Lake Sturgeon Management Plan for the Oswego River Watershed, New York, 2010 – 2020

Thomas Brooking[1], James R. Jackson[1], Scott Krueger[1], Lisa Holst[2], Jeff Loukmas[2], Douglas Carlson[3], Frank Flack[3], Roger Klindt[3], Dave Lemon[4], Dawn Dittman[5], Kathy McGrath[6], and Errol Scheid[6]

[1]Cornell University, Biological Field Station
900 Shackelton Point Rd.
Bridgeport, NY 13030

[2]NYS Dept. of Environ. Conservation, Central Office
625 Broadway
Albany, NY 12233

[3]NYS Dept. of Environ. Conservation, Region 6
317 Washington St.
Watertown, NY 13602

[4]NYS Dept. of Environ. Conservation, Region 7
1285 Fisher Ave.
Cortland, NY 13045

[5]USGS Great Lakes Science Center, Tunison Laboratory of Aquatic Science
3075 Gracie Road
Cortland, NY 13045

[6]State University of New York, College of Environmental Science and Forestry
1 Forestry Dr.
Syracuse, NY 13210

March 22, 2011

Introduction

Lake sturgeon (*Acipenser fulvescens*) are the largest and longest living freshwater fish in New York State. They were a historically abundant and widely distributed species in the Great Lakes drainage, but by the early 20th century overharvest and habitat degradation resulted in drastic population declines. Severely depleted stocks ultimately led to the closure of the State's lake sturgeon fishery in 1976. In 1983 lake sturgeon were listed as a Threatened Species in New York State, and populations were considered absent, sparse or declining in 6 of the 9 watersheds where they historically occurred.

Lake sturgeon are considered a priority species for recovery in New York State and a recovery plan was first developed in 1994 (Bouton 1994) and revised in 2000 and 2005 (Carlson 2000, 2005). The recovery goal was to maintain current sturgeon populations in five border waters and restore populations in three other areas (Carlson 1995, 2000). The plan specified that the species would be eligible to be removed from the current Threatened Species listing, or down-listed to a Species of Special Concern (as defined in NY Codes Rules and Regulations Title 6, Part 182) if self-sustaining populations with successful reproduction and recruitment were documented in these eight populations. A self-sustaining population was defined as the presence of at least 3 year classes of sexually mature adult females, and evidence of natural recruitment in at least 3 years. Toward that end, this plan describes the historic and current status of lake sturgeon in the Oswego River watershed and outlines management goals and strategies designed to establish a self-sustaining population there. This plan represents the collaborative input from researchers and fish managers from three NYSDEC Regions (Region 6, Region 7, and Central Office), SUNY ESF, Cornell University Biological Field Station (CBFS), and USGS, most of whom have ongoing projects and/or extensive field experience in the Oswego River watershed.

Management Area

The Oswego River watershed covers over 5,000 mi^2 and is one of the largest basins in New York State (Figure 1). It includes the drainages of the Oswego, Oneida, Seneca and Clyde Rivers and most of the Finger Lakes, including (from east to west) Otisco, Skaneateles, Owasco, Cayuga, Seneca, Keuka, and Canandaigua lakes. Other significant water bodies include Oneida,

Onondaga, and Cross lakes. Its headwaters originate in the southwestern Adirondack Mountains in the east, and along the northern edge of the Appalachian Plateau to the south and west, and flow across the central lowlands before entering Lake Ontario. The Erie and Barge canals extend east-west through the watershed and provide connections via water channel to adjacent watersheds. Also, there are numerous barriers such as locks and dams which hamper fish movement throughout the basin. Because of these connecting waters and barriers, the watershed is not a well-defined, closed system; thus it was necessary for the purposes of this plan to establish boundaries within the watershed that could be used for lake sturgeon management activities. Fish Creek, flowing into the Barge Canal near Sylvan Beach (Oneida Lake), was designated as the easternmost boundary, with the uppermost reaches beginning at the dam at Rome Reservoir near Taberg (East Branch) and the dam at McConnellsville (West Branch). Seneca Falls on the Seneca River was designated as the westernmost boundary, as this presents a significant barrier to upstream fish passage. However, locks are present there and these may allow some fish passage to and from Seneca Lake. Seneca Lake and the Seneca Lake Outlet may be considered for management in the future if research is initiated to explore the potential of these sites for lake sturgeon. The western lowlands in the Clyde River system are connected via the Erie Canal, but the dam and lock at Mays Point constitutes a barrier. Also, winter draw-down practices in this section of the canal likely make it unsuitable as year-round sturgeon habitat. Therefore, this section was identified as the western extent of the Erie Canal for this plan. The downstream endpoint of the watershed is the outflow of the Oswego River into Lake Ontario at Oswego Harbor.

