Potential adverse effects and management of Silver & Bighead carp in Minnesota: Findings from focus groups

A working paper for the Minnesota Department of Natural Resources produced by the Minnesota Aquatic Invasive Species Research Center

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1. Executive Summary

Silver, Bighead, Grass, and Black (SBGB) carp, often referred to as "Asian carp", are invasive species that have garnered much recent attention in Minnesota because of their advancing invasion front and concerns over their potential impacts in Minnesota. As SBGB carp advance, there is a need for research to inform a statewide risk assessment for, and management of, SBGB carp. To contribute to this, we conducted five focus groups with Minnesota Department of Natural Resources (MN-DNR) officials and stakeholders involved with SBGB carp. These focus groups were used to: 1) create a list of potential adverse effects that could result from the establishment of silver and bighead carp in Minnesota – a list that will help inform a risk assessment on silver and bighead carp in Minnesota; and 2) better understand the views that exist concerning what could and should be done to manage SBGB carp, including where improvements in existing management efforts are needed.

An essential first step of a risk assessment is gathering an inclusive and robust list of potential adverse effects. In this case, that involves the potential harms that could result from the establishment of silver and bighead carp in Minnesota. To ensure the list of potential adverse effects was complete and legitimate, we included a diverse set of MN-DNR officials and stakeholders within the focus groups. The adverse effects collected in these focus groups were associated with 26 valued and potentially affected entities that were grouped into 9 categories: Native fish species; Plankton/Cyanobacteria; Other aquatic organisms; Birds and other animals; Ecosystems; Diseases/Parasites/Pathogens; Commercial fishing/Commercial bait/Commercial aquaculture/Commercial transportation; Tourism/Recreation; and Public perception and relationship to water resources. Representing the first time that a diverse set of agency officials and stakeholders have systematically developed such a list of potential adverse effects, these findings provide a solid foundation for a subsequent statewide risk assessment.

During these focus groups, participants also discussed the management of SBGB carp in Minnesota. MN-DNR participants identified the following potential management options for SBGB carp: barriers/deterrents, rules and enforcement, habitat improvement, monitoring,

managing native fish, commercial fishing, biological control, water level drawdown for winter kill on shallow lakes, and chemical control. Stakeholder participants emphasized the following actions when discussing what should be done to manage SBGB carp: barriers/deterrents, enforcement and education, monitoring, biological control, commercial fishing, and laws and statutes. MN-DNR participants also identified the need to address research and information gaps and the need for a holistic approach to SBGB carp management. In discussing who should be involved with management efforts, MN-DNR participants largely identified a list of agencies, institutions and groups that should be involved, while stakeholder participants focused on the need for better leadership, communication, and coordination. In addition to providing insights on the existing views of SBGB management, these results will be used to inform subsequent in-depth interviews on the management of SBGB in Minnesota.

2. Introduction

Silver, Bighead, Grass, and Black (SBGB) carp, often referred to as "Asian carp", are invasive species that have garnered much recent attention in Minnesota because of their advancing invasion front and concerns over their potential impacts in Minnesota. In 2014, one bighead and two silver carps were captured in Pool 2 of the Mississippi River, the furthest upstream the Mississippi river that individual silver and bighead carp have been found. As SBGB carp advance, there is a need for further research to study and help inform the risk assessment and management of SBGB carp in Minnesota.

The findings presented here are the result of five focus groups conducted with Minnesota Department of Natural Resources (MN-DNR) officials and stakeholders involved with SBGB carp. The goals of this research were twofold: 1) to create a list of potential adverse effects that could result from the establishment of silver and bighead carp in Minnesota – a list that will help inform a risk assessment on silver and bighead carp in Minnesota; and 2) to better understand the views that exist concerning what could and should be done to manage SBGB carp, including where improvements in existing management efforts are needed. Silver and bighead carp were chosen as the focus for the list of potential adverse effects because they

pose the most imminent threat for Minnesota. Black carp are still restricted to the southern United States and grass carp have occurred in Minnesota and the region for many decades without causing the level of concern surrounding silver and bighead carp. Yet because SBGB carp species may potentially cause many of the same adverse effects, the insights from this list can have broader relevance than just for silver and bighead carp.

