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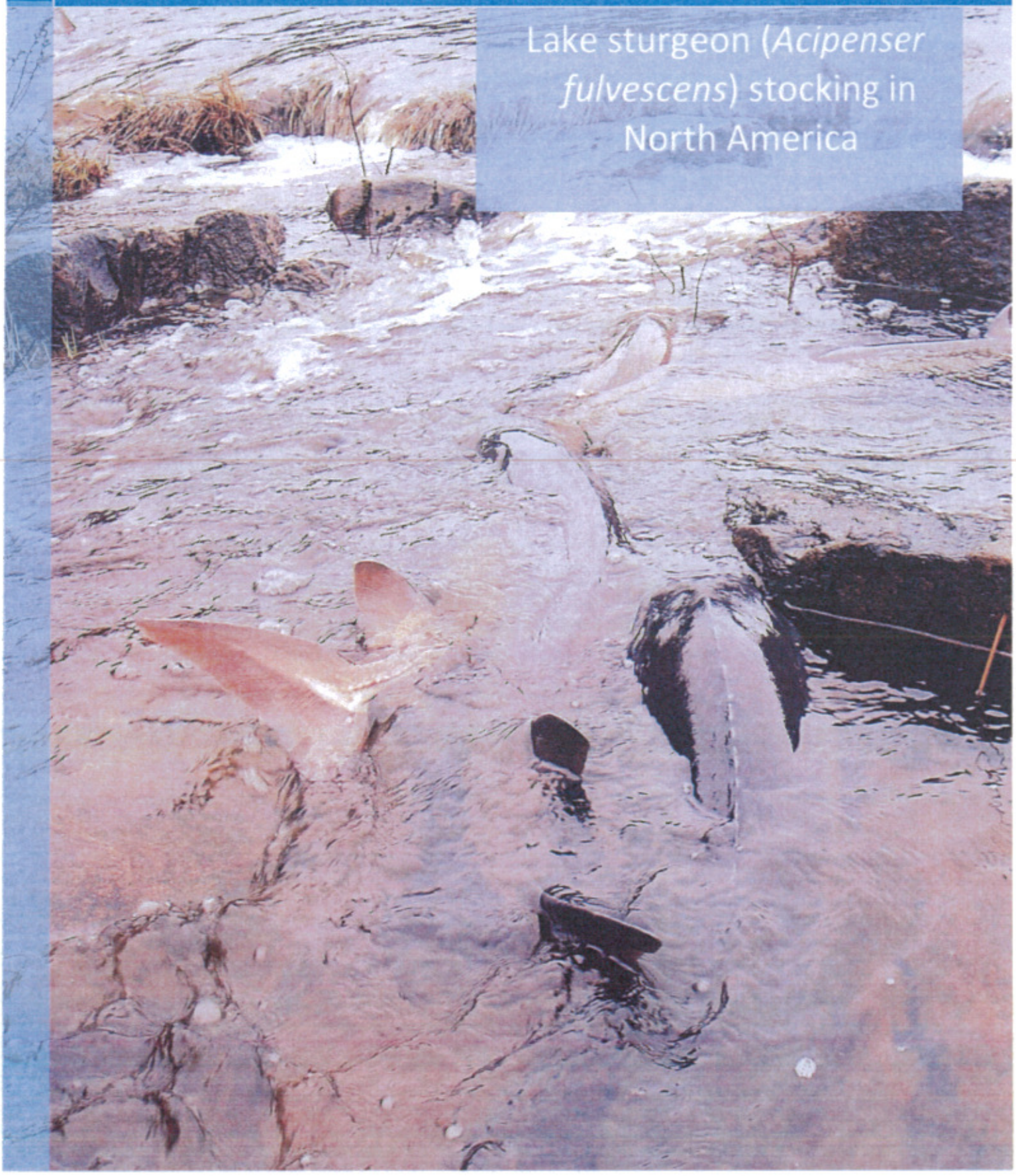
Lake sturgeon (*Acipenser fulvescens*) stocking in North America



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Cover photo: Lake sturgeon spawning in Northern Ontario River (photo courtesy of David Barbour, OMNR)

Cette publication hautement spécialisée : Aquatic Research Series (ongoing series of reports) *Lake Sturgeon (Acipenser fulvescens) Stocking as a Management Tool in North America* n'est disponible qu'en anglais en vertu du Règlement 411/97, qui en exempte l'application de la Loi sur les services en français. Pour obtenir de l'aide en français, veuillez communiquer avec le ministère {Amanda Smith} au {Amanda.smith@ontario.ca}.

Executive Summary

Currently many Ontario lake sturgeon (*Acipenser fulvescens*) populations remain at low levels as a result of unregulated commercial harvests in the late 1800s and large scale habitat alterations over the past century. In September 2009, lake sturgeon in northwestern Ontario and the Great Lakes-Upper St. Lawrence River drainages were listed as "threatened" and populations in the Hudson Bay-James Bay drainage were designated as "special concern" by the Committee on the Status of Species at Risk in Ontario (COSSARO).

In accordance with the *Endangered Species Act, 2007*, the Ministry of Natural Resources must ensure a recovery strategy is prepared for this species. The recovery strategy will provide science-based recommendations for the Minister of Natural Resources and other interested parties on the protection and recovery of lake sturgeon in Ontario. This background report has been assembled to consolidate information on lake sturgeon stocking to be considered during the preparation of a recovery strategy.

Stocking has been used as a management strategy to rehabilitate or reintroduce lake sturgeon throughout their range in North America. This document consolidates information on lake sturgeon stocking programs, provides insight on the common factors affecting programs, evaluates the use of stocking as a management tool, and examines practices currently adopted by various management agencies.

Lake sturgeon stocking has occurred for over 20 years in some North American jurisdictions. Wisconsin and Michigan have the most advanced stocking programs and management experience. Overall, effective stocking strategies for lake sturgeon are limited due to the life history characteristics of slow maturity and long life expectancy.