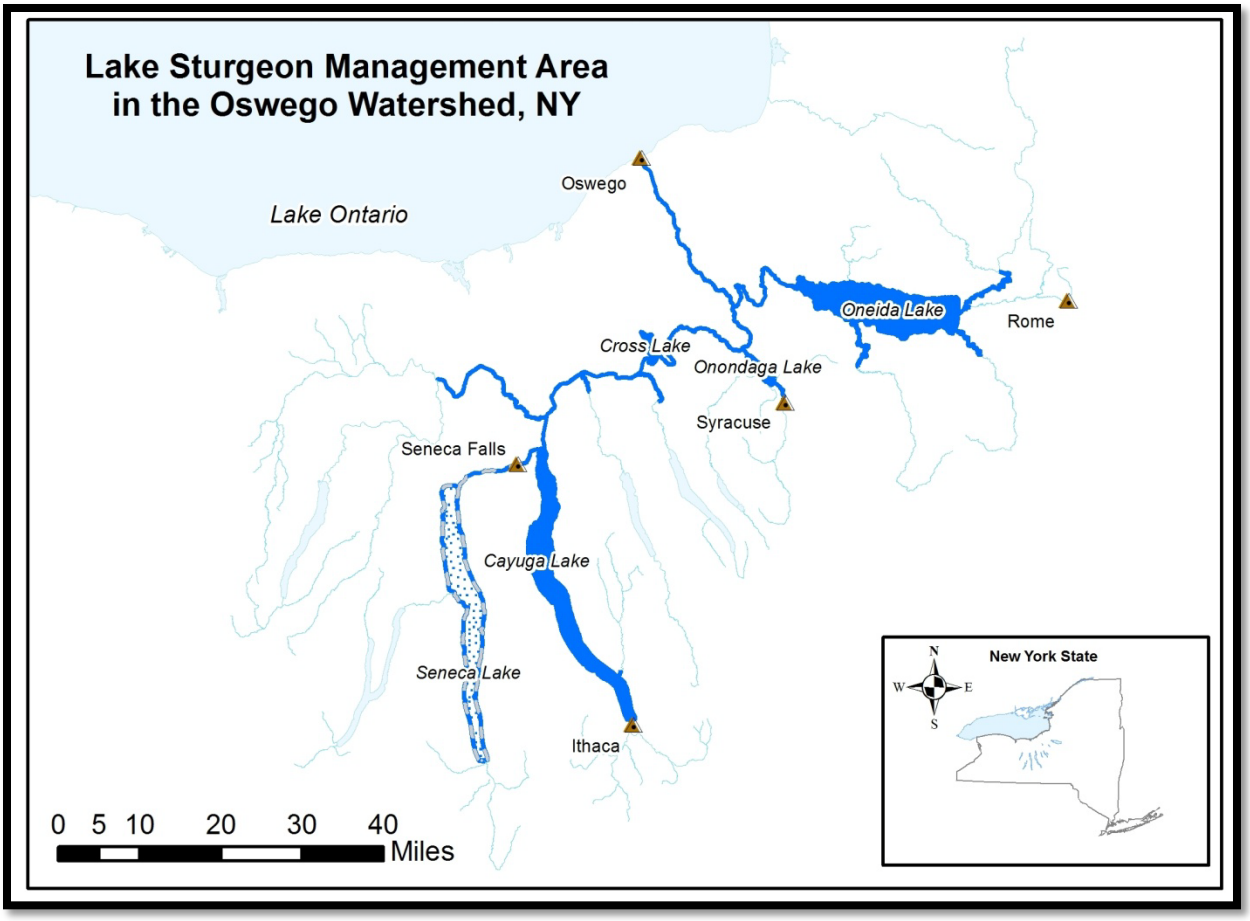

Figure 1. Lake sturgeon management area in the Oswego River watershed (blue highlight). Seneca Lake and its outlet may provide additional available habitat and may be considered for management in the future.

The primary water bodies within the designated boundaries that are addressed in this plan include Oneida, Cayuga, Onondaga, and Cross lakes, and the Seneca, Oswego, and Oneida rivers. Oneida Lake plays a crucial role in the overall lake sturgeon management plan for the watershed because of its large size, favorable habitat, and the apparent success of previous stocking efforts. Of the Finger Lakes, lake sturgeon management efforts will focus on Cayuga Lake because it is connected to the canal and river system by the Seneca-Cayuga Canal, and previous sturgeon stocking has been successful there in the past. Onondaga and Cross lakes are connected to the river system and may provide enough of the resources necessary to support various life stages. Otisco, Owasco, and Skaneateles lakes are separated from the system by

barriers that are likely to be impassable to sturgeon, and thus are not considered target areas for lake sturgeon restoration activities at this time.

Historic Distribution of Lake Sturgeon in the Watershed

Previous to dam and canal construction in the early 1800s, the falls and rapids at Oswego were, in all likelihood, a barrier to the upstream movement of lake sturgeon in the system. Sturgeon were not reported from the system prior to canal construction and were absent from older Native American and Jesuit missionary accounts from the region. Similarly, DeWitt Clinton's journal of conditions in the area prior to canal construction did not mention sturgeon above Oswego falls (Jackson, Cornell University, personal communication). Reports of sturgeon in the watershed began in the mid-19th century and these may have been transitory fish that arrived via canals. The earliest lake sturgeon record in the system was a report from 1856, when a large adult was documented from Oneida Lake (Table 1). There were two other reports of lake sturgeon in the watershed prior to 1900, one from Cayuga Lake and another from the Seneca River. Verifiable reports of lake sturgeon were made in several locations in the watershed between 1900 and 1994 before stocking began, indicating that sturgeon had at least intermittent access to the Oswego watershed from Lake Ontario and that this basin was able to provide at least the necessary habitat to support transient fish. Whether or not populations of sturgeon stayed in this part of the system for their entire life cycle remains obscure. It is clear however that sturgeon have had access to this part of the system since at least 1856.

