Mission Statement

The mission of the Great Lakes Fishery Trust is to provide funding to enhance, protect, and rehabilitate the Great Lakes fishery. The Trust will manage its resources to compensate for the lost use and enjoyment of the Lake Michigan fishery resulting from the operation of the Ludington Pumped Storage Plant.

Great Lakes Fishery Trust

Research and Assessment Needs to Restore Lake Sturgeon in the Great Lakes

Results of a Workshop Sponsored by The Great Lakes Fishery Trust

Great Lakes

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Lake Sturgeon

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Executive Summary

The Great Lakes Fishery Trust (Trust) sponsored a workshop to identify the research and assessment needs to rehabilitate lake sturgeon in the Great Lakes. Results of the workshop, held on June 27-28, 2000, in Muskegon, MI, will assist the Trust board and its Scientific Advisory Team in the development of a directed research grant program to supplement lake sturgeon rehabilitation efforts within the Great Lakes basin.

Forty-five workshop participants identified four major problems that limit effective rehabilitation of sturgeon in the Great Lakes: 1) lack of adequate knowledge of the status and distribution of sturgeon populations in the entire Great Lakes system, 2) lack of sufficient understanding of habitat constraints throughout the life cycle of sturgeon populations and the role of habitat structure in the regulation of sturgeon population structure, 3) lack of adequate fish passage technologies for lake sturgeon in areas where dams form barriers to upstream and downstream movement and where dam removal is unlikely, and 4) lack of cost-effective artificial propagation techniques and associated strategies to accelerate recovery of sturgeon populations. Research approaches were developed that correspond to each of the four problems:

Status Assessment and Development of a Rapid Survey Process - Specific research activities in this category include consolidation of existing information, design of indicators and survey strategies to provide comprehensive and system-wide inventories, and coordination of periodic census efforts;

Individual System and Habitat Requirement Studies - The lack of detailed understanding of habitat utilization by various life-history stages and the associated lack of detailed habitat classification and inventory are critical information gaps that must be filled;

Fish Passage Technology for Lake Sturgeon - Research into the design of safe and effective upstream and down stream passage of dams for lake sturgeon is needed;

Propagation Techniques and Strategy Development - Participants identified the need for research and development to improve hatchery production and stocking success.

A working definition of a healthy/restored Great Lakes sturgeon population was developed based on criteria for fish density, age structure, and habitat. The current status of lake sturgeon in the Great Lakes was described from a questionnaire completed by participants prior to the workshop and refined at the workshop. Lake sturgeon have been extirpated from 35 sites throughout the Great Lakes. Of the four populations that were considered large and healthy, none of them have barrier free access to the main basin of the Great Lakes. Of the 63 sites that are supporting lake sturgeon, successful reproduction is known from only 20. Impediments and knowledge gaps to lake sturgeon rehabilitation where identified by five discussion groups. Participants also learned about the role of the Trust in sturgeon rehabilitation, a review of lake sturgeon in the Great Lakes, and a review of existing goals from 10 lake sturgeon rehabilitation plans from across the Great Lakes basin. The evaluation by the participants indicated that the workshop objectives were met.

Introduction

This report will provide the results of a workshop "Research and Assessment Needs to Restore Lake Sturgeon in the Great Lakes," sponsored by the Great Lakes Fishery Trust (Trust) and held in Muskegon, Michigan, from June 27-28, 2000. The workshop results are intended to assist the Trust board and its Scientific Advisory Team in the development of a directed research grant program to supplement lake sturgeon rehabilitation activities within the Great Lakes basin (Great Lakes Fishery Trust Strategic Plan 2000). Lake sturgeon researchers and managers from the United States and Canada within the Great Lakes basin were invited to participate in the workshop and share their knowledge on the research and assessment needs to restore Great Lakes lake sturgeon.

Interest in lake sturgeon rehabilitation appears to be growing within fishery agencies and the public. Of the twenty-seven sturgeon species known worldwide, lake sturgeon (Acipenser fulvescens) is the only species endemic to the Great Lakes (Auer 1999a). Lake sturgeon, the largest freshwater fish in the Great Lakes basin, originally ranged throughout the Mississippi River, the Laurentian Great Lakes, and the Hudson Bay drainages (Harkness and Dymond 1961). By the early 1900s, the commercial harvest of lake sturgeon in the Great Lakes had declined significantly from the late 1800s. Lake sturgeon populations have been slow to recover from their depressed state (Smith 1968) and factors implicated for their continued low abundance include physical impacts on spawning and nursery habitats, barriers to migration and exploitation (Rochard et al. 1990).

The Great Lakes Fishery Trust was created in 1996 as a result of a court settlement to mitigate fish losses from the operation of the Ludington Pumped Storage Hydroelectric facility located on Lake Michigan near Ludington, Michigan. The most unique aspect of the settlement agreement was the creation and funding of a grants program by the Great Lakes Fishery Trust. Lake sturgeon is one of two species specifically referenced under population rehabilitation in the settlement agreement. The legal settlement specified five categories the Trust can provide grants to mitigate for damages related to Great Lakes fisheries: fish population rehabilitation, public education, fisheries research, habitat enhancement/protection, and public access. The Trust has awarded over ten million dollars in grants since its inception to non-profit organizations, universities, and state, federal and tribal agencies.

Workshop Organization, Goals, and Objectives

The workshop was organized by a steering committee approved by the Scientific Advisory Team. Membership on the steering committee included Mark Holey, U.S. Fish and Wildlife Service and Scientific Advisory Team member, Dr. Edward Baker, Michigan Department of Natural Resources, Thomas Thuemler, recently retired from the Wisconsin Department of Natural Resources, and Robert Elliott, U.S. Fish and Wildlife Service. Dr. Joseph Koonce, Case Western Reserve University, was retained to facilitate the workshop and assisted the steering committee with the planning efforts.

Identifying the critical research and information gaps that limit fishery managers ability to restore lake sturgeon populations in Lake Michigan and the Great Lakes was the goal chosen by the steering committee for the workshop (Table 1). The intent was to utilize the collective knowledge of the invited researchers and managers from across the basin to identify the gaps in knowledge that could be addressed by a research agenda. Seven objectives were identified to achieve the stated goal (Table 1). The first four were chosen to develop the basic building blocks to describe the research and information gaps as completely as possible. The last three objectives were designed to enhance communication between Great Lakes sturgeon biologists and managers, describe what role the Trust plays in lake sturgeon restoration, and provide a report to the Trust on the workshop proceedings.

Table 1. Workshop goals and objectives established by the steering committee.

Goal: Identify the research and information gaps that limit our ability to restore lake sturgeon in Lake Michigan and the Great Lakes.

Objectives:

- Define the characteristics of a healthy/restored lake sturgeon population.
- Synthesize existing knowledge of lake sturgeon distribution, abundance, and biology in Lake Michigan and the Great Lakes Basin.
- Identify the impediments to lake sturgeon restoration and enhancement.
- Identify and prioritize a list of research and management questions that need to be answered to enhance the success of lake sturgeon restoration efforts.
- Foster communication among lake sturgeon managers and researchers in the Great Lakes basin by providing an opportunity for formal and informal interactions.
- Introduce lake sturgeon managers and researchers to the role and funding guidelines of the Great Lakes Fishery Trust relative to lake sturgeon rehabilitation efforts.
- Provide a report on the workshop proceedings to the Great Lakes Fishery Trust that can be used to guide future funding decisions.

Facilitated discussion groups were used as the primary tool to accomplish the objectives and achieve the goal of the workshop (Appendix A, see agenda). Forty-five attendees participated in the group discussions (Appendix B). The demographics of the participants included representatives from State, Federal, Provincial, and Tribal natural resource agencies, Universities, and one private organization. Seven states and two provinces within the Great Lakes basin were represented (Appendix B). During the discussion times, groups were asked to review the information collected prior to the workshop on the status and distribution of Great Lakes lake sturgeon, develop a working definition of a healthy/restored lake sturgeon population, identify and prioritize the impediments and gaps in our present knowledge of lake sturgeon populations, and identify the research necessary to improve our understanding. The discussion groups were supplemented with prepared presentations on the role of the Great Lakes Fishery Trust in lake sturgeon restoration, the history and status of lake sturgeon in the Great Lakes, and a review of existing restoration and management goals for lake sturgeon in the Great Lakes. In addition, a social was held on the evening of June 27, during which participants shared informal discussion and informational materials on their sturgeon activities that included copies of reports and published papers, posters, and video presentations.

Summary of Prepared Presentations

The Role of the Great Lakes Fishery Trust

The role of the Great Lakes Fishery Trust in lake sturgeon rehabilitation was presented by K. Cool, Director of the Michigan Department of Natural Resources and Great Lakes Fishery Trust Board Chair. Director Cool explained that establishing the lake sturgeon as the Trust's logo and symbol of their activities illustrates the priority the Trust has placed on sturgeon as a key species on which to focus. The Trust is looking to develop a directed research grant process to compliment the rehabilitation goals of resource management agencies across the Great Lakes. The Trust is obligated under the settlement agreement to focus its primary interest on the Lake Michigan fisheries. However, it can and has funded research, public access, and educational grants that extend beyond the Lake Michigan watershed. A super majority of the board is required to fund projects that are focused outside of Lake Michigan. For lake sturgeon, the board recognizes that certain types of research and/or restoration efforts outside of the Lake Michigan watershed may have substantial indirect benefits and direct management implications for the Lake Michigan fisheries.

"The Trust is looking for the collective scientific judgement and consensus professional opinions of this group on the information or research needed to successfully rehabilitate lake sturgeon population."

K.L. Cool, Director MDNR and GLFT Board Chair

The Trust is also interested in fostering formal and informal interactions between lake sturgeon researchers and fisheries managers who collectively synthesize existing knowledge on the distribution, abundance, and biology of lake sturgeon. Finally, the Trust hopes to encourage collaborative efforts between research organizations and/or management agencies. The funding guidelines of the Trust are sufficiently flexible to accommodate a wide range of cooperative arrangements under a single proposal or as a series of independent projects. The only hard rules require that the organizations involved must be non-profit, governmental, or educational institutions, and that the grant funds complement but not replace traditional sources of funding.

Review of Lake Sturgeon in the Great Lakes

Dr. Nancy Auer, Michigan Technological University, presented information on the history and status of lake sturgeon in the Great Lakes. Dr. Auer emphasized the intrinsic value of lake sturgeon as a prehistoric relic that has persisted to present times and that formerly represented a much larger segment of the Great Lakes fish fauna. Lake sturgeon, along with lake trout, are probably the best aquatic indicators of Great Lakes ecosystem health. Lake sturgeon were valued by Native Americans in the Great Lakes region as food, oil, and leather and by some accounts were described as the Tribes daily bread (Auer 1999a). Lake sturgeon were not considered as valuable by the early European settlers to the Great Lakes. However, as their value grew, commercial fisheries for lake sturgeon blossomed and reported harvest peaked at over 7 million kilograms in the late 1880s (Auer 1999a). Lake sturgeon are now extremely valuable, especially with the decline in sturgeon stocks worldwide. Sturgeon are especially valued for their caviar in addition to the quality of their flesh, and are subject to demands by commercial fisheries and illegal poaching activities to provide these products to willing buyers worldwide.

