were given the opportunity to suggest modifications and to add others to the list.

Expert Panel Resource Guide and Behavior List

An Expert Panel Resource Guide was provided to members to review before the panel meetings. The resource guide provided an overview of the project, some information on Community-Based Social Marketing, and the methodology to be used by each Expert Panel member to review the behavior list. The resource guide is included in Appendix A of this report. The methodology for reviewing the list of potential behaviors is included in Appendix A, Section 3 Assessing Potential Behaviors.

A Microsoft Excel file (*Minnesota AIS Expert Panel Behavior Worksheet*) containing the list of potential behaviors was also provided to the members.

Online Behavior Review Meetings

Three online meetings were held in order to meet the schedule requirements of the Panel members. Each Panelist attended only one of the three sessions. Prior to the meetings, each of the Panel members was offered an opportunity to discuss the resource guide and the process in case there was any confusion or concerns. In all three meetings, participants reviewed and discussed the list of behaviors together and followed up after the meetings to submit their scoring worksheets.



There were no deletions of behaviors, but Panel members suggested the following additional behaviors:

- Drain ballast tanks in motorized watercrafts
- Include pets as a pathway and add the behavior of removing material attached to their fur, and another to bathe them
- Split the behavior of rinsing watercraft into two behaviors, with a distinction of whether the water was hot or cold
- Unintentional release through restocking programs for the live bait pathway
- Differentiate online and in-store sale of aquarium and water garden species

With those changes made, Panel members were asked to rank behaviors for:

- Effectiveness in preventing the spread of AIS
- Likelihood of the behavior being adopted by the target audience
- The opportunity for growth in the number of people performing the desired behavior (a reflection of current market penetration)

The Panel members did the ranking on their own time and then submitted them to the consulting team. The submissions were then aggregated and analyzed.

3. Overview of The Ranking Analysis

The detailed results of the Expert Panel rankings are contained in an Excel file. The following is a summary of the results by pathway.

In the tables, the Average Impact, Average Uptake, and Average Market are the calculated average of the ratings submitted by the Expert Panel members (using a range from 1 to 5 as discussed in Section 3 of Appendix A).

The **Average Impact** column represents the Expert Panel's determination of how beneficial the action described would be at stopping the spread of aquatic invasive species. The range is 1 to 5, with 5 being the highest impact.

The **Average Uptake** represents the Expert Panel's determination of how likely it is that people would take up the action listed. For example, behaviors that are considered time-consuming, costly, or requiring special equipment are likely to be scored lower than those that are convenient, easy and inexpensive. The range is 1 to 5, with 5 being the highest likelihood of uptake.

The **Average Market** is an indication of market potential or how many people are not yet taking action. If the behavior has already been adopted by many people and there is little room for

AZENTIVE ATTITICE

increasing the number of people engaged in it, then the score will be low. However, if it is a new behavior that is just being introduced, then the market potential will score high. The range is 1 to 5, with 5 being the highest market potential.

The **Product of Averages** is calculated by multiplying together the values found in the three previous columns.

Product of Averages = Average Impact X Average Uptake X Average Market

Figure 1: Behavior Scoring Example: Blood Donation in the United States

An example of scoring a simple behavior – donating blood in the United States of America.

Since the act of donating blood has the ability to save lives, the impact would likely be 5. The probability of uptake is not so high though, as screening prevents some people from donating, and fear prevents others from doing so (to list two of many factors). In fact, only 38% of Americans are allowed to donate. So the uptake might be about 2 out of 5.

Only about 3.5% of Americans donate blood, so the market potential is very high. It would rank around 4.5 out of 5.

So the product of the rankings can be calculated as:

Average Impact (5) X Average Uptake (2) X Average Market (4.5) = 45.

In the following tables, behaviors are listed with the averages of the Expert Panel rankings and the product of the three ranked categories, as discussed above.

The values are color-coded in order to provide a quick visual indication of the values in relation to those of other behaviors. Bright red squares indicate low rankings, bright yellow squares indicate rankings at the mean, and bright green squares indicate the highest rankings.

This process of behavior selection provides guidance based on three important factors. However, choosing behaviors must take into account many other elements as well, such as the level of risk, number of people involved, etcetera. For example, although it is estimated that 86% of Americans wear seatbelts, the market potential for getting more drivers to comply is quite low. However, given the consequences of being in an accident while not wearing a seatbelt, and the fact that there are 222 million drivers in the country, it makes sense to continue to promote seatbelt safety, even though the product of impact, uptake and market potential would be small, due to a high market penetration.



Or in other words, in the context of aquatic invasive species – even if 90% of watercraft users were already cleaning, draining and drying their boats, zebra and quagga mussel infestations are so damaging that it makes sense to continue to promote the action, even if the market potential is low. The risk still remains high as it would only take one boat with zebra mussels attached to contaminate an entire lake.

4. Overview of Results

This section provides the findings of the Expert Panel rankings, presented by pathway. The rankings of all behaviors for all pathways can be found in Appendix B.

Motorized Recreational Watercraft

Behaviors associated with motorized watercraft were generally ranked low to average, with only removing visible debris and draining ballast tanks rated highly. As can be seen, while many of the behaviors were considered to have a significant impact, they were rated relatively lower on the likelihood of uptake and the opportunity for increasing the number of people already doing it.

Notwithstanding the results of the evaluation, both motorized and non-motorized watercraft are very significant pathways that present a very high risk of transporting invasive species. There are many watercraft users in Minnesota, and the potential damage of just one boat carrying invasive species from one lake to another is enormous. It is necessary to consider such risks in addition to the factors assessed by the Expert Panel.

Some of the low rankings of potential uptake on behaviors such as pressure-washing or rinsing a boat with water are related to known reported barriers, such as not having the appropriate equipment available or space at a boat landing to take the actions. It is likely that the uptake would be greater if the behavior was made more convenient, or if there were higher penalties for non-compliance. Removing barriers is a fundamental approach to behavior change. The Expert Panel scoring of the behaviors, particularly with respect to pressure-washing and rinsing watercraft, underscores the importance of removing barriers that prevent people from taking these actions. The scoring of the "Inspect boat and trailer" and "Remove visible debris" reflect the importance of barriers, as there are no significant ones to taking these actions, and therefore uptake is scored very high.

It is also likely that the success of the existing watercraft inspection program has resulted in the Average Market being scored lower than it would have been several years ago before the program was introduced. In other words, many people already inspect, clean, and drain their watercraft.