Stocking as a conservation strategy may be an essential tool required to rehabilitate selected lake sturgeon populations. A stocking strategy has the potential to have negative impacts on wild populations and should only be applied where a strong biological rationale exists and where other strategies have been deemed unsuitable for achieving management objectives.

Sommaire

À l'heure actuelle, bon nombre des populations d'esturgeon jaune (*Acipenser fulvescens*) de l'Ontario sont faibles en raison de la pêche commerciale non règlementée de cette espèce vers la fin des années 1800 et des altérations importantes de son habitat survenues au cours du siècle dernier. En septembre 2009, l'esturgeon jaune du Nord-Ouest de l'Ontario et des bassins versants des Grands Lacs et du Saint-Laurent était désigné comme espèce menacée, et les populations d'esturgeon jaune du bassin de la Baie d'Hudson et de la Baie James étaient désignées comme espèce préoccupante par le Comité de détermination du statut des espèces en péril de l'Ontario (CDSEPO).

Aux termes de la *Loi de 2007 sur les espèces en voie de disparition*, le ministère des Ressources naturelles doit veiller à formuler une stratégie de rétablissement pour cette espèce. Cette stratégie fournira au ministre des Richesses naturelles et aux autres parties intéressées des recommandations basées sur des travaux scientifiques destinées à protéger et à rétablir les populations d'esturgeon jaune en Ontario. Ce document d'information a été préparé dans le but de réunir les données sur l'empoissonnement de l'esturgeon jaune à prendre en compte dans l'élaboration d'une stratégie de rétablissement.

L'empoissonnement a constitué une stratégie de rétablissement ou de réintroduction de l'esturgeon dans l'ensemble de ses habitats en Amérique du Nord. Le présent document réunit des renseignements sur les programmes d'empoissonnement de l'esturgeon, explique les facteurs qui ont une incidence sur ces programmes, évalue l'empoissonnement comme outil de gestion et examine les pratiques actuelles de divers organismes de gestion.

L'empoissonnement de l'esturgeon jaune est pratiqué depuis plus de 20 ans sur certains territoires d'Amérique du Nord. Le Wisconsin et le Michigan sont dotés des programmes d'empoissonnement les plus évolués et d'une expérience poussée de la gestion des populations. Dans l'ensemble, l'efficacité des stratégies d'empoissonnement d'esturgeon de lac est limitée par la maturité lente et la longue espérance de vie de l'espèce.

L'empoissonnement peut s'avérer une stratégie de conservation essentielle au rétablissement des populations d'esturgeon jaune ciblées. Elle peut cependant nuire aux populations sauvages et devrait uniquement être utilisée si le contexte biologique le justifie et si d'autres stratégies ne conviennent pas aux objectifs de gestion.

Table of Contents

Introduction

This report is intended to provide background information on lake sturgeon (*Acipenser fulvescens*) stocking for population rehabilitation or reintroduction.

At the national level, lake sturgeon populations have been identified as special concern, threatened, and/or endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In Ontario, COSEWIC identified five designatable units for lake sturgeon (Table 1). The COSEWIC recommendations for lake sturgeon are currently being considered for listing under the federal *Species at Risk Act*.

Table 1. Ontario lake sturgeon designatable units classified by COSEWIC.

Designatable Unit	Classification
Red-Assiniboine rivers – Lake Winnipeg (DU4)	Endangered
Winnipeg River-English River (DU5)	Endangered
Lake of the Woods-Rainy River (DU6)	Special Concern
Southern Hudson Bay and James Bay (DU 7)	Special Concern
Great Lakes and western St. Lawrence River (DU8)	Threatened

An "endangered" species is one which is found in the wild but is in danger of facing imminent extinction. A "threatened" species is any species that lives in the wild in Ontario and is likely to become endangered if steps are not taken to address factors threatening to lead to its extinction. A species of "special concern" is a species which may become threatened or endangered because of a combination of biological characteristics and identified threats.

At the provincial level, lake sturgeon have been assigned status by the Committee on the Status of Species at Risk in Ontario (COSSARO) under Ontario's Endangered Species Act. The northwestern Ontario and Great Lakes-Upper St. Lawrence River populations were classified as threatened and the Hudson Bay-James Bay population was maintained as special concern (Figure 1).

Figure 1. 2009 COSSARO lake sturgeon designations.

Under Ontario's *Endangered Species Act, 2007*, a zero catch and possession

quota was established for all commercial and recreational fisheries within northwestern Ontario and the Great Lakes-Upper St. Lawrence River drainages. The killing, capturing and possessing of lake sturgeon and the damage or destruction of their habitat is prohibited under this Act.

History of Sturgeon Stocking

By the early 1900s sturgeon populations had declined from unregulated harvest and extensive habitat alteration and destruction (OMNR 2009). The global decline of this species triggered the development of culture methods for commercial sale and population rehabilitation.

Sturgeon were first cultured in Russia (Vedrasco et al. 2002). By the first half of the 20th century, researchers in Russia had developed the first procedures for artificial reproduction (Chebanov and Billard 2001) and sturgeon culture research commenced in North America.

During early experimentation, scientists were faced with many challenges (Anderson 1984, Meehan 1909). However, by the 1980s, many of the challenges were resolved, paving the way for Wisconsin Department of Natural Resources (WIDNR) to launch one of the first lake sturgeon stocking and culture programs for population rehabilitation (Folz et al. 1983).

In North America, Wisconsin and Michigan have the largest lake sturgeon stocking programs, having implemented stocking as a management strategy for over 15 years. Smaller scale stocking programs currently exist in Minnesota, New York, Tennessee, Missouri, Kentucky, Saskatchewan, Manitoba, Quebec and Ontario (Appendix 1).

Lake Sturgeon Stocking in Ontario

In North America, sturgeon management planning started during the late 1990s as resource users began to acknowledge the urgency for active management in the face of severely depleted populations worldwide (Mohler 2003).