"Three factors have been implicated as major reasons for the decline of sturgeons worldwide, physical impacts on spawning and nursery habitat, barriers to migration, and effects of fishing."

Nancy Auer

Review of Existing Goals for Lake Sturgeon Rehabilitation in the Great Lakes

Existing restoration and management goals of fishery agencies within the Great Lakes basin were reviewed by Robert Elliott, U.S. Fish and Wildlife Service. Ten available published or draft management/research plans for the Great Lakes were compared to reveal current lake sturgeon priorities of fishery agencies. All reports reviewed were copied and provided to each of the participants (Appendix C). The majority of the plans had a goal of conservation, rehabilitation, and enhancement of lake sturgeon populations, some with reference to delisting as a state threatened species or preventing stocks from being considered as threatened or endangered (Appendix C). Objectives from these plans included rehabilitation throughout their historic range, assessment of status, harvest restrictions, identification and restoration of critical habitat, mitigating or eliminating negative effects of barriers and dams, genetic strategies for fish culture, and public education (Appendix C).

Working Definition of a Healthy/Restored Great Lakes Lake Sturgeon Population

The attributes of a healthy or restored lake sturgeon population are critical information required by fishery managers to judge the success of their lake sturgeon rehabilitation programs. Each discussion group was asked to develop a definition of a restored lake sturgeon population. There was a high degree of similarity among all five discussion groups (see individual group definitions in Appendix D). The distinction between the terms restored versus rehabilitated was addressed by some of the groups and overall was felt that rehabilitated implied making a population healthy while restored implied returning to its original state. For the purpose of this report, the term rehabilitate is used.

Of the attributes mentioned, density or abundance, age structure, and available habitat or use of habitat were mentioned the most. The density or abundance attribute was defined either as a specific number or number per area of fish in a stream. Some groups used the term self-sustaining stocks and attempted to define what that meant. Several groups also felt that a rehabilitated population should be capable of providing a harvest. The age structure attribute was most often described in terms of sex ratio, number of age classes in the population, genetic diversity, successful recruitment, and the percentage of adult or older aged fish. As an attribute, habitat had several definitions depending on the spatial scale considered. In a single stream, there should be adequate habitat for the requirements of all life stages. For a basin, designating the percentage of historical habitat that should be available or used was thought to be appropriate. Some groups felt that available habitat for sturgeon in lakes should include all waters less than 40 feet in depth. One group felt that rehabilitation meant that present habitat be restored to what was historically available.

The steering committee proposes that a working definition of a healthy or rehabilitated sturgeon population should contain at least three elements: density/abundance, age structure, and habitat use. It is also appropriate to consider separate attributes of healthy or restored for individual streams versus entire lake basins. The following proposed working definitions will not be complete for specific values for each attribute. The lack of attribute values is an indication of our lack of knowledge and represents a key knowledge gap. The range of values discussed during the workshop can be found in Appendix D.

Density

Tributary Stream – A certain number of fish per acre of river needs to be met. That exact number is a knowledge gap. There is very little information in the literature on historic densities of lake sturgeon populations in unexploited rivers. This number should account for a population having both river resident and migratory individuals. It should be based on the productivity and the size of the river and it should include at least enough adults to provide a self-sustaining population (able to support at least a five percent exploitation rate).
Lake Basin - A specific number of fish per acre that needs to be met. That number should be based on the productivity of the lake and it should be based on the amount of useable sturgeon habitat in the specific lake. For instance, Lake Erie would have a higher number of sturgeon per acre in a rehabilitated population than Lake Superior, because that lake would have a higher productivity and a larger portion of the lake would be useable sturgeon habitat. It was felt that the amount of useable sturgeon habitat in a specific lake would be equal to the area of that lake under forty feet in depth.

Age Structure

Tributary Stream – The population of sturgeon in the restored river should include females at least 70 years old and males at least 40 years old. Although annual recruitment would not be needed, significant year classes should occur at a minimum of once every 5 years.
Lake Basin - At least forty year-classes should be represented in a restored population. Ten to fifteen percent of the population should be made up of mature fish and three percent of the population should be age 40 or older.

Habitat

Tributary Stream – Sturgeon should have access to the same amount of habitat as was historically available to them in a river. This would include spawning, nursery, and adult habitat. If certain habitat that was historically used in a river system was inaccessible, then similar amounts of habitat should be provided.
Lake Basin - At least fifty percent of the tributaries to the lake, which historically contained sturgeon populations, should be available and utilized to meet our definition of a rehabilitated lake basin for sturgeon. If shoal spawning was also a significant factor in the particular lake than at least fifty percent of these shoals should also be available for spawning.

Current Status of Lake Sturgeon in the Great Lakes

Knowledge of the current status of lake sturgeon populations in the Great Lakes is an important building block in the identification of impediments, knowledge gaps, and research needs for rehabilitation. Development of a current status map of Great Lakes sturgeon was a tool used during group discussions to compare current distribution and abundance with historical accounts. Prior to the workshop a questionnaire, designed to assess the current state of knowledge regarding the Great Lakes wide distribution and abundance of lake sturgeon, was sent to all invited participants. Survey data from the 28 questionnaires returned were used to construct a map of historic and current lake sturgeon distribution in the Great Lakes basin and the St. Lawrence River (Figure 1, page 8-10). The map and the corresponding data were presented to the participants at the start of the workshop. Revisions to the map were completed based on participant input at the workshop.

Returned surveys indicated that lake sturgeon have been extirpated from 35 sites throughout the Great Lakes and only four lake sturgeon populations are considered to be large/healthy (arbitrarily defined for this questionnaire as having more than 500 adult fish in the annual spawning run). None of these four large/healthy lake sturgeon populations have barrier free access to the main basin of the Great Lakes. In addition, an obvious conclusion that can be drawn from the survey data is there is a tremendous amount of uncertainty regarding the current status of lake sturgeon populations. Spawning lake sturgeon populations are known from 63 sites throughout the Great Lakes and St. Lawrence basin. However, spawning run size estimates exist for only 17 of those sites. In addition, shoal spawning is suspected from three areas in the Great Lakes but no data have been collected to confirm the presence of shoal spawning. Of the 63 sites that are supporting spawning lake sturgeon, successful reproduction is known from only 20. It is not known whether there is successful spawning in the remaining 43 rivers.

Although the survey data and map represent the collective knowledge of the survey respondents, the data and map should not be regarded as complete or completely accurate. Much of the data on current lake sturgeon distribution represents anecdotal information gathered from a variety of sources. In fact, very little quantitative data have been collected on existing populations. In addition, lake sturgeon were probably more widely distributed historically than is indicated by the map. Like the current status data, historic data presented in the map and data table may be anecdotal and are not the result of an intense library search of historic documents.

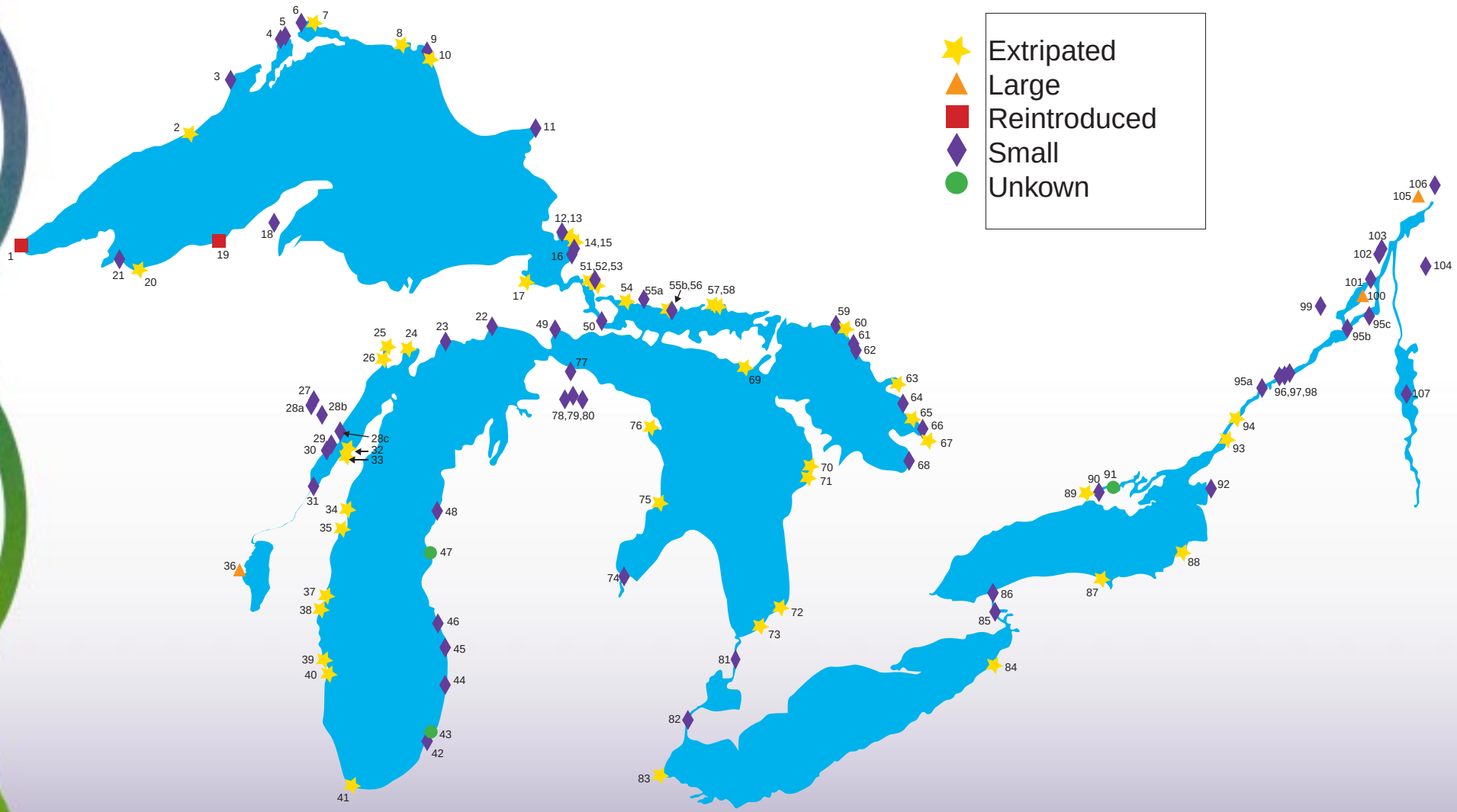

Figure 1. Status of lake sturgeon in the Great Lakes based on information provided by workshop participants. See pages 9 and 10 for more details

Great Lakes

Figure 1 Legend

Summarized lake sturgeon questionnaire data from 23 respondents. Successful reproduction was defined as recent capture of larval or juvenile sturgeon. Population status definitions are large = 1,000 or more adults in the annual spawning runs; small = less than 1,000 adults in annual spawning run; extirpated = no adults known to spawn in river; reintroduced = hatchery fish stocked into system in reintroduction attempt.