To approach decision making concerning SBGB carp using a risk assessment-based approach, an important first step is to identify the potential harms, whether ecological, economic, or social, that may be caused by the stressor in question (in this case silver and bighead carp).[1,2] Such an approach helps ensure that management is informed by a sound assessment of potential risk instead of the mere novelty or fear of a species or of inconsequential change. In addition, it can help ensure that all potential harms are explicitly considered within the assessment of an invasive species. In the realm of risk assessment, identifying potential adverse effects – changes that are considered undesirable because they alter valued characteristics of ecosystems or their components – is an essential step in the problem formulation phase of risk assessment, after which the analysis phase of a risk assessment can take place to quantify and rank the importance of each of the potential harms. Because what constitutes an adverse effect is partially a values-based judgment, it is important to engage a diversity of officials and stakeholders to identify them – as completed in this research. The list of potential adverse effects presented in this document will help inform a subsequent risk assessment of silver and bighead carp in Minnesota and will be useful for reflecting upon existing decision making and discussions concerning SBGB carp.

Invasive species management is often a site of conflict, which takes a form that is largely influenced by the specific context.[3] Studying a diversity of views of existing management efforts can help bring attention to tensions and can help achieve more effective management.

[1] Anderson, M., Adams, H., Hope, B., and M. Powell. 2004. "Risk Assessment for Invasive Species." *Risk Analysis 24*(4): 787-793.
[2] US Environmental Protection Agency. 1998. *Guidelines for Ecological Risk Assessment.* Washington, D.C.
[3] Estevez, R.A., Anderson C.B., Pizarro, J.C., and M.A. Burgman. (2014). "Clarifying values, risk perceptions, and attitudes to resolve or avoid social conflicts in invasive species management." *Conservation Biology 29*(1): 19-30.

Understanding the aspects of management that are largely agreed upon as beneficial can help identify practices and activities on which to build further collaboration and construct a climate of cooperation. The focus groups also explored participant views of existing management efforts, which will be used to inform subsequent in-depth interviews on the management of SBGB in Minnesota.

3. Methodology

Participants

Five focus groups were conducted with two different groups of people: officials from the MN-DNR and stakeholders involved with SBGB carp. Two focus groups were held with program and field staff at the MN-DNR who had experience working with SBGB carp and related issues (e.g., area fishery managers, program managers, field biologists). An additional focus group was held with MN-DNR regional fisheries managers or assistant regional managers from the MN-DNR's four regions. Finally, two focus groups were held with stakeholders who have been active with the issues surrounding SBGB carp. Each focus group lasted approximately 1.5 hours and a total of 20 people took part in the five focus groups. The focus groups took place by conference call and also used the online platform WebEx to allow all participants to view the same working document in real time. The focus groups were conducted between December 2014 and February 2015.

Participants from the MN-DNR were selected using input from MN-DNR staff knowledgeable of who within the agency was working on SBGB-related issues. Stakeholder participants were identified from conversations with individuals who had been extensively involved with SBGB carp in Minnesota and from observations of key stakeholder meetings, such as the Invasive Carp Forum, that took place on December 15th, 2014. Stakeholders were selected based upon their interest in and experience with SBGB carp. The sampling provided a diversity of individuals who had been actively thinking about and working on the issues surrounding SBGB carp.

Topic #1: List of Potential Adverse Effects

The first goal of these focus groups was to create a list of potential adverse effects that may result from the establishment of silver and bighead carp in Minnesota. Drawing upon established guidelines for ecological risk assessment[2], we defined adverse effects as "changes that are considered undesirable because they alter valued characteristics of ecosystems or their components." Each potential adverse effect specifies an entity (e.g., species, ecosystem, tourism, etc.), an attribute of that entity (e.g., population size, species richness, sedimentation rate, revenue etc.), and a direction of change in that attribute that is judged to be detrimental. An example of a potential adverse effect, then, is a *walleye* (entity) *population size* (attribute) *decrease* (direction of change). We included within this definition undesirable changes that are ecological, economic, or social – any potential consequence from the establishment of silver and bighead carp in Minnesota.

These focus groups did not estimate the likelihood of these adverse effects occurring or the severity of these adverse effects, and did not quantify or rank them. These questions will be taken up in subsequent parts of this project. The aim was to create as complete a list as possible of the potential adverse effects. To help better describe and understand the significance of these potential adverse effects, we also asked focus group participants to state the potential cause and importance of each adverse effect. The causes were listed to help clarify the potential adverse effects, not to try to gather all possible ways that the adverse effects could be arrived at. Finally, although we focused on silver and bighead carp, we also asked participants to identify when grass or black carp were notably relevant for a particular adverse effect.