All behaviors related to watercraft were ranked above the mean for impact for all behaviors, although some are ranked higher than others.

Although the Product of Averages scoring is relatively low for the watercraft-related behaviors, other factors support promoting the actions with behavior change strategies.

Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Inspect boat and trailer	4.1	4.5	2.0	36.8
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Remove visible debris	4.8	4.1	2.2	42.0
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Wash with high pressure	3.9	2.0	3.4	26.8
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Rinse with cold water	3.4	2.8	3.8	37.1
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Rinse with hot water	3.8	2.3	3.9	33.8
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Air dry for at least 5 days	3.7	2.6	3.3	30.8
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Drain live well	3.9	3.5	2.4	33.1
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Dry live well	3.3	2.8	2.7	25.2
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Drain bilge	4.0	3.8	2.3	34.4
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Drain balast tanks	4.2	3.1	3.6	46.0
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Tip/drain motor	3.7	3.2	3.1	35.9
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Run motor for 5-10 seconds to blow out excess water	3.3	2.8	3.5	33.1

Table 1: Motorized Recreational Watercraft Scoring

Non-Motorized Recreational Watercraft

Other than removing visible debris, rinsing with cold water and tipping to drain, non-motorized watercraft behaviors were ranked quite low. This was primarily because the Expert Panel members ranked many behaviors as unlikely to be adopted or that people were already doing it. As with the motorized watercraft, barriers associated with pressure-washing and rinsing actions that require equipment available were ranked low on uptake.

As per the discussion in the section on motorized recreational watercraft above, even though the Product of Averages is lower for these behaviors, there are other factors associated with the



magnitude of risk that suggest it would be important to apply behavior change strategies to this pathway.

Pathway	Source	Behavior s	Average Impact	Average Uptake	Average Market	Product of Averages
Recreational Watercraft	Attachment to and movement of non-motorized watercraft (canoes, kayaks, paddleboards)	Remove visible debris	4.4	4.2	1.9	35.3
Recreational Watercraft	Attachment to and movement of non-motorized watercraft (canoes, kayaks, paddleboards)	Wash with high pressure	3.3	2.0	3.6	23.3
Recreational Watercraft	Attachment to and movement of non-motorized watercraft (canoes, kayaks, paddleboards)	Rinse with cold water	3.4	3.1	3.3	34.2
Recreational Watercraft	Attachment to and movement of non-motorized watercraft (canoes, kayaks, paddleboards)	Rinse with hot water	3.3	2.2	3.2	22.9
Recreational Watercraft	Attachment to and movement of non-motorized watercraft (canoes, kayaks, paddleboards)	Air dry for at least 5 days	3.3	3.2	2.4	25.5
Recreational Watercraft	Contaminated water captured on/in non-motorized watercraft (canoes, kayaks, paddleboards)	Tip/drain watercraft	3.5	4.3	2.2	32.6

Table 2: Non-Motorized Recreational Watercraft Scoring

Retail Plant Trade

Almost all retail plant trade behaviors were ranked high. In fact, four of the top ten ranked behaviors overall related to the retail plant trade (see Appendix B). While uptake numbers were in the middle of the range of 1 to 5, Panel members ranked their impacts highly and the potential market highly.

Table 3: Retail Plant Trade Scoring

Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Retail Plant Trade	Planting of high-risk plants (intentional or unintentional)	Recognize and purchase of only non/low-risk species (individuals and service providers)	4.2	3.0	4.2	52.3
Retail Plant Trade	Planting of high-risk plants (intentional or unintentional)	Check purchases and recognize invasive species/unwanted hitchhikers and dispose of in garbage	3.8	2.9	4.1	45.4
Retail Plant Trade	Planting of high-risk plants (intentional or unintentional)	Accurately identify and only sell non/low-risk species (retailers)	4.4	3.0	4.3	56.3
Retail Plant Trade	Unintentional escape from private ponds and water gardens	Follow design and installation best practices (distance from natural waterways/flood areas, closed system, planting in containers, etc.)	3.5	2.8	4.1	41.0
Retail Plant Trade	Unintentional escape from private ponds and water gardens	Recognize and install only non/low- risk species	4.2	3.0	4.2	53.0
Retail Plant Trade	Unintentional escape from private ponds and water gardens	Follow maintenance best practices	3.5	2.8	3.9	37.7
Retail Plant Trade	Intentional dumping of unwanted high-risk plants	Identify high risk species and dispose of in garbage	4.2	3.4	3.7	52.2

Docks/Lifts/Rafts and Associated Equipment

All behaviors associated with heavy equipment such as docks, lifts and rafts were ranked highly with relatively high values for all three factors. Like other pathways, removing visible debris was ranked high, but letting the equipment air dry was even higher, based mostly on the feeling that few people were doing that now.

Gear and Equipment – Research, hunting and hiking, and pets

Behaviors associated with research gear were generally in the middle of the rankings, with the exception of "Remove visible debris."



Removing visible debris also ranked highly for hunters, whereas other behaviors were ranked much lower. Expert Panel members appeared to feel that hunters were a moderate risk as a pathway, which contributed to the lower ratings.

Behaviors related to hikers were considered to be on the low end of the behavior priority list. This is largely because they appear to be considered a relatively low-risk pathway for AIS.

Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Remove visible debris	4.2	4.6	2.6	49.3
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Rinse inside and outside of gear with cold water	2.8	3.8	3.0	32.4
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Rinse inside and outside of gear with hot water	3.2	3.1	3.4	33.4
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Drain water from water containing devices	3.3	4.3	2.7	38.5
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Air dry for at least 5 days	3.6	3.5	3.1	39.2
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Remove visible debris	3.8	4.0	3.0	45.3
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Rinse gear and footwear with cold water	3.2	3.1	3.4	33.5
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Rinse gear and footwear with hot water	3.1	2.3	3.5	25.3
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Wash waders and clothing	3.2	3.2	3.1	32.0
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Air dry for at least 5 days	2.8	2.9	3.1	25.3
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Remove visible debris	2.9	3.8	2.3	25.2
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Rinse gear and footwear with cold water	2.1	2.8	3.0	17.2
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Rinse gear and footwear with hot water	2.4	2.0	3.4	16.4
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Wash clothing in wash machine	3.0	3.6	2.3	24.8
Pets	Attachment to pets	Remove visible debris	3.5	3.8	3.5	46.6
Pets	Attachment to pets	Wash pets	2.5	2.6	3.3	21.3

Table 4: Gear and Equipment Scoring – Research, hunting and hiking, and pets

Expert Panel members ranked the behavior of removing visible debris from pets quite highly. Due to their belief that the likelihood of adoption was low, washing pets was ranked low.