Basin/Site Number	Site Name	Population Status	Size of Annual Spawning Run	Reproduction Successful?
Lake Superior				
1	St. Louis River	Reintroduced	Unknown	Unknown
2	Pigeon River	Extirpated		
3	Kamanistikwia River	Small	140	Yes
4	Wolf River	Extirpated		
5	Black Sturgeon River	Small	Unknown	Unknown
6	Nipigon River	Small	Unknown	Unknown
7	Gravel River	Extirpated		
8	Prairie River	Extirpated		
9	Pic River	Small	Unknown	Unknown
10	White River	Extirpated		
11	Michipicoten River	Small	Unknown	Unknown
12	Batchawana River	Small	Unknown	Yes
13	Chippewa River	Small	Unknown	Unknown
14	Harmony River	Extirpated		
15	Stokely Creek	Extirpated		
16	Goulais River	Small	Unknown	Yes
17	Tahquamenon River	Extirpated		
18	Sturgeon River	Small	≅200	Yes
19	Ontonagon River	Reintroduced	Unknown	Unknown
20	Montreal River	Extirpated		
21	Bad River	Small	≅350	Yes
Lake Michigan				
22	Millecoquins River	Small	<10	Unknown
23	Manistique River	Small	10's	Unknown
24	Sturgeon River (Nahma)	Extirpated		
25	Whitefish River	Extirpated		
26	Escanaba River	Extirpated		
27	Pike River	Small	Unknown	Unknown
28a	Menominee River (between Grand Rapids and White Rapids dams)	Small	≅200	Yes
28b	Menominee River (between Grand Rapids and Park Mill dams)	Small	Unknown	Yes
28c	Menominee River (below last dam)	Small	Unknown	Unknown
29	Peshtigo River	Small	≅200	Yes
30	Oconto River	Small	Unknown	Yes
31	Fox River	Small	Unknown	Unknown
32	Sturgeon Bay	Extirpated		
33	Little Sturgeon Bay	Extirpated		
34	Kewaunee River	Extirpated		
35	East/West Twin Rivers	Extirpated		
36	Wolf River	Large	22,000	Yes
37	Sheboygan River	Extirpated		
38	Barr Creek	Extirpated		
39	Milwaukee River	Extirpated		
40	Root River	Extirpated		
41	Wolf Lake	Extirpated		
42	St. Joseph River	Small	Unknown	Unknown
43	St. Joseph Shoal	Unknown	Unknown	Unknown
44	Kalamazoo River	Small	Unknown	Unknown
45	Grand River	Small	Unknown	Unknown
46	Muskegon River	Small	Unknown	Unknown
47	Ludington Shoal	Unknown	Unknown	Unknown
48	Manistee River	Small	≅50	Unknown

Basin/Site Number	Site Name	Population Status	Size of Annual Spawning Run	Reproduction Successful?
Lake Huron				
49	Carp River	Small	Unknown	Unknown
50	St. Marys River	Small	Unknown	Unknown
51	Root River	Extirpated		
52	Garden River	Small	Unknown	Unknown
53	Echo River	Extirpated		
54	Thessalon River	Extirpated		
55a	Mississagi River	Small	150	Yes
55b	Mississagi River (landlocked)	Small	Unknown	Unknown
56	Blind River	Extirpated		
57	Serpent River	Extirpated		
58	Spanish River	Extirpated		
59	French River	Small	Unknown	Unknown
60	Key River	Extirpated		
61	Magnetawan River	Small	Unknown	Unknown
62	Naiscoot River	Small	Unknown	Unknown
63	Seguin River	Extirpated		
64	Moon River	Small	Unknown	Unknown
65	Go Home River	Extirpated		
66	Severn River	Small	Unknown	Unknown
67	Sturgeon River	Extirpated		
68	Nottawasaga River	Small	Unknown	Yes
69	Manitou River	Extirpated		
70	Sauble River	Extirpated		
71	Saugeen River	Extirpated		
72	AuSable River	Extirpated		
73	Blue Point	Extirpated		
74	Saginaw River	Small	Unknown	Unknown
75	AuSable River	Extirpated		
76	Thunder Bay River	Extirpated		
77	Cheboygan River	Small	Unknown	Unknown
78	Burt Lake	Small	Unknown	Unknown
79	Mullett Lake	Small	Unknown	Unknown
80	Black Lake	Small	≅60	Yes
Lake Erie				
81	St. Clair River	Small	Unknown	Unknown
82	Detroit River	Small	Unknown	Unknown
83	Maumee River	Extirpated		
84	Cattaraugus Creek	Extirpated		
Lake Ontario				
85	Upper Niagara River	Small	Unknown	Unknown
86	Lower Niagara River	Small	Unknown	Yes
87	Oswego River	Extirpated		
88	Genesee River	Extirpated		
89	Salmon River	Extirpated		
90	Trent River	Small	Unknown	Yes
91	Amherst Island Shoal	Unknown	Unknown	Unknown
92	Black River	Small	Unknown	Unknown
St. Lawrence				
93	Black Lake	Extirpated		
94	Oswegatchie River	Extirpated		
95a	St. Lawrence River	Small	100's	Unknown
95b	St. Lawrence River	Small	Unknown	No
95c	St. Lawrence River	Small	Unknown	Yes
96	Grasse River	Small	10's	Unknown
97	Raquette River	Small	Unknown	Unknown
98	St. Regis River	Small	Unknown	Unknown
99	Ottawa River	Small	Unknown	Unknown
100	Des Prairies River	Large	≅7,000	Yes
101	Des Milles Iles River	Small	Unknown	Yes
102	Quaron River	Small	<1,000	Yes
103	L'Assomption River	Small	Unknown	No
104	St. Francois River	Small	≅100	Unknown
105	St. Maurice River	Large	≅1,250	Yes
106	Batiscan River	Small	Unknown	Unknown
107	Lake Champlain	Small	Unknown	Unknown

Impediments and Knowledge Gaps to Lake Sturgeon Rehabilitation

To complete a foundation of information to develop a research framework from, the workshop discussion groups were also asked to identify the range of impediments and knowledge gaps that prevent the successful rehabilitation of lake sturgeon in the Great Lakes. There was little attempt by discussion group leaders to filter or pare down the suggested impediments or knowledge gaps identified by the participants. The summary that follows represents a synthesis by the steering committee of the many suggested impediments and knowledge gaps. A complete version of each group's findings is provided in the discussion group summaries (Appendix D).

Impediments

Participants were asked to list impediments and then rank them according to priority. Table 2 provides the results of the discussions of all five groups.

Table 2. Impediments to lake sturgeon rehabilitation in the Great Lakes identified by workshop discussion groups and ranked according to the number of groups that listed the impediment.

IMPEDIMENT	# OF GROUPS
Barriers to spawning grounds Unfavorable flow regimes Lack of public awareness to the value of sturgeon	5
Habitat fragmentation Contaminants Negative impacts of TFM Lack of knowledge of sturgeon early life history and food base Impact of exotics on sturgeon Over exploitation Lack of funding Interjursidictional differences	4
Spawning habitat degradation - sedimentation, etc. Water quality, DO and temp Lack of current genetics information Lack of knowledge on historic abundance and range	3
Changes in Great Lakes benthos populations Turbine mortality Channelization Draining of wetlands Low abundance of sturgeon currently Insufficient Hatchery capacity Juvenile/nursery habitat Long term goals take institutional commitment Limited availability of broodstock	2
Global warming Mortality from boat traffic Competition between species Illegal harvest Imprinting of fry/fingerlings Shoal habitat quality Failure of some populations to reproduce successfully Lack of habitat assessment information Lack of management plans Nutrification of spawning areas Limitations of survival of stocked sturgeon	1

The steering committee's interpretation of the impediments considered highest priority by the participants were issues related to habitat loss. Dams may be the greatest impediment to lake sturgeon rehabilitation in the Great Lakes because they remove access to spawning areas that were historically important (Rochard et al. 1990). In addition to blocking migration, altered flow patterns below dams can greatly affect adult spawning behavior (Auer 1996a), the survival of sturgeon eggs and fry, and result in habitat fragmentation within an entire river system (Brousseau and Goodchild 1989). Land use problems such as erosion, sedimentation, and other water quality problems related to both point and non-point source pollution have also degraded the quality of spawning and nursery areas in many Great Lakes tributary streams that formerly supported spawning sturgeon stocks. Lastly, stream channelization destroys habitat critical for lake sturgeon survival.

Overexploitation or incidental mortality is another category of impediments that involves not only issues of managing users of the resource and their take or harvest, but also public opinion as to the value of a healthy lake sturgeon population (Auer 1999a). Once lake sturgeon reach a certain size in their first year of life, there are few native predators to affect their abundance. However, their longevity and low reproductive rate renders lake sturgeon especially vulnerable to excessive harvest or incidental mortality. There is great demand worldwide for the legal and illegal harvest of lake sturgeon because of the high value of their flesh and especially their eggs as caviar (Auer 1999a). Effects of turbine mortality and entrainment are also thought to contribute to elevated mortality rates. An impediment to curbing all forms of harvest and excess mortality is the apparent lack of public concern for the problem. If the public was more aware of the values to society for maintaining healthy sturgeon populations, then the risks of activities that elevate mortality of sturgeon, in the form of regulation and penalties, would become the deterrent to curb such activities.

The use of the lampricide TFM to control sea lamprey abundance must also be managed carefully to avoid the incidental mortality of lake sturgeon (Auer 1999a). Sturgeon are one of the most sensitive fish species to TFM. Control agents for both the United States and Canada have developed a treatment protocol for streams that possess sturgeon and are treated for sea lampreys, to minimize impacts on sturgeon.

The longevity and interjurisdictional nature of lake sturgeon are also potential impediments to its rehabilitation. Lake sturgeon have been found to range great distances and even migrate among lakes (Auer 1996b, Auer 1999b). Such a distribution requires coordination of a number of fishery agencies to ensure adequate protection across their entire range. Participants judged the lack of political will and agency funding as potential impediments to sturgeon rehabilitation. Because sturgeon rehabilitation will likely require decades to measure results, fishery agencies can find it difficult to maintain a focus on rehabilitation unless there are measurable results on a shorter time frame than decades. There also can be a problem with passing on institutional memory. The results of management decisions agency personnel make today may not succeed until long after those personnel have retired.