Table 1. Historic reports of lake sturgeon in the Oneida, Oswego and Cayuga watersheds previous to the first sturgeon stocking in 1994. Records are maintained from various sources by D. Carlson, NYSDEC Region 6 and listed in Chalupnicki et al. (in press, 2011).

Name of water body	Date	Report
Oneida Lake	1856	May 5, at Brewerton, adult (6' 11", 104 lb) angler catch (Shute, Brewerton Inn)
Cayuga Lake	1880 and earlier	Several were angler-caught (Meek 1889)
Seneca River	1895	June, Jacks Reef, adult (4'), (Beauchamp 1908)
Seneca Lake	1900	Around turn of century, angler observed, (reported to C. Widmer in 1960's)
Seneca River	1905-1908	Cayuga and Seneca Canal near Montezuma
Seneca River	1950-60's	In Cross Lake area
Cayuga Lake	1957	Report to Region 7
Cayuga Lake	1961	Angler caught (recorded by E. Raney, CU)
Oneida Lake	1976	Adult (27 lb), angling (Ruggieri) (also picture in Oneida Lake Bulletin)
Oneida Lake	1973	May, Frenchman's Isl., adult (4', 40 lb), angling (Bronner) (also by Clady 1976)
Oswego River	1982	May 19, below dam at Oswego, adult (3-5.5'), (L.Wedge, Reg. 7)
Owasco Lake Outlet	1986	Near outlet to Owasco Lake (J. Barcak)

Current Distribution and Status of Lake Sturgeon in the Watershed

Lake sturgeon are now more prevalent in the Oswego River watershed as a result of ongoing management efforts. Implementation of the initial statewide recovery plan (Bouton 1994) resulted in the development of a stocking program for Oneida and Cayuga Lakes in 1995. From 1995 – 2004, 11,879 lake sturgeon fingerlings were periodically stocked in these lakes at varying rates, depending on availability (Table 2). The majority were stocked in Oneida Lake (approximately 68%), with one large allotment in 1995 and six smaller stockings from 1996 – 2004. Cayuga Lake also received its largest allotment of fingerlings in 1995, but received a smaller quantity of fish in only 3 additional years through 2004. Survival from these stockings

has been substantial, and the apparent success of these stockings has received much positive attention from the research community, media, and angling public.

Table 2. Number of lake sturgeon fingerlings stocked in Oneida and Cayuga lakes, 1995 – 2004.

Year	Oneida Lake	Cayuga Lake
1995	5000	2800
1996	550	-
1997	-	-
1998	387	370
1999	320	-
2000	300	412
2001	-	-
2002	-	-
2003	370	-
2004	1200	170

Staff at the Cornell University Biological Field Station at Shackelton Point have concentrated sampling efforts on Oneida Lake, as part of standard fisheries sampling from 1995-2001, and as part of a directed sturgeon sampling program from 2002-present (Jackson et al. 2002). Sampling has included abundance indices from standardized gill net sampling, age and growth studies, tagging and diet composition. Sturgeon stocked into Oneida Lake have exhibited extremely high growth rates, with the largest fish captured so far weighing over 38 kg (85 lbs). Diet assessments show that amphipods and snails are the most common food items of smaller juvenile sturgeon, with zebra mussels becoming the dominant diet item as sturgeon grow above 700 mm. Mark-recapture data from standardized gill net sampling and tagging data suggest that as many as 40% of fish stocked in 1995 were present in the lake in 2002 (Program MARK based estimates, 95% confidence limits 22-59% survival and/or retention of the 1995 stocking through 2002). Of the 8,127 sturgeon stocked in the lake, approximately 2,934 (36%) have been tagged

using either dangler tags or PIT tags to determine movement and origin of fish. Through tag recaptures by anglers and netting surveys, sturgeon from Oneida Lake have been documented throughout most of the Oneida and Oswego rivers and into Lake Ontario, with multiple recaptures from Caughdenoy and Minetto, and they have also been found in Onondaga Lake. To the east, sturgeon are annually reported from Sylvan Beach and Fish Creek around the time of spawning. In 2000, DEC captured two lake sturgeon (699 and 692 mm) during Barge Canal netting surveys, approximately two miles east of the Mohawk River confluence. Oneida Lake has functioned as a fertile rearing-ground for young and sub-adult sturgeon; growth rates of juvenile and sub-adult fish are higher than any other sturgeon population found in the literature. Outmigration from Oneida Lake has also resulted in sturgeon reports from most of the Oswego River watershed.