Aquaculture in Ontario began in the 1850s (MacCrimmon et al. 1974) and focused on the production of salmonids. The first attempts at lake sturgeon culture were performed by The Biological Board of Canada in 1919 and the Ontario Fisheries Research Laboratory at the University of Toronto between 1922 and 1926. Early efforts to culture lake sturgeon in Ontario were largely unsuccessful (Kerr 2006). In spite of this, there has been continued interest in lake sturgeon culture for stocking purposes but large-scale programs have not been developed in Ontario (Kerr 2006).

In 1988, a Lake Sturgeon Culture Techniques Manual (EAG 1988a) and Stocking Plan (EAG 1988b) were prepared for the Northeast Region of the Ontario Ministry of Natural Resources (OMNR). The plans were incorporated into the Northern Region Sturgeon Management Strategy (Northern Region Sturgeon Committee 1989) which recommended the completion of a pilot project prior to the development of the stocking plan (EAG 1988b). Despite these recommendations, no pilot project was ever implemented.

In Ontario, lake sturgeon have only been stocked for symbolic release in the

northwest. Since 1993, the Manitou Rapids Fish Hatchery, Lake of the Woods, Ontario has reared lake sturgeon for the Rainy River, Dalles First Nations, and multiple U.S. lake sturgeon management agencies.

As of 1999, the Manitou Rapids Fish Hatchery has produced and stocked an annual average of 40,000 lake sturgeon fry into the Rainy River (J. Hunter, pers. comm. Manitou Rapids Fish Hatchery, January 2009). Wild brood stock are collected annually from the Rainy River.

The Lake Sturgeon Rehabilitation Plan for Lake Superior, produced by the Great Lakes Fisheries Commission (GLFC) (Auer 2003) is the only other document providing management direction for lake sturgeon stocking in Ontario waters. The plan was designed to coordinate lake sturgeon programs and provide recommendations for the management of lake sturgeon in Lake Superior. The primary goal of the plan was to return lake sturgeon populations to self-sustaining levels in historically occupied habitats (Auer 2003). In addition, the Lake Ontario Management Unit (OMNR) and New York Department of Environmental Conservation are developing a Lake Ontario Lake Sturgeon Restoration Plan, which identifies stocking as a rehabilitation management strategy (A. Mathers, pers. comm. Ministry of Natural Resources, January 2009).

Overview of Lake Sturgeon Culture Approaches

Lake sturgeon culture techniques have evolved in a traditional hatchery facility. The Genoa National Fish Culture Hatchery has published one of the few manuals for culture techniques for lake sturgeon (Aloisi et al. 2006).

Traditional hatcheries are designed to raise lake sturgeon in a controlled setting usually involving a permanent structure (Holtgren et al. 2007, Figure 2). Recently, streamside rearing facilities (SRF) are being used to culture lake sturgeon. SRF are typically portable and located near stocking sites. SRF capitalize on environmental conditions of the natal stream and release site. The fish are reared with local water, natural photoperiods and sometimes food. Therefore, fish are exposed to local thermal regimes, water chemistry, and prey items throughout juvenile development. The primary goal of this facility type is to reduce the impacts of domestication typically observed in migratory fishes cultured in traditional hatcheries (Ritter 1997).

The possible effects of domestication during lake sturgeon culture are not well studied. Studies have shown that SRF may produce cohorts with higher genetic and biological diversity and have closer representation to wild cohorts than lake sturgeon reared in a traditional culture environment (Crossman 2008; Eggold et al. 2009).

Figure 2. Fertilized egg trays inside a streamside rearing facility (photo courtesy of Sturgeon for Tomorrow, Black Lake Michigan Chapter).

Due to slow sexual development, lake sturgeon gametes have traditionally been collected from wild fertile adults rather than captive brood stock. All existing lake sturgeon culture programs rely on annual collection of gametes or offspring from wild populations. This can be done in three ways: direct gamete takes, dispersing larvae, or naturally produced eggs from wild lake sturgeon.

The gamete/offspring collection method varies by project and stocking objectives. Most programs collect milt and eggs directly from fertile adults. This is termed the "direct gamete take". This method produces the highest abundance of progeny and is used when brood stock are abundant (Eggold et al. 2009). The direct gamete take method is optimal for reintroduction and rehabilitation stocking for genetically similar stocks. It is best applied to self-sustaining populations capable of supporting an egg collection. Direct gamete take collections do not reflect the genetic diversity of wild populations, whereas, naturally produced eggs and dispersing larvae reflect a natural cohort (Eggold et al. 2009). Collecting naturally fertilized eggs or dispersing larvae may yield less individuals for stocking than the direct gamete take, but will minimize the chance of negative genetic impacts (Eggold et al. 2009).

Collection methods are project and population specific. The potential overall harm of gamete/offspring collection should be carefully analyzed post collection.

Regardless of the collection method, gamete/offspring collection should sample the entire spawning period and at all known spawning locations to ensure the cultured stock reflects the native population as much as possible (Eggold et al. 2009).

Overview of Lake Sturgeon Stocking Approaches

Lake sturgeon are stocked to maintain ecosystem function, create self-sustaining populations, provide fisheries for recreational, commercial, or cultural use, and preserve local biodiversity and cultural traditions. (Drauch and Rhodes 2007, TRLSMP 2007, Gale et al. 1986). For certain populations, stocking may be the only way to prevent population collapse until long-term management actions, such as habitat enhancement and harvest restriction can be implemented (UCRWSRT 2002).

Stocking can be used both as a short-term and long-term management strategy, through reintroduction or rehabilitation stocking methods (see Glossary). Reintroduction stocking involves the release of individuals into waters they formerly occupied (OMNR 2002). The goal of reintroduction projects are to re-establish naturally reproducing populations.

Rehabilitation stocking is the addition of individuals to an existing population (OMNR 2002,Figure 3). Rehabilitation stocking is used to address population deficiencies such as weak recruitment or failed ecosystem function.