Lastly, there were a group of impediments identified that relate to sturgeon aquaculture. There are a number of technical impediments in hatching and rearing sturgeon that need to be solved before hatchery rearing can be implemented as a rehabilitation tool on a basin-wide scale. Developing a captive broodstock is unlikely for sturgeon and establishing a reliable source of wild lake sturgeon populations as a donor broodstock is a potential impediment. If hatchery rearing is a significant component to lake sturgeon rehabilitation efforts, maintaining genetic diversity of the stocked fish is another likely impediment.

Knowledge Gaps

Key knowledge gaps identified were closely associated with the categories of impediments. Gaps identified by two or more discussion groups are presented in Table 3.

Upon review of the knowledge gaps listed in Table 3., it becomes apparent that there is much to learn about the basic biological parameters and habitat requirements of Great Lake's lake sturgeon. Coupled with the apparent dearth of knowledge on the status of current sturgeon stocks (see earlier status section), many of the impediments to rehabilitation can not be corrected until managers and researchers collect basic biological and population information.

Table 3. Knowledge gaps to lake sturgeon rehabilitation in the Great Lakes identified by two or more workshop discussion groups and ranked according to the number of groups that listed the impediment.

KNOWLEDGE GAPS	# OF GROUPS
What are the habitat use requirements for various sturgeon life stages? Is there shoal spawning populations in the Great Lakes?	5
What are the current lake sturgeon population sizes throughout the Great Lakes Basin? What is the minimum home range for lake sturgeon? What are typical movement patterns of various life stages? Are there specific staging areas?	3
Uncertainties about how to sample for lake sturgeon. Need for effective gear for sampling various life stages. Need technology for effective up and downstream passage of sturgeon around dams and other barriers. What is the distribution of larval and YOY fish under normal conditions (not impacted by dams)? What is the impact of contaminants on lake sturgeon? What are contaminant levels in sturgeon and on the spawning grounds? What are the characteristics of successfully created spawning reefs? What were the historic population sizes of lake sturgeon in rivers and lakes throughout the basin? What are appropriate stocking rates and optimum time and place to stock sturgeon? What are survival rates of stocked fish?	2

Research Framework to Enhance Lake Sturgeon Rehabilitation Efforts

Research needs identified by the workshop discussion groups share a common purpose, to identify and resolve impediments and knowledge gaps to rehabilitation of lake sturgeon in Lake Michigan and the Great Lakes and to assist the evaluation of priorities for their removal. The research needs and priorities identified by each discussion group during the workshop were very similar and provide a range of alternatives for the support of sturgeon research and rehabilitation by the Great Lakes Fishery Trust (see discussion group summaries in Appendix D). Discussions at the workshop indicated that there might be merit in the integration of these research needs into a set of research programs that are linked through focus on fundamental problems.

Workshop participants identified four major problems that limit effective rehabilitation of sturgeon in the Great Lakes. The first problem is the lack of adequate knowledge of status and distribution of sturgeon populations in the entire Great Lakes system (Auer 1999a). As our attempts to summarize current understanding of the status of sturgeon stocks illustrate, there does exist a wide range of potential restoration sites and populations of widely varying status. This information, however, is not adequate for effective justification of habitat restoration initiatives or for the design of research projects. The second problem is the lack of sufficient understanding of habitat constraints on the life cycle of sturgeon populations and in the role of habitat structure in the regulation of sturgeon population structure (Auer 1999a). For some life stages there is simply too little documentation of habitat preferences. Without this information it is quite difficult to classify and inventory habitat features sufficiently to make predictions about the effects of habitat loss or gain on the production of sturgeon from specific systems. A third problem is the need to develop adequate fish passage technologies for lake sturgeon for areas where dams form barriers to upstream and downstream movement and where removal is unlikely (Auer 1999a). Access to quality spawning and rearing habitat in upper reaches of rivers blocked by dams will remain unavailable unless adequate passage technologies for lake sturgeon are developed. Finally the fourth problem is the lack of cost-effective artificial propagation techniques and associated strategies to use stocking to mitigate or accelerate recovery of sturgeon populations.

Our recommendation is to organize research into programs that focus on each of the questions. This integrated approach contrasts with an alternative of developing a set of request for proposals that focus on theme areas. We believe that an integrated approach will more effectively promote collaboration and partnerships. Research approaches that correspond to each of the four problems are summarized on the following page.

Status Assessment and Development of a Rapid Survey Process.

Solving the lack of understanding of current status of lake sturgeon populations is an essential first step in promoting effective rehabilitation projects and research to support them. The goals of these surveys, however, must be carefully constrained to assure timely results. To guide research and cost effective rehabilitation projects, more standardized information and Great Lakes system-wide reconnaissance are required. Specific research activities that are unified in this process are consolidation of existing information, design of indicators and survey strategies to provide comprehensive and system-wide inventories, and coordination of periodic census efforts. The purpose of these surveys is to establish a consistent and unbiased assessment of spawning stock status and distribution in order to select candidate sites for rehabilitation, protection, monitoring, and research.

Individual System and Habitat Requirement Studies.

Spawning sites, nursery areas, and adult habitat form linked systems that support meta populations of lake sturgeon in the Great Lakes. Little is known of the meta population structure of sturgeon nor of the production potential of individual systems and their distribution. A core problem affected by this uncertainty is the inability to predict effects of habitat restoration on production of sturgeon. Such predictions are needed for cost effective allocation of funding for restoration initiatives. Participants identified a number of research topics that are unified in these studies. The lack of detailed understanding of habitat utilization by various life-history stages and the associated lack of detailed habitat classification and inventory are critical information gaps that must be filled. Effective design of these studies, however, requires reliable system-wide surveys of stock status.

Fish Passage Technology for Lake Sturgeon.

Dams on most of the Great Lakes tributary rivers preclude lake sturgeon access to much of their former spawning and nursery habitat. In addition, lake sturgeon must be given a safe route to pass downstream through hydroelectric dams to minimize the amount of turbine mortality. Effective fish passage technology for lake sturgeon has not been developed to date. Research into the design of safe and effective passage for lake sturgeon both upstream and downstream of dams is needed.

Propagation Techniques and Strategy for Deployment.

Unlike other fish management challenges, lake sturgeon rehabilitation suffers from the lack of cost-effective propagation techniques. Participants identified the need for research and development to improve hatchery production and stocking success. Also of concern, however, was the need for consideration of a wider range of stocking strategy issues such as where to use the stocking option, the effects of stocking on extant population structure, and related issues. Additional concerns include the availability of donor stocks to serve as a source of gametes for artificial propagation and what strategy will be used to maintain genetic diversity of sturgeon stocks while increasing hatchery production. Unifying research under this topic might accelerate the more rapid development of these techniques.

Workshop Evaluation and Emerging Issues

Workshop Evaluation

"It was a great opportunity to meet and share information regarding lake sturgeon. The outcome of this workshop will be extremely useful when dealing with my agency. Thank you."

The 29 participants that completed an evaluation agreed that the workshop was very successful in achieving the goal and objectives of the workshop (Appendix E). More than 90% of the participants that responded agreed or strongly agreed with eight of the nine questions regarding the goals and objectives. One question, "Characteristics of a healthy/restored Great Lakes sturgeon population have been adequately defined?" was supported by only 76% of the respondents. This question, however, is related to a scientific conclusion that represents the state of our knowledge on what are characteristics of a restored population. Because the definition developed during the workshop remained incomplete, it is understandable that concurrence on the definition remains incomplete. The second part of Appendix E provides additional comments on the workshop, what could have been improved, and what aspects were most and/or least useful.

Emerging Issues

"I gained a lot of knowledge of lake sturgeon biology, research procedures and interpretation of habitat use etc. An excellent workshop!"

The absence of an organizational structure or rehabilitation plan to address lake sturgeon on a basinwide scale in the Great Lakes and the need for improved public information and education programs are two emerging issues identified during the workshop, the Trust may want to consider supporting, in addition to the four major problems described above.

"Very well organized, well focused."

The workshop provided the first opportunity for such a diverse group of sturgeon biologists to meet and interact. There was a near unanimous opinion of the participants that some kind of annual meeting be sponsored to continue the communication of sturgeon work across the Great Lakes basin. Most of the groups also felt strongly that a rehabilitation plan for Great Lakes lake sturgeon be developed and accepted by all of the fishery agencies responsible for sturgeon management. In addition to the development of a rehabilitation plan, there is a need for some organization/agency to take the lead in the development and implementation of the basinwide plan. The Trust may want to partner with the Great Lakes Fishery Commission and determine how to organize and support annual lake sturgeon meetings similar to what the Great Lakes Fishery Commission does with coordinating lake trout rehabilitation.

Informing and educating the public was a second emerging issue that was mentioned by many workshop participants. Lake sturgeon are unique fish and the story of there existence and rehabilitation is an important message to provide the public in the Great Lakes region. Increased public awareness will mean increased interest and funding support for programs that result in the rehabilitation of lake sturgeon (Auer 1999a). The trust may want to consider directing some of its funding in the public education category specifically on lake sturgeon rehabilitation.

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RESEARCH AND ASSESSMENT NEEDS TO RESTORE LAKE STURGEON IN THE GREAT LAKES

A Workshop Sponsored by the Great Lakes Fishery Trust

JUNE 27-28, 2000
HOLIDAY INN-MUSKEGON HARBOR
939 THIRD STREET
MUSKEGON, MI 49440-1197

AGENDA

Tuesday, June 27

10:00 am	Introductions, Workshop Goal and Objectives - Mark Holey, USFWS
10:15 am	Welcome and The Role of the Great Lakes Fishery Trust in Lake Sturgeon Restoration - K. Cool, Director, Michigan Department of Natural Resources and Chair of the Great Lakes Fishery Trust
10:30 am	History and Status of Lake Sturgeon in the Great Lakes Dr. Nancy Auer, Michigan Technology University
11:15 am	Facilitated Discussion of Current Distribution Map Dr. Joe Koonce, Case Western Reserve University Dr. Ed Baker, MDNR
12:00 noon	Lunch Provided
1:00 pm	Review of existing restoration and management goals for lake sturgeon in the Great Lakes - Rob Elliott, USFWS
1:30 p.m.	Facilitated Breakout Group Discussions – Dr. Joe Koonce[1] Goal: Definition of a restored lake sturgeon population
2:30 p.m.	Break (refreshments provided)
3:00 p.m.	Facilitated Breakout Groups Goal: List impediments to restoration
5:00 p.m.	Adjourn
5:30 p.m.	Social - Hors D'oeuvres and refreshments provided. Informal exchange of posters, reports, handouts, or videos of lake sturgeon activities by participants.

Wednesday, June 28

7:30 a.m.	Full Breakfast provided
8:15 a.m.	Brief Orientation for Day 2
8:30 a.m.	Facilitated Breakout Groups Goal: Revise Map of restored populations and list knowledge gaps
10:30 a.m.	Break (refreshments provided)
11:00 a.m.	Facilitated Breakout Groups Goal: Identify research to improve understanding of impediments and to close information gaps
12:00 noon	Lunch provided
1:00 p.m.	Facilitated Breakout Groups Goal: Prioritize Impediments and knowledge gaps
3:00 p.m.	**Adjourn**

[1]Breakout group discussions will focus on three issues: definition of restored or healthy lake sturgeon populations, identifying impediments or bottlenecks to restoration, and identifying knowledge gaps that need to be filled and ways of filling them. These topics will be revisited iteratively during the workshop breakout sessions.