Live Bait

Live bait behaviors were generally ranked highly by the Panel members across all three criteria. They felt that it was important to ensure invasive species were not sold or purchased as bait, and that bait is disposed of properly. The rankings for the impact of these behaviors indicate that the Expert Panel believes that bait is a very risky pathway. All three factors for the live bait pathway were generally ranked higher than the mean for all behavior rankings.

The Panel members ranked behaviors related to bait packaging and eDNA significantly lower. eDNA was considered to be too expensive and inconvenient for use by retailers.



Table 5: Live Bait Scoring

Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Live Bait	Intentional release of live fish bait by anglers	Disposal of unused live bait in garbage	4.0	3.7	3.4	51.0
Live Bait	Dumping of bait bucket water in or near body of water	Dispose of bait water on land	3.3	3.7	3.4	42.2
Live Bait	Disposal of live worms and packaging on shorelines/in-water	Dispose of live bait/packaging in garbage	3.9	3.7	3.3	47.7
Live Bait	Use of invasive species as live bait (intentional and unintentional)	Purchase of only non/low-risk species	3.6	2.9	3.3	35.2
Live Bait	Sale of invasive species (intentional and unintentional)	Sell only non-invasive species	4.2	3.3	3.1	42.9
Live Bait	Sale of invasive species (intentional and unintentional)	Visually inspect bait stocks	3.8	2.9	4.1	45.5
Live Bait	Sale of invasive species (intentional and unintentional)	Conduct environmental DNA surveillance	2.7	1.8	4.1	19.9
Live Bait	Sale of invasive species (intentional and unintentional)	Return/dispose of invasive species	3.8	2.7	4.3	44.7
Live Bait	Sale of invasive species (intentional and unintentional)	Implement labelling practices	3.3	2.3	4.3	32.6
Live Bait	Contaminated bait packaging	Identify and remove contamination	3.0	2.1	3.8	23.8
Live Bait	Contaminated bait packaging	Switch to alternative packaging	2.6	1.9	3.5	17.0
Live Bait	Unintentional release through restocking programs	Follow best practices to control unwanted species	3.5	3.1	2.8	30.2

Retail Aquarium Trade

Similar to the plant trade, the aquarium trade was considered to be an important pathway. Like the plant trade, the highest ranked behaviors are related to not buying/selling high-risk species and disposing of them properly.

What to do with unwanted animal species is a bit of a vexing problem. While all three behaviors (euthanize and dispose of, take back to the retailer, and re-home) were considered to have a high impact, the uptake was not highly ranked. Although the Expert Panel felt that the market potential was high for people to return them to a retailer or to re-home them, there is no consideration of whether a retailer will take them back or if others want them. There are also several target audience sectors, from hobbyists to teachers conducting school science projects, so the barriers could be very diverse.



Table 6: Retail Aquarium Trade Scoring

Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Recognize and purchase of only non/low-risk species	4.2	3.0	4.2	52.7
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Dispose of unwanted plants in the garbage	4.2	3.6	3.6	54.2
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Euthanize and dispose of unwanted animals	4.0	2.5	3.6	36.0
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Return unwanted animals to pet stores	3.5	2.8	4.3	41.6
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Re-home unwanted species	3.0	3.0	4.1	36.9
Aquarium Trade	Unintentional release through aquarium and equipment cleaning	Dispose of cleaning water and fish waste on lawn or garden	2.8	3.0	2.8	23.1
Aquarium Trade	Unintentional escape from private ponds and water gardens	Follow design and installation best practices	3.0	2.7	3.5	28.0
Aquarium Trade	Unintentional escape from private ponds and water gardens	Follow maintenance best practices	3.0	2.8	3.5	29.2
Aquarium Trade	Sale of high-risk species in stores	Accurately identify and only sell non/low-risk species	4.2	3.2	3.8	50.9
Aquarium Trade	Sale of high-risk species in stores	Visually inspect products for contamination	3.4	3.0	3.9	39.4
Aquarium Trade	Sale of high-risk species in stores	Return/dispose of invasive species	3.9	3.1	3.7	44.8
Aquarium Trade	Sale of high-risk species online	Accurately identify and only sell non/low-risk species	4.0	2.7	4.1	44.3
Aquarium Trade	Sale of high-risk species online	Visually inspect products for contamination	3.3	2.8	4.0	36.7
Aquarium Trade	Sale of high-risk species online	Return/dispose of invasive species	3.9	2.5	3.9	38.1

Some General Observations

There are several interesting outcomes of the research that span all of the pathways and deserve attention.

1. Removing visible debris is highly ranked in all pathways where it was evaluated. It is consistently ranked as effective at preventing the spread (impact) and likely to be adopted (uptake), contributing to high rankings after the criteria are multiplied together. An effective yet easy behavior is a good candidate for a gateway behavior. That is, if people can be convinced to take the easy step of examining and removing visible material from any sort of equipment, it can be a stepping stone to getting them to take on more challenging behaviors. It is also easy for people to learn to look for and remove visible debris from anything that comes out of the water, from a dog to a piece of hunting equipment to research equipment to watercraft. It is an effective, universal behavior with few, if any, barriers.



