RESTORING THE UPPER MISSOURI RIVER ECOSYSTEM: A PLAN FOR MANAGING FISH IN THE UPPER MISSOURI RIVER

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CHAPTER 1 UPPER MISSOURI RIVER ECOSYSTEM

1.1 SCOPE

The scope of this plan includes the Upper Missouri River ecoregion, which includes the portion of the Missouri River from the Canadian border south to Nebraska. It includes eastern Montana, northern Wyoming, northwest Nebraska, western South Dakota, and southwestern North Dakota (The Nature Conservancy, 2013).

1.2 ECOSYSTEM DESCRIPTION

The Upper Missouri River constitutes part of the longest river in America and is a major watershed area. The Missouri River itself empties into the Mississippi River, which eventually flows into the Gulf of Mexico. The Upper Missouri passes through mountains and plains, including the arid grasslands that make up the Great Plains. The Upper Missouri watershed area also encompasses the "Prairie Pothole Region" of the Great Plains, an endangered wetland area (The Nature Conservancy, 2013). This river section has been subjected to extreme anthropogenic modifications, such as channelization and damming. Historically the "Big Muddy" was a warm, slow flowing, muddy river. Now it is cool, fast flowing, and clear. These substantial alterations damage the overall health and productivity of the ecosystem and the services that it provides (United States Fish and Wildlife Service).

1.3 VISION

Our vision is to restore and conserve ecosystem services in the Upper Missouri River for the health and productivity of the ecosystem in the face of climate change. By achieving a balance between modern day needs and conservation for future generations, we hope to attain a stable and sustainable ecosystem that will also benefit the country as a whole.

CHAPTER 2 INTRODUCTION TO UPPER MISSOURI FISH

2.1 ROLE OF FISH

Fish are an important provisioning service in the Upper Missouri River. Fish have nutritional value and are harvested commercially and non-commercially. In additional, they play an important role in a functioning aquatic ecosystem and are valued culturally. In the early 1900's the commercial fishing industry was a large thriving industry, but it was hit hard by anthropogenic river alterations, habitat degradation, and a 1992 ban on catching catfish, a major species of commercially caught fish (Nebraska Wildlife Federation). Although there is still a commercial industry, it is but a fraction of its former size. Recreational fishing, on the other hand, is a thriving industry. There are approximately 150 fish species in the Upper Missouri River that recreationalists come to fish. The river also includes a United States Fish and Wildlife Service (USFWS) classified threatened species, the shovelnose sturgeon (United States Geological Survey, 2013).

Fish also play important ecological and cultural roles. They are part of the aquatic food web and can regulate carbon flux, nutrient cycling, and sediment processes, which represent other important ecosystem services. They also serve as a link between ecosystems, act as indicator species for environmental issues, and transport nutrients, carbon, minerals, and energy. Furthermore, they assist in controlling algae, some types of waste, and disease spread. They may also be used in science as models, biotechnology, or medicine. Fish also play an important cultural role in society. They have an aesthetic value and the tradition of fishing is important in many communities. Fishing also supports many local economies and has been woven into the economic, cultural, and social history of the region (Holmlund and Hammer, 1999).

2.2 VALUE OF FISH

Each of the roles of fish reflects a value. These different values are extremely difficult to quantify, especially in total, but they can be used to determine the importance of fish and help select optimal management objectives and actions. To begin, fish bring in a substantial amount of tourists interested in fishing. Using data on tourism from Montana, North Dakota and South Dakota it can be estimated that 167,000 tourists visit the Upper Missouri annually to fish. These

tourists bring in an estimate $564 million to the area, which helps support the local economy. These figures were estimated using information from wildlife surveys in these areas (United States Fish and Wildlife Service, 2006; United States Fish and Wildlife Service, South Dakota, 2011; United States Fish and Wildlife Service, Montana, 2011). A 1992 study indicated that the overall recreational value of stream fisheries in Montana alone was over three billion dollars (Duffield, 2003). There is limited data on the value of commercial fishing in the Upper Missouri, but comparisons can be made with the well-studied Upper Mississippi river, which contains similar commercially fished species. Studies have placed a value on commercial fishing in the Upper Mississippi around 4 million dollars for approximately one million pounds of fish harvested each year (United States Army Corps of Engineers, 2012).