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Summary of Great Lakes Lake Sturgeon Plans

Existing lake sturgeon plans pertaining to Great Lakes waters :	Abbreviation Code
Auer, N.A. (ed.). 2000. **A Lake Sturgeon Rehabilitation Plan For Lake Superior.** Lake Sturgeon Subcommittee of the Lake Superior Technical Committee.	**SUP**
Busian, T.R. (ed.). 1990. **Fish-community objectives for Lake Superior.** Great Lakes Fishery Commission Special Publication 90-1, Ann Arbor, MI.	**LS-FCO's**
Carlson, D. 2000. **A Recovery Plan for the Lake Sturgeon (Acipenser fulvescens) in New York.** Draft. New York State Department of Environmental Conservation, Division of Fish and Wildlife, Bureau of Fisheries, Endangered Fish Project.	**NYDEC**
Cavander, T.M. 1994. **Ohio's Lake Sturgeon Management and Recovery Program for Lake Erie.** Division of Fishes, Museum of Biological Diversity, The Ohio State University. Columbus, Ohio.	**OHIO**
DesJardine, R.L., T.K. Gorenflow, R.N. Payne, and J.D. Schrouder. 1995. **Fish-community objectives for Lake Huron.** Great Lakes Fishery Commission Special Publication 95-1, Ann Arbor, MI.	**LH-FCO's**
Eshenroder, R.L., M.E. Holey, T.K. Gorenflo, and R.D. Clark, Jr. 1995. **Fish-community objectives for Lake Michigan.** Great Lakes Fishery Commission Special Publication 95-3, Ann Arbor, MI.	**LM-FCO's**
Hay-Chmielewski, L., and G. Whelan, editors. 1997. **Lake sturgeon rehabilitation strategy.** Michigan Department of Natural Resources. Fisheries Division Special Report Number 18, Ann Arbor, MI.	**MDNR**
Mathers, A. 1996. **Lake Sturgeon Rehabilitation Within The Bay Of Quinte.** Draft. Ontario Ministry of Natural Resources, Ontario Canada.	**QUINT**
Rakes, A.A., W.V. Booker, F.A. Chapman, S.P. Filipek, L.K. Graham, J.L. Rasmussen, K.J. Semmens, R.A. St. Pierre, and T.J. Smith. 1993. **Framework for the management and conservation of paddlefish and sturgeon species in the United States.** National Paddlefish and Sturgeon Steering committee, U.S. Fish and Wildlife Service, Washington, D.C.	**US**
Scheidegger, K. 2000. **The draft Wisconsin lake sturgeon management plan.** Sturgeon Management Assessment Team, Wisconsin Department of Natural Resources, Madison, WI.	**WDNR**
Stewart, T.J., R.E. Lang, S.D. Orsatti, C.P. Schneider, A. Mathers, M.E. Danials. 1999. **Fish-community objectives for Lake Ontario.** Great Lakes Fishery Commission Special Publication 99-1, Ann Arbor, MI.	**LO-FCO's**
Societe de la faune et des parcs du Quebec. 2000. Plan de gestion de l'esturgeon jaune du fleuve Saint-Laurent 2000-2003. **(St. Lawrence River Lake Sturgeon Management Plan, 2000-2002).** FAPAQ, Directions de l'amenagement de la fuane du Centre-du-Quebec, de Lanaudiere, de la Monteregie et de Montreal.	**St.LR**
Thuemler, T.F., E.A. Baker, and R.F. Elliott. 1999. **Draft Lake sturgeon plan for the Green Bay basin.** Wisconsin DNR, Michigan DNR, and U.S. Fish and Wildlife Service draft document.	**GrnB**

Compilation of goals identified in the various Great Lakes lake sturgeon plans:

Successful sturgeon management. (WDNR)

Conserve, rehabilitate, and re-establish self-sustaining populations to levels that permit delisting as a threatened species. (MDNR)

Provide background information and present state of knowledge of Lake Erie sturgeon populations for use in developing recovery and management plans. (Ohio)

Self-sustaining population recovery sufficient for removal from threatened or endangered status to Special Concern. (NYDEC, LO-FCO's)

Re-establish depleted stocks to self-sustaining levels through rejuvenation, protection or replacement of degraded habitat. (LS-FCO's)

Maintain, enhance and rehabilitate self-sustaining populations where historically occurred. (LS-FCO's)

Enhance self-sustaining populations. (LM-FCO's)

Enhance existing naturally reproducing populations. (GrnB)

Re-establish self sustaining naturally reproducing populations throughout historic range. (GrnB)

Develop harvestable surplus through natural reproduction and provide harvest opportunities. (GrnB)

Increase the abundance of lake sturgeon to the extent that the species is removed from its threatened status in United States waters. (LH-FCO's)

Maintain or rehabilitate populations in Canadian waters. (LH-FCO's)

Ensure the conservation, rehabilitation and wise use of this sensitive species. (Quint)

Develop a national perspective for management and conservation of sturgeon species. (US**)**

<u>Common objectives listed in the various Great Lakes lake sturgeon plans:</u>

Protect and Conserve Existing Stocks
(WDNR, MDNR, Ohio, NY, SUP, GrnB, Quint, St.LR, FCO's, US)

Restore/Rehabilitate/Reestablish/Establish Throughout Historic Range
(WDNR, MDNR, NY, SUP, GrnB, Quint, FCO's, US)

Inventory, Measure, and Monitor Population Levels and Status
(WDNR, MDNR, Ohio, NY, SUP, GrnB)

Restrict or Ban Harvest of Populations During Restoration
(WDNR, MDNR, Ohio, NY, SUP, GrnB)

Allow Harvest of Restored Self-Sustaining Populations
(WDNR, MDNR, NY, SUP, GrnB, Quint, St.LR)

Maintain High level of Regulation, Reporting, and Enforcement
(WDNR, MDNR, Ohio, SUP, GrnB)

Identify and Measure Critical Habitats for All Life Stages
(WDNR, MDNR, Ohio, NY, SUP, GrnB, Quint, FCO's, US)

Protect, Enhance, Rehabilitate and/or Restore Critical Habitat
(WDNR, MDNR, Ohio, NY, SUP, GrnB, Quint, FCO's, US)

Minimize, Mitigate, or Eliminate Negative Effects of Barriers and Dams
(WDNR, MDNR, GrnB)

Identify, Develop, and Coordinate Genetically Appropriate Hatchery Products for Stocking
(WDNR, MDNR, Ohio, NY, SUP, GrnB, Quint, St.LR, US)

Identify, Measure, and Reduce Point, Nonpoint, and Contaminant Source Pollutants for Sturgeon
(WDNR, MDNR, NY, SUP, GrnB)

Support Sea Lamprey Control Methods that are compatible with Sturgeon Restoration
(MDNR, SUP, GrnB)

Inform, Educate, and Involve the Public
(WDNR, Ohio, NY, SUP, Quint, US)

Increase Understanding of Population and Live History Characteristics
(WDNR, MDNR, Ohio, NY, SUP, Quint, St.LR, US)

Summary of Discussion Group 1

Participants:

Mark Holey (group leader), Brad Latvaitis (day 1), Brett Fessel, Rick Huber, Doug Carlson, Jerry Wiese, Eve McQuowan, Fred Binkowski (day 2), Terry Lychwick, Mike Thomas, Kelley Smith (day 2), and Sharon Hanshue (recorder)

Definition of a Restored Lake Sturgeon Population

A restored lake sturgeon population is one that:

- Occupies 50% of the historic spawning streams or spawning habitat - need to define the time frame or spatial scale variation.
- Is self reproducing.
- A minimum of 500 spawning adults per river each year.
- Has 20 year classes of females in spawning population.
- Restored populations should reflect the available diversity of existing wild stocks.
- Is capable of providing a harvest.

Impediments - in priority order

Habitat
- Fragmentation
- Barriers limiting access to spawning grounds - upstream and downstream.
- Spawning habitat degradation - sedimentation, channelization, etc.
- Flow regimes unfavorable to life cycles.
- Water quality - temp, DO, contaminants, TFM.
- Juvenile/nursery habitat.
- Shoal habitat quality.

Public Awareness
- Number of people looking, information exchange/publishing, funding.
- Public awareness and sensitivity to the value of sturgeon as a resource.
- Institutional memory/commitment and political will to the long term goals.
- Institutional Management/Commitment - Interjurisdictional cooperation.

Genetic
- Limited availability of broodstock, access to eggs.
- Insufficient females to achieve effective population number.
- Limitations in the survival of stocked sturgeon (size, health, condition, and predation).
- Different strategies for rehabilitation (existing stocks) or restoration (no existing stocks).
- Hatchery capacity/ ability - imprinting to hatchery?

Lack of knowledge on historic and current abundance and range
- Information - not enough known to make management decisions and too few staff and budgets.

Populations
- Overexploitation, illegal harvest, excessive loss of females.

Interjurisdictional Management
- Maintaining priority across agencies.
- Organizational differences.

Summary of Discussion Group 1 (cont.)

Species Interactions
- Competition/predation - exotics, gobies, carp, sea lamprey.
- Resumption of stocking in void rivers.

Knowledge Gaps

Spawning Habitat
- Attributes - clean rock, water flow, temp, particle size.
- Lack of knowledge on the range of spawning substrate attributes that are successful.
- Adequate inventory of existing habitat - especially in rivers with low numbers or no sturgeon.
- Phantom shoal spawning habitat.

Larvae
- Very little known where larval fish go.
- Newly hatched through 25 mm.
- Post larvae, to age 2, predation is less of a concern.

The ability to evaluate sturgeon population responses to dam removal

How to manage dams that are not removed - passage, flow, etc.

TFM Concerns
- What streams have spawning sturgeon.
- How long do larvae stay in river.
- Spatial distribution of sturgeon in the river.

Barrier Dams
- Mitigation of barrier dams to pass sturgeon - existing and new dams.
- Barrier dam impact assessment.
- Design criteria for lamprey barriers to minimize adverse impacts.

Water Quality
- Lethality of chemicals, esp related to eutrophication, nitrogen, ammonia, copper, chlorine, PCBs etc.
- Little known about the body burdens and effects on egg survival.

Genetics
- Know little about the level of variability or stock structure.
- Need to identify the relationship between genetics and habitat.
- Hatchery management concerns.
  - Improve egg taking techniques
  - Information sharing
  - Comparability between researchers working in stock identification
  - Plan or strategy on how to address the effective brood stock size in stocking programs
  - The importance of imprinting related to stocking program

Present carrying capacity vs historic capacity

Public awareness/ Institution
- How to build commitment for support.
- How to implement a rehabilitation strategy.
- Education program for public and anglers.