The 3,752 fingerling lake sturgeon stocked in Cayuga Lake were not tagged and follow-up assessments of these fish have been more limited. Incidental catches of sturgeon from Cayuga Lake have occurred during several fall lake trout egg collection operations conducted by DEC hatchery personnel, as well as during lake trout assessments conducted by DEC Region 7 Fisheries management staff. Between 2000 and 2009, hatchery staff captured 12 sturgeon; 7 of these fish captured in 2002 were measured. Assuming the two smallest fish were from the 1998 stocking and the five larger fish were from the 1995 stocking, the mean lengths of the two cohorts were 800 mm (range: 787- 813 mm) and 1,039 mm (range: 991 – 1092 mm), respectively. On July 27, 1999 Region 7 staff captured nine sturgeon, most likely from the 1998 stocking, which averaged 414.8 mm (range: 340-462 mm). This limited data suggests that growth rates in Cayuga Lake of juvenile and sub-adult fish was similar to the rates found in Oneida Lake, suggesting habitat conditions are favorable for sturgeon growth.

Lake sturgeon have emigrated from both Oneida and Cayuga lakes and have been captured in other areas of the watershed. From 2007 to 2009, USGS biologists conducted gill netting surveys below the lock at the Cayuga Lake Outlet and caught 46 lake sturgeon, none of which were tagged fish from Oneida Lake. Twenty-two untagged lake sturgeon were also caught during gill net surveys in Cross Lake. Sampling on the Oswego River from Phoenix to Minetto resulted in the capture of 76 lake sturgeon, 8 of which were previously tagged in Oneida Lake. There has also been at least one report of a tagged Oneida Lake sturgeon found in Lake Ontario.

Current Research Activities

Thus far, management actions have been largely based on the use of stocking to build the Oswego River watershed population and follow-up monitoring to determine the success of these stockings. From 1996 – 2004, the brood stock source for lake sturgeon propagation was the St. Lawrence River below the Moses-Saunders Power Dam (the 1995 cohort was from the Des Prairies River, Quebec). The stocking program was temporarily suspended in 2006 due to the presence of Viral Hemorrhagic Septicemia (VHS) in several fish species (not including sturgeon) from the river. The egg take was resumed in 2009 and 2010, however eggs had 100% mortality, thus no sturgeon were available for stocking.

Monitoring has determined good survival and growth of stocked fish in Oneida and Cayuga lakes, but available data is generally lacking for other important criteria including habitat quality and use, movement, spawning, and genetic diversity in the rest of the watershed. Gaining further knowledge of these parameters is essential in determining the overall success of management efforts. In order to gain this knowledge about lake sturgeon in the watershed, and to reestablish a propagation program, a 5-year State Wildlife Grants project was initiated in 2007 (Grant T-14; Project 4 – Assessment and Implementation of Lake Sturgeon Recovery Efforts in New York State). This project was comprised of 5 studies and involved NYSDEC, Cornell University, USGS, SUNY Cobleskill, SUNY Oswego, and SUNY ESF.

Study 1: Lake Sturgeon Habitat Use, Outmigration and Spawning in Oneida Lake

Cornell University biologists have been monitoring lake sturgeon growth, survival, and condition since 1995. However, despite the documentation of exceptional growth rates and good survival of stocked fish, the successful establishment of a self-sustaining population of lake sturgeon in Oneida Lake will ultimately depend on the availability of suitable habitats for spawning and survival of early life stages. Also, outmigration and the potential effects of barriers to movement of sturgeon that leave the system represent unknown parameters in the dynamics of the Oneida Lake sturgeon population. Beginning in spring of 2011, Cornell researchers will deploy up to 100 sonic tags to track sturgeon, determine spawning areas, and examine these current information gaps regarding lake sturgeon dynamics in Oneida Lake.

Study 2: Lake Sturgeon Distribution, Population Dynamics, and Habitat Use in the Central and Western Oswego Basin

Recent monitoring and angler reports have established that some lake sturgeon stocked into Oneida and Cayuga lakes have migrated to, and now reside in, the Oswego River system (Dittman 2007). This system consists of some highly altered reaches, with a large number of dams and a canal system. These alterations provide a unique set of habitat conditions for lake sturgeon and likely affect use of the system. In order to evaluate the potential of the Oswego River basin to support a self-sustaining lake sturgeon population, SUNY ESF and USGS biologists developed a study to examine the current distribution and abundance, delineation of critical habitats for all life stages, documentation of spawning activity and habitat, and the effects of river channelization and barriers on sturgeon.

The study was initiated in 2009, with an assessment of sturgeon habitat use and spawning in the Seneca, Oswego, and Oneida Rivers. Twenty-one sites were sampled in 2009 in the Oswego (6 sites), Oneida (3 sites), and Seneca (12 sites) Rivers. Netting captured five lake sturgeon, two in the Oswego River and three in the Seneca River. None were previously-tagged fish. This work will be continued in 2010 and future years, along with additional habitat mapping, summer sturgeon netting, searching for spawning activity at one or more sites, a spawning habitat availability assessment, and study of barrier restriction of fish travelling to spawning areas.