The data on potential adverse effects was garnered in three steps. First, in advance of the focus groups, participants were asked to provide three potential adverse effects by email. These potential adverse effects were combined and used to form the initial entries on the list used in the focus group. Second, during the focus groups, participants were each asked to add a potential adverse effect to that list until participants had no further ones to contribute

(Nominal Group Process). As each potential adverse effect was listed, the potential cause was discussed and recorded. The use of the online platform WebEx allowed participants to view and comment on the list being made in real time. Participants could ensure that the moderator was adequately capturing their views and intentions. Third, after the adverse effects were added to the list, the importance of each adverse effect was discussed. Guiding questions included: A) Why is the adverse effect important? B) To whom or to what is the adverse effect important? C) On what spatial scale is it important (does it have local, regional, or statewide importance)?

A draft report with the complete list of potential adverse effects obtained during the focus groups was reviewed for completeness by four additional people with experience and expertise in SBGB carp and their management, including individuals from academia, the MN-DNR, and a federal agency. During this review, these individuals suggested an additional 5 attributes to be added to existing entities. These are included in this final report.

Topic #2: Management of SBGB carp

The second goal of the focus group was to better understand what current views exist concerning what could and should be done to manage SBGB carp, including where improvements are needed. This discussion happened after creating the list of potential adverse effects. Since many management actions could impact all SBGB carp species, we discussed management in the context of all SBGB carp species. Guiding questions differed slightly for MN-DNR officials and for stakeholders. Focus groups with MN-DNR officials discussed the following questions: 1) What are potential management options to help address potential adverse effects? 2) Who else, if anyone, should be involved in management efforts? 3) What else should be done for the management of SBGB carp? Focus groups with stakeholders discussed: 1) What should be done to manage SBGB carp? 2) Who should be involved in these management efforts?

4. Findings

Findings are presented in two parts: Section 4.1 and Section 4.2. Section 4.1 is the table of potential adverse effects that could result from the establishment of silver and bighead carp in Minnesota. This table was created by combining the five lists of potential adverse effects created during the five focus groups. The potential adverse effects are grouped into the following categories:

- Native fish species
- Plankton/ Cyanobacteria
- Other aquatic organisms
- Birds and other animals
- Ecosystems
- Diseases/Parasites/Pathogens
- Commercial fishing/Commercial bait/Commercial aquaculture/Commercial transportation
- Tourism/Recreation
- Public perception and relationship to water resources

Listed in each row of the table are the entity, attribute, and direction of adversity, in addition to the potential cause(s), potential spatial scale of effect, and the rationale for its importance. Scale was noted when there was an area of the state that was likely to be especially susceptible to a specific adverse effect. When scale is not stated explicitly, the adverse effect is likely to be statewide.

Participants sometimes listed multiple different attributes for a particular entity. As a result, some entities have more than one attribute listed with them. In those cases, each attribute (with the associated entity and direction of adversity) represents a potential adverse effect. When multiple attributes are present for an entity, some of them may be state variables and some of them may be rate variables. Given that it takes at least two measurements to determine a rate variable while only one measurement to determine a state variable, it may be advantageous to focus on state variables in the analysis phase of the risk assessment when it is possible to do so.

Sometimes focus group participants identified a group of entities, such as game fish, in addition to listing some examples of particular species making up that group. In these instances the individual species are listed below the group. In the example of game fish, each individual game fish species, with each attribute listed would represent a potential adverse effect. For example: decrease in population size of walleye, change in the size structure of walleye [and so on]; decrease in the population size of blue gill, change in the size structure of blue gill [and so on]. These individual species effects were not explicitly listed in the table, but should not be ignored in future risk assessment steps.

Section 4.2 provides a summary of responses provided during the discussions on the management of SBGB carp. They are organized by the questions asked (see Topic #2 above). In the second question taken up by stakeholders, "*Who should be involved in these management efforts?"*, participants focused on what was needed to improve how people and institutions interact around SBGB management. It should be noted that the presence of a response in the section does not indicate it was supported by all or most members of the focus group or by all MN-DNR or stakeholder participants. All contributions are listed to help understand the breadth of views that exist around SBGB management.

4.1. Findings: List of potential adverse effects

Entity	Attribute	Adversity	Potential cause and Importance
Native fish species			
1. Game fish – e.g., Bass, Blue Gill, Channel Catfish, Crappie, Lake Sturgeon, Muskie, Northern Pike, Perch, Walleye	Population size Size structure Relative abundance Recruitment Larval growth Catch rate Stunting	Decrease Change Decrease Decrease Decrease Decrease Increase	*Potential Cause:* • SBGB carp consume zooplankton and phytoplankton to a point of disrupting the food chain for game fish • Altered fish community structure and predator/prey relationships result in a decline in game fish • Loss of nursery habitat and competition for plankton negatively impact larval game fish • Stunting: SBGB carp compete for plankton, increasing density of native fish in lake systems as they move out of river systems to avoid SBGB carp *Importance:* • Recreational fishing, tourism, economic impact • Economic loss from decreased fishing, recreational opportunities • Way of life/cultural significance for European Americans and Tribal Nations • Diverse/resilient game fish community is a good defense against SBGB carp, e.g., bluegill also a potential predator of SBGB carp young • Sportsman community (and those they interact with) are a major block supporting water quality and soil conservation initiatives; Reduction in game fish could reduce number of sportsmen and thereby reduce support for water quality and soil conservation • Hurt efforts to get more people using natural resources • Scale: Statewide/region wide

