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Michigan's Lake Sturgeon Rehabilitation Strategy

Editors:

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and
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EXECUTIVE SUMMARY

Substantial population declines since the 1800s led the State of Michigan to list lake sturgeon as a threatened species. The primary causes of the decline of lake sturgeon are insufficient recruitment due to habitat loss and degradation, often caused by dams and poor spawning habitat quality, and excess mortality on adults through fishing. This document provides guidance for the management of lake sturgeon with the goal of eventually rehabilitating this species to the point of removal from the threatened species list and to levels that provide productive and unique fishery opportunities. The primary goals for lake sturgeon are to: (1) conserve populations that are currently self-sustaining; and (2) rehabilitate depressed populations to the point that they are self-sustaining at a higher level of abundance.

Currently, there are 24 lake sturgeon populations as distinguished by major watersheds in Michigan waters: two in the Lake Superior drainage, 11 in the Lake Michigan drainage, nine in the Lake Huron drainage, and two in the Lake Erie/Lake St. Clair complex. Of these 24 populations, only five are large in size and three of these are considered to be abundant and stable enough to support harvest fisheries. Among the remaining 19 populations, 12 are below the minimum viable population size (80 adults) and are at high risk of extirpation due to random factors. Four populations are classified as small in size (80–200 adults) and are at a high risk of declining to below the minimum viable population size. Three populations are classified as medium in size (200–750 adults).

A limited number of management actions can be taken to achieve population objectives for lake sturgeon. Some of the tools available to fishery managers include fishery regulations and enforcement to reduce fishing mortality, habitat rehabilitation to improve conditions or connectivity, stocking, and education. Use of these tools for the rehabilitation of this species should focus on: (1) minimizing or eliminating fishing mortality for populations with less than 750 adults and maintaining fishing mortality at or below 2–5% per year for large populations; (2) improving habitat conditions or access to spawning habitat; (3) supplemental stocking in populations where recruitment is limited and spawning habitat improvements are not feasible or cost effective; (4) working with the U.S. Fish and Wildlife Service to promote the most effective sea lamprey control techniques that still protect lake sturgeon populations; and (5) educating anglers and the general public about the plight of lake sturgeon to encourage them to participate in management and rehabilitation of this unique species.

Prioritization of management actions for lake sturgeon rehabilitation activities is necessary given limited fiscal and personnel resources and in consideration of management needs of other species across the state. Although a case-by-case evaluation will typically be needed, higher priority for action will be given to smaller populations that are above the minimum viable population size and populations that are experiencing declines of more than 30% over a 15-year period. Populations below minimum viable population size provide particular challenges, and management actions such as stocking should be considered only after the factors leading to such a depressed state are evaluated. Combining resources and encouraging cooperative participation by other state, federal, tribal, and provincial agencies and nongovernmental organizations will be required for the goal of lake sturgeon rehabilitation to be realized.

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Michigan's Lake Sturgeon Rehabilitation Strategy

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INTRODUCTION

Of the 29 species of sturgeon worldwide, only the lake sturgeon (*Acipenser fulvescens*) is native to Michigan. Lake sturgeon are the largest and longest living fish to swim in Michigan's waters, with the potential to weigh more than 250 lb and reach 150 years of age (Scott and Crossman 1973). These unique life history traits, along with delayed maturation, intermittent spawning, low natural mortality of adults, and high fecundity tend to buffer lake sturgeon from extremes in the environment (Peterson et al. 2006). These characteristics have contributed to the success of the species, but they have also put them at risk due to human-induced mortality and habitat changes.

The history of lake sturgeon in Michigan is characterized by three periods: abundance, scarcity, and rehabilitation. Prior to the mid-1800s, lake sturgeon were plentiful but often killed as a nuisance species for causing damage to fishing nets (Tody 1974). In the late 1800s, markets developed for sturgeon flesh, eggs, and organs, sparking a targeted fishery that caused substantial mortality and decimated stocks by the early 1900s (Tody 1974). The excess mortality was coupled with increases in logging and development of industry, which resulted in severe habitat degradation and widespread loss. Construction of dams prevented access to spawning sites, thereby reducing or eliminating recruitment for many populations. The species was considered to be on a path to extinction and largely ignored for much of the 20th century (Auer 1999). It was not until the late 1900s that rehabilitation became a priority. As a result of their low abundance and loss of recruitment, lake sturgeon were listed as threatened under the State of Michigan's Endangered Species Act (MCL 324.3605, 1994 PA 451) for more than 30 years. Other states and provinces around the Great Lakes region have recognized the value and uniqueness of this species and have taken similar protective action in hopes of rehabilitating depressed populations of lake sturgeon.

Lake sturgeon are a valuable species that deserve management action to increase populations that remain depressed. They are a key component of the native biodiversity of the Great Lakes ecosystem, a biodiversity that the Michigan Department of Natural Resources (MDNR), Fisheries Division, is entrusted to conserve (Biological Diversity Conservation Act; 1992PA 93). They serve an important role in the environment as a native benthivore, feeding on insects, crustaceans, and fish that occupy the benthos of lakes and rivers. Lake sturgeon attract public interest due to their large size, accessibility, and prehistoric appeal. In many areas they spawn in shallow water, attracting attention and offering a unique and unforgettable viewing experience. If populations are healthy and of a robust size, they can support a trophy fishery that provides the potential to catch a once-in-a-lifetime fish.

Lake sturgeon also serve an important cultural role in the lives of tribal people as described in the Nmé Stewardship Plan (LRBOI 2008).