Figure 3. Releasing lake sturgeon fingerlings (photo courtesy of Sturgeon for Tomorrow, Black Lake Michigan Chapter).

In rehabilitation stocking, a firm understanding of population biology and available habitat is required to ensure the addition of individuals will not adversely influence the remnant population.

Assessment of stocking programs requires a minimum of 15-20 years (a lake sturgeon generation) for comprehensive program results. The life history of lake sturgeon makes assessment difficult. Most stocking programs have not been adequately evaluated and many programs rely on intermittent, short-term, or anecdotal indicators of program success.

Only two published studies have examined long-term lake sturgeon stocking programs. Schram (2007), reported on the St. Louis River, Lake Superior, mark-recapture program preformed from 1985-2007. Lake sturgeon were tagged and monitored during routine fisheries assessment. The majority of stocked lake sturgeon remained close to their stocking sites and did not migrate to other areas of the lake.

The second study (Drauch and Rhodes 2007) analysed the transfer of genetic diversity from a source population to a reintroduced population. The reintroduced population showed similar levels of genetic diversity to the source population, however genetic bottlenecking (see Glossary) was observed in the source population reared in the hatchery. This study supports the importance of multiple-year lake sturgeon stocking strategies to minimize the loss of genetic diversity from source to reintroduced populations.

Despite the lack of long term stocking assessments, many agencies are gaining important knowledge from short-term stocking studies (WIDNR 2002, Hay-Chmielewski and Whelan 1997). Experimental studies involving the release of lake sturgeon have provided confirmation of population decline, recruitment failure, and over-harvest. They have also enhanced the understanding of lake sturgeon movements (Schram 2007, Smith and King 2005), life-stage specific habitat use, responses to environmental changes such as flow and water temperature (Benson et al. 2005, Thuemler 1988), and exposure to point source contamination. The continuation of experimental research will provide important feedback on the success of stocking methods and will facilitate adaptive management.

Lake Sturgeon Culture and Stocking Programs in North America

Stocking programs are commonly part of a broader management and recovery plan, incorporating additional rehabilitation techniques such as habitat restoration, harvest management,

enforcement and public awareness (WIDNR 2002, North/South Consultants Inc. 2002, Hay-Chmielewski and Whelan 1997). Generally, U.S. management agencies have applied stocking as a management strategy more than Canadian agencies, where 8 states are committed to lake sturgeon stocking programs. In Canada, three provinces (Ontario, Saskatchewan and Manitoba) are currently taking steps to actively manage lake sturgeon population through species-specific plans.

The majority of today's stocking programs have been in operation for less then 25-30 years, or one lake sturgeon generation. This life history trait has made reporting on stocking programs difficult. Stocking programs rely on angler reporting and small-scale mark and recapture and tracking studies (which are sometime ineffective due to the lack of population movement and range information) for feedback on stocking success. Most short-term information is centered around culture techniques verses stocking techniques or management strategies.

In North America, Wisconsin and Michigan have the most experience using stocking as a management tool for lake sturgeon rehabilitation. Overall, lake sturgeon stocking programs typically proceed with minimal biological or genetic population information. Even though management plans are present for the majority of jurisdictions, stocking has typically been in operation prior to completion of these plans, and stocking practices such as sites, densities and abundance, and donor selection are based on trial and error.

Manitoba and Saskatchewan

In 1997, Manitoba Natural Resources produced a "Sturgeon Management in

Manitoba" document which outlined long-term objectives, guidelines and principles, and identified stocking as a management option (Manitoba Natural Resources 1997).

The Manitobal lake sturgeon management plan will be amended in the near future. Until that time, the province will continue stocking fry and fingerling lake sturgeon into the Red River, collecting baseline biological data, and refining culture and stocking techniques (D. McDonald, pers. comm. Manitoba Water Stewardship, January 2009).

Manitoba Water Stewardship has been working with the Saskatchewan Ministry of Environment, SaskPower, First Nations, industry, and public organizations on a Saskatchewan River Management Plan. This plan is dedicated to preventing further decline of the Saskatchewan River lake sturgeon between the E.B. Campbell Dam (SK) and the Grand Rapids Dam (MB). The long-term objective is to create a self-sustaining population capable of supporting traditional subsistence use of the local Aboriginal people. The initial culture and stocking techniques for the program, which were implemented in 2005, were adopted from the Wisconsin Department of Natural Resources (M. Koob, pers. comm. Saskatchewan Ministry of Environment, December 2008). In 2008, the stocking component of the program was suspended pending a technical assessment of the supplementation program (M. Koob, pers. comm. Saskatchewan Ministry of Environment, December 2008).

Wild gametes were collected from one spawning site and fertilized eggs were reared in the Fort Qu'Appelle hatchery in Saskatchewan and the Grand Rapids

Hatchery in Manitoba. Juvenile lake sturgeon were released in efforts to supplement the remnant lake sturgeon population (R. Campbell, pers. comm. Manitoba Water Stewardship, December 2008).

A similar program is occurring in Manitoba on the Nelson River, by the Nelson River Sturgeon Co-Management Board (R. Campbell, pers. comm. Manitoba Water Stewardship, December 2008). The Saskatchewan government does not have a management plan for lake sturgeon or provincial policy to support lake sturgeon rehabilitation stocking programs (R. Campbell, pers. comm. Manitoba Water Stewardship, December 2008). However, local community groups continue working together to rehabilitate lake sturgeon of the Nelson and Saskatchewan Rivers, where youth participate in the release of lake sturgeon and aboriginal commercial fishers are employed as assessment and monitoring technicians.

Québec

The Québec government does not have a provincial sturgeon management plan or policy. Private hydroelectric companies have started stocking lake sturgeon to compensate for impacts associated with the construction of large scale hydroelectric facilities. Hydro-Quebec stocked lake sturgeon in the Eastman River and Reservoir from 2004-2008. Wild brood stock were collected by seining in known spawning habitats. Gravid adults were flown to a hatchery, spawned, fitted with external transmitters and released into the Eastman 1 reservoir (Environnement Illimité Inc. 2009).