2. Native fish species – e.g., Bigmouth buffalo; Paddlefish, Gizzard Shad, Shiner species; especially planktivores and benthic fish communities	Population size Size structure Extirpation Recruitment Stunting Age structure Growth rates Overall health – Relative weight, reproductive success	Decrease Change Increase Decrease Increase Change Decrease Decrease	*Potential Cause:* • SBGB carp consume zooplankton and phytoplankton to a point of disrupting the food chain for native fish • SBGB carp alter water quality and benthic habitat • Stunting: SBGB carp compete for plankton, increasing density of native fish in lake systems as they move out of river systems to avoid SBGB carp • Extirpation: Altered fish community structure results in extirpation of native fish species • Age structure change: SBGB carp outcompete younger members of cohort *Importance:* • Forage food for game and commercial fish species and for other native fish species • Importance to the ecology of the river; interconnected nature of these ecosystems – fish, animals • Age structure change: Population would be more susceptible to dramatic declines if all you have is older aged individuals • Native fish species provide a strong defense against SBGB carp • Relative weight, reproductive success (overall health): Leads to less viable fish populations, less stability • Scale: Statewide – One of the broadest because of migratory fish • Scale: River systems of most concern for certain Benthic fish communities
3. Commercial fish species – e.g., Bigmouth Buffalo, Catfish, Smallmouth Buffalo, and in some cases Common Carp	Population	Decrease	*Potential Cause*: • SBGB carp consume zooplankton and phytoplankton to a point of disrupting the food chain for commercial fish species *Importance:* • Negative impact on commercial fishing • Important part of ecosystem • Provide forage base for game fish

4. Threatened and endangered non-game species – e.g., Paddlefish, Topeka Shiner	Population size	Decrease	• *Importance*: A decrease in population size could cause extirpation – furthered by the fact that many of these species are riverine, areas where carp are likely to arrive first

Plankton/ Cyanobacteria

5. Plankton – zooplankton, phytoplankton	Population size Community structure Size structure	Decrease Change Change	*Potential Cause:* • SBGB carp consume plankton • Certain types of plankton are consumed by each species of SBGB carp *Importance:* • Negative impacts on larval fish, native fish species, mollusks, and aquatic vegetation • If zooplankton are overgrazed, algae can increase, increasing turbidity, etc. • Ecosystem integrity – wide ranging, unpredictable effects once these disturbances are made; move towards monoculture of SBGB carp • Anything SBGB carp take out of system would not be available for other species • Will reduce recruitment of naturally reproduced gamefish or stocked fish (walleye, yellow perch, black and white crappie) due to low survival of Age 0 gamefish • Reduces fishery productivity from an angler and recreation standpoint • Key source of food for young game fish and native fish species • Scale: Statewide; Eutrophic lakes in MN are most at risk – waterbodies similar to IL river
6. Cyanobacteria	Population Population	Decrease Increase	*Potential Cause*: • Silver and bighead consume cyanobacteria, which are not largely consumed by other species, decreasing their population • Change in ecosystem dynamics lead to an increase in cyanobacteria

			Importance: • A decrease in cyanobacteria could decrease blooms and allow for other aquatic invasive plants to establish, like Eurasian water milfoil • An increase in cyanobacteria can be toxic

Other aquatic organisms

7. Aquatic native vegetation – e.g., wild rice, wild celery	Population size	Decrease	*Potential Cause:* • A reduction in nutrients (from silver and bighead carp) and direct consumption (from grass carp) • Destruction of habitat by SBGB carp • Potential impacts on algal plants and small plants *Importance:* • Decrease in native plant species will provide space for invasive aquatic plants – e.g., Eurasian water milfoil, curly pond weed • Aquatic vegetation provides physical habitat for fish species • Decrease in aquatic native vegetation can lead to a reduction in nursery areas for first year fishes • Healthy habitat is a way to prevent establishment of SBGB carp – aquatic habitat will have a role to play positively or negatively • Healthy aquatic habitat helps native fish – which will help withstand SBGB carp invasion • Decrease in aquatic native vegetation would result in a decrease in dissolved oxygen – hurting native fish species • Decrease in aquatic native vegetation would increase general turbidity, suspended solids, etc. • Provide nursery habitats and cover for fish; Waterfowl food; • Many plants are already stressed due to impoundment • Scale: Statewide ○ In the upper MS river, aquatic vegetation is an indicator for overall river health; whereas in MN river there isn't as much aquatic vegetation