In 1997, the MDNR completed the first lake sturgeon rehabilitation strategy (Hay-Chmielewski and Whelan 1997). That document served as a reference for decision making about lake sturgeon management in the State of Michigan. This document builds upon the 1997 strategy, incorporating advances in our knowledge of lake sturgeon biology and management, as well as an update on the management goals and objectives for this species. The primary goals for lake sturgeon management are to:

(1) develop self-sustaining populations across Michigan's jurisdictional waters of the Great Lakes and its tributaries to a level which would allow lake sturgeon to be removed from the list of state threatened species, and

(2) maintain some populations of sufficient size to provide fisheries that support the recreational and cultural desires of state and tribal fishers.

For this strategy, a population is defined as those individuals spawning within a major watershed. Populations fragmented by impassible dams may still exchange individuals and gametes; however, passage only occurs in the downstream direction. These population fragments may be treated differently for management and fishery regulations, but rejoining fragmented populations is an eventual goal. In the Great Lakes, assignment of individuals to populations can be difficult outside of the spawning season as populations are mixed in the lakes, and fish could stray into Michigan waters from other jurisdictions. Although lake sturgeon are listed as threatened statewide, the status of each individual population varies widely. As a result, the overall goal of developing self-sustaining populations can be broken down into three subgoals, which are to:

(1) conserve and maintain populations that are currently self-sustaining,

(2) rehabilitate depressed populations so they become self-sustaining at a higher abundance, and

(3) reintroduce lake sturgeon to suitable, vacant habitat.

In some areas of the state, lake sturgeon exist in large numbers (e.g., >750 adults), and efforts to ensure those populations maintain their abundance are a priority. Other populations persist but at a lower level. Whenever possible, rehabilitation strategies to increase these populations and move them towards self-sufficiency should be implemented. Where populations have become locally extinct (also known as extirpated), the probable reasons for the loss need to be identified and corrected before reintroduction should be considered. Candidate waters for reintroduction include those where appropriate habitat exists for self-sustaining or artificially-supported populations. Rationales for reintroductions include but are not limited to, native species rehabilitation, gene banking, fishery creation, and establishment of populations for social and cultural reasons.

The goals and subgoals presented above provide a long-term vision for guiding lake sturgeon management. However, given the species' life history attributes, realizing these goals will take decades. As such, a number of more specific, measurable, and time-constrained objectives are presented. Achieving individual objectives will move rehabilitation efforts towards the longer-term goal of lake sturgeon delisting.

The State of Michigan recognizes several treaties between the United States government and Native American Tribes residing in Michigan. Tribal governments' signatory to the 1836 and 1842 Treaties retained hunting, fishing, and gathering rights for tribal members. Tribal governments are sovereign nations who have their own regulations for fishing and are partners in conserving this resource for generations to come; however, they may view the management of lake sturgeon differently than the state.

Population Objectives

Two population characteristics were chosen as benchmarks in setting population objectives. Abundance of fish is a typical measure representing the current status of a population and was thus chosen as the first metric. Adult abundance (i.e., sexually mature individuals) was the focus because this life stage is the easiest to sample given their congregation in rivers during the spawning season and their vulnerability to common sampling gears outside the breeding season. The other population-level metric chosen for evaluation was trajectory or rate of change over time. This benchmark indexes whether or not a population is self-sustaining and helps identify priorities for population rehabilitation. Adult abundance and population trajectory are measurable attributes of lake sturgeon populations, but challenges (e.g., open populations, low density, need to sample nondestructively) exist in their practical estimation. Details of the many estimation techniques available for these metrics are beyond the scope of this document, but because of these challenges, population-level objectives are set within relatively coarse guidelines and case-by-case assessments may be necessary.

Based on these two metrics, adult abundance and population trajectory, categories were established for lake sturgeon populations throughout Michigan (Figure 1). Populations with adult abundances below 80 individuals were categorized as having populations below Minimum Viable Population level (MVP; Schueller and Hayes 2011a). These are populations where management efforts may be unsuccessful due to random environmental events and the effects of genetic inbreeding. Small populations were classified as those with adult abundances between 80 and 200 individuals, and these are at the highest risk of falling below the MVP. Populations between 200 to 750 individuals were categorized as medium, with a lowered but still present risk of extinction. The final category included populations with more than 750 adult lake sturgeon. These large populations were viewed as having a relatively low risk of extinction (Welsh et al. 2010). The separation points for the MVP and large populations were drawn from the literature (Schueller and Hayes 2011a, Welsh et al. 2010), but the separation point for the small/medium populations was largely based on professional judgment by the Fisheries Division, Lake Sturgeon Committee using experience with sturgeon populations and setting and implementing fishery regulations.

Each abundance category was then classified as increasing, stable, or decreasing as determined by the trajectory over a 15-year window, the approximate amount of time needed for male lake sturgeon to mature. Stable population trajectories were populations which experienced less than a 30% increase or decrease. Therefore, populations that are stable can still experience increases and declines. The 30% boundary for these categories was selected because lake sturgeon populations can be difficult to assess and measurement error is often high. The committee felt that a change of that magnitude could be detected via methods currently used to measure population abundance and trends. This 30% change would be subject to evaluation in a 15-year period of time.