Table 7: Scoring for behavior: Removing visible debris

Pathway	Source	Behaviors	Average Impac	Average Uptak	Average Marke	Product of Averages
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Remove visible debris	4.8	4.1	2.2	42.0
Recreational Watercraft	Attachment to and movement of non-motorized watercraft (canoes, kayaks, paddleboards)	Remove visible debris	4.4	4.2	1.9	35.3
Gear and Equipment	Attachment to and movement of fishing gear	Remove visible debris	4.0	4.3	2.4	41.1
Gear and Equipment	Attachment to and movement of SCUBA diving/snorkelling wetsuits and gear	Remove visible debris	3.8	4.5	2.3	39.9
Gear and Equipment	Attachment to and movement of docks, lifts, rafts, anchors, and associated equipment	Remove visible debris	4.3	3.7	3.0	47.7
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Remove visible debris	4.2	4.6	2.6	49.3
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Remove visible debris	3.8	4.0	3.0	45.3
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Remove visible debris	2.9	3.8	2.3	25.2
Pets	Attachment to pets	Remove visible debris	3.5	3.8	3.5	46.6

- Similarly, proper disposal often comes up as a highly ranked behavior in different pathways, including bait, retail plant trade, and aquarium trade. Apart from the challenges associated with asking people to dispose of live animals, disposal actions have few barriers and can similarly be pursued as gateways to more challenging behaviors.
- 3. Behaviors that are perceived to have barriers rank lower than those that do not, mostly because the uptake is considered to be low. However, the rankings do not reflect what the uptake might be if the barriers were removed. Convenient access to water, for instance, might increase uptake significantly. Low uptake numbers should be considered as a potential opportunity to identify and remove barriers to increase the number of people taking the desired action. They are an indication of a need to examine further, rather than an automatic rejection of the behavior.
- 4. Of the three criteria on which the Expert Panel members scored the behaviors, the market potential is likely the least accurate. This is because the members are from various parts of Canada and the USA, and many would have to make an educated guess about how many Minnesotans are, and aren't, already performing the behaviors. It does not mean that the numbers should be disregarded, but care should be taken in accepting them without scrutiny.
- 5. Some of the pathways comprise many different sectors. For example, the retail plant and aquarium trades include sellers, buyers, service providers, indoor aquariums, people with outdoor water gardens, etc. Watercraft users include people with paddle-boats, fishing boats, sailboats, Jon boats, runabouts, personal watercraft, wakeboard boats, pontoons, yachts, etc. Canoes, paddleboards, and kayaks can be launched and taken out of the water from any accessible shoreline, where larger boats are mostly limited to public and private water accesses and marinas. The barriers to adopting behaviors are different for various sectors, and are better determined through the literature review done for this project and through barrier research.



6. It is likely that some of the sectors or target audiences span several pathways. For instance, anglers with watercraft have boats they should be cleaning, bait to source and dispose of properly, and equipment to clean.

4. Recommendations and Next Steps

The following recommendations have been informed through analysis of the Expert Panel behavior rankings, the literature review, and discussions amongst the Project Team. They are organized by pathway.

These recommendations are associated with the next step in the Community-Based Social Marketing project, which is to conduct barrier and benefits research.

This work considers several important AIS pathways, each with its own set of multiple behaviors. Each of those behaviors has their own barriers and benefits. Conducting surveys on each behavior in each sector is prohibitively expensive and time-consuming.

Barrier and benefits research must be conducted strategically and efficiently. There is an opportunity to conduct surveys on multiple behaviors/sectors/pathways, but at the same time surveys with a narrower focus will draw more insights on very specific barriers and benefits and result in more refined CBSM behavior change strategies. Some of the pathways and behaviors have also been studied in other jurisdictions. Those studies provide insight, but not local knowledge. The Project Team will discuss and decide on how to best strike a balance with the barrier and benefit research with limited resources given the following recommendations.

Pathways Recommended for Barriers and Benefits Research

Minnesota would benefit most by conducting additional research on these pathways. They are not listed in any particular order.

Retail Plant Trade

The top scoring behaviors for retail plant trade focus on both sellers and buyers. Sellers include growers, retailers, and lawn care service providers. Buyers include pond and water garden enthusiasts. Additionally, there may be non-retail trade of invasive plant species through clubs and sharing amongst friends.

A better understanding of the challenges associated with this pathway and the different sectors could be accomplished with barriers and benefits research.

A survey of retailers and consumers is recommended to determine:



- Knowledge and attitudes towards AIS and the risks they present
- Levels of concern about the spread of AIS
- Barriers and benefits to the following behaviors:
 - o Identifying and not selling/buying AIS
 - Recognition, removal, and disposal of AIS plants in the garbage (and not in the wild or in compost)
 - Proper management of ponds to manage an escape

The surveys should be conducted through industry associations and clubs willing to assist in the research. Some outreach will be required to bring groups on board, but there are benefits to engaging with them on the research as they may be willing to assist in measures to promote behaviors and disrupt the pathway. Separate surveys and qualitative research would be needed for the industry audience and the consumer audience because their awareness, behaviors, and activities very different.

Aquarium Trade

Similar to the retail plant trade, the top-ranking behaviors relate to not selling/buying high-risk species and disposing of them properly. Target audiences are aquarium enthusiasts and aquarium retailers (both in-store and online). Online aquarium trade presents challenges in targeting international sellers.

There appears to be significant market potential for controlling AIS amongst consumers and retailers, according to research done in Minnesota. The industry is regulated, but research has demonstrated that online orders of aquatic plants can include invasive species, whether or not an invasive species were ordered. This may be reflected in the Expert Panel estimating uptake potential as being relatively low.

The aquarium trade should be advanced for barrier and benefits research. A survey of aquarium enthusiasts should be conducted through aquarium societies to understand awareness levels and barriers and benefits associated with the preferred behaviors.

A survey of retailers should be conducted through industry associations to understand perspectives, barriers, and benefits to preferred behaviors. There could be an opportunity to reach consumers through retailers as well (e.g. retailers inviting their customers to complete a survey). Separate surveys and qualitative research would be needed for the industry audience and the consumer audience because their awareness, behaviors, and activities very different.

Efficiencies could be realized by combining the retail plant surveys and the aquarium surveys as they are likely very similar.



Equipment (Docks, Lifts, Rafts, Anchors, etc.)

There are two target audiences associated with these behaviors – Lake Service Providers (LSP) and shore property owners. The Expert Panel ranked all behaviors highly: remove visible debris, high-pressure wash, and air dry for 21 days. A survey of the two target audiences should be conducted to determine barriers and benefits for both target audiences, as well as current knowledge level of AIS and the risks they present, particularly as they relate to the movement of equipment. Separate surveys of LSPs and shore property owners is needed because their awareness, behaviors, and activities very different.

Online survey links could be distributed to LSP's through the registration records, and to property owners through appropriate associations. The surveys would be likely very similar, but branching could provide an opportunity to ask questions more specific to each of the target audiences.

Live Bait

Two elements of fishing were examined by the Expert Panel – bait management and gear – as separate pathways (watercraft is also associated with this sector).