Population dynamics
- Basic understanding to predict/forecast population trends.

Research

- Extensive review of historic information
- Inventory of present range and abundance
- Classify appropriate spawning, nursery, overwinter habitat by life stage.
- Determine the distribution and requirements of sac fry to the time they leave the river and age 2.
- Determine the use of shoal spawning and their contribution to basin populations.
- Strategies for restoration/rehabilitation of remnant populations vs. streams now void of sturgeon.
- Dam flow regimes and fish passage.
- Standardize genetic markers across labs.
- Coordination of tissue collection of breeding populations and sharing of markers.
- Toxicology experiments.
- Develop a public information marketing strategy.
- Determine if sturgeon imprint.

Summary of Discussion Group 2

Participants:

Ed Baker (group leader), Randy Claramunt (recorder), Dave Borgeson, Lloyd Mohr, Roger Gordon, Ellie Koon, Lee Meyers, Jennifer Hayes, Mike Costello

Before defining the characteristics of a restored population there was some discussion about the use of the term "restored." Our group decided that the term rehabilitated was better than restored because restored implies returning to a prior condition and we all agreed that we will never bring lake sturgeon populations back to what they were prior to European settlement of the Great Lakes region.

Definition of rehabilitated lake sturgeon population: A population that is self-sustaining and has an abundance, range, age-structure, and genetic diversity that is compatible with system productivity. A rehabilitated population will also be able to support some harvest. Some specific attributes of a rehabilitated population in addition to those already listed are: 1)an adequate sex ratio to insure genetic diversity 2) at least 70 age classes in population 3) successful annual recruitment and 4) a high percentage of large, old fish.

Impediments (in rank order 1 through 5) that will need to be overcome to meet the rehabilitation goals are:

1. A lack of knowledge of the current distribution and abundance of lake sturgeon in the Great Lakes basin.
2. Habitat loss and fragmentation in the Great Lakes and in rivers used for spawning.
3. The presence and operation of hydropower dams on major Great Lakes tributaries.
4. The low abundance of lake sturgeon.
5. A lack of knowledge of lake sturgeon life history, particularly the early life history.

Other impediments we discussed but did not rank are:

-Lack of knowledge about the genetic diversity and structure of existing remnant populations
-Low genetic diversity in remaining stocks
-Lack of knowledge about contaminant levels in lake sturgeon and the impacts of contaminants lake sturgeon biology
-Global warming
-Pollutants
-Exploitation, both legal and illegal
-The continued high commercial value of lake sturgeon (caviar)
-Unknown fish community interactions in the Great Lakes with exotic species
-Sea lamprey control efforts, specifically TFM and low head lamprey barriers
-Changes in the benthos composition in the Great Lakes
-Public ignorance of lake sturgeon and their historical and current status (lack of public education)
-Mortality associated with commercial and recreational boat traffic (prop chop)
-Lack of funding

Summary of Discussion Group 2 (cont.)

The **Knowledge gaps** that we discussed relative to the map revision of rehabilitated populations are:
What is limiting existing populations from becoming more abundant?
What is the carrying capacity for a particular river system?
What is good nursery habitat for YOY to 2 year old fish?
How many fish should be stocked to reintroduce a population to a former habitat?
What is the best donor stock to use for reintroduction?
For riverine populations, how much emigration is occurring over dams?
Is there shoal spawning in the Great Lakes?
What is the distribution of larval and YOY fish under "normal" conditions? (not hydropower impacted)
What is the minimum home range for lake sturgeon?
What should the benchmarks be for rehabilitation?
Can remnant populations recover on their own if left alone and protected?
What is the minimum viable population size for lake sturgeon?
What is a population?
Will there be adverse affects of rehabilitation?
Is the lake sturgeon niche empty?

Research Needs
Finally, our prioritized list of research needs are as follows:

1. A system-wide assessment of the current status of lake sturgeon populations including their distribu tion and abundance, spawning site fidelity, age structure, range, and whether existing populations are successfully reproducing. Included should be development of standard sampling protocols, tagging methods, and development of a centralized Great Lakes wide database.

2. Multi-system life history research from egg to adult stage and including genetic analysis of existing stocks. Specific questions that need to be addressed are: 1)what are the vital habitat needs for all life stages? 2) what are natural mortality rates for all stages of lake sturgeon and what are the sources of mortality (egg to adult) 3) what is the recruitment rate for populations? 4) what is the minimum viable population size?

3. Research to determine stream specific habitat suitability in an effort to determine carrying capacity, both existing and potential. Included in this research should be an analysis of habitat available both above and below existing hydropower or other unnatural barriers. Habitat quantified should include temperature characteristics of the river, substrate composition and distribution (feeding and spawning habitat), cover, flow characteristics, fish community composition, water quality, and watershed charac teristics (land use, etc.).

4. Research into the utility of reintroducing lake sturgeon via hatchery culture including research into improved culture techniques, long term research on return of stocked fish, and research aimed at determining the appropriate donor stock for reintroduction. Specific questions that need to be addressed are: 1) at what age do lake sturgeon imprint? 2) what is the appropriate life stage to stock? 3) what is the appropriate stocking density? 4) what is the best method to mark stocked fish? and 5) do stocked fish survive to return and successfully spawn as adults?

5. Research into fish passage (up and down stream) and mitigation measures to prevent entrainment/impingement at hydropower facilities.

6. Research into lake sturgeon compatibility and interactions with the existing mix of native and exotic fishes.

Other research needs we discussed are:

-What are the current contaminants and their loads in lake sturgeon and are contaminants affecting lake sturgeon biology, particularly reproductive success?
-What types of public education efforts are needed and, when implemented, are they successful?
-What habitat improvement efforts are needed and when are they successful?

Summary of Discussion Group 3

Participants:
Tom Thuemler (Group Leader), Steve Fajfer, Nancy Auer, Pat DeHann, Tracy Hill, S. Jerrine Nichols, Tom Trudeau, Brandon Schroeder (recorder-first day), Holly Madill (recorder-second day), and July Metty (second day)

Definition of a Restored Lake Sturgeon Population

Our group felt that you could have a restored population in a river system without restoring the population of one of the Great Lakes. Therefore we came up with separate definitions for a restored river population and a restored lake population.

There were three main components to having a restored lake sturgeon population in a river. These were reaching a specific density, having a certain age structure and having certain habitat available. The specifics of each of these components are detailed below.

Density – A certain number of fish per acre of river needs to be met. What that number is, we felt was a knowledge gap. There is very little information in the literature on historic densities of lake sturgeon populations in unexploited rivers. This number should account for a population having both river resident and migratory individuals. It should be based on the productivity and the size of the river and it should include at least enough adults to provide a self-sustaining population.

Age Structure – The population of sturgeon in the restored river should include females at least 70 years old and males at least 40 years old. Although annual recruitment would not be needed, we felt there should always be recruitment in the 0 to 5-year group of fish.

Habitat – It was felt that sturgeon should have access to the same amount of habitat that was historically available to them in the river. This would include spawning, nursery and adult habitat. It was felt that if certain habitat that was historically used in a river system was inaccessible, then similar amounts of habitat had to be provided.

Our group's definition for a restored lake sturgeon population in one of the Great Lakes had the same three components.

Density – Again there was a specific number of fish per acre that needs to be met. That number should be based on the productivity of the lake and it should be based on the amount of sturgeon habitat in the specific lake. For instance, Lake Erie would have a higher number of sturgeon per acre in a restored population than Lake Superior, because that lake would have a higher productivity and a larger portion of the lake would be sturgeon habitat.

Age Structure – At least twenty year classes should be represented in a restored population. Ten to fifteen percent of the population should be made up of mature fish and three percent of the population should be age 40 or older.

Habitat – At least fifty percent of the rivers tributary to the lake which historically contained sturgeon populations should meet our definition of a restored sturgeon river. If shoal spawning was also a significant factor in the particular lake than at least fifty percent of this should also be restored.

Impediments to Restoring Lake Sturgeon Populations (prioritized)

Loss of critical habitat
Impacts of dams – inaccessible habitat, flooded habitat, river fluctuations below dams, entertainment and turbine mortality
Land use problems – sedimentation, water quality problems both industrial and agricultural, erosion
Altered aquatic ecosystems – channelization of rivers, draining of wetlands
Not enough resources directed to restoring sturgeon populations
Lack of funding for sturgeon research and management programs
Knowledge gaps on sturgeon biology, habitat use, management and genetics
The public's lack of knowledge of lake sturgeon biology and management
Need for protection of remnant and restored stocks from over harvest and poaching
Instill in the public a better appreciation for lake sturgeon and the uniqueness of this species
Management problems caused by political boundaries (interstate and international) and policies
Lack of consistent regulations and management strategies between the various governmental organizations responsible for the management of Great Lake's sturgeon populations.
Bureaucracy can cause delays in approving regulation changes because of the various governmental agencies involved with the management of sturgeon throughout the Great Lakes.
Time element because sturgeon are a long lived, late maturing fish
Impacts of changes in management strategies can take a long time to see because sturgeon are such a long lived fish.
Personnel managing sturgeon stocks often move on or retire before management strategies for lake sturgeon can be fully evaluated.

Summary of Discussion Group 3 (cont.)

Others
Impact of sea lamprey control programs on lake sturgeon is not fully understood.
Effect of TFM on lake sturgeon
Effect of electrical barriers and weirs on lake sturgeon tributary streams
The impact of various contaminants on lake sturgeon is not fully understood.
The impacts that exotic species have on lake sturgeon populations is not fully understood.
Causes of failure of successful reproduction in some populations of lake sturgeon.

Knowledge Gaps to Restoring Lake Sturgeon Populations (not prioritized)
Productivity of water body versus lake sturgeon densities
Population structure – resident versus migratory fish in rivers. Are there genetic differences between these fish or is it more density related.
Information on sturgeon energetics for population modeling.
Diseases and parasites of lake sturgeon.
Assessment of public's knowledge of lake sturgeon.
Current population status in most rivers and lakes.
Do fry or fingerlings imprint on natal spawning rivers.
Genetic structure of sturgeon population basin wide.
Technology for up and downstream passage of sturgeon around dams and possibly other barriers.
Interactions with other species
Endemic species
Exotic species – sea lamprey, others
Impact of contaminants on lake sturgeon
Non-lethal method to determine body burden
Contaminant levels in sturgeon
Contaminant levels on spawning grounds
Improved methods for collecting finrays for aging
Characteristics of successfully created spawning areas.
Rearing techniques for sturgeon
Feeds and feed acceptance
Optimum time and place to release sturgeon
Methods for release of sturgeon
Improved egg collection methods
Movement patterns of various life stages of lake sturgeon
Movement patterns of lake sturgeon within and between the Great Lakes
Why does the historic population of lake sturgeon in Lake Erie appear to be so high? Was it because of habitat availability or because of movement from other Great Lakes?
Estimates of historic populations in rivers and lakes and spawning runs.
Estimates of natural survival rates for eggs and other life stages for unexploited populations.
Estimates of survival rates for stocked fish.
Characteristics of nursery areas. Types of habitat used and locations in specific rivers, bays and lakes.
Sampling methodology
Effective gear for assessing various life stages of sturgeon
Standardized procedures for assessing populations throughout their range in the Great Lakes. Need for coordinated program to assure that all agencies are collecting similar data.
Need for methodology to determine production from spawning areas.