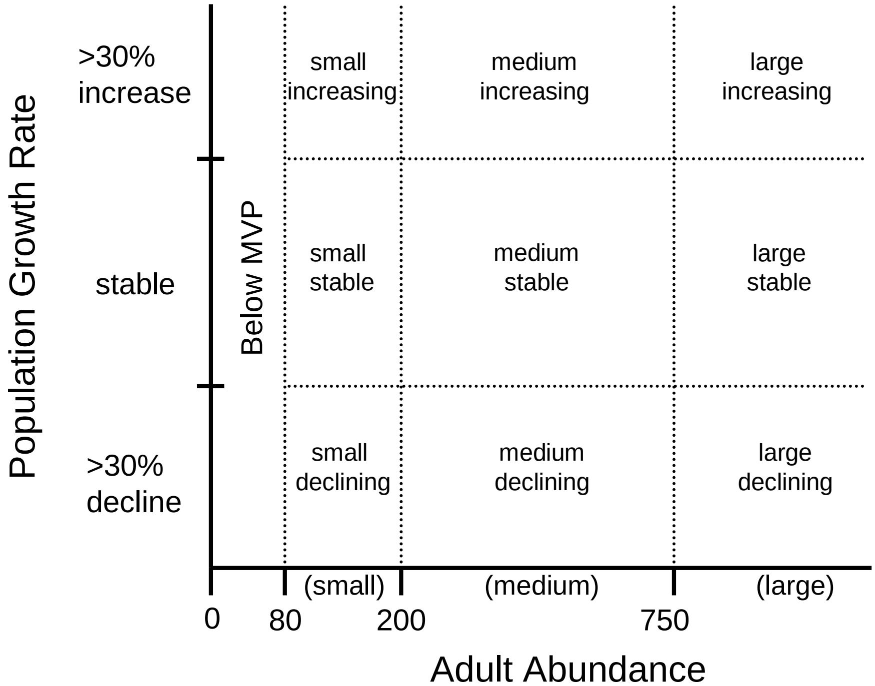

Figure 1.–General framework for placing lake sturgeon populations into categories based on knowledge of their adult population abundance and trajectory over a 15-year period.

Based on the established goals for lake sturgeon management and current population status by category, MDNR will use the following objectives as guidelines for lake sturgeon rehabilitation. The categorical objectives (1–4) and intended movement of populations between categories based on management strategies are graphically displayed in Figure 2.

Population Objectives**:**

1. Offset declines in populations that have been reduced by at least 30% over 15 years.
2. For stable populations, encourage practices that will cause expansion.
3. Maintain positive growth in populations that have increased by more than 30% in the last 15 years.
4. Evaluate populations that are below the minimum viable population size on a case-by-case basis to determine if management action is a prudent use of the limited resources available.
5. For areas with suitable habitat that currently lack a lake sturgeon population, restore or establish new populations of lake sturgeon with suitable genetic practices. This objective is a low priority and should be pursued opportunistically through collaborative efforts.

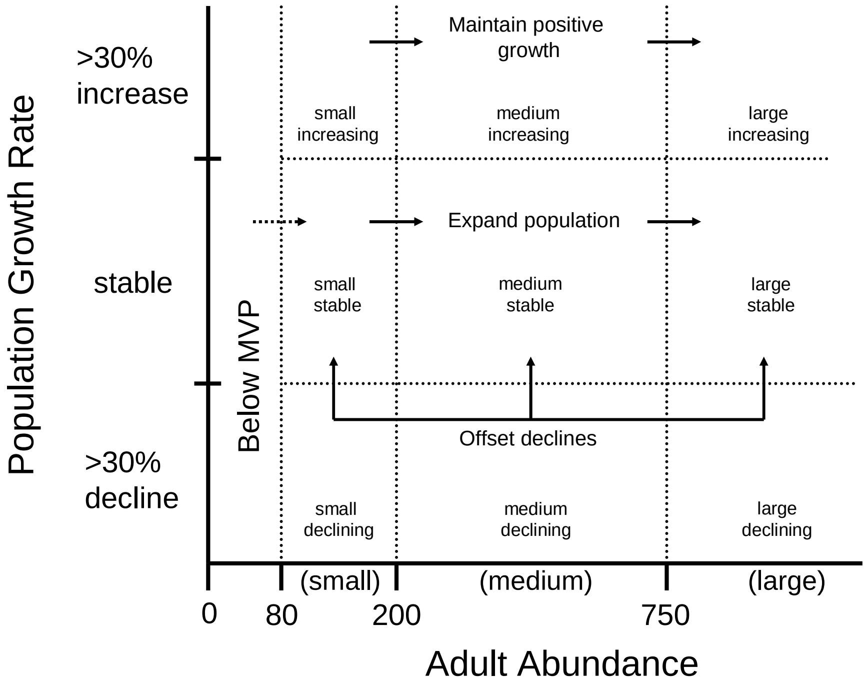

Figure 2.–Population objectives for lake sturgeon based upon categorical classification of individual populations by abundance and trajectory over a 15-year period, solid arrows represent desired movement of populations, broken arrow represents possible movement of populations below MVP after careful evaluation on a case-by-case basis.

Because of their low numbers and inherent sampling difficulty, abundance and trajectory data are lacking for some lake sturgeon populations. When making management decisions in such cases, MDNR has and will continue to use best professional judgment and the precautionary principle, ensuring that conservative and protective actions are taken if uncertainty exists about a population. The status and trajectory of all known lake sturgeon populations in Michigan were compiled for a starting reference (Table 1).

Table 1.–Size and category for known lake sturgeon populations in Michigan. MVP = Minimum Viable Population, MDNR = Michigan Department of Natural Resources, LRBOI = Little River Band of Ottawa Indians, LSSU = Lake Superior State University, USFWS = U.S. Fish and Wildlife Service.