There are two audiences for anglers and bait retailers, and the behaviors related to bait were ranked high for each of the audiences. Gear behaviors for those audiences were ranked quite low, except for removal of visible debris. This was partially because cleaning gear was considered difficult with low take up, but important for stopping the spread of spiny waterflea.

A survey of anglers should be conducted through the licensing program to determine awareness, attitude, barriers, benefits, present activities, best communications channels, etc. for bait management. A survey would help fill a gap in available information.

There may be an opportunity to also ask some questions about watercraft inspection in the survey. Because anglers represent a large part of the boating community, some important information could be gathered about watercraft behaviors by including relevant questions in the angler survey.

Recommended for Partial Barrier and Benefits Research

The following pathway is recommended for some research in order to supplement the available data from research conducted in Minnesota and in other jurisdictions.

Recreational Watercraft

There are two target audiences associated with watercraft: users of motorized watercraft, and users of non-motorized watercraft.



Recreational watercraft is an important pathway with the potential to significantly spread AIS. As a result, the pathway has been targeted by Minnesota DNR, with a mature and comprehensive program that includes regulations and inspections, decontamination stations and an effective communications program. In fact, behaviors related to the pathway were not ranked overall as high as others because the potential market component of the calculation was rated relatively low. This is likely because many Minnesotans are already taking proper behaviors. Nonetheless, the Expert Panel ranked the impact of the watercraft pathway behaviors very high, reflecting the level of risk associated with having so many watercraft as potential transporters of AIS.

While there has been a lot of local CBSM research over the past 15 years, it would be advantageous to get a more current assessment of behaviors, barriers, and benefits. This could be done by reviewing existing studies and not necessarily conducting new barrier and benefit research on this sector.

Not Recommended for Barrier and Benefits Research

Four pathways: Hunting, Diving, Equipment, and Pets, are not recommended for barrier and benefit research. However, it is still important to engage these groups about AIS and the behaviors they can adopt to prevent the spread. For all of these behaviors, a layer of CBSM could be added to the promotion of Best Management Practices.

Other than removing visible debris, the behaviors ranked relatively low in all four pathways.

Best Management Practices for waterfowl hunting that include cleaning gear already exist. There is an opportunity to engage hunters through licensing and encourage adoption of best practices.

Diving could also be addressed through diver certification associations, and adoption of Best Management Practices could be promoted using principles of CBSM.

Pets were added as a pathway at the suggestion of the Expert Panel. Little research is available on pets and the spread of AIS. However it is believed that there is an opportunity for pets to carry AIS in their fur, and it is addressed in terrestrial invasive species programs.

There is a reference to checking pets in the terrestrial invasive species educational materials; targeting the specific pet-related behavior may fit better with that program.

The research equipment sector includes anyone using equipment for research, including sampling, control, etc. There are Best Management Practices available for the maintenance of AIS research equipment, and they include cleaning, drying, and quarantining equipment.



Next Steps

The DNR will use these recommendations to determine which topics to pursue barrier and benefit research (CBSM Step 2) in the first half of 2019. With limited resources, not all topics of concern will be addressed as part of this project. However, recommendations listed here that are not pursued during this project could be pursued in the future by the DNR and/or other interested organizations as resources and funds become available. Whenever possible, efforts should be coordinated to ensure consistent and efficient behavior change research and strategies related to AIS prevention are employed throughout Minnesota.



Appendix A – Expert Panel Resource Guide



DEPARTMENT OF NATURAL RESOURCES

Minnesota Department of Natural Resources Aquatic Invasive Species Community-Based Social Marketing Project



Jay Cooke State Park. (Courtesy of the Minnesota DNR via mprnews.org)

Expert Panel Resource Guide

November 2018





This document is part of the Minnesota Department of Natural Resources (DNR) Invasive Species Program's Community-Based Social Marketing (CBSM) project. The project aims to better promote the adoption of desirable aquatic invasive species (AIS) prevention behaviors and create positive social norms around AIS prevention in Minnesota.

Tina Wolbers

Minnesota DNR Project Manager tina.wolbers@state.mn.us 651-259-5146

Ken Donnelly Consultant Team Lead ken@beyondattitude.com 902-223-6123



1. Introduction

About the Project

The Minnesota Department of Natural Resources (DNR) delivers the Invasive Species Program with the goals of preventing introductions of new invasive species into Minnesota, preventing the spread of invasive species within Minnesota, and reducing the impacts caused by invasive species to Minnesota's environment, society, and economy.

In August 2018, AZENTIVE, LLC and Beyond Attitude Consulting were awarded a contract to deliver the Aquatic Invasive Species (AIS) Community-Based Social Marketing (CBSM) project for the DNR. The purpose of the project is to apply behavioral psychology techniques to address the human behaviors that contribute to the introduction and spread of AIS in Minnesota waters.

The project is being delivered in two phases: The first phase is focused on the identification and prioritization of target behaviors to most effectively manage AIS in Minnesota and identifying the barriers and benefits to one or more of those target behaviors. The second phase will focus on the development of strategies to foster target behaviors and implementation and evaluation of those strategies. The DNR will use the results to promote the adoption of desirable AIS prevention behaviors and create positive social norms around AIS prevention.

Role of the Expert Panel

The Expert Panel is a group of experienced professionals who bring the most current thinking on AIS and provide a diversity of perspectives that are grounded in real life experiences to the project. The Panel will collaborate with the project team to define and assess behaviors to target and provide advice and recommendations in response to quantitative research being undertaken.

Purpose of the Resource Guide

This Resource Guide provides the Panel members with the introductory, background, and guidance materials to effectively contribute to the first Expert Panel meeting. It provides an introduction to the project, summarizes key outcomes of work completed to-date, and contains an exercise to assess potential target behaviors. A primer on CBSM is also included as Appendix A.

If you have any questions about the project or the work of the Expert Panel, please contact:

Jeff Garkowski, Lead Researcher jeffrey.garkowski@gmail.com 416-895-3632



2. Identifying Desired Behaviors

Overview

Developing an effective behavior change program begins with selecting the right behavior(s) and right audience to target. To better understand the pathways of AIS introduction and spread, a scan of the literature was completed, followed by contextualizing general findings relevant to Minnesota with the input of the Minnesota DNR team and the Expert Panel.

Literature Scan

A scan of available literature was conducted to gather information from published sources to identify research on aquatic invasive species, particularly behavior-change approaches. The purpose of the scan was to explore the anthropogenic sources of AIS relevant to Minnesota; the key pathways that could contribute to the spread of invasive species, the range of potential target audiences, and interventions undertaken locally and elsewhere.