Study 3: Spawning use of the Oswego River Harbor by Lake Sturgeon

The mouth of the Oswego River used to provide an important spawning area for Lake Ontario lake sturgeon (Carlson 1995). Spawning congregations have not been seen in recent times at this location, but current survey information on actual lake sturgeon use of this site is lacking. The Oswego River watershed may eventually provide an important source of fish to Lake Ontario; which may, in turn, bolster the Oswego River stock with upstream migrants through locks of the Barge Canal. If the Oswego River watershed population continues to increase and move downstream it is expected that spawning congregations may be seen at the river's mouth within the 10 years encompassed by this plan. In order to more fully understand the potential contribution of the Oswego River watershed population to Lake Ontario and the resulting use of the river's mouth as a spawning area, a current, comprehensive baseline survey

of lake sturgeon in Oswego Harbor is necessary. Region 6 DEC staff began conducting surveys at this location in 2009 and 2010. Substrate mapping was begun, to identify potential spawning areas. Netting surveys captured two sturgeon in 2010 which were similar in size to fish that may have out-migrated from Oneida or Cayuga lakes. Tissue samples were collected for genetic analysis.

Study 4: Genetic Assessment of the Hatchery-Produced Lake Sturgeon Population in the Oswego River Basin

The lake sturgeon population in the Oswego River watershed is a product of stocked fish from two populations in the St. Lawrence River, one located near Massena, NY (stocked from 1996 – 2006) and the other near Montreal, Quebec (stocked in 1995 only). These two populations were found to be close genetically (Welsh 2008) and therefore have an established set of boundaries on their genetic diversity. Fish from the earliest stockings appear to be reaching sexual maturity and spawning may soon take place in the Oswego River watershed population. However, if the genetic diversity is too limited or inappropriate for the environmental conditions in the watershed, the reproductive success of these fish may be compromised. Furthermore the majority of fish stocked in these systems came from 1995, from very low numbers of adult parentage (2 females and 4 males). In order to assess the potential risks and appropriate courses of action, and to determine the genetic feasibility of using the Oneida Lake population for future egg collection, it is important to measure the genetic characteristics of the lake sturgeon populations in the Oswego River basin.

Scientists at SUNY Oswego conducted a study in 2009-2010 to describe the genetic characteristics of lake sturgeon in the Oswego basin as derived from stocking in 1995-2004, and compare them to wild populations in the Great Lakes and Des Prairies and St. Lawrence Rivers. The genetic suitability of Oneida Lake sturgeon as a brood stock for other New York waters will also be assessed. If Oneida Lake is deemed an appropriate brood source, this may alleviate the need for parental stock from the St. Lawrence River, where the presence of VHS has hampered the propagation program. The initial genetic diversity assessments by Welsh (in prep.) have guided recommendations on courses of action with regard to stocking the Oswego River basin (see Recommended Actions to Achieve Objective 1).

Study 5: Lake Sturgeon Egg Take, Propagation, and Stocking

Since 1995, sturgeon populations in New York waters have been established or supplemented through the stocking of hatchery-reared fingerlings cultured at the DEC Oneida Hatchery. However, stocking efforts were temporarily halted in 2006 with the outbreak of VHS in the St. Lawrence River and Great Lakes. Reestablishment of a viable stocking program is necessary for continuation of the sturgeon restoration program both in the Oswego River watershed and statewide. This study was designed to provide the resources for SUNY Cobleskill and DEC to develop quarantined areas in their respective hatcheries that could effectively hold St. Lawrence River fish until disease testing could occur, which allowed for the reinstatement of lake sturgeon egg take activities from the St. Lawrence River in 2009 and 2010. The egg take component of this project is largely being funded through a Fish Enhancement, Mitigation, and Research Fund (FEMRF) grant. Unfortunately, eggs taken for propagation in both 2009 and 2010 were non-viable and failed to hatch, effectively halting propagation efforts. Egg take procedures will be reevaluated and resumed in 2011.

Management Plan Goal and Objectives

Due to the considerable scope of ongoing research in the Oswego watershed which will provide important information to guide sturgeon management, the goals set forth in this plan are considered to be the most appropriate for the current situation. Outcomes of current and future studies will likely result in the modification and continual review of objectives outlined herein, so the ability to remain flexible and incorporate future changes in activities is vital to the success of lake sturgeon management efforts in the Oswego River watershed.

The goal of the initial statewide lake sturgeon recovery plan was to establish self-sustaining populations in at least 5 separate locations, which would result in its delisting as a threatened species. Consideration would then be given to managing the species as a sport fish "…for perpetuity and sustainable yield based on regenerative capacities" (Bouton 1994). In order to achieve the first goal of delisting, recognizing that some failures may occur, the plan's objective was to select 6 to 8 waters for restoration or enhancement. Carlson (2005) determined

that self-sustaining populations should be maintained or established in at least 8 waters (Lake Erie, Lake Ontario, Upper and Lower Niagara Rivers, St. Lawrence River, Grasse River, St. Regis River, Oswegatchie River, and Black Lake) prior to delisting and that management and recovery actions will be conducted in 3 additional waters (Oneida Lake, Cayuga Lake and the lower Genesee River). Because of the high likelihood of intermixing between Cayuga and Oneida Lake sturgeon, fish from these waters will be considered to be part of one population within the Oswego River watershed (i.e., all waters in the Oswego River watershed will constitute one "separate location" for the purpose of statewide recovery plan goals) unless future research indicates separate and sustainable spawning populations within the watershed.

The principle goal of this plan is to establish a self-sustaining lake sturgeon population in the Oswego River watershed as a means to achieve the statewide goal of delisting the species. This work also contributes to the broader goal of achieving adult densities sufficient to manage sturgeon as a sport fish and as an integral part of the historic food web.