Wisconsin

Lake sturgeon initiatives are guided by the Wisconsin Lake Sturgeon Management Plan and the Sturgeon Management Assessment Team (WIDNR 2002). Their mission is to preserve, protect, and restore lake sturgeon populations (WIDNR 2002).

The Sturgeon Management Assessment Team and government agencies have identified clear objectives and recommendations for lake sturgeon management. The culture and stocking strategies address genetics, propagation, transfers, and reintroduction. The main objectives of these strategies are to: define existing strains/populations; determine the role of genetics in management; ensure state-wide coordination of propagation programs; maximize genetic variability in hatchery-reared fish; and establish the best technical criteria and protocols for propagation quality assurance (WIDNR 2002).

The Wisconsin Department of Natural Resources (WIDNR) developed national lake sturgeon culture procedures with the U.S. Bureau of Indian Affairs and the U.S. Fish and Wildlife Service. The 'Genoa National Fish Hatchery Lake Sturgeon Culture Standard Operating Procedure' (Aloisi et al. 2006) was based on methods developed within the Wild Rose Fish Hatchery in Wisconsin, which has been rearing lake sturgeon for over 20 years (Aloisi et al. 2006). These procedures have become the foundation of lake sturgeon culture programs in North America

The Genoa National Fish Hatchery (GNFH) started rearing lake sturgeon in 1993 to restore the population in a section of the Menominee River. Lake sturgeon hatchery production has since

expanded, and includes collaborations with Aboriginal communities, the Minnesota Department of Natural Resources and the Missouri Department of Conservation. The Wild Rose State Fish Hatchery supplies lake sturgeon to multiple projects, including restoration stocking of the St. Louis River (since the 1980s), Yellow River (since 1995), Upper Flambeau/Manitowish River system, Menominee River, Wolf River and the middle Wisconsin River (WIDNR 2002).

The WIDNR is also working with the Michigan Department of Natural Resources (MIDNR), Great Lake Fisheries Trust and non-government organizations, in multiple lake sturgeon streamside rearing facility (SRF) projects. Since 2006, they have been operating four SRFs located on the Milwaukee River, and the Manitowaoc River in Wisconsin and the Cedar, Black, and Whitefish Rivers in Michigan. Research has focused on culture techniques, SRF design and short term movements of stocked fish. The program is currently leading lake sturgeon culture research and advancing culture and stocking methods.

Michigan

As indicated in the Wisconsin review, MIDNR and WIDNR are collaborating on lake sturgeon management and stocking programs. Michigan's lake sturgeon management programs are guided by the Lake Sturgeon Rehabilitation Strategy (Hay-Chmielewski and Whelan 1997). Stocking is used to rehabilitate lake sturgeon populations or re-establish self-sustaining populations in historic sturgeon ranges with appropriate habitat (Hay-Chmielewski and Whelan 1997).

Minnesota

The Minnesota Department of Natural Resources (MNDNR) has been stocking sturgeon throughout the state since 1998, annually increasing the number of fish and water bodies stocked. Minnesota is another partner of WIDNR, collaborating in the St. Louis River Lake Sturgeon Reintroduction Program. Stocking has taken place in the St. Louis River since 1983 (Schram et al.1999).

In 1997 and 1998, 378 Lake of the Woods adult sturgeon were transferred into Red River tributaries, the Big Detroit and Otter Tail Rivers. The transfer of adult sturgeon was ceased due to high angler harvest and high water flow. In 2001 the MNDNR made lake sturgeon restoration in the Red River a priority, stocking lake sturgeon fry and fingerlings into eight locations of the Red River basin. The initiative will be reviewed in 2020 (MNDNR 2002).

The U.S Fish and Wildlife Service has established a working relationship with the OMNR, Rainy River First Nations, and White Earth Reservation. Program details are provided in the guiding document "Restoration of Extirpated Lake Sturgeon in the Red River of the North Watershed" (MNDNR 2002).

New York

Prior to 2000, New York State stocked lake sturgeon as fingerlings and yearlings in experimental projects. Stocking occurred in the Oneida River from 1995 to 2000, during which time over 6500 fish were stocked. In 2000, stocking focused on the Oswegatchie and St. Regis Rivers as well as Black Lake. The New York State Department of Environmental Conservation has drafted a management plan "The Next

Ten-Years of Planning for the Management of Lake Sturgeon (*Acipenser fulvescens*) in New York" (Carlson 2005).

Currently, the New York Department of Environmental Conservation (NYDEC) is collaborating with the OMNR on the Lake Ontario Lake Sturgeon Management Plan (A. Mathers, pers. comm. Ministry of Natural Resources, January 2009).

Tennessee
Lake sturgeon have been extirpated in Tennessee since the 1960s (TRLSWG 2007). Loss of this species triggered the development of the 'East Tennessee Reservoir Fisheries Management Program' by the Tennessee Wildlife Resource Agency and the 'Management Plan for Restoration of the Upper Tennessee River Lake Sturgeon Population' guided by the Tennessee River Lake Sturgeon Working Group. This group consisted of the U.S Fish and Wildlife Service, WIDNR and nine public and industry organizations (TRLSWG 2007).

Since 2000, reintroduction efforts have focused on re-populating the native lake sturgeon ranges of the Tennessee River (TRLSWG 2007). The Tennessee River is being reintroduced with lake sturgeon stock from the Wolf River, Wisconsin, provided by the WIDNR. Rearing methods have been adopted from the Genoa National Fish Hatchery Lake Sturgeon Culture Standard Operating Procedure (TRLSWG 2007).