Prioritized List of Research Needed to Restore Lake Sturgeon Populations
Our group felt that it was imperative that a restoration plan for lake sturgeon within the Great Lakes Basin be developed and accepted by all of the various agencies responsible for the management of this species. In addition to the development of such a plan, there was a need for an agency to take the lead in the coordination and the imple mentation of this plan.
A comprehensive inventory of lake sturgeon populations throughout the Great Lakes Basin. Develop sampling proce dures, produce a standardized database for the inventory data, develop database of contaminant information, assure that data collected between populations is comparable, collection of genetic information from sturgeon populations throughout their range in the Great Lakes, assess 'fitness' of various sturgeon populations.
Inventory and define characteristics of critical habitat for all life stages of sturgeon. Collect information on the biology and population dynamics of various life stages of lake sturgeon. Determine interactions of lake sturgeon with other species.
Develop technologies that can be used to effectively pass lake sturgeon both up and downstream of barriers such as dams. Different technologies may be needed depending on the actual location and type of barrier.
A basin wide movement study of lake sturgeon is needed. This would include a coordinated basin wide tagging system and database. There is also a need for some specific movement studies in sub basins and for various life stages (i.e., movement pattern of fry after hatching; movement of adults into or out of Lake Erie)
There is a need for a public information and education program on the uniqueness of lake sturgeon and their status within the Great Lakes Basin. This would be a marketing program for the restoration of lake sturgeon throughout the basin.
There will be a need to provide hatchery reared lake sturgeon to restore certain populations within the Great Lakes Basin. Better culture methods will be needed. Research on stocking size and methods, feeds, egg take procedures, and diseases are all needed.
The impact that various contaminants have on lake sturgeon populations.

Summary of Discussion Group 4

Participants:

Rob Elliott (group leader), Ron Bruch, Tim Eder, Brant Fisher, Mike Friday, Chris Lowie, Erik Olsen, Doug Peterson, Jim Snyder, and John Weisser

Definition of Restored Population

Populations in all current and historic sturgeon tributaries in each basin that have potential for restoration.

Minimum number of tributaries per lake basin are:
Lake Superior = 12
Lake Michigan = 8
Lake Huron = 14
Lake Erie = 4 (including large ones in L. St Claire and Detroit River)
Lake Ontario = 5
St. Lawrence = 8

A Restored Population has:

-Females up to age to age 70 and males up to age 40
-Spawning population sex ratio of females to males of 1:5
-Minimum Adult stock size of 10,000 fish per watershed with multiple spawning sites
-Naturally self sustaining
-Eventually capable of supporting a sustained harvest of no more that 5% exploitation

Impediments (priority order)

Highest and of nearly equal Priority

1) Dams prohibiting passage and causing entrainment problems
2) Habitat availability/limitations (spawning, nursery, etc.)
3) Lack of adequate population and habitat assessment information
4) Lack of adequate $ to do work

Medium and nearly equal Priority

5) Inconsistencies between management agencies/jurisdiction
6) Land use impacts/non-point pollution
7) Negative impacts of flow regime management
8) Lack of adequate genetic data to make management decisions
9) Contaminant problems/information on loadings and physiological affects
10) Negative interaction of exotics and their control
11) Lack of management plans for spawning tributaries
12) Inadequate hatchery/rearing facilities/capacity/technology
13) Lack of public understanding/support
14) Open Season/Harvest/By-catch issues

Potential but unknown impediments

15) Brood stock availability (genetics issues)
16) Benthic food supply changes

NOTE that these are not in priority order of when they should be done or acted upon, just in order of what might be of greatest impediment to sturgeon.

Summary of Discussion Group 4 (cont.)

Information/Knowledge Gaps (not priority order) (not a comprehensive list as some are listed only in research needs - see next section)

Habitat Use/Requirements - Juvenile fish
Additional/Continued TFM Information
Management Profile/Plan for Recovery Streams
- -Current and Historic Population status
- -Current Habitat and Enhancement Potential

Ready Access to a Current Basin Distribution Information with:
- -Historic Presence
- -Historic Spawning
- -Current Presence
- -Current Spawning
- -Successful Reproduction/Recruitment
- -Planned for Restoration (or Restoration Priority)

Prioritization of Restoration Tributaries
Physiological Impacts of Contaminants
Comprehensive Information on Contaminant Levels from All Basins:
- - in Whole Body Burden, Blood Serum levels, Egg concentrations, Caviar Concentrations

Standardized Marking Techniques for Hatchery Fish
- - the need to be able to distinguish wild from hatchery product and to identify hatchery source (lot) to identify age, strain, location etc without sacrificing fish

Priority Identification of Potential Restoration Sites/Tributaries
- -will involve quantifying habitat available now and habitat that would be available if/when fish passage is attained.

Dam Removal Affects Related to Sturgeon Spawning: Sediments, contaminants, Sea Lamprey
New Fish Passage Techniques that Exclude Lamprey and Provide Up & Down stream Passage W/O Entrainment
Is Lake distribution Related of Food distribution, Temperature, Depth
Priority List of streams to Initiate Restoration (add to GIS Distribution Map)
Nursery Habitat: The Need to Identify and Quantify for Each System Type:
- -small shallow river, shallow estuary, deep river, shoal spawning

Spawning Habitat Identification for Each Tributary/System
- -With and Without existing barriers

Identify Best Locations and Rock/Material Types for Spawning Habitat Addition
- - include Expected Life Span (replacement time- based on previous experience)

Identification of Feasibility and Time Line for Barrier Removal or Passage
Is there a Relation Between spawning Periodicity/Maturation Age and Population Density
Understanding of Maturation Rates and potential differences between systems
Method for Sexing Live Fish that is Field and Fish Friendly
Understanding of Movement/Staging Behavior

Research Needs Associated With Information Gaps and Impediments

1. Dams
   - New fish passage techniques that exclude lamprey and provide up and down stream passage w/o entrainment
   - Feasibility and time line for barrier removal or passage
2. Habitat
   - Identify/define nursery habitat (will differ between systems)
   - Identification of spawning habitat for each system
   - Best locations for spawning habitat addition and needed replacement time frame
3. Population Assessment (lack of)
   - Adult presence
   - Spawning
   - Successful recruitment for predictive capability
   - Age structure and abundance
   - Recruitment relationships (system specific)
4. Land Use Impacts/Non Point Pollution
   - Rating of how important land use/non-point source pollution is for sturgeon habitat relative to other factors
5. Flow Regime Management
   - Current flow management practices, potential management, and limitations due to licenses (hat are the flow regimes/curves we have to work with)
6. Genetics
   - Adequate number of markers for analysis (have 4, 8 more needed, has funding)
   - Need samples from all spawning populations/stocks across basin (25 samples/river)
   - Effective population size
   - Genetic effects of stocking on top of or near remnant stocks
7. Contaminants
   - Are there physiological problems (reproductive)
   - What are contaminant levels

Summary of Discussion Group 4 (cont.)

8. Exotics
    - Competition: presence and significance (carp, gobies, suckers)
    - Egg predation: presence and significance (carp, gobies, suckers)
    - Lamprey predation (mortality estimates linked to observed scaring rates)
9. Life History (Biology/Behavior)
    - Is there a relation between spawning periodicity/maturation age and population density
    - Maturation rates
    - Field and fish friendly sex identification tool (scope, ultrasound)
    - Is staging habitat critical and can it be defined
    - Determine/characterize in lake habitat
    - Diet studies/understanding
10. Stocking
    - Best life stage to stock (imprinting/survival)
    - Stocking densities needed
11. Population Assessment
    - Adult presence
    - Spawning
    - Successful recruitment (need to define life stage where "recruitment" measures have predictive capability)
    - Age structure and abundance
    - Recruitment relationships (system specific)
12. Information Consolidation
13. Structured Organization: to continue focused work

Research Projects

I. Distribution and Status Inventory:

A comprehensive GIS database of existing information with ready access to all and that is easily updated that will serve as a point for investigator information exchange and a tool for public information.
To include:
1) Historic Presence
2) Historic Spawning
3) Current Presence
4) Current Spawning
5) Successful Recruitment
6) Barriers (type and location)
7) Ongoing Restoration
8) Planned Restoration

II. Define and Identify Spawning and Nursery Habitat for All Systems

1) Start with current BEST remnant stocks (streams)
2) Define nursery habitat
3) Some spawning habitat still needs definition
4) ID spawning and nursery habitat with and w/o existing barriers
5) ID locations and material types for spawning habitat enhancement
6) ID time line and feasibility for barrier removal or fish passage
7) FINAL STEP (GOAL): Prioritize watersheds for research/restoration efforts

III. Identify Population Characteristics and Status (add data to inventory database - I. above)

Start with current BEST remnant stocks to determine:
1) Spawning run size
2) Age structure and abundance of population
3) Growth
4) Recruitment relationships
5) Genetic Characteristics
6) Movement (requires standardized marking protocol)
7) Contaminants
8) Sex and stage of maturation and spawning periodicity

IV. Create a Structured Organization for Coordinating and leading Great Lakes Lake Sturgeon Research and Restoration Effort
-could be independent or associated with current structures (GLFC, Sturgeon Society etc.)
-will require sponsorship (GLFT, GLFC, etc.)
-will involve committees, boards, chairs, leadership responsibility

Summary of Discussion Group 5

Participants:

Joe Koonce (group leader), Archie Martel (recorder), Gary Whelan, Kim Scribner, Ed Iwashewski, Jim Boase, Henry Quinlan, Greg Kornely, Michel LaHaye

Definition of a restored lake sturgeon population

1. Restored self-sustaining spawning population in a tributary to Lake Superior
    - 20+ year classes of adults (>15 years old)
    - 1500+ spawning adults
    - sex ratio 1:1
2. Self – sustaining
3. Age structure, reproduction, large enough site to survive adverse conditions
4. Lake wide – all stocks self-sustaining (adults >500)
    - stock sizes (aggregate – historical)
    - stock size: greater than 500 Adults – comparable to historical; > 350 juveniles
    - Lake area <40 feet – (food supply) used to calculate useable lake area
    - Follow spawning population over time
5. Numbers of spawners on each spawning ground
    - where are spawning grounds
    - look at repeat returns
    - Regional assessment – surveys of spawning grounds
        - Spawning returns (annual returns)
        - Spawning grounds – adults, collect eggs, larvae in drift
        - Larval production/spawners
        - Follow year class of juveniles to predict recruitment to spawning population
6. Base population number on existing populations, reference Sturgeon River and Bad River
    - Pop.size: ~ 1500 spawning adults.
    - Age structure
    - Sex ratio: ?
    - Larval production
7. Restored populations are not possible
    - problem with the word restored; should use self-sustaining or rehabilitated.
    - Scale the goal/objective to the size of the system
        - Individual tributary/stream/river
            - Spawner density
            - Age structure
            - Sex ratio
            - Larval production
            - Habitat suitability index
        - Lake wide: scale production to biomass based on suitable habitat
8. Population response to exploitation
    - trends in age, size structure of harvest
    - yields
    - characteristics of fishery
9. Define population:?