Watershed Population	Estimated adult population size	Category	Source, Affiliation
Lake Superior			
Ontonagon River [a, b]	<25	Below MVP	Ed Baker, MDNR
Sturgeon River [c]	1,808	Large stable	Ed Baker, MDNR
Lake Michigan			
Cedar River [a, b]	<25	Below MVP	Ed Baker, MDNR
Grand River [c]	103	Small declining	Kregg Smith, MDNR
Indian Lake [a]	60	Below MVP	Dave Caroffino, MDNR
Kalamazoo River [c]	88	Small declining	Kregg Smith, MDNR
Manistee River [a, c]	400	Medium stable	Marty Holtgren, LRBOI
Manistique River [a]	<25	Below MVP	Steve Scott, MDNR
Big Manistique Lake [a]	<25	Below MVP	Steve Scott, MDNR
Menominee River [c, d]	5,272	Large stable	Ed Baker, MDNR
Millecoquins Lake [a]	<25	Below MVP	Steve Scott, MDNR
Muskegon River [c]	166	Small increasing	Kregg Smith, MDNR
St. Joseph River [a]	<25	Below MVP	Kregg Smith, MDNR
Lake Huron			
Au Sable River [a]	<25	Below MVP	Steve Sendek, MDNR
Black Lake [c]	1,125	Large stable	Ed Baker, MDNR
Burt Lake [b]	100	Small stable	Ed Baker, MDNR
Carp River [a]	<25	Below MVP	Roger Greil, LSSU
Mullett Lake [b]	<25	Below MVP	Ed Baker, MDNR
Otsego Lake [a, e]	500	Medium stable	Tim Cwalinski, MDNR
Rifle River [a]	<25	Below MVP	Jim Baker, MDNR
St. Marys River [c]	354	Medium stable	Bauman et al. 2011
Saginaw River [a]	<25	Below MVP	Jim Baker, MDNR
Lake Erie			
St. Clair River/Lake St. Clair [c]	15,882	Large stable	Mike Thomas, MDNR
Detroit River [c]	4,838	Large stable	Justin Chiotti/Jim Boase, USFWS

[a] Estimate is based on public reports, observation, bycatch, and professional judgment. For consistency, all areas where estimates were well below MVP, abundance was considered to be <25 adults.
[b] Populations that were either extinct or below MVP but are anticipated to increase as a result of recent stocking.
[c] Estimate is based on mark-recapture analysis.
[d] Menominee River estimate includes all river segments, which are currently fragmented by dams.
[e] Otsego Lake's population is nonnative and was created through stocking experiments, which provide fishing opportunities regardless of population size.

POPULATION MONITORING

In many areas throughout Michigan, the estimates of lake sturgeon abundance are based on professional judgment. This is in part due to the inherent difficulty and expense of sampling small populations and reflects the need for better monitoring of our existing populations throughout the state. As part of the resource management process, information on the status of lake sturgeon populations is critical for evaluating progress toward objectives and adjusting management actions where needed to meet these objectives. The unique biology of this species presents particular challenges toward their assessment, and each population poses situation-specific challenges and opportunities. In addition, fiscal and personnel limitations affect the ability of MDNR to assess all lake sturgeon populations, and prioritization is needed to identify the situations where an assessment is most critically needed.

Given the 15-year time frame set for analysis of trajectory, populations should be evaluated at least that often. More frequent assessment of some populations may be desired, but the benefit of more information about a particular population must be weighed against the cost of less information about another. Absolute abundance estimates are necessary to determine population status and management options, and many methods are available for making them. Both open and closed population estimators have been used to determine abundance for Michigan waters (Baker and Borgeson 1999, E. Baker and M. Thomas, MDNR, personal communication). The preferred method for estimating adult abundance in Michigan waters will be specific to each population and sampling regime designed by the investigators, taking into account the size of the population, time of year, and type of sampling. If adult lake sturgeon can be effectively captured using large-mesh gill nets or set lines during nonspawning times of the year, abundance may be estimated during a single year. However, if sampling is to occur on the spawning grounds, the fact that lake sturgeon adults do not return each year to spawning streams requires that assessments occur annually over a 4–5 year period using an open population model.

Regardless of survey timing or duration, all lake sturgeon captured provide opportunities for short and long term data collection. Lake sturgeon are large enough to allow a broad range of marking options, all of which have little or no effect on the fish or their behavior. MDNR has used passive integrated transponder (PIT) tags for nearly a decade and they remain the preferred tagging method. These tags contain a unique 15-digit number than can be read electronically by passing a wand over the fish. The ability to uniquely mark each fish allows valuable data on movement, growth, and behavior to be collected at each recapture event, which may be many given the longevity of the species. In addition, capture and handling of lake sturgeon provides an opportunity for collection of tissue samples which can be used or stored for genetic analysis.

Priorities for population monitoring should focus on where the information provided will be most useful in distinguishing among management options. We recommend the following priorities:

1. Populations with a harvest fishery where abundance estimates are needed to set fishery regulations or to allocate harvest.
2. Populations perceived to be near the cutoff for MVP.
3. Populations currently classified as declining.
4. Populations currently classified as stable, with higher priority for smaller populations.
5. Populations currently classified as increasing, with higher priority for smaller populations.

Not all harvest fisheries fall under the first priority, only those that require a population estimate to set a quota and allocate sturgeon harvest under the terms of the 2007 Consent Decree. Other harvest fisheries that do not require a population estimate for setting a quota are given a lower priority according to their trajectory and size. Data on whether a population is above or below a minimally viable level is important for determining which management resources, if any, should be devoted to a particular population. The final three categories were prioritized based on the relative level of risk for each population. Those that are declining are at more risk that those that are stable, which are at more risk than those that are increasing, and prioritization should follow that risk gradient. In each of these instances, population monitoring should also be prioritized by size, with small populations taking precedence.

MANAGEMENT APPROACHES

Threats to lake sturgeon population persistence and recovery in Michigan are similar to other sturgeon species worldwide. Major obstacles include excess mortality rates caused by fishing or other sources, reduced spawning habitat as a result of physical barriers, and general degradation of habitat required by each life stage (Rochard et al. 1990). The sections below discuss the effects of these and other threats as well as general management approaches for conservation and rehabilitation of this species in Michigan.