The project team scanned 150+ published academic and grey literature, case studies, and technical reports, and summarized the 93 most relevant sources as a means to determine the most important AIS Pathways that could be addressed by a CBSM effort in Minnesota. For the purposes of this work, pathways refer to the mode of transport for an AIS to spread and sector refers to the group or audience that contributes to the spread of AIS via a pathway. Pathways may have more than one sector that can contribute to the spread.

Findings from the literature scan indicate that the majority of research on anthropogenic pathways for the introduction and spread of AIS relevant to Minnesota (i.e., excluding major global pathways such as shipping and canal building) can be grouped into five primary pathways. Below are the five primary pathways identified, including a brief description and notable findings from the scan.

Recreational Watercraft

Numerous research studies indicate that recreational boating is a major pathway for the spread of AIS. This pathway can generally be categorized into overland transport and waterway-based movement. Within this pathway, there are a number of sub-paths including hull fouling, bilge water, live wells, trailers, and other standing water.

Notable findings from the literature scan include:

- Some research documents the spread of AIS on smaller boats and non-motorized watercraft that are more likely to be moved between multiple lakes (e.g., canoes, kayaks).
- Research has also looked at boating activities contributing to the spread of AIS between connected waterways and frequent draining of standing water to prevent spread.



- There is significant research on target behaviors related to this pathway (surveys, interviews, etc.).
- Behaviors related to boaters may also be relevant to activities of lake service providers, such as movement and storage of boats and other equipment.

Live Bait

Research shows the main pathways are the release of live bait, bait water release, contaminated bait, and packaging for worms. Pathways associated with live bait can be categorized into angler activity (primarily recreational) and commercial trade. Audiences include anglers, bait shops, dealers, and harvesters.

Notable findings from the literature scan include:

- There is significant research on target behaviors related to this pathway.
- Some research has also identified disposal of worms on shorelines contributing to the spread of AIS.
- Angler equipment is also a sub-path, offering the opportunity to address anglers with bait and boating behaviors together.

Gear and Equipment

Across many of the sectors reviewed in the literature, a common pathway for the spread of AIS is through various gear and equipment. Sectors include hunters, anglers, divers, lake service providers, researchers/academics, and other recreationalists. The common element is that AIS may attach to gear and equipment and transport from one area to another, either overland or within bodies of water.

Notable findings from the literature scan include:

- Gear and equipment is often a sub-path associated with an audience that is also a high risk of spreading AIS through other pathways.
- Common behavioral approaches related to gear and equipment is the need to diligently inspect and clean equipment.

Docks/Lifts/Rafts and Associated Equipment

Minnesota is a leader in addressing equipment such as docks, lifts, and rafts as a pathway. The Lake Service Provider program addresses this through a certification program for people who work with shoreline equipment.

There is little research available on this type of equipment as a pathway or Lake Service Providers as a sector. Nonetheless, it is intuitively obvious that equipment situated in a lake can potentially harbor invasive species, and moving the equipment can move the species as well. Although there is little information available on behaviors, we can learn more by speaking with service providers and studying similarities with behaviors for watercraft owners.



Aquarium Trade

The aquarium trade is one of the top pathways for AIS identified globally. Research documented AIS being sold in a large number of stores in numerous jurisdictions in the Great Lakes region, including Minnesota. This pathway would include addressing behaviors for aquarium shop owners/workers and consumers' decision-making and purchases.

Notable findings from the literature scan include:

- Industry regulation poses a challenge for addressing this pathway.
- Limited research is available on behaviors related to managing the spread of AIS through the aquarium trade.
- Most research related to aquarium industry related behaviors seems to focus on education (shops, consumers) and labeling.

Retail Plant Trade

Research documented AIS plants are readily sold in stores and available for purchase online, as well as other issues such as the mislabeling of plants. The live plant trade includes aquarium plants and water garden or ornamental plants. Limited research is available on behaviors associated with preventing the spread of invasive aquatic plants through the aquarium and live plant trade.

The project team acknowledges that there may be gaps in this list since literature may not exist or may not be readily available for some potential pathways and sectors at this time. The absence of literature does not necessarily mean that a pathway or sector does not present a substantial risk.

List of Potential Behaviors

Based on the literature scan, insights from the DNR team, and project team experience, a list of potential desirable AIS prevention behaviors have been identified (please see accompanying Excel file *Minnesota AIS Expert Panel Behavior Worksheet*).

The list includes behaviors that are organized into one of the five pathways that emerged from the literature review. In some cases, there are several behaviors that can be taken to accomplish the same outcome; however, each may have its own set of barriers and benefits (i.e., some may be easier to do than others).

The purpose of the long list of behaviors is to systematically outline the AIS pathway, which sector contributes to this pathway and how, and identify what needs to be done to eliminate or minimize the risk of AIS introduction or spread. This list of behaviors is the basis for conducting an assessment of which behaviors to target through CBSM. Developing an effective behavior change program begins with selecting the right behavior(s) and right audience to target.



Expert Panel Task 1 of 2 – Reviewing Behaviors

In advance of the Expert Panel meeting in November, please review the list of behaviors to familiarize yourself with them and complete preliminary scoring (see Task 2 below). During the meeting, Panel members will have an opportunity to seek clarity on any of the behaviors and discuss them further.

Consideration/Discussion Questions:

- 1. Are there other known sources related to each pathway?
- 2. Do the behaviors adequately capture what is needed to occur?
- 3. Are there any additional behaviors that should be considered?
- 4. Are there any behaviors that should be removed from consideration?

The outcome of this task will be a list of behaviors that captures all steps that are needed to prevent the spread of AIS for each pathway. The next step will be to assess each behavior, as explained in Section 3.

3. Assessing Potential Behaviors

Probability-Impact-Penetration Analysis

Building on the literature scan, research conducted, Expert Panel input, and the project team expertise, a Probability-Impact-Penetration Analysis will be conducted to help identify top behaviors to target for each target audience. This analysis is a CBSM tool that explores a range of possible behaviors and assesses the impact each would have on preventing the spread of AIS, the likelihood that the target audience would engage in the behavior, and the market potential for the behavior change.

Expert Panel Task 2 of 2 – Assessing Behaviors

Expert Panel members are requested to review the list of behaviors and complete a Probability-Impact-Penetration scoring exercise using the accompanying Excel worksheet.