8. Native freshwater mussels	Population size
	
	Recruitment
		Decrease
		
		Decrease
			Potential Cause:
			• Reduction in nutrients (from silver and bighead) and direct consumption (from black carp)
			• Mussels feed on plankton; impacted by competition from SBGB carp
			• SBGB carp disrupt the food chain
			• SBGB carp negatively impact native fish species that are hosts for these mussels
			Importance:
			• Ecosystem services value – filter feeder in the system; utilize nutrients (N and P) in the system; could negatively impact native fish, water quality, etc.
			• Many mussels are threatened and endangered; Important hosts for riverine species (e.g. channel catfish); Substrate relied upon by mussels are also used by game fish
			• Mussels are food source for fish, raccoons, etc.
			• Scale: Highest risk in larger river systems, because that is where they occur; they do not occur so much in lakes
			  ○ Endangered mussels are in St. Croix River
			  ○ Life history is important – some are extremely long lived with low reproductive rates

9. Aquatic invertebrates	Population size	Decrease	*Potential Cause:* • SBGB carp disrupt food chain and compete with aquatic invertebrates *Importance:* • Integrity of food systems for native fish and invertebrates

Birds and other animals

10. Waterfowl	Population size	Decrease	*Potential Cause:* • Wetland community changes due to pressures on aquatic plants and plankton from SBGB carp • SBGB carp could feed on plankton (impacting dabblers) and reduce forage fish base (impacting divers)

			Importance: • Waterfowl habitat has been greatly diminished in MN, another source of stress may not be able to be tolerated • Fewer opportunities for waterfowl hunting and birding; decrease in biological integrity of ecosystem – Large proportion (~40%) of North American waterfowl use/migrate through the MS National Park corridor • Scale: Statewide; especially Mississippi River National Park corridor
12. Migratory birds	Population	Decrease	• *Potential Cause*: Changes to river ecosystem and a decrease in native fish populations • *Importance*: Large proportion (~60%) of neotropical migrating bird species use/migrate through the river corridor • Scale: Statewide; especially Mississippi River National Park corridor
13. Other animal species reliant upon water ecosystems: otters, etc.	Population	Decrease	• *Potential Cause*: Changes to river ecosystem and a decrease in native fish populations

Ecosystems

14. Freshwater ecosystem	Species diversity Species richness	Decrease Decrease	• *Potential Cause:* SBGB carp disrupt food chain and negatively impact native fish and plant species *Importance:* • Reduced species richness will create more opportunities for new aquatic invasive species • Could impact stability of lake and productivity
15. Water quality in lakes and rivers	Dissolved oxygen Turbidity Nutrient	Decrease Increase Increase	*Potential Cause:* • Grass carp consume aquatic plants and excrete large amounts of organic matter • More fish will require more dissolved oxygen, decreasing what is available to other species, especially in winter and spring; • Larger and more dense population of fish that disturb bottom

	loading Algae blooms	 Increase	sediment and re-suspend phosphorus; *Importance:* • Decreased dissolved oxygen can shift a waterbody into winter kill status • Water quality important for habitat and ecological health; • Shift in algal growth and other water quality could impact fish growth

Diseases/Parasites/Pathogens

16. Diseases for native fish (e.g. VHS, spring viraemia) Parasites of native fish – e.g. gill flukes Pathogens of native fish – e.g. Asian carp tapeworm	Prevalence Population size Infestations	Increase Increase Increase	*Potential Cause:* • SBGB carp bring in new or exotic diseases, parasites, and pathogens that spread to native fish • SBGB carp increase the speed of transmission of existing diseases, parasites, and pathogens to native fish species *Importance:* • Impact on native species, however large amounts of uncertainty concerning potential impacts • Some parasites are species specific, don't know if they will carry over, but the potential is there • Scale: Basin wide – fish are moving around the system and have the potential to bring other diseases and parasites

Commercial fishing/Commercial bait/Commercial aquaculture/Commercial transportation