Addressing Mortality Limitations

In Michigan, adult lake sturgeon experience mortality from two broad sources, natural causes and humans. Natural mortality includes old age, disease, predation, and parasitism, and also some human-induced causes including boat strikes and impingement and entrainment on screens protecting water sources. Estimates of lake sturgeon natural mortality have ranged widely depending on location, population, and method chosen (Baker 1980; Nowak and Jessop 1987; Dumont et al. 1987). However, Bruch (2009) estimated natural mortality for the Lake Winnebago population of lake sturgeon using a statistical-catch-at-age model and reported a value of 5.4%, similar to what is reported in the literature for this and other sturgeon species (Baker 1982; Woodland 2005; Killgore et al. 2007). Lake sturgeon populations are highly sensitive to changes in rates of adult mortality (Velez-Espino and Koops 2009; Schueller and Hayes 2010), and because MDNR does not have direct control or influence over many of the natural mortality factors, human-induced mortality will generally need to be limited or even absent to balance the total mortality equation to ensure long-term viability of a population.

Fishery regulation–The MDNR works cooperatively with tribes signatory to the 1836 Treaty of Washington Consent Decree regarding lake sturgeon harvest opportunities; however, the state does not regulate tribal fishing of lake sturgeon, and individual tribes throughout the 1836 and 1842 Treaty-ceded waters set regulations for their members. Accordingly, the sturgeon fisheries discussed in this plan reference recreational fishing by state anglers; however, fishing mortality rates apply to extractions by all individuals regardless of affiliation.

Commercial fishing for sturgeon has been prohibited in all United States waters of the Great Lakes since 1977, and this regulation should be continued to minimize fishing mortality rates. However, lake sturgeon may be captured as by-catch in commercial fisheries. Commercial fishermen have cooperated with the MDNR and the U.S. Fish and Wildlife Service (USFWS) to collect biological data and tag lake sturgeon by-catch. This is an important information gathering partnership that is encouraged to continue.

Lake sturgeon are listed under the State of Michigan's Endangered Species Act and harvest of a state threatened species is regulated under that act. A person may not take, possess, transport, import, export, process, sell or offer for sale, buy or offer to buy, any state-determined threatened species. However, the taking of a threatened species, when it has been determined that its abundance justifies a controlled harvest, is not in violation of the law and is an acceptable practice in specific locations

(MCL 324.3605, 1994 PA 451). As such, an important consideration is the level of abundance that would justify a controlled harvest.

Two fishery regulatory schemes are available for management of lake sturgeon in Michigan: catch and release and harvest. A catch and release fishery allows anglers to target a specific species of fish, then upon landing the fish it must be immediately released back into the water unharmed. Direct estimates of hooking and handling mortality are unavailable for lake sturgeon. Even though sturgeon are a hardy fish, evidence for white sturgeon suggests that hooking mortality may range between 2 and 4% (Jager et al 2002; Jager 2005). A harvest fishery refers to anglers targeting and removing fish from a population. Within harvest fisheries, many anglers release their catch, so mortality occurs through hooking and handling, as well as harvest.

Sturgeon fishery regulations should be based on population size and trajectory in order to limit fisheries to populations that could support such practices; the overall strategy is outlined in Figure 3. Because of the risk of extirpation for small populations and their sensitivity to even low amount of hooking and handling mortality, directed fisheries (i.e., the ability to target lake sturgeon specifically) on populations of less than 200 adults should be prohibited. Consistent with objectives for medium populations and large populations in decline, only catch-and-release fisheries should be considered for these populations. Expanding and stable large populations may have harvest fisheries, but possibly at different rates, depending on the specific objectives for each population. Several values have been proposed as sustainable fishing mortality rates, generally ranging from 2 to 5% (Priegel and Wirth 1975, Bruch 2009). Observations from Lake Winnebago (Bruch 2009) suggest that for populations to increase, the fishing mortality rate should not exceed 2% of the adult population each year. For those populations that have reached carrying capacity or continue to produce surplus production, a fishing mortality rate not to exceed 5% should allow the population to sustain itself, assuming other mortality sources are not high (e.g., natural mortality <6%) and recruitment is sufficient to offset mortality.

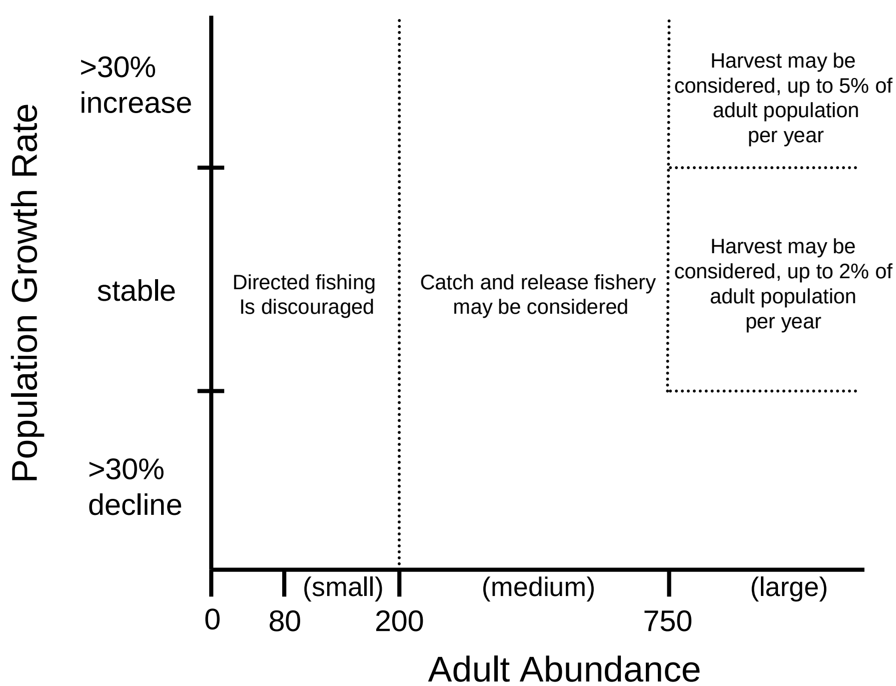

Figure 3.–Fishery considerations for single lake sturgeon populations based upon population size and trajectory over a 15-year period.