When South Dakota residents were asked in 2004 survey by the South Dakota Department of Game, Fish and Parks "How important do you think healthy fish and wildlife populations are to the economy and well-being of South Dakota residents," they assigned an average number of 2.75 to the importance, where 2 is moderately important and 3 is very important (Gigliotti, 2004). Using this information, in combination with an understanding of the economic and ecological role of fish, it can be seen how highly fish are valued. Part of this value includes an intrinsic value that the fish hold in their existence. These numbers are extremely difficult to quantify and valuation methods will require ethical judgments and assumptions. Valuation, however, can highlight the importance of an ecosystem service, be used as a lens to determine environmental action, and act as a tool for policymaking.

2.3 THREATS TO FISH

Overfishing, habitat degradation, damming, the introduction of invasive species, development, and climate change all threaten the health and long-term presence of native fish species in the Upper Missouri River. Extensive channelization and water flow alterations from damming have cause dramatic changes in the river's flow. The river, which historically transported fine sediment and experienced significant flooding, now runs clear and does not flood

regularly (United States Fish and Wildlife Service). Since native fish were adapted to the historical flow regime, this changes the suitability of the habitat for many species and alters the overall species composition of the river. Water level changes can also act as spawning cues for fish, so changes in water flows can affect breeding and the long-term viability of populations. Damming impacts spawning by altering water characteristics and physically blocking fish movement. In addition, development near the river can have negative impacts on the river and can limit what management actions can be taken (Montana Fish, Wildlife, and Parks, 2010).

The shovelnose sturgeon serves as an excellent example of a fish species that has suffered from a variety of threats. This sturgeon is a bottom-dwelling freshwater fish that typically lives in turbid rivers. The Missouri River was formerly an ideal habitat for the sturgeon, but alterations to the river have decreased the amount of suspended sediment. Also, for spawning the shovelnose sturgeon must migrate to historical breeding grounds, many of which have been destroyed by dams. In addition, shovelnose sturgeon roe, which is marketed as "hackleback" caviar, is considered a delicacy and has resulted in poaching problems. These sturgeon are also protected because they resemble another at-risk species, the pallid sturgeon. Actions aimed at protecting the pallid sturgeon also benefitted the shovelnose sturgeon and encouraged the listing of the shovelnose sturgeon as endangered. The benefits one species gets from the protection of another highlights the importance of a multi-species approach to management (United States Geological Survey, 2007).

Climate change may also severely impact fish, which have adapted to the environmental conditions prior to climate change alterations. Climate change has the potential to severely compound current problems and cause new issues. For example, climate change may directly impact water temperature and flow issues, disease spread, invasive species survival, and pollution (Inkley, 2013).

2.4 OPPORTUNITIES AND CHALLENGES FOR PROTECTION

Large-scale anthropogenic modifications such as the six dams in the Upper Missouri were costly to implement and would be costly to modify. However, they are potential sites that can be adjusted to cause extensive ecosystem modifications. For example, as recommended by the USFWS, dams can lower the water level during spawning season to encourage breeding (United States Fish and Wildlife Service). However, other anthropogenic modifications, such as channelization and development, are so widespread that it might be impossible for large-scale alterations to occur. For example, many homes are located directly on the riverbanks of the channelized river and its tributaries. Any proposed management actions involving the developed riverbanks will involve private properties owners, properties rights, and ethical issues (Montana Fish, Wildlife, and Parks, 2010). The river also covers an extremely large area. This makes management extremely difficult and expensive. Uniform management will require that states located in the ecoregion cooperate towards attainment of management objectives and implementation of policy. Although slight adjustments may be needed to meet the ecological, social, and cultural needs of an individual region.

Climate change also poses a huge challenge to fish management. Changes in temperature and precipitation directly impacts river characteristics, which influences fish habitat suitability. Climate change may also lead to the spread of non-natives and disease. Additionally, an increase in the prevalence and severity of natural disasters is a potential threat to habitat stability (Inkley, 2013). Since there is uncertainty in climate change models management actions should be focused in areas, such as spawning habitat, that will be benefit regardless of climate change impacts. Finally, the investment of numerous stakeholders provides both opportunities and challenges for protection.