In order to achieve the goal of establishing a self-sustaining population one must define what a self-sustaining population is. Carlson (2005) defined a self-sustaining lake sturgeon population as one with at least 3 year classes of sexually mature adult females, and evidence of natural recruitment in at least 3 years. However, Welsh et al. (2010) have since developed a recommendation of establishing a population of at least 750 sexually mature lake sturgeon in each separate spawning location. This recommendation was based on evidence that this number was the minimum number thought to be present in stable or increasing Great Lakes populations, with the caveat that target adult population size may vary depending on management goals and habitat availability. Recommendations from Welsh et al. (2010) are based on current genetic guidelines and include propagation and stocking procedures and sample stocking numbers designed to achieve the target adult population. These guidelines will provide the foundation for stocking objectives in this plan. However, because most of the fish previously stocked in Oneida and Cayuga Lakes are from a single year class (1995) and they were from a limited number of parents, the measure of an adequate adult population in each lake will also include the presence of 3 separate year classes in addition to the minimum population size of 750 mature adults. The measure of successful recruitment will be evidence of naturally produced fish to age 2+ in at least 3 years.

To achieve the goal of establishing a self-sustaining population as described above, the following activities should be addressed:

1) Establish and implement a stocking strategy to continue rehabilitation efforts in Oneida Lake and Cayuga Lake.
2) Determine if the lake sturgeon previously stocked in Cayuga and Oneida Lakes are sexually mature and spawning, and if and where successful reproduction and recruitment is occurring within the watershed.
3) Determine the suitability of Onondaga Lake and Cross Lake to contribute to lake sturgeon recruitment in the watershed. If these lakes are deemed suitable, a set of stocking recommendations similar to those for Cayuga and Oneida Lakes should be established.
4) Assess the potential long-term viability of the Oswego River watershed population.
5) Develop public outreach and education materials to build support for, and promote awareness of, lake sturgeon management efforts.

Recommended Actions to Achieve Objectives

1) Establish and implement a stocking strategy to continue rehabilitation efforts in Oneida Lake and Cayuga Lake.

A. Background and rationale: From 1995 – 2004, 8,127 lake sturgeon from 7 year classes have been stocked in Oneida Lake and 3,752 fish from 4 year classes have been stocked in Cayuga Lake. If survival to adulthood is 40% (for the 1995 year class in Oneida Lake, though confidence intervals are large; Jackson, unpublished data; see also Jackson et al. 2002), there may already be enough lake sturgeon in Oneida and Cayuga Lakes from these stockings to eventually meet population goals, though most fish are from a single year class. Therefore, the primary reasons for continued stocking of these waters are to increase genetic diversity of the adult stock and to add multiple year classes to the spawning stock since the spawning interval of female sturgeon sometimes may only be at 1-7 year intervals (USFWS 2009). After preliminary population goals are met (i.e., at

least 750 sexually mature adults, and 3 year classes of spawning adults, and 3 years of recruitment to age-2+), continued stocking for restoration purposes will be considered to increase genetic diversity.

Breeding guidelines to reduce genetic risks associated with lake sturgeon propagation indicate that, at a minimum, 200 parents (100 females and 100 males) summed over a period of one generation (25 years) should be used (Welsh et al. 2010). These guidelines were suggested because the species is long lived, late to sexually mature, and an intermittent spawner. Under this scenario, the average yearly effective population size (N_e) of parents used is 8. Welsh et al. (2010) calculated a minimum requirement of 3 female and 6 male parents, or 4 female and 4 male parents, in order to achieve $N_e = 8$. Only in 2004 was $N_e = 8$ achieved for the Oneida/Cayuga Lake stockings; thus, following these recommendations would result in annually stocking both lakes until at least 2034. However, while the rationale behind the recommendations is strong, they are likely not realistically achievable due to uncertainties associated with lake sturgeon egg survival and propagation, and staffing and program direction over the long term. Therefore, periodically determining the degree of genetic diversity maintained between parents and stocked offspring is essential to the implementation of a genetically conservative stocking strategy. If the genetic diversity of the parent population is largely attained in the stocked population then a more abbreviated stocking plan may be warranted.

B. Stocking strategy:
    a. Of the total annual lake sturgeon fingerlings allocated to this watershed, 50% will be stocked into each of Oneida and Cayuga Lakes at least until preliminary population goals are met (note: three separate year classes will reach maturity (age 15) in Oneida Lake by 2013 and in Cayuga Lake by 2015). If Onondaga or Cross Lakes are considered suitable stocking candidates (Objective 3), the stocking rates will be split equally among each suitable water.
        i. Specific allocations are not given because the number of sturgeon fingerlings available for stocking is highly variable and seldom known ahead of time.

ii. Current maximum hatchery production capacity is approximately 2,000 lake sturgeon fingerlings from DEC hatcheries. Production capacity from other sources such as SUNY Cobleskill and USFWS Hatcheries should be investigated.

iii. Allocations will also be dependent on stocking requirements in other watersheds.

iv. Onondaga and Cross lakes are not expected to provide exclusive self-sustaining populations, but they may provide enough quality habitat to support lake sturgeon recruitment in the watershed. Therefore, population goals are not set for these lakes.