The guidelines for each population category should be the basis of lake sturgeon fishery regulations. The suggested mortality rates are maximums, and lower rates may be warranted for some populations that provide benefits beyond fishing (i.e., broodstock sources, key watchable wildlife populations, or critical research information). Minimum size limits that have the potential to shift harvest pressure to large females are discouraged. If harvest of large sturgeon is not a management goal, slot limits, the details of which have not yet been biologically evaluated for lake sturgeon, may provide harvest potential and protection for a large portion of the spawning stock. Seasonal bag limits are appropriate as are seasonal closures to protect highly vulnerable spawning and staging fish. Catch and release fisheries should also be limited to nonspawning times of the year. Currently, directed sturgeon fishing is allowed statewide from mid-July through November. The tools to manage lake sturgeon fishing and harvest are many, but regulations should be implemented and evaluated on a case-by-case basis to ensure that total mortality does not reach a level that impedes rehabilitation objectives. Mandatory registration of all lake sturgeon harvested is currently practiced and allows MDNR to collect valuable biological and harvest information. This practice should continue until populations and harvest levels reach a size where it is impractical or unnecessary.

Illegal harvest can rapidly reduce sturgeon populations, and can seriously undermine rehabilitation efforts. Illegal harvest is of particular concern for sturgeon populations that visibly spawn in shallow water, but it can negatively affect any population. The success of concerned citizens in reducing illegal harvest on Black Lake indicates that coordinated efforts between law enforcement and the general public can be an effective approach to fight this problem. During all times of the year, the MDNR should continue to seek assistance from the public to report and identify illegal harvest.

Sea lamprey–Sea lampreys do not affect inland populations of lake sturgeon, but they have the potential to contribute to natural mortality in Great Lakes populations both directly and indirectly. The abundance of sea lamprey varies throughout the Great Lakes, as does their effect on lake sturgeon. Although the extent of lamprey-induced mortality on lake sturgeon throughout the Great Lakes remains largely unknown, wounding rates as high as 22% were observed in the St. Marys River (Sutton et al. 2004). Large adult lake sturgeon can withstand and survive attacks; whereas, sub-adults and young mature adults may not (Patrick et al. 2009). Lake sturgeon that survive an initial attack from a sea lamprey are still at increased risk for secondary infection at the wound site, which can lead to mortality (Patrick et al. 2009). In addition to these direct effects of sea lamprey, the control program for this species can unintentionally lead to negative effects on lake sturgeon. In particular, application of the chemical 3-trifluoromethyl-4-nitrophenol (TFM) can occasionally result in mortality of age-0 juvenile lake sturgeon. Further, sea lamprey barriers, both physical and electric, fragment and reduce lake sturgeon habitat in similar ways to dams.

Historically, treatment of streams for sea lamprey control had the potential to negatively affect lake sturgeon recruitment. A revised treatment protocol was developed for applications of TFM to streams where lake sturgeon were thought to exist. This called for lower doses and stream treatments later in the season to reduce potential mortality of juvenile lake sturgeon; however, this resulted in reduced effectiveness of the treatments for killing lamprey. Population modeling has suggested that if adult lake sturgeon mortality increases as a result of higher lamprey abundance it would be more detrimental to populations than periodically affecting recruitment (Sutton et al. 2004). The revised treatment protocol has been widely applied in the past, including many rivers without documented natural reproduction of lake sturgeon. The protocol has been modified in recent years to improve lamprey killing efficiency while still protecting lake sturgeon (M. Fodale, USFWS and G. Whelan, MDNR, personal communication). However, the modified TFM treatment protocol should only be applied where documented natural reproduction of lake sturgeon occurs. In areas where lake sturgeon reproduction has not been documented, application of the sturgeon protocol creates unnecessary risks to the Great Lakes fish community.

Addressing Recruitment Limitations

Mortality is not the only challenge facing lake sturgeon populations. Once mortality is controlled, opportunities exist to expand the populations. Lake sturgeon reproduce and rehabilitate themselves very slowly, thus management to assist the rehabilitation through directly enhancing populations and their habitat are critical to the rehabilitation of lake sturgeon populations.

Habitat rehabilitation and evaluation–Throughout Michigan, lake sturgeon continue to be limited by habitat. Degradation of spawning and nursery habitat, as well as barriers reducing access to these habitats are the primary causes of recruitment limitations leading to population decline (Auer 1999). Thus, protecting currently occupied lake sturgeon habitats and providing access to previously inaccessible habitats through enhanced fish passage is crucial to maintaining the status of healthy sturgeon populations. Addressing habitat limitations for degraded populations is a critical long-term goal.

Habitat projects should be prioritized based on their size, cost, and potential benefits. Most large-scale habitat projects provide benefits to multiple species and are likely the most effective at achieving the goal of long-term self-sufficiency for lake sturgeon. The nature of lake sturgeon and their threatened status often provide strong justification for pursuing habitat rehabilitation when opportunities are presented. Maintenance of high quality riparian zones and natural patterns of stream flows through regulatory review is necessary to ensure that critical habitat requirements are protected.