CHAPTER 3 STAKEHOLDERS

3.1 IDENTIFICATION OF STAKEHOLDERS AND STAKEHOLDER POSITIONS

Stakeholders include commercial fishers, consumers, sportsman's groups, recreationalists, government agencies, community members and organizations, environmentalists,

Native Americans, and farmers. Most of these stakeholders are invested in the presence of thriving fish populations in the Upper Missouri River. Those who fish the river, such as commercial fishers, sportsman's groups, and recreationalists, want fish to be readily available for harvest. At the same time, these stakeholders may act in their own self-interest and overharvest fish. Oftentimes regulations, such as bag limits, are used to prevent this. It should be noted that although the focus of this plan is native species protection and management, not all recreational fishers care about the type of fish they are catching, though native fish species are usually the attractant (Montana Fish, Wildlife, and Parks, 2010).

Usually government agencies, community members and organizations, environmentalists, and Native Americans are also invested in maintaining fish populations for their existence value. Community members and local organizations also likely rely indirectly on the fish for their local economic impacts (Holmlund and Hammer, 1999). The government also depends on the economic benefits of the fish and has taken on the majority of the responsibility for protecting fish, wildlife, and natural habitats. (Montana Fish, Wildlife, and Parks, 2010). Environmentalists and Native Americans value fish for their non-use value, they value these fish intrinsically and would like them to exist for future generations. For many Native Americans and locals, fish also hold significant cultural value. Native Americans also have historically reserved fishing rights (Holmlund and Hammer, 1999).

It should also be noted that there are stakeholders who will likely be opposed to management actions. Although these stakeholders may not be "against" fish they may oppose actions that impose additional regulations on their actions or that affect them financially. For example, farmers may not be willing to change their land management practices that affect the ecosystem. Those who economically benefit from harvest shovelnose sturgeon roe will also be opposed to a ban on collecting roe, even if the goals of the overall plan positively impact long-term fish populations (Montana Fish, Wildlife, and Parks, 2010). This variety in stakeholders and types of valuation contribute to the difficulty of managing fish in the Missouri river.

3.2 PLAN FOR ENGAGEMENT OF STAKEHOLDERS

Engaging stakeholders in all stages of an adaptive management plan, both directly and indirectly, will likely contribute to the overall success of the plan. To begin, the formulation of a management plan will be publicized in order to reach out to stakeholders. Then a public hearing or workshop in which stakeholders are able to directly discuss and formulate management objectives will give stakeholders the opportunity to share their priorities and give them a sense of ownership over management decisions. For those who are less directly involved, electronic polling methods or telephone/mail surveys may also be a feasible way to determine the issue salience and stakeholder's opinions. Stakeholders will also have the option of joining a working group, which will meet on a regular basis to discuss the implementation and results of the plan. The working group will then help determine how the plan should be altered to meet management objectives. Stakeholders should also be involved in monitoring. Easily identifiable environmental indicators should be recognized and communicated so stakeholders can personally monitor the river. Since the plan is an adaptive management plan stakeholders should be prepared to be involved with a continuous, cyclic process of assessing, designing, implementing, monitoring, evaluating and adjusting (United States Environmental Protection Agency, 2013).

A key component of engaging stakeholders in the long-term success of the plan will be public education. The goal of education would not only be to directly involve interested parties in the formation of the plan, but also to get those who are less involved invested in the success of the plan. For example, local parks may be able to distribute educational materials or implement a campaign on the importance and value of the river to visitors. Educational materials could also be made available for teachers or parents online. The media can also be involved to help report on the current health of the river and could be notified of any improvements made. To ensure that the public is aware of the current and future challenges with ecosystem management, the threat of climate change should also be included as a key component of Missouri River ecosystem management. Stakeholder engagement will not only ensure investment in management objectives

but will also allow for formulation of management objectives that are fair to stakeholders and reflect stakeholder priorities.