17. Commercial fishing	Revenue	Decrease	*Potential Cause:* • SBGB carp cause change or decrease in commercial fish species • SBGB carp replace more valuable commercial fish species - SBGB carp are currently 18 to 22 cents a pound and bighead buffalo are about a dollar a pound *Importance:* • Commercial fishermen are important for management as they are on the water helping identify fish trends and movements – if commercial fishing lessens then this management resource will also be

			diminished • Major businesses in MN (Bait, commercial fishing, aquaculture), could have major economic impact on all three, across the state;
18. Commercial bait	Revenue	Decrease	• *Potential Cause:* Could have to shut down to prevented spread of SBGB carp • *Importance:* Important industry in Minnesota
19. Commercial aquaculture	Revenue	Decrease	• *Potential Cause:* If they were to be contaminated, they would be shut down or it would be costly to deal clean up • *Importance:* Important business in Minnesota
20. Commercial transportation on waterways	Cost Opportunities for	Increase Decrease	• *Importance:* Far reaching economic implications from impacts on commercial shipping – perhaps needing to rely on more trucking, pipelines, etc.

Tourism/Recreation

21. Water-related recreation – Boating (canoeing, kayaking, boating)	Opportunities for/ Quality of/ Safety of	Decrease	*Potential Cause:* • Jumping silver carp cause harm to people and property • Metal hulls & boats may scare the fish more; may limit boating to just canoe and kayak – may change the type of boating • If there was a die off – nuisance of carcasses *Importance:* • Parts of the threatened Mississippi and St. Croix rivers are National Parks • Major economic input – boating and fishing shows, outfitting, retail, tourism, tax revenue • Could reverse improvements that have been being made to the Minnesota river • People expect and cherish lakeshore in MN – aesthetic value of water resource • Quality of life and parks on the Mississippi River – part of reason why these parks are so highly valued is because of the quality of the

			water, there has been a lot of work to bring the community back to the river and this could undermine all of that work.

22. Water-related recreation – Fishing	Opportunities for/ Quality of/ Safety of	Decrease	*Potential Cause:*
			• Jumping silver carp cause harm to people and property
			• SBGB carp decrease game fish populations, reduce catch rate of game fish, disrupt ecosystem beyond game fish
			• Metal hulls & boats may scare the fish more; may limit boating to just canoe and kayak – may change the type of boating
			• If there was a die off – nuisance of carcasses
			Importance:
			• Negatively impact boating and fishing
			• People expect and cherish lakeshore in MN – aesthetic value of water resource
			• Quality of life
			• Major economic input – local fishing-related economies, boating and fishing shows, outfitting, retail, tax revenue
			• Could reverse improvements that have been being made to the MN river
			• Marketing Minnesota – fishing is integral backbone; We are a major destination for recreation – if we lose our comparative advantage and rich history then we are in trouble
			• Fishing is important to way of life in Minnesota – accessible to everyone; encourages diverse use of river, fishing piers (and fishing from shore) are often most diverse use of river in urban setting;
			  ○ Important site of family connection
			  ○ Community identity, because of quality of fishing there

23. Tourism/ Lake and River-related local economies/ Marinas & Resorts	Revenue	Decrease	*Potential Cause:* • Reduction in people coming to Minnesota to fish and utilize waterways because of concerns over safety, reduced game fish populations, and compromised water-related ecosystems *Importance:*

			• Tourism is a key parts of local and rural economies • Marinas and resorts are important part of lake and river recreation; marketing tool for recreation, social hub – place to gather • Identity of Minnesota (Land of 10,000 Lakes) – people coming in to use the waterways, people within state using waterways; • If you can't economically support local communities with this tourism revenue, you lose the character and culture of the small towns; which leads to worse experience with rivers and lakes – reinforcing a downward positive feedback loop • Competitive edge in tourism comes from healthy ecology – makes us stand out right now
24. Management agencies	Revenue	Decrease	*Potential Cause:* • Compromised game fish and water-related ecosystems lead to fewer people purchasing fishing and watercraft licenses, decreases funding for management agencies *Importance:* • Licenses and fees are an important source of funding for management agencies
25. Waterfront property	Value/Resale value	Decrease	*Potential Cause:* • SBGB carp reduce the ability to use waterways • SBGB carp reduce water quality *Importance:* • Tax revenue, Quality of life