v. In the event that the stocking allocation is not high enough to warrant distribution of fingerlings among all suitable waters then priority stocking order will be 1) Oneida Lake, 2) Cayuga Lake, 3) Onondaga/Cross Lakes.

b. When preliminary population goals are met a reevaluation of genetic diversity should be conducted between lake sturgeon from the St. Lawrence River at Massena and those stocked in the Oswego River watershed.

i. A recent genetic assessment by Welsh (in prep.) provided evidence that the Oneida Lake population did not fully reflect the genetic diversity of the parent Massena population. While some measures of genetic diversity, such as allelic richness and heterozygosity, were similar between populations, the frequency of alleles was significantly different.

ii. An appropriate level of genetic diversity will be attained when the frequency of key alleles (218, 222, 226, 230, Welsh in prep.) are similar between the Massena and Oswego River watershed populations.

c. If genetic diversity goals are then met, stocking will end. If genetic diversity goals are still not met then stocking will continue at the aforementioned percentages until 2020, at which point the management plan for the Oswego River watershed will be reevaluated.

d. Fingerling lake sturgeon should be directly stocked into lakes rather than tributaries because previous lake stockings have resulted in high growth rates and

survival. Current work has already established that sturgeon will distribute themselves throughout the system.

2) Determine if the lake sturgeon previously stocked in Cayuga and Oneida Lakes are sexually mature and spawning, and if and where successful reproduction and recruitment is occurring within the watershed.

   A. Continue monitoring efforts of populations already underway in Oneida Lake (Cornell University); Cross Lake and the Oneida, Oswego, and Seneca Rivers (USGS, SUNY ESF, Cornell University); and Onondaga Lake (multi-agency). The Cayuga Lake monitoring may be evaluated by further interpretation of sampling at the north end, or expansion of sampling within the lake (NYS DEC, others).

   B. Identify streams being used by sturgeon for spawning. This action is being addressed in the current SWG research projects (Studies 1 and 2). Angler reports and tag returns are also being used to gain further insights into spawning patterns. Implementation of exploratory surveys using nets, underwater cameras, or egg mats should also be considered. Potential spawning streams include:

      a. Oneida Lake – Fish Creek (39.2 km), Chittenango Creek (37.5 km), Limestone Creek (16.4 km), Butternut Creek (14.8 km), Scriba Creek (0.7 km), Oneida Creek (27.4 km)
      b. Cayuga Lake – Taughannock Creek (2.3 km), Fall Creek (1.5 km), Cayuga Inlet (16.3 km), Salmon Creek (5 km)
      c. Onondaga Lake – Nine-Mile Creek (6.4 km), Onondaga Creek (1 km)
      d. Oneida, Oswego, Seneca, Cayuga rivers – Potential spawning around several rapids and downstream of barriers (i.e., Mud Lock, dams at Phoenix, Fulton, Minetto, and Oswego)

   C. Determine the extent and quality of available spawning habitat, and whether barriers in the canal system prevent or discourage access to good quality spawning habitat.

This action will be addressed as part of the current SWG research projects (Studies 1 and 2)

D. Determine the potential impact of egg predators (e.g., round gobies) on lake sturgeon spawning success.

E. Estimate the number of spawning adults, by sex, in the principle spawning streams for Oneida and Cayuga Lakes. Visual estimation, underwater camera, tagging, electrofishing, or sampling nets could be used.

F. Measure the preliminary success of spawning by surveying spawning locations for eggs. Egg mats have been used successfully in previous areas like the Black and St. Lawrence Rivers (Rodger Klindt, NYSDEC, unpublished data). Spawning would be deemed "successful" upon finding at least one fertilized viable egg.

G. Implement habitat management and improvement options if warranted. Artificially enhanced spawning substrate, stream flow management, and fish passage devices are some options that may be considered.

H. If spawning is determined to be successful, survey for juvenile lake sturgeon using larval drift nets, seining, and/or other gears.

I. Estimate recruitment to the sub-adult stock (via gill net surveys or other gear) based on juvenile success.

3) Determine the suitability of Onondaga Lake and Cross Lake to contribute to lake sturgeon recruitment in the watershed. If these lakes are deemed suitable, a set of stocking recommendations similar to those for Cayuga and Oneida Lakes should be established.

A. Onondaga Lake (2,981 acres) was identified as an underutilized resource for sturgeon with great potential to contribute to recruitment in the watershed, although ongoing

pollution remediation complicates management efforts there. Stocking in Onondaga Lake would likely be delayed until at least 2012 or later while remediation efforts continue. Cross Lake (1,947 acres), which also is connected to the river system without barriers, may provide another suitable habitat. Sturgeon currently occupy both waters and are currently being studied by USGS in Cross Lake, and various agencies in Onondaga Lake.

a. For each lake, studies should determine extent of habitat use, movement, and the potential of each lake to contribute to recruitment within the watershed before stocking recommendations are established.
b. Another consideration for assessment would be Seneca Lake (43,342 acres) which is accessible via locks around Seneca Falls and may potentially provide a significant amount of habitat in the western part of the basin. However, no research on lake sturgeon has been conducted there to date.