Summary of Discussion Group 5 (cont.)

- Demarcation of subpopulations
- Identification of metapopulation
- Possibilities of extinction (minimum number of individuals)
- Population in demographic equilibrium
- Stable or increasing, intensive rate of increase
- Minimum number of individuals : greater than 500 or 1500 ?
- Buffers for inbreeding, catastrophic events

Definition:

1) Networks of spawning grounds
2) Regional organization of subpopulations
3) Life history continuity – space and time and habitat availability
4) Determine abundance

List and Rank Impediments

- access to spawning habitat
- unstable flow/peaking operations
- limited spawning habitat/destroyed habitat
- poor water quality, possible historical, paper mill waste
- D.O. problems, temperature regime
- Nitrification of spawning areas
- Nursery habitat – wetlands at river mouths/deltas
- Food base for all life history stages – lack of knowledge
- Lampricide
- Political will – sturgeon are an attractive sport and commercial species (Canadian Issue)
- Low enthusiasm for restoration

Impediment agents

- up and downstream passage
- dams, flow regimes, block access, alter temps,
- channel modifications

What is the goal of restoration?

- Existence
- Exploitation
- Ecosystem function

- Low population size – time frame
- Potential harm from money too quickly
- Information needs:
  - Population structure
  - Genetic information
  - Distribution
- Effect on delivery of limited funds
- Lack of cost effective fish culture techniques

History – Collapse Causes

St. Lawrence Stocks	- over exploitation
	- dams
	- catastrophic paper mill spill
	- pollution
Ontario Stocks	- over exploitation
	- dams
	- loss of wetland habitat
	- habitat alteration (channelization)
	- sedimentation, land conversion, loss of LWD
	- pollution
Michigan and Ohio	- land conversion
	- dams
	- pulp mill waste
	- log drives

Summary

Restored Sturgeon Population

Lake wide - meshed set of linked spawning grounds, nursery grounds and adult habitat

Summary of Discussion Group 5 (cont.)

Attributes: Number of self sustaining stocks
Abundance of sturgeon habitat(<40 feet deep)
Stock (tributary specific --spawning grounds), self-sustaining, in demographic equilibrium
Attributes: Spawning density
Age structure (20 year classes)
Sex Ratio
Larval production (>300 juveniles)

Knowledge Gaps

- assessment and monitoring limitations
  - budgets and manpower
  - uncertainties about sampling (need some surveys)
  - location/timing
  - juvenile distribution patterns
  - preferred habitats of various life history stages
- low population sizes
- use local fishermen for information

Select sites for concentrated efforts –

Lake Superior	-	Kaministiquin River
	-	Bad River
	-	Sturgeon River
Lake Michigan	-	Menominee River System
	-	Peshtigo River
	-	Wolf River, Lake Winnebago System
	-	Muskegon River
	-	Manistee River
Lake Huron	-	Black River and associated lakes
	-	French River
Lake Erie	-	St. Clair River
	-	Upper Niagara River
Lake Ontario		

Transfer of information
- scale issues
- system characteristics
- Behavior patterns
- Feeding/distribution
- Localization of juvenile habitat, velocity refugia
- Shallow areas with benthic inverts.

Research Ideas

Approach

life history system

1) Define HIS – habitat preference studies
2) Connectivity of life history stages and habitat supply patterns
3) Habitat supply inventory – appropriate to HIS
4) Include consideration of non-habitat variables:
   - mortality/exploitation
   - chemicals
   - weather
   - climate changes
   - competition - other species
   - harvest

Problems

- Information on populations in various areas is limited
- Expectations of larval production from specific sites
- Knowledge of what is good habitat for various life history stages – map them!
- Variability of habitat – production
- Spawning – water depths, substrate, flow/turbulence
- Standard method of assessment
- Predict larval production from a sustainable population

Summary of Discussion Group 5 (cont.)

Research Program
Individual system studies standardized
- over several years
- over several systems (over range)
- coordinated process

Regional – lake wide – integration

Research Problems
1) Expectation of production of a specific site and its associated adult habitat
2) Improve knowledge of status and distribution of sturgeon and distribution of sturgeon habitat and populations in the Great Lakes
3) Need information of genetic similarity and variation of sturgeon stocks, develop expectations about sturgeon structure
4) Sampling
   Indicators
   - Spawning density
   - Age structure
   - Sex ratio
   - Larval production

   efficiency of monitoring program

Index for status (combination of indicators – trend measures)
Causes of problems with hatchery production of sturgeon and successful plantings
- diets
- needs for stocking
- extensive culture
- rearing, stocking schemes

Research Approaches
Life cycle interaction with habitat availability
1) Survey process
- Quick
- Comprehensive (spatial)
- General indications of status (order of magnitude)
- Repeatable/standardized
- Stratified
- Samples to develop genetic markers

1) Detailed census studies of a few systems
2) Hatchery Techniques

Prioritize
Research Approaches
#1 = 2
#2 = 1 coupled with 3
#3 = 4

Research Agenda
Goal: Implement a Research Framework to identify impediments to rehabilitation of lake sturgeon in Lake Michigan and the rest of the Great Lakes

Fundamental Problem
1) Uncertainty of status
2) Expectation of Production
3) Lack of hatchery option/management tools

Research Approach
1) Develop and implement a rapid survey process
2) Detailed individual system studies
3) Research and development of hatchery techniques and associated issue

Summary of Workshop Evaluation Completed by Workshop Participants

Research and Assessment Needs to Restore Lake Sturgeon in the Great Lakes

A Workshop Sponsored by the Great Lakes Fishery Trust

Twenty-nine surveys were returned, eighteen of which had written comments. Those comments are listed as written on page two. Below is the number of responses for each question that fell into each of the five categories.

The Great Lakes Fishery Trust would appreciate your evaluation of the lake sturgeon workshop. Below are several statements or questions that we would like you to rate as strongly agree, agree, neutral, disagree, or strongly disagree. Please provide any other comments you may have on the bottom of the form. Your opinions on the success of the workshop are important to us and we appreciate you taking the time to compete the evaluation. Thanks again for a productive workshop.

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
The Workshop has identified the impediments to lake sturgeon restoration and enhancement in the Great Lakes?	18	11 (100% agree)			
Characteristics of a healthy/restored Great Lakes sturgeon population have been adequately defined?	2	20 (76% agree)	6	1	
Your knowledge of lake sturgeon distribution, abundance, and biology in Lake Michigan and the Great Lakes has increased?	14	13 (93% agree)	2		
The workshop fostered communication among lake sturgeon researchers and managers across the Great Lakes basin?	23	6 (100% agree)			
Have you gained an understanding of the role of the Great Lakes Fishery Trust relative to lake sturgeon restoration in the Great Lakes?	8	18 (90% agree)	2	1	
The workshop has identified the primary research and assessment needs that limit our ability to restore lake sturgeon in the Great Lakes.	11	17 (97% agree)	1		
Will the results of this workshop be helpful to you and your agency in planning lake sturgeon priorities for the waters you work on?	15	11 (90% agree)	2	(one non-response)	
Would you attend another Great Lakes Fishery Trust sponsored workshop?	17	10 (93% agree)	2		
The organization, methods, and procedures of the Workshop encouraged participants to contribute to the discussions.	22	6 (97% agree)	1		

Appendix E cont.

Do you have any general comments or suggestions how the Workshop could have been improved? What aspects of the Workshop were most useful and which were least useful?

1. Joe Koonce did a great job of facilitating. The group and individual discussions were most useful. Some of the overview talks were of marginal value.

2. I wished we could have re-arranged groups for each small group meeting because some strong personalities dominate or one group becomes too large/small - not enough full group interchange - I missed talking to some folks.

3. I believe the closing comments by the group requires more time. Is it possible to have someone arrange all the notes and comments into a draft proceedings and sent to the participants. Most useful: Bridging the communication.

4. The break out groups were extremely useful and productive. Having said that, I feel many of the nuances of these break out group discussions may have been lost in the synthesis of the groups work in the last hour of the meeting.

5. It was a great opportunity to meet and share information regarding lake sturgeon. The outcome of this workshop will be extremely useful when dealing with my agency. Thank You.

6. Most useful: the breakout groups and the mixer. Least useful: the DNR Director's slide show.

7. More time to synthesize the info as a whole group. Most useful - breakouts, structure. Least useful - none.

8. Very well organized, well focused. Information regarding recovery/management in various jurisdictions well done. Informal info exchange with other participants was great. Thanks for the invitation.

9. There was a good mix of members in my group (#2). We had a very fruitful, interesting discussion.

10. Most useful in terms of breakout groups with broad geographic representation among group. Useful to meet at end of conference to look at each groups priorities.

11. Break-out groups were effective b/c it gave a small group of people the opportunity to not only have the chance to speak, but also enabled the group to discuss things in a smaller setting.

12. I had hoped to learn more about projects/research currently being carried out on lake sturgeon, whether it be in the form of formal presentations, posters, videos etc. I would suggest possibly devoting more time to presentation of such things and less for the group work.

13. I appreciate the opportunity to attend the workshop and continue communication with . . .

14. I gained a lot of new knowledge of lake sturgeon biology, research procedures and interpretation of habits/habitat use etc. An excellent workshop!

15. Actually Fund Sturgeon Research.

16. I thought the workshop was excellent. Many good ideas were shared and many expressed on restoring lake sturgeon in the Great Lakes. Joe Koonce did an excellent job of moderating my group (#5). In particular, Michel La Haye was an asset to our group and his knowledge was valuable. I, on the other hand, was very quiet. My personality does not lend itself to discussions other than one to one. Thank you. Greg Kornely.

17. Need a Great Lakes basin lake sturgeon restoration plan. Sponsoring, singly or in partnership, a facilitated workshop to develop a restoration plan would be a good first step.

18. Many members of our group had limited interplay with the discussion and there should have been other mechanism offered to solicit their participation – maybe a worksheet to complete over night – or post workshop mechanisms? The food and social amenities were very well done. The benefit of the exchange among participants was facilitated very effectively. The technology of keeping discussion groups and their listing and prioritizing must be more advanced so we could react to the large group's output while we were still interacting. The final hour on hearing reports from the group's moderators was of limited value beyond that which could have been mailed to us later. I hope that you do some follow-up with the participants so we can see what you gleaned from all of this.

Group Photo

Great Lakes

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