Public perception and relationship to water resources

26. Public perception of and relationship to waterways and watershed	Pride in, value of, respect for, and love of waterways	Decrease	*Potential Cause:* • Perceived compromised integrity of rivers and lakes change how people relate to waterways *Importance:* • Health of the river is important to people's relationship to it • When people value something they are more likely to care for it,

			more likely to engage in protection; ○ When people lose respect for rivers and lakes there is an increase in apathy towards those resources; ○ Where waterways are nice/healthy, there is a better relationship to it – with both economic and social implications • Perceived harm to waterways from SBGB carp will decrease the urgency to protect and steward our land and waters • Positive attitude towards waterways increases quality of life – hard to put dollar value on, but it impacts how people feel about where they live and work

4.2. Findings: Management of SBGB carp

A. What are potential management options to help address potential adverse effects? (MN-DNR Officials)

Preventing spread

- Barriers to slow the spread of SBGB carp up rivers
- Barriers for preventing watershed breaches
- Enforcement/rules/policy to prevent human-mediated fish movement
    - Containment rules for aquaculture
    - Restrict importation of minnows for feeding aquaculture fish – especially from infested areas
    - Prevent importation and release back into natural environment

Habitat Improvement

- Maintain healthy habitat, native species, and native fish populations - The healthier the system the more resilient it is in the face of invasion
    - E.g., Habitat restoration projects on Mississippi River
        - Restoring islands and land barriers that were present
        - Breaking up of wind fetch to reduce wave action – helps reduce turbidity, increase abundance of aquatic plants
        - Increase depth for overwintering habitat
        - Bringing back mussel habitat, spawning habitat
    - Improve water quality
        - Reduce nutrient loading, sediment, etc.

- Barrier removal
    - Allowing competitors and top predators (e.g., flathead catfish) to recolonize – species that are negatively impacted by barriers
    - Planktivores – they are extremely negatively impacted by fragmentation, allow them to more successfully compete with SBGB carp
    - Increasing connectivity – improve native fish movement and water quality
    - Help mussel populations, which may be negatively impacted by SBGB carp

Monitoring

- Monitoring of SBGB carp and native fish
    - Determine health of native fish community to help improve it
    - Help create a baseline of native fish populations for comparison if SBGB carp become established
    - Help inform management and justify funding

Managing native fish

- Biological control - Manage game fish/commercial populations to improve fish species (populations, age structure, etc.) that could consume SBGB carp
- Manage to help establish native species that are not as affected by SBGB carp
- Stocking – More advanced stocking of game fish species, basically manage for put and take fishery
- Prevent overharvesting of commercial and game fish populations

Other management options for SBGB carp

- Drawdown for winter kill on shallow lakes
- Attractants to aid in commercial harvest
- Chemical control – e.g. Rotenone
- Subsidizing commercial harvest
- Classical biological control

B. Who else, if anyone, should be involved in management efforts? (MN-DNR Officials)

Groups needing to be involved

- Federal agencies
    - FWS – Needs additional resources for its leadership role in management
- Other state agencies and institutions – e.g., MPCA, academic institutions
- Industry – e.g., commercial fishing, bait industry
- Recreation groups
    - Marina associations/recreation groups
        - Creating new management options/regulations
    - Watershed associations and lake associations
- Politicians
    - Challenges: workload, competing interests for funding, constituent knowledge of issues
- Within MNDNR
    - Invasive species and enforcement need to be major players in DNR – Fisheries may not need to be point people
- Counties
    - With their AIS funding, have approached area offices to see how they could help with management

Existing collaborations

- State and Federal agencies (e.g., USFS, USGS, Wisconsin) are all involved, and everyone is working together basically well
    - Certain difficulties exist when there are so many players:
        - Agencies backing out last minute from larval sampling
        - Coordination hurdles – Funding levels; Long vs. short-term commitments

- On Mississippi River, there is pretty good collaboration (doing detection work, understanding fish movement) from pool 2 down

C. What else should be done for the management of SBGB carp? (MN-DNR Officials)

Address research and information gaps

- Need answers to key questions concerning impacts of SBGB carp and the impacts of the management actions proposed to stop them
    - Uncertainties about impacts of SBGB carp undermine efforts to get people on board
- Need to be engaging with states that have been dealing with these species – determining adverse effects already experienced and understanding systems where they are not present in large numbers
    - More communication and soliciting input from those who may have useful knowledge

Impediments to holistic approach – desire for silver bullet

- No one silver bullet is going to solve problem – need many management options
- Barriers are not a silver bullet, but are sometimes seen as one
    - They are conceptually simplistic, yet reality is actually much more complex than understood in this simplicity - This is not like closing the doors and windows to keep mosquitoes out of the living room
    - We are ignoring the ecology learned about the negative impacts of barriers on native fish species
    - May get forced by public/political pressure into putting something out there (e.g. electric barrier), as a silver bullet, instead of broader approach
- Need better public education of the issues
    - Hard, because reliant upon media
    - Perception is that SBGB carp are here and there is nothing we can do, which is not true
    - Not great public understanding of: management actions vs. research science vs. examining potential management actions
    - Citizen science: Need to know how to identify, what to do with it, etc.