B. If these waters are deemed suitable, stocking will be initiated at rates described under Objective 1. Stocking success should be monitored. If successful, stocking should be continued until spawning, recruitment, and genetic goals for the Oswego River watershed are met or until 2020, when the Oswego River watershed plan will be reassessed.

4) Assess the potential long-term viability of the Oswego River watershed population.

A. Assess lake sturgeon population parameters (growth, condition, abundance, distribution, movement, spawning activity and success, recruitment, natural mortality).

B. Assess the genetic diversity of the lake sturgeon population.

5) Develop public outreach and education materials to build support for, and promote awareness of, lake sturgeon management efforts.

A. Ensure public awareness and support for lake sturgeon management efforts by providing informational and educational material on this species.

B. Write or facilitate articles for magazines (NYS Conservationist) and produce newspaper releases.

C. Increase awareness of anglers to report sturgeon catches, especially of tagged fish. Encourage reporting of tagged fish.

D. Communicate with the DEC Division of Law Enforcement in regard to location of spawning areas or areas where sturgeon are frequently caught by anglers, and encourage positive interactions between Law Enforcement and the public.

E. Support voluntary watch groups to assist Law Enforcement Division in protecting spawning sturgeon.

F. Provide live fish to public aquariums; offer educational programs to local schools. Obtain funding for trained professionals to develop a program and deliver it to local schools.

G. Purchase of life-size sturgeon mount similar to the Hudson River Foundation and development of more educational displays.

H. Encourage presentations at events such as the NYS Fair, which provide the opportunity for a large display that could reach many thousands of people (also zoos, environmental education centers, NYPA Facilities, DEC offices, angler groups, web sites, etc.).

Summary

The lake sturgeon was once common throughout the Great Lakes basin and a number of contiguous areas of New York State, and supported valuable commercial and recreational fisheries. Due to overharvest and habitat degradation the species is now listed as a Threatened Species in New York. Restoration of this unique species is a high priority for New York State as well as management agencies throughout the Great Lakes basin. Lake sturgeon should ultimately

be restored beyond the intentions of the threatened species program, with the goal of restoring sturgeon to a sport fish species for recreation and towards their historic role in ecosystem interaction. We believe the Oswego watershed has already begun to play a major role in this restoration process, and efforts over the next 10 years could contribute significantly to achieving overall statewide goals. The consensus of this group and a larger statewide research group is that the continuation of a formalized sturgeon propagation and stocking program is a top priority to restore a self-sustaining lake sturgeon population in the Oswego River watershed and other areas statewide. Stocking for restoration purposes will be re-evaluated after establishing at least 750 spawning adults, 3 age classes of spawning adults, and 3 years of recruitment to age-2+. Further stocking will be considered if an increase in genetic diversity is warranted. Continued monitoring of sub-adults and searching for spawning fish, eggs, and juveniles are all part of the plan for the next 10 years, as well as a public education and awareness program. Successful restoration and management of sustainable sturgeon populations will potentially lead to new and valuable recreational fisheries, and restore lake sturgeon to the important role they once had in their respective historic fish communities.

References

Beauchamp, W. M. 1908. Past and present of Syracuse and Onondaga County, New York. S. J. Clarke, New York.

Bouton D. 1994. A recovery plan for the lake sturgeon in New York. New York State Department of Environmental Conservation, Albany, NY.

Carlson, D.M. 1995. Lake sturgeon waters and fisheries in New York State. Journal of Great Lakes Research 21: 35-41.

Carlson, D.M. 2000. A recovery plan for the lake sturgeon (*Acipenser fulvescens*) in New York. New York State Department of Environmental Conservation. Albany.

Carlson, D.M., R. Colesante, J.S. Hayes, S.L. Schlueter. 2004. Lake Sturgeon (*Acipenser fulvescens*) and its recovery programs in New York State. New York State Department of Environmental Conservation. Albany.

Carlson, D.M. 2005. The next ten years of planning for the management of lake sturgeon in New York. New York State Department of Environmental Conservation, Albany, NY.

Chalupnicki, M. A., D.E. Dittman and D.M. Carlson (accepted 2011). Distribution of lake sturgeon in New York: 11 years of restoration management. Journal of Great Lakes Research, 2011 in press.

Clady, M.D. 1976. Distribution and abundance of larval ciscoes and burbot in Oneida Lake. Journal of Great Lakes Research 2: 234–247.

Jackson, J. R., A. J. VanDeValk, T. E. Brooking, O. A. VanKeeken, and L. G. Rudstam. 2002. Growth and feeding dynamics of lake sturgeon in Oneida Lake, New York: Results from the first 5 years of a restoration program. Journal of Applied Icthyology 18:439-443.

Meek, S.E. 1889. Notes on fishes of Cayuga Lake basin. Annals of the New York Academy of Sciences 4:297-316.

USFWS. 2009. Great Lakes Lake Sturgeon Web Site. http://www.fws.gov/midwest/sturgeon/biology.htm

Welsh, A.B., R.F., Elliot, K.T. Scribner, H.R. Quinlan, E.A. Baker, B.T. Eggold, J.M. Holtgren, C.C. Krueger, B. May. 2010. Genetic guidelines for the stocking of lake sturgeon (*Acipenser fulvescens*) in the Great Lakes Basin. Great Lakes Fishery Commission. Miscellaneous Publication 2010-01.