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Lake Sturgeon Distribution and Status in Michigan, 1996–2005

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Abstract.–Lake sturgeon is listed as a threatened species in Michigan and throughout much of its native range. There are several impediments to lake sturgeon rehabilitation and management including uncertainty about the distribution and current status of populations and a lack of knowledge of lake sturgeon early life history. I sampled waters across northern Michigan to gain a better understanding of lake sturgeon status and early life history. A total of 1,261 adult and juvenile lake sturgeons were captured from 10 of the 19 waters sampled. Only four populations appear to be reproducing successfully and self-sustaining: Black Lake, Sturgeon River, Menominee River, and Lake St. Clair. In the Sturgeon River larval lake sturgeons drifted downstream after hatching and were captured up to 61 km downstream from the spawning site. Young of the year and juvenile lake sturgeons proved difficult to capture, but collaborative efforts in Black Lake and Sturgeon River/Portage Lake provided insights into lake sturgeon early life history. In the Sturgeon River, young lake sturgeons drifted downstream and were present in the lower river until at least mid-August. In the Black River, some larval lake sturgeons likely drifted out of the river and into Black Lake, located only 11 km from the spawning site. Young of the year and juvenile lake sturgeons were found over sand, or sand and small gravel, substrates in the Sturgeon River and over sand in the Black River. In the Ontonagon River, which was stocked with lake sturgeons from 1998 to 2004, age-0 and yearling lake sturgeons were captured in the lower river over soft substrates of sand and silt. Rehabilitating and reestablishing lake sturgeons will likely require continued prohibitions on harvest as well as future stocking efforts to reintroduce lake sturgeons to former habitats.

Lake sturgeon *