To determine which waters have the highest probabilities of successful rehabilitation or establishment of lake sturgeon populations, rivers and lakes throughout Michigan were evaluated by Hay-Chmielewski and Whelan (1997). The goal of this analysis was to support prioritization efforts for habitat work that could benefit lake sturgeon populations. The priority list (documented in Hay-Chmielewski and Whelan 1997) should be updated with new data. Quantitative habitat assessments, similar to those completed by Daugherty et al. (2009), are encouraged as they would provide more detailed information regarding the needs and potential for habitat rehabilitation in each body of water evaluated. This information could be used to prioritize the limited resources available for habitat projects.

Stocking–Stocking is one of the key tools of fisheries management and has a role in lake sturgeon rehabilitation. In cases where addressing habitat limitations to spawning are infeasible or cost-prohibitive, stocking is the primary means of ensuring a population can persist or grow until habitat can be improved and self-sustaining status can be achieved. Only eight populations in Michigan waters are believed to be self-sustaining: Muskegon River, Manistee River, Black Lake, Menominee River, Sturgeon River, St. Marys River, Lake St. Clair/St. Clair River, and the Detroit River (Baker 2006; J. Chiotti, USFWS, personal communication). Stocking is an appropriate management tool for increasing abundance because of lake sturgeon’s naturally slow life cycle. All lake sturgeon stocking should follow best management practices for genetic conservation, and the plans outlined in this document closely follow those recommended by Welsh et al. (2010).

Production of lake sturgeon for rehabilitation is limited by available funds and space, requiring a strategy for prioritizing waters for stocking. Goals for sturgeon stocking may range from creating a large, self-sustaining population to immediately rescuing a population from the threat of extirpation. Goals should be explicit in any stocking proposal to facilitate the necessary prioritization. Stocking proposals will be prioritized based on the hatchery resources available and the candidate waters available to receive fish. Generally, proposals designed solely for creation of a fishery will be prioritized lower than those seeking to rescue or rebuild a population. Given production capacity limits and cost, MDNR cannot stock all areas and will prioritize populations based on size and trajectory. With a focus on achieving self-sufficiency of populations and protecting the genetic integrity of the species as a whole, the priority stocking efforts are for:

1. Small-declining populations which are above MVP (80 adults)
2. Small-stable populations and medium-declining populations
3. Medium-stable populations
4. Populations below MVP (discussion below)
5. Extinct or new populations

This prioritization was chosen in order to maintain genetic integrity, rescue populations from the threat of extirpation, and facilitate achievement of population objectives. As such, it is important to note that supplementation is not recommended for populations within the increasing category since they are likely to reach population objectives on their own, without the risks (e.g., domestication selection) that stocking incurs. Likewise, stocking is not recommended in large stable or large decreasing populations. Large stable populations already show evidence of being self-sustaining at a high level and stocking is not necessary. For large decreasing populations, the focus should be on determining why the population is declining rather than on simply supplementing it; however, if abundance declines to the point that the population falls into the medium category, stocking would then become a priority. Within the classes of populations where stocking is needed to achieve objectives, small, declining populations above MVP were given the highest priority because they are in the most serious jeopardy. Small stable populations and medium declining populations likely face similar risk of degradation without stocking, and were next in the priority list. Populations below MVP are proposed to be fourth in priority, and the special situation of these populations is discussed below. Finally, locations where lake sturgeon formerly occurred but are now extinct, and locations where lake sturgeon were not known to occur fall last in the priority list since stocking in these locations will not likely lead to self-sufficient populations.

Populations below MVP were given a low stocking priority for several reasons. One major concern is that populations with such low abundance likely reflect situations with multiple limitations on the population, and until the cause of the low abundance is addressed, successful spawning and recruitment will likely not occur. The circumstances surrounding each population below MVP are likely to differ, and each of these situations should be evaluated on a case-by-case basis. For those populations well below MVP, management efforts are unlikely to succeed; however, populations near MVP may be treated more like small populations and receive higher priority. Further, obtaining gametes directly from populations with such a low abundance is likely to be difficult, create genetic bottlenecks in offspring, and of low cost effectiveness. However, supplementation simulations suggest that only a relatively small number of progeny is needed to raise a population above MVP (Schueller and Hayes 2011b). Thus, if progeny from another population are genetically similar, populations below MVP may be “rescued” at relatively low cost.

If stocking is warranted, an appropriate donor stock must be available. Many sturgeon populations are genetically distinct, such that progeny for stocking should preferentially come from within the population being stocked. In situations where this is not feasible (e.g., capture of spawning adults is difficult) stocking from a closely related population can be considered (Welsh et al. 2010). Lake sturgeon within the Great Lakes Basin have been classified into genetic stocking units (GSU), which are groups of populations based on genetic similarity. These GSUs provide managers with guidance when choosing a donor stock (Welsh et al. 2010). In Michigan waters, four GSUs have been identified: Sturgeon River (Lake Superior), the St. Marys River, Green Bay, and all populations tested in the Lower Peninsula (Welsh et al. 2008, Welsh et al. 2010, J. Comben, Lake Superior State University, unpublished data). All donor populations should be within the same GSU as the target population and be large enough to provide acceptable levels of genetic diversity over the duration of the stocking program and have surplus gametes available so as not to harm the donor population.

The number of sturgeon that should be stocked will depend on population status, proposed longevity of the stocking program, and the estimated survival to maturity of the life stage chosen for stocking (Welsh at al. 2010). MDNR should use two strategies for stocking lake sturgeon. The goal of the first will be to restore a self-sustaining population at a rehabilitated population size of 750 sexually mature adults. To maximize genetic diversity, the target stocking time period should span a generation so that no single year class of progeny or adult crosses contribute disproportionately to the population (Miller and Kapuscinski 2003). Welsh et al. (2010) outline potential numbers to stock depending on assumed survival rates to adulthood. The goal of the second stocking strategy is to rescue populations that are at high risk of extirpation, such as those near MVP. This strategy can be used to maintain populations when hatchery resources are not available to begin or sustain a full-scale rehabilitation effort. Details on the number to stock and time frame will be case specific.