Kentucky
The Cumberland River lake sturgeon population was extirpated in the 1950s. The Kentucky Department of Fish and Wildlife Research began reintroducing lake sturgeon into the Cumberland River in 2006. Upper Mississippi River lake sturgeon gametes have been provided by the WIDNR Wild Rose State Hatchery (S. Marple, pers. comm. Kentucky Department of Fish and Wildlife Resources, January 2009).

Missouri
The Missouri Department of Conservation (MDC) have had a lake sturgeon re-introduction program since the 1980s, when lake sturgeon were classified as extirpated from all Missouri state waters (Gale et al. 1986). In the late 1990s the MDC refined the WIDNR basic lake sturgeon propagation techniques for large scale production (Gale et al. 1986) contributing to current Genoa Hatchery culture methods. The WIDNR has supplied brood stock from the Lake Winnebago and Wisconsin River to the state of Missouri from 1984 to present. Lake sturgeon have been primarily stocked in the Missouri and Mississippi Rivers: over 143,000 sturgeon have been stocked in the Mississippi River since 1984, and 114,300 in the Missouri River since 1992. As of 2007, natural reproduction of the reintroduced sturgeon has yet to be observed (Drauch and Rhodes 2007).

Georgia
Lake sturgeon have been extirpated from Georgia waters since 1959. The Georgia Department of Natural Resources (GDNR), has initiated a long-term reintroduction program for the Coosa River (GDNR 2009). Since 2002, fingerlings have been released into the Coosa River, with the goal being to re-establish a native fishery (GDNR 2009).

Over 40,000 fertilized eggs are provided annually to the Summerville Fish Hatchery, U.S. Fish and Wildlife Service Warm Springs Hatchery, and University of Georgia Cohutta Hatchery from WIDNR. Juvenile sturgeon are released

at multiple sites of the Coosa River basin when they reach a size of 10 cm in length (GDNR 2009). Georgia University researchers have been conducting radio tracking studies on movement, behaviour, survival and growth of stocked lake sturgeon (GDNR 2009).

Factors Affecting the Success of Lake Sturgeon Stocking Programs

The following factors may affect the success of stocking programs and should be carefully considered prior to program development.

Program Commitment

Lake sturgeon stocking procedures have generally not been researched in depth due to lake sturgeon life history traits. Culture methodologies are more advanced, but still require more research at the population level. The establishment of any lake sturgeon stocking program requires a long-term commitment to allow gathering of essential background data, development of local stocking and culture methods, and fostering community support and engagement programs.

Remedy Population Decline

Identifying and alleviating the factors responsible for population decline may require considerable research and resource commitment. It will also determine if stocking is the most appropriate management tool. If stocking is deemed appropriate, alleviating or understanding the factors responsible for population decline is essential for an effective stocking program.

Data Gaps

Essential information required for effective management is typically deficient for lake sturgeon. Basic data required for management and stocking program assessment includes but is not limited to: available habitat for all life stages; identifying genetic profiles; spatial and movement patterns; population structure; local life history requirements; and adaptations. Engaging in rehabilitation or reintroduction stocking without adequate population information may pose great risks, specifically for lake sturgeon since their life history dictates a minimum of one-two generations (20-60 years) for recovery from inappropriate genetic mixing, disease or parasite infections (WIDNR 2002). Most lake sturgeon rehabilitation stocking initiatives have started without basic population information, posing high risks to remnant populations.

Progeny collection

Obtaining lake sturgeon gametes or progeny has been reported as the largest problem for lake sturgeon stocking programs. The degree of difficulty associated with progeny collection is dependent on the identification of and accessibility to a spawning population. The spawning population should satisfy a comprehensive genetic stocking plan in terms of the numbers and genetic representation of individuals collected.

Genetics

Stocking lake sturgeon may create genetic risks including outbreeding depression (see Glossary), domestication, and inadequate representation of genetic diversity in the cultured population (Welsh et al. 2007). Multiple factors may contribute to these genetic risks such as: selected donor stock; brood stock or gamete collection methods; genetic diversity of the cultured population; and rearing

environment (Crossman 2008). Genetic risks of stocking should be assessed on the population level.

Fish Health

Antibiotic treatments are limited for lake sturgeon, which enhances the requirement for disease monitoring and prevention within a culture environment (Dr. K. Scribner, pers. comm. Michigan State University, January 2009). The addition of medicine to live feed is currently not a viable option (Aloisi et al. 2006) and is problematic considering lake sturgeon are reared on live feed. Live feed itself may be a health risk and may need to be monitored for contaminants.

Stocking Principles and Practices Adopted by other Jurisdictions

The development of lake sturgeon stocking programs should be consistent with existing state and provincial stocking policies and utilize the best science available. On this basis, multiple factors should be considered:

1. The reason(s) for population decline should be identified to determine if stocking is the appropriate management tool. Where other factors, such as exploitation or habitat deterioration are identified, actions should be taken to address these issues before stocking is undertaken.

2. Stocking for the purposes of rehabilitation or reintroduction should be given priority over stocking for artificial purposes.

3. Careful consideration must be given to the selection of donor stocks. Ideally, parental fish would be from the stock being rehabilitated. Efforts should be made to maximize genetic diversity during egg collections.

4. Rearing conditions should simulate the natural environment as closely as possible.

5. Select the most appropriate size or life stage of fish based on characteristics of the receiving waterbody and the stocking objective.

5. Stocking sites should be selected to avoid predators which ensures that forage is available and habitat conditions are suitable.

6. A stocking assessment plan should be developed prior to stocking. Objectives must be clearly defined for stocking projects and quantified benchmarks should be established from which to monitor success through stocking assessment.

In addition to provincial policy, lake sturgeon stocking programs should integrate federal and bi-national lake sturgeon policies and goals.