Instructions to Complete Scoring Exercise:

- 1. Review the list of behaviors to familiarize yourself with them.
- 2. For each behavior consider how impactful it would be in terms of preventing the introduction and/or spread of AIS in Minnesota waters. Provide a score from 1 to 5 in the "Impact" column, where 1 is no or minimal impact and 5 is a large impact.
- 3. For each behavior consider how likely someone would be to adopt it. Provide a score from 1 to 5 in the "Probability of Uptake" column, where 1 is unlikely and 5 is very likely.



- 4. For each behavior consider the level of market penetration or how many people are already doing it. Provide a score from 1 to 5 in the "Market Penetration" column, where 1 is low market potential (many people already to it) and 5 is high market potential (very few people already do it).
- 5. Add notes, if applicable. For instance, if you have additional comments about a particular behavior or would like to indicate the basis of your scoring.

NOTE: If you feel that you DO NOT have significant knowledge of a particular pathway or behavior and feel uncomfortable providing a score, please indicate this in the notes column and do not provide a score.

Completion of the scoring exercise is a multi-step process:

- **1. In advance of the Expert Panel meeting:** Review the list of behaviors provided in the Excel worksheet and complete the preliminary scoring of each behavior. This will be helpful in preparing for the meeting discussion.
- 2. During/after the Expert Panel meeting: Following the completion of Expert Panel Task 1 (clarity, review, and confirmation of the behaviors), please make any updates to your scoring to reflect your understanding of each behavior. Discussion during the Expert Panel meeting may help inform your scoring. An updated scoring sheet may need to be distributed to Expert Panel members to reflect any significant changes to the behavior list resulting from Task 1.
- **3. After the Expert Panel meeting:** Once your final scoring is complete, please submit your completed worksheet to the project team via email.

The outcome of this task will be individual assessments of each behavior. All Expert Panel member scorings will be compiled and aggregate scores will be used to assess the behaviors.

4. Conclusion

Outcomes of Expert Panel Engagement

Through engagement of the Expert Panel, a broad range of knowledge and perspectives will be brought to the identification and assessment of desired behaviors to help control the spread of aquatic invasive species. Final assessment of the behaviors will help prioritize where to focus efforts as the project advances.

Next Steps

In the winter of 2019 primary survey research will be carried out amongst the target audiences related to the prioritized behaviors stemming from the Expert Panel work. The purpose of the surveying will be to build an understanding of the barriers and benefits to the target behaviors in the Minnesota context.



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Retail Plant Trade	Planting of high-risk plants (intentional or unintentional)	Accurately identify and only sell non/low-risk species (retailers)	4.4	3.0	4.3	56.3
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Dispose of unwanted plants in the garbage	4.2	3.6	3.6	54.2
Gear and Equipment	Attachment to and movement of docks, lifts, rafts, anchors, and associated equipment	Air dry for at least 21 days	4.1	3.7	3.6	53.6
Retail Plant Trade	Unintentional escape from private ponds and water gardens	Recognize and install only non/low- risk species	4.2	3.0	4.2	53.0
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Recognize and purchase of only non/low-risk species	4.2	3.0	4.2	52.7
Retail Plant Trade	Planting of high-risk plants (intentional or unintentional)	Recognize and purchase of only non/low-risk species (individuals and service providers)	4.2	3.0	4.2	52.3
Retail Plant Trade	Intentional dumping of unwanted high- risk plants	Identify high risk species and dispose of in garbage	4.2	3.4	3.7	52.2
Live Bait	Intentional release of live fish bait by anglers	Disposal of unused live bait in garbage	4.0	3.7	3.4	51.0



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Aquarium Trade	Sale of high-risk species in stores	Accurately identify and only sell non/low-risk species	4.2	3.2	3.8	50.9
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Remove visible debris	4.2	4.6	2.6	49.3
Live Bait	Disposal of live worms and packaging on shorelines/in-water	Dispose of live bait/packaging in garbage	3.9	3.7	3.3	47.7
Gear and Equipment	Attachment to and movement of docks, lifts, rafts, anchors, and associated equipment	Remove visible debris	4.3	3.7	3.0	47.7
Pets	Attachment to pets	Remove visible debris	3.5	3.8	3.5	46.6
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Drain balast tanks	4.2	3.1	3.6	46.0
Live Bait	Sale of invasive species (intentional and unintentional)	Visually inspect bait stocks	3.8	2.9	4.1	45.5
Retail Plant Trade	Planting of high-risk plants (intentional or unintentional)	Check purchases and recognize invasive species/unwanted hitchhikers and dispose of in garbage	3.8	2.9	4.1	45.4
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Remove visible debris	3.8	4.0	3.0	45.3
Aquarium Trade	Sale of high-risk species in stores	Return/dispose of invasive species	3.9	3.1	3.7	44.8
Live Bait	Sale of invasive species (intentional and unintentional)	Return/dispose of invasive species	3.8	2.7	4.3	44.7
Aquarium Trade	Sale of high-risk species online	Accurately identify and only sell non/low-risk species	4.0	2.7	4.1	44.3



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Gear and Equipment	Attachment to and movement of docks, lifts, rafts, anchors, and associated equipment	Wash with high pressure	4.0	3.0	3.7	44.0
Live Bait	Sale of invasive species (intentional and unintentional)	Sell only non- invasive species	4.2	3.3	3.1	42.9
Live Bait	Dumping of bait bucket water in or near body of water	Dispose of bait water on land	3.3	3.7	3.4	42.2
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Remove visible debris	4.8	4.1	2.2	42.0
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Return unwanted animals to pet stores	3.5	2.8	4.3	41.6
Gear and Equipment	Attachment to and movement of fishing gear	Remove visible debris	4.0	4.3	2.4	41.1
Retail Plant Trade	Unintentional escape from private ponds and water gardens	Follow design and installation best practices (distance from natural waterways/flood areas, closed system, planting in containers, etc.)	3.5	2.8	4.1	41.0
Gear and Equipment	Attachment to and movement of SCUBA diving/snorkelling wetsuits and gear	Remove visible debris	3.8	4.5	2.3	39.9