All lake sturgeon stocked must be marked to identify them as hatchery-reared fish. A variety of methods have been used, but most recently coded-wire tags have been used. Although these tags have a number associated with them, their use in lake sturgeon is only for presence or absence of a tag as lethal sampling is required to read the tag number. PIT tags have also been used to mark juvenile lake sturgeon. This is the preferred method of marking juveniles greater than 150 mm, as it allows nonlethal identification of unique individuals and a much broader range of information to be obtained. Whatever tagging method is used, the marking of hatchery fish allows the success of stocking programs to be evaluated and helps determine if natural reproduction is occurring within a supplemented population.

Managing adult mortality is the primary focus for lake sturgeon, but if populations are to persist or grow, recruitment must at minimum replace every adult that dies. While stocking is often a necessary tool for lake sturgeon rehabilitation, it should be viewed as a temporary option. The goal for lake sturgeon management is to produce self-sustaining populations, not those that require perpetual stocking. Natural reproduction that leads to adult recruits is critical to the long-term health of sturgeon populations in Michigan and can be measured either early in life (larvae, age-0 juveniles) or just prior to adult recruitment (10–20 years after hatch). The best method and time for evaluating the success of natural reproduction will depend on the population and resources available. If natural reproduction is absent or limited and stocking is required to maintain a population, there is an underlying problem limiting natural reproduction that should be identified and addressed when possible.

Education

Education is key to increasing interest in lake sturgeon and will promote the species, encourage wise use of the resource, and discourage illegal harvest. Fisheries professionals and the general public alike are fascinated by lake sturgeon because of their longevity, size, prehistoric nature, and historical and cultural significance throughout Michigan and the Great Lakes. Lake sturgeon are Michigan's charismatic fish megafauna. MDNR should actively promote the story of the lake sturgeon and educate the public about the uniqueness of this species. As more people become aware of the species and the threats it continually faces, they will be more likely to join the rehabilitation efforts or report those who attempt to stall them. Lake sturgeon rehabilitation will be most likely to succeed if MDNR can partner with other governmental agencies, interest groups (e.g. Sturgeon for Tomorrow), and members of the public to protect current populations and improve communication about goals and desires.

Nonprofit organizations are critical to engaging the public to protect this resource and to advance awareness about sturgeon. In addition to providing information about lake sturgeon to the public, these organizations devote time to protecting the lake sturgeon from poachers during spawning migrations with innovative sturgeon guarding programs. The MDNR needs to continue to engage these groups, encourage their participation in lake sturgeon management, and facilitate their activities with the public.

IMPEDIMENTS

MDNR has substantial knowledge and expertise for effectively managing lake sturgeon; however, monetary and personnel resources remain limiting. Lake sturgeon are only one component of the fish biodiversity in the State of Michigan. Available management resources have to be divided to address all of the diverse interests and resources that the state holds in trust for its citizens. While significant progress has been made on our understanding and knowledge of sturgeon biology and life history requirements since the 1997 rehabilitation strategy, lake sturgeon management is still impaired by several information gaps. The following three issues have been identified as most critical.

Fish passage–Connectivity of habitats is a key issue for lake sturgeon rehabilitation. Although dam removal provides the most effective means of removing impediments to spawning migration and should be the first option examined, removal is not always feasible. Consequently, MDNR should encourage opportunities to test innovative lake sturgeon passage technologies in Michigan waters. As effective methods of passage are developed and implemented, connectivity to historic spawning and nursery habitat can be improved. Lake sturgeon are entrained and killed by hydroelectric powerhouses and spillways. To fully allow fish passage, it is essential that lake sturgeon are protected while moving downstream from spawning, rearing, and feeding habitats and effective downstream passage technologies should be developed in cooperation with other state, federal, tribal, and provincial management agencies as well as the private sector. Once suitable passage methods have been identified, monetary resources would need to be allocated and installation carried out in conjunction with Federal Energy Regulatory Commission licensing and relicensing proceedings along with other voluntary and regulatory proceedings.

Hatchery needs–The ability of MDNR to raise lake sturgeon continues to be limited by space, expense, and availability of gametes. Development of alternative culture methods is needed to produce larger numbers of lake sturgeon at a lower cost with a low risk of straying. Feed for lake sturgeon culture remains costly. There is a continuing need to test artificial food sources to decrease the cost of rearing lake sturgeon. In some areas, gametes, fertilized eggs, or even larvae are captured from the wild and reared for up to four months in a hatchery trailer located adjacent to the source stream. This process is known as streamside rearing and may provide benefits beyond a traditional hatchery (Holtgren et al. 2007). Continued evaluation of streamside rearing relative to traditional hatchery settings is needed, both in terms of overall cost effectiveness as well as effects on juvenile imprinting. The limited availability of gametes that represent the genetic diversity of lake sturgeon throughout the state also impairs culture options. As rehabilitation progresses and more populations enter the large size category, they may become eligible to be used as broodstock sources, allowing for enhancement of more populations as culture facilities are available.

Genetic stock analysis–To ensure that genetically appropriate sources are used for supplementation or reintroduction, continued refinement of the GSUs is critical (Welsh et al. 2010). Some populations in Michigan have not yet been genetically described, and the potential for unique populations to exist remains. The genetic composition of existing populations should continue to be monitored to evaluate the rate of change in genetic diversity. These data should be used to guide selection of broodstock sources and to ensure that any harvest strategy protects this species and unique population segments.

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