The most relevant guide for sturgeon stocking (Welsh et al. 2007) provides recommendations for selecting lake sturgeon stocking sites and donor populations based on population genetics for the Great Lakes sturgeon populations. The principals of lake sturgeon stocking outlined in Welsh et al. (2007) are as follows:

1. The reasons for population extinction, decline or suppression should be identified and management actions planned to remedy them by the time stocked fish will be sexually mature. If not, stocking is not recommended until a sufficient plan has been developed to alleviate limiting factors to lake sturgeon abundance.

2. Reintroduction stocking is recommended if a population is predicted to be at high risk of extinction.

3. Donor stocks should have at least one population within the genetic population with sufficient numbers, genetic diversity, and logistical feasibility so that gamete collection will not affect recruitment and diversity of the donor population.

4. Reintroduction stocking is not recommended if an appropriate donor population is not available. Management should focus on conservation of existing remnant populations until a potential donor source becomes available.

5. If a proposed stocking site is geographically isolated from all priority populations or if the risk of reintroduced individuals straying has been removed and an appropriate donor stock and stocking site has been selected with appropriate propagation techniques to ensure long-term fidelity of stock fish to the target river, then only gametes or fertilized eggs from the donor population should be used.

The second document, currently guiding the stocking practices of lake sturgeon in Ontario is from the Great Lakes Fishery Commission (GLFC). The GLFC recommends that stocking should only occur in streams that have had historical lake sturgeon spawning populations but are currently not occupied. In addition, stocking should only occur in conjunction with habitat protection, restoration and exploitation control (Auer 2003).

Stocking as a Management Tool in Ontario

Stocking lake sturgeon may enhance recovery by supplementing natural reproduction. However, stocking may have negative consequences. The potential for negative impacts to native populations and the methods chosen to minimize these negative impacts should be considered carefully before starting a lake sturgeon stocking program. Stocking should only occur where a strong biological rationale exists (including suitable habitat) and local stocking plans have been developed.

A comprehensive stocking program would require the development of a provincial lake sturgeon stocking plan that clearly defines the fundamental principals of donor and receiving population selection and their, associated gamete/progeny collection methods and rearing environment.

It is important for management agencies to recognize that obtaining sufficient quantities of gametes/progeny from an appropriate donor population is one of the largest barriers impeding the development or expansion of lake sturgeon stocking programs today. This barrier is compounded by the lack of genetic, biological and ecological population data for many remnant lake sturgeon populations.

Ontario has general information on several lake sturgeon populations. If a stocking program was developed many populations would require extensive baseline data collection including the identification of population decline or impedance to recovery before stocking could be considered as a management strategy.

A comprehensive stocking and culture plan should be required for each stocking initiative and be consistent with Ontario's government goals for lake sturgeon. Each plan should strive to preserve genetic diversity and uniqueness by using culture methods which reduce domestication.

Most importantly, all stocking and culture strategies should include a long-term monitoring plan designed to assess the program success. Monitoring plans need to be comprehensive enough to provide feedback on stocked and remnant population (if present) survivorship, recruitment, growth rates, and population genetic profiles in order to facilitate real adaptive management with reliable and statically comparable data.

Due to the lake sturgeon's life history (slow maturation and growth),rehabilitation requires a long-term commitment. In addition to science needs, public engagement and stewardship programs should be fostered as integral components of any stocking program. They provide the foundation for program longevity and growth, funding and new policies.

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References

Aloisi, D., R.R. Gordon Jr., N.J. Starzl, J.L. Walker, and T.R. Brady. 2006. Genoa National Fish Hatchery lake sturgeon culture standard operating procedures. U.S. Fish and Wildlife Services, Genoa, Wisconsin. 19 p.

Anderson, E.R. 1984. Artificial propagation of lake sturgeon *Acipenser fulvescens*, under hatchery conditions in Michigan. Michigan Department of Natural Resources. 32 p.

Auer, N.A. 2003. A lake sturgeon rehabilitation plan for Lake Superior. Miscellaneous Publication 2003-02. Great Lakes Fisheries Commission. Ann Arbor, Michigan. 27 p.

Benson, A.C., T.M. Sutton, R.F. Elliott, and T.G. Meronek. 2005. Seasonal movement patterns and habitat preferences and age-0 lake sturgeon in the Lower Peshtigo River, Wisconsin. Transactions of the American Fisheries Society 134:1400-1409.

Carlson, D.M. 2005. Draft: The next ten years of planning for the management of lake sturgeon (*Acipenser fulvescens*) in New York. New York Department of Environment Conservation, Division of Fish and Wildlife and Marine Resources. 7 p.

Chebanov, M., and R. Billard. 2001. The culture of sturgeons in Russia: production of juveniles for stocking and meat for human consumption. Aquatic Living Resources 14: 375-381.

Crossman, J.A. 2008. Evaluating collection, rearing, and stocking methods for lake sturgeon (*Acipenser fulvescens*) restoration programs in the Great Lakes. Ph.D. Dissertation. Michigan State University, East Lansing, Michigan.

Drauch, A.M., and O.E. Rhodes, Jr. 2007. Genetic evaluation of the lake sturgeon reintroduction program in the Mississippi and Missouri Rivers. North American Journal of Fisheries Management 27:434-442.

Eggold, B., S. Hogler, S. Fajfer, J. M. Holtgren, E. Baker, and B. Sloss. 2009. Lake sturgeon rehabilitation using stream-side rearing facilities. Progress report submitted to the Great Lakes Fishery Trust, Lansing, Michigan.

Environmental Applications Group (EAG). 1988a. Lake sturgeon culture techniques manual. 108p.

Environmental Applications Group (EAG). 1988b. Lake sturgeon stocking plan. 36p.

Environnement Illimité Inc. 2009. Aménagement hydroélectrique de l'Eastmain-1- Suivi de l'esturgeon jaune et des aménagements pour l'ichtyofaune, travaux 2008. Rapport porduit par F Burton, G. Tremblay, J. Gingras, M. Gendron, et M. Simoneau présenté à la Société d'énergie de la Baie James. 154 p. + annexes.