Attributes of holistic approach

- Consider the negative impacts of control efforts
    - The fragmentation of river and stream systems have collateral damages to native species [such as Sturgeon] (similar to non-selective poisons, etc.), or otherwise result in loss of biodiversity. This has been demonstrated for many other introduced species as well.

    - The ultimate result of control efforts can be to create systems relatively free of predator and competition controls on SBGB carp, leading to ecological dominance by these and other tolerant species.
- Address altered landscape
    - Drainage systems have altered hydrology, providing avenues to infest new waters
    - Analyses of impacts should take into account changes due to eutrophication, impoundment, and fragmentation
    - The more altered and nutrified a waterbody is, the more friendly it is for AIS; what attributes favor a healthy native community and how can we achieve that?
- Understand that ecosystems and waterways change over time
- Barriers - Use in certain circumstances where they can be most beneficial
    - Protecting smaller areas, historically isolated basins, addressing artificial watershed connections
- System management rather than protecting individual species
    - Combination of population suppression techniques and knowing key life stages of individual SBGB carp species
        - Strategies differ based on location
    - When get too focused on individual species can lose track of the entire system and connections within it

D. What should be done to manage SBGB carp? (Stakeholders)

Preventative measures

- Need to take actions beyond research and monitoring
    - Have found individual SBGB carp in Mississippi river, so need to prevent further spread
- Barriers/Deterrents
    - Determine effectiveness of, and potential sites for, barriers/deterrents
        - Make sure they are intact and working well
        - Need redundancy with deterrent technology
        - Potential sites: Confluence of St. Croix and Mississippi rivers; Lock and Dam (L&D) #19
    - Part of slow, stop, control until there is better knowledge
        - Use “deterrent” instead of “barrier” as descriptor, because barrier implies complete stop, yet there is no 100% effective barrier, we don’t want to imply such efficacy
    - Modify use of L&D to help prevent spread - reduce service level at L&D #1
- Education (especially in areas without current populations) and enforcement

Other management actions and research

- Continued monitoring of population with respect to spatial dispersion

- Determining weakness of particular SBGB carp species – looking for potential biological solution
    - Gain a better understanding of how well SBGB carp would feed in particular areas and what that means

Commercial fishing

- Commercial fishing to decrease biomass of SBGB carp
- Need to identify wintering and spawning areas with radio tags to aid in large scale fishing
    - Hard to reach some of the most important areas… not worthwhile from a commercial perspective to go into some of these areas
- Need methods to quantify SBGB carp populations
    - We need to know what percentage of fish have been removed from fishing efforts
    - Will help determine thresholds to see if you need to continue removing fish from a specific population
- Problem on IL river is that people engaging in commercial fishing are doing so to optimize profit
    - They aren't fishing for management – they are using too big of net size, so the small fish are making and keeping the populations healthy… actually make it worse
    - Don't use IL river as an example of what should be done in MN
- Need a better program with commercial fishermen

Statues

- Review of existing laws and statutes that may aid in management efforts
    - With regards to permitting – the amount of time needed might keep you from a rapid response effort
    - Bait, and regulations that may impact spread
    - Making sure that bordering states are on same page with laws and statutes

E. Who should be involved in these management efforts? (Stakeholders)

Leadership

- Upper MS river need federal attention, like Great Lakes
    - USFWS was put in charge of coordinating agencies with the WRRDA legislation
        - Need to be provided resources to do so
- Need stronger leadership
    - From Governor: a governor's forum, stronger regional leadership
    - From additional legislation: Mandate action and cooperation
    - There needs to be more money on the ground – not just meetings
- Need to make someone accountable on this issue

    - Need to have expectations for what this person accomplishes
    - Need this at the state level or federal level
    - Communication, coordination, sharing research results, research overlap, implementation of management
    - Multi-agency, cross-discipline unified response

Communication and coordination

- Need better communication between all parties working on SBGB carp
    - Sharing of information is not happening – need policy makers to understand this
        - Need DNR to communicate better
    - People need to know what everyone else is doing – eliminate duplication and work together
    - Agencies don't want to do public outreach – because of the bureaucracy they need to go through certain channels
    - Need better regional coordination
    - US Army Corps of Engineers has at times not been cooperative
- Agencies need to work better together
    - Being prevented by turf protection – benefiting self, not cooperating

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