CHAPTER 4 OBJECTIVES

4.1 STATEMENT OF OBJECTIVES

After consideration of the role, value, threats, opportunities and challenges of fish management and the stakeholders' positions, three management objectives were formulated. These objectives were chosen based on level of impact, feasibility (including financial and time considerations), and risk. Overall these objectives were selected by targeting key areas that will allow for the attainment of the overall objective. The first of these management objectives is to maintain or restore optimal habitat. Since habitats in the Upper Missouri River have been so severely degraded, restoring these habitats is imperative (United States Fish and Wildlife Service). In addition, preventing additional habitat areas from being degraded is necessary and more cost-effective. The second objective, which was chosen based on risk, is to prevent large-scale catastrophic events, such as introduction of nonnatives, disease outbreak, and overfishing, which could severely impact fish populations. The final objective is to balance species demographics, which ensures that a multiple species approach to management is being taken, which provides for the long-term viability of numerous native species (Montana Fish, Wildlife, and Parks, 2010).

4.2 OBJECTIVES AND STAKEHOLDERS

As discussed above, the majority of stakeholders are invested in the existence of viable populations of fish. Since management objectives are targeted towards increasing fish populations, the majority of stakeholders should support these objectives. Even if stakeholders, such as local business owners, do not directly rely on the fish populations they may still receive the benefits of fish populations, such as an increase in tourism from fisherman or river areas that are more aesthetically pleasing. In addition, increasing suitable habitat for fish will mean attempting to restore the Missouri River to its natural state. This natural state will likely positively

impact many other ecosystem services, which rely on the functioning of a productive ecosystem. Therefore, anyone who relies on any ecosystem service that benefits from habitat restoration will be affected.

Prevention of large-scale catastrophic events will likely have less easily identifiable impacts on stakeholders. Preventative measures will, however, minimize negative outcomes for stakeholders. These larger issues, such as the introduction of an invasive species or spread of an infectious disease, could have devastating affects on the ecosystem which would then impact all stakeholders. Therefore preventing major issues benefit the ecosystem (and thus the stakeholder).

It is important to note, however, that the degradation of the ecosystem was human driven. That means that those people who are responsible for the degradation of the ecosystem were either unaware of the value of the ecosystem, held it in lower value than their actions, or were unaware of their impact on their ecosystem. Therefore, in order to prevent further degradation and promote restoration it is imperative that people are made aware of the value of the ecosystem and how their actions impact it. Furthermore, if education can't prevent self-interest from overriding environmental damage then other incentives, such as financial incentives, may be necessary. In addition, actions may need to be taken to deter individual or group action from negatively impacting the ecosystem. For example, fishing restrictions prevent individuals and the commercial industry from overfishing. A violation of these restrictions is punishable by law, which acts as a deterrent to potential violators. Although those who are invested in the long-term existence of fish will likely support refinement and reinforcement of these restrictions some non-commercial and commercial fisherman may oppose these actions if they affect them personally or economically. It should also be noted that although education is undeniably important, it is not considered a primary objective in this plan, instead it is understood as an essential part of stakeholder engagement.

CHAPTER 5 POTENTIAL MANAGEMENT ACTIONS

5.1 IDENTIFICATION OF MANAGEMENT ACTIONS

The three management actions that were chosen as most pertinent to achieving management objectives are increasing optimum spawning habitat, implementing aggressive invasive species prevention, and refining and reinforcing fishing restrictions. To begin, increasing optimum spawning habitat was chosen as an objective because it requires that key habitat areas be restored which positively influences species demographics. Better spawning habitat should lead to an increase in breeding and thus an increase in fish populations (United States Fish and Wildlife Service). Invasive species prevention was also chosen because it will prevent competition and subsequent decrease in native fish populations, which will help to balance fish demographics. Invasive species prevention is also extremely important given the threat of climate change. Indeed, climate change is increasing the threat of invasive species by altering climate conditions that determine habitat suitability for a species. The third management action, refining and reinforcing fishing restrictions, was also determined using the lens of climate change. Given the potential for climate change to alter habitat and influence species composition, routine refinement of fishing restrictions is imperative for maintaining species demographics in a changing ecosystem (Inkley, 2013). In addition, refining fishing restrictions prevents overfishing and reinforcement of restrictions ensures that rules are followed. Whenever possible, fishing restrictions can also be made more lenient, which may attract additional fisherman and help with the tourism industry.