Folz, D.J., D.G. Czeskleba, and T.F. Thuemler. 1983. Artificial spawning of lake sturgeon in Wisconsin. The Progressive Fish Culturist 45:231-233.

Gale, R.L., C.A. Purket. Jr., D.F. Dickneite, and J.P. Fry. 1986. Reintroduction of lake sturgeon into Missouri. Missouri Department of Conservation.

Georgia Department of Natural Resource (GDNR). 2009. Lake sturgeon reintroduction to the Coosa River basin. Available: http://georgiawildlife.dnr.state.ga.us/fishing.aspx (February 2009).

Great Lakes Fisheries Commission (GLFC). 2009. Great Lakes Fish Stocking Database. Available: http://www.glfc.org/fishstocking (April 2009).

Hay-Chmielewski, E.M., and G.E. Whelan. 1997. Lake sturgeon rehabilitation strategy. Special Report 18. State of Michigan Department of Natural Resources. Lansing, Michigan. 51 p.

Holtgren, M.J., S.A. Ogren., A.J. Paquet., and S. Fajer. 2007. Design of a portable streamside rearing facility for lake sturgeon. North American Journal of Aquaculture 69:317-323.

Kerr, S.J. 2006. An historical review of fish culture, stocking and fish transfers in Ontario, 1865-2004. Fisheries Section, Fish & Wildlife Branch. Ontario Ministry of Natural Resources. Peterborough, Ontario. 154 p.

LeBreton, G.T.O., F.W.H. Beamish, and R.S. McKinley. 2004. Sturgeons and paddlefish of North America. Fish and Fisheries Series. Kluwer Academic Publishers. 323 p.

Manitoba Natural Resources. 1997. Sturgeon management in Manitoba. Manitoba Natural Resources Fisheries. 25. p.

MacCrimmon, H.R., J.E. Stewart, and J.R. Brett. 1974. Aquaculture in Canada: The practice and the promise. Fisheries and Marine Services. Department of the Environment. Ottawa, Ontario. 84 p.

Meehan, W.E. 1909. Experiments in sturgeon culture. Transactions of the American Fisheries Society 39:85-91.

Minnesota Department of Natural Resources (MNDNR). 2009. Online Stocking Records. Available: http://www.dnr.state.mn.us/fisheries/management/stock.html (April 2009)

Minnesota Department of Natural Resources (MNDNR). 2002. Restoration of extirpated lake sturgeon (*Acipenser fulvescens*) in the Red River of the north watershed. Division of Fisheries, Minnesota, 9p.

Mohler, J.W. 2003. Culture manual for the Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*. U.S. Fish & Wildlife Service. Hadley, Massachusetts. 56 p.

North/South Consultants Inc. 2002. Saskatchewan River sturgeon management board: ten year management plan. Winnipeg.

Northern Region Sturgeon Committee. 1989. Northern region sturgeon management Strategy. Ontario Ministry of Natural Resources. 8 p.

Ontario Ministry of Natural Resources (OMNR). 2002. Guidelines for Stocking Fish in Inland Waters of Ontario. Fisheries Section, Fish and Wildlife Branch. Peterborough, Ontario. 43 p.

Ontario Ministry of Natural Resources (OMNR). 2009. The lake sturgeon in Ontario. Fisheries Section, Fish and Wildlife Branch. Peterborough, Ontario. 48 p. + appendices.

Ritter, J.A. 1997. The contribution of Atlantic salmon (*Salmo salar*) enhancement to a sustainable resource. Journal of Marine Science 54:1177-1187.

Saskatchewan River Sturgeon Management Board (SRSMB). 2009. Sturgeon recovery. Available: http://www.saskriversturgeon.ca/sturgeon_recovery/index.html (May 2009).

Schram, S.T. 2007. Dispersal of stocked lake sturgeon in Wisconsin waters of Lake Superior. Fisheries Management Report No. 152. Bureau of Fisheries Management, Wisconsin Department of Natural Resources. Madison, Wisconsin.

Schram, S.T., J. Lindgren, and L.M.Evrard. 1999. Reintroduction of lake sturgeon in the St. Louis River, western Lake Superior. North American Journal of Fisheries Management 19:815-823.

Smith, K.M., and D.K. King. 2005. Movement and habitat use of yearling and juvenile lake sturgeon in Black Lake, Michigan. Transactions of the American Fisheries Society 135:1159-1172.

Tennessee Wildlife Resources Agency. 2009. Lake Sturgeon Restoration. Available: http://www.tnfish.org/LakeSturgeonRestoration_TWRA/AcipenserFulvescensRestorationTennessee_TWRA.htm (May 2009).

Tennessee River Lake Sturgeon Working Group (TRLSWG). 2007. Management plan for restoration of the upper Tennessee River lake sturgeon population. 18 p.

Thuemler, T.F. 1988. Movements of young lake sturgeons stocked in the Menominee River, Wisconsin. American Fisheries Society Symposium 5:104-109.

Upper Columbia River White Sturgeon Recovery Team (UCRWSRT). 2002. Upper Columbia River White Sturgeon Recovery Plan. 90 p.

Vedrasco, A., V. Lobchenko, I. Pirtu, and R. Billard. 2002. The culture of live food for sturgeon juveniles, a mini review of the Russian literature. International Review of Hydrobiology 87:569-575.

Welsh, A., R. Elliott, C. Krueger, H. Quinlan, and B. May. 2007. Draft-Genetic guidelines for the stocking of lake sturgeon (*Acipenser fulvescens*) in the Great Lakes basin. 46p.

Wisconsin Department of Natural Resources. 2009. Fish Stocking Summary. Available: http://infotrek.er.usgs.gov/doc/wdnr_biology/Public_Stocking/StateMapHotspotsAllYears.htm (May 2009).

Wisconsin Department of Natural Resources (WIDNR). 2002. Wisconsin's lake sturgeon management plan. Bureau of Fisheries Management and Habitat Protection. Madison, Wisconsin. 12 p.

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