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Aquarium Trade	Sale of high-risk species in stores	Visually inspect products for contamination	3.4	3.0	3.9	39.4
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Air dry for at least 5 days	3.6	3.5	3.1	39.2
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Drain water from water containing devices	3.3	4.3	2.7	38.5
Aquarium Trade	Sale of high-risk species online	Return/dispose of invasive species	3.9	2.5	3.9	38.1
Retail Plant Trade	Unintentional escape from private ponds and water gardens	Follow maintenance best practices	3.5	2.8	3.9	37.7
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Rinse with cold water	3.4	2.8	3.8	37.1
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Re-home unwanted species	3.0	3.0	4.1	36.9
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Inspect boat and trailer	4.1	4.5	2.0	36.8



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Gear and Equipment	Attachment to and movement of SCUBA diving/snorkelling wetsuits and gear	Drain water from water containing devices (buoyancy compensator, regulator, cylinder, boot, etc.)	3.3	4.0	2.8	36.7
Aquarium Trade	Sale of high-risk species online	Visually inspect products for contamination	3.3	2.8	4.0	36.7
Aquarium Trade	Release of unwanted aquatic and terrestrial species (enthusiasts, school science programs, classroom aquariums)	Euthanize and dispose of unwanted animals	4.0	2.5	3.6	36.0
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Tip/drain motor	3.7	3.2	3.1	35.9
Recreational Watercraft	Attachment to and movement of non- motorized watercraft (canoes, kayaks, paddleboards)	Remove visible debris	4.4	4.2	1.9	35.3
Live Bait	Use of invasive species as live bait (intentional and unintentional)	Purchase of only non/low-risk species	3.6	2.9	3.3	35.2
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Drain bilge	4.0	3.8	2.3	34.4
Recreational Watercraft	Attachment to and movement of non- motorized watercraft (canoes, kayaks, paddleboards)	Rinse with cold water	3.4	3.1	3.3	34.2
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Rinse with hot water	3.8	2.3	3.9	33.8



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Rinse gear and footwear with cold water	3.2	3.1	3.4	33.5
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Rinse inside and outside of gear with hot water	3.2	3.1	3.4	33.4
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Drain live well	3.9	3.5	2.4	33.1
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Run motor for 5-10 seconds to blow out excess water	3.3	2.8	3.5	33.1
Recreational Watercraft	Contaminated water captured on/in non- motorized watercraft (canoes, kayaks, paddleboards)	Tip/drain watercraft	3.5	4.3	2.2	32.6
Live Bait	Sale of invasive species (intentional and unintentional)	Implement labelling practices	3.3	2.3	4.3	32.6
Gear and Equipment	Attachment to and movement of research equipment, gear, clothing, footwear	Rinse inside and outside of gear with cold water	2.8	3.8	3.0	32.4
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Wash waders and clothing	3.2	3.2	3.1	32.0
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Air dry for at least 5 days	3.7	2.6	3.3	30.8



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Live Bait	Unintentional release through restocking programs	Follow best practices to control unwanted species	3.5	3.1	2.8	30.2
Aquarium Trade	Unintentional escape from private ponds and water gardens	Follow maintenance best practices	3.0	2.8	3.5	29.2
Gear and Equipment	Attachment to and movement of SCUBA diving/snorkelling wetsuits and gear	Rinse inside and outside of gear with cold water	2.7	3.6	2.9	28.1
Aquarium Trade	Unintentional escape from private ponds and water gardens	Follow design and installation best practices	3.0	2.7	3.5	28.0
Gear and Equipment	Attachment to and movement of fishing gear	Air dry for at least 5 days	3.2	3.1	2.8	27.7
Gear and Equipment	Attachment to and movement of SCUBA diving/snorkelling wetsuits and gear	Air dry for at least 5 days	3.0	3.3	2.8	27.5
Recreational Watercraft	Attachment to and movement of motorized watercraft, boat equipment (including lifejackets, anchor ropes, etc.), trailers	Wash with high pressure	3.9	2.0	3.4	26.8
Recreational Watercraft	Attachment to and movement of non- motorized watercraft (canoes, kayaks, paddleboards)	Air dry for at least 5 days	3.3	3.2	2.4	25.5
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Rinse gear and footwear with hot water	3.1	2.3	3.5	25.3
Gear and Equipment	Attachment to and movement of waterfowl hunting gear, decoys, clothing, footwear	Air dry for at least 5 days	2.8	2.9	3.1	25.3



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Recreational Watercraft	Contaminated water captured on/in motorized watercraft	Dry live well	3.3	2.8	2.7	25.2
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Remove visible debris	2.9	3.8	2.3	25.2
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Wash clothing in wash machine	3.0	3.6	2.3	24.8
Live Bait	Contaminated bait packaging	Identify and remove contamination	3.0	2.1	3.8	23.8
Recreational Watercraft	Attachment to and movement of non- motorized watercraft (canoes, kayaks, paddleboards)	Wash with high pressure	3.3	2.0	3.6	23.3
Aquarium Trade	Unintentional release through aquarium and equipment cleaning	Dispose of cleaning water and fish waste on lawn or garden	2.8	3.0	2.8	23.1
Recreational Watercraft	Attachment to and movement of non- motorized watercraft (canoes, kayaks, paddleboards)	Rinse with hot water	3.3	2.2	3.2	22.9
Gear and Equipment	Attachment to and movement of fishing gear	Rinse gear with cold water	2.9	2.7	2.9	22.6
Pets	Attachment to pets	Wash pets	2.5	2.6	3.3	21.3
Gear and Equipment	Attachment to and movement of fishing gear	Rinse gear with hot water	3.0	2.0	3.5	20.7
Live Bait	Sale of invasive species (intentional and unintentional)	Conduct environmental DNA surveillance	2.7	1.8	4.1	19.9
Gear and Equipment	Attachment to and movement of fishing gear	Wash waders and clothing	2.7	2.5	2.7	18.2
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Rinse gear and footwear with cold water	2.1	2.8	3.0	17.2



Pathway	Source	Behaviors	Average Impact	Average Uptake	Average Market	Product of Averages
Live Bait	Contaminated bait packaging	Switch to alternative packaging	2.6	1.9	3.5	17.0
Gear and Equipment	Attachment to and movement of hiking gear, clothing, footwear	Rinse gear and footwear with hot water	2.4	2.0	3.4	16.4
Gear and Equipment	Attachment to and movement of SCUBA diving/snorkelling wetsuits and gear	Rinse inside and outside of gear with hot water	2.4	1.9	3.1	14.2