5.2 CONSTRAINTS OF MANAGEMENT ACTIONS

Surveys, such as the one discussed in valuation, indicate that the general public in the South Dakota recognizes the importance of fish. The same survey also revealed that the majority of residents believe that the state agency's efforts to conserve and protect wildlife in the state are between "slightly too little" to "just about right". They majority of people surveyed also believed that money generated from fishing licenses and state and federal taxes should be used to preserve fish populations (Gigliotti, 2004). In addition, money generated under the Dingell-Johnson Act, which taxes fishing equipment for sport fish restoration, can be used. These sources of funding

are preserved specifically for wildlife and fisheries management but represent a somewhat limited fund (Montana Fish, Wildlife, and Parks, 2010). Therefore management actions, such as those selected, should have large-scale impacts and/or allow for attainment of numerous management objectives to ensure that funds are used efficiently. Public opinion may be swayed if residents perceive that funds are used in an uneconomical way.

CHAPTER 6 MODELING

6.1 IDENTIFYING MODELING

Models can be used to help determine optimal management objectives and attainment towards these objectives. Habitat suitability models will likely be the best tools for managers who need to determine how to restore habitat for individual species. For example, the United States Geological Survey has published a habitat suitability model for the shovelnose sturgeon.(United States Geological Survey, 2007). Population dynamics should also be considered through the use of minimum viable population models, maximum sustainable yield models, and Nurgaliev's law for population size change, among others (Hallam et al. 2000).

There are other models that may be key for attainment of other management objectives. The likelihood of invasive species success can be determined using the symbiotic traits, biological characteristics, and invasion site characteristics determined by Moyle and Marchetti (2006). Epidemiological models of disease, such as models for Whirling Disease, should also be used to determine if managers are addressing variables that influence disease spread (Hiner and Moffitt, 2011). Furthermore, global and regional models of climate change can also be interpolated to determine the potential affects of climate change on fish habitat in the region.

CHAPTER 7 MONITORING

7.1 IDENTIFYING MONITORING

To ensure that management actions are in line with our objectives, monitoring of numerous variables is necessary. This data should be collected by state Fish and Wildlife Departments using uniform methods of collection and reporting, thus allowing for increased

cooperation and collaboration among states. Fish counts will be necessary and data on nonnative invasive species introduction, disease prevalence, and spawning will be needed to sufficiently monitor populations. Although yearly seasonal monitoring may be necessary, it may take several years for fish populations to respond to changes. Therefore seasonal data should be analyzed over a multiple year period to determine any trends and overall demographics (Montana Fish, Wildlife, and Parks, 2010). Additional research on interspecies dynamics may also be necessary for determining how to balance species demographics. Data on commercial and non-commercial fishing should also be collected to determine harvest rates. If using the Moyle and Marchetti model further research on potential aquatic invasive species may also be needed (Moyle and Marchetti, 2006). Any invasive species that are discovered in the ecosystem should be thoroughly studied. In addition, aquatic habitat quality indicators, including stream bank and riparian areas, can be measured. It is recommended that this information be compared with monitoring records on other non-aquatic species and habitats to determine far-reaching trends. Finally, as discussed, qualitative stakeholder personal monitoring and reporting will be encouraged (Montana Fish, Wildlife, and Parks, 2010).

CHAPTER 8 DECISION MAKING

8.1 OPTIMAL MANAGEMENT OBJECTIVE

The optimal management action will likely be increasing optimum spawning habitat. If attained, this objective is likely to have the most obvious and far reaching effects that will appeal to stakeholders. This objective can be easily measured in terms of amount of amount of spawning habitat available over time and the effects of spawning habitat increase can be examined by monitoring fish populations. Increasing the amount of optimum spawning habitat will also require that climate change impacts in these areas, such as warm temperature rise, are mitigated, a key component of the success of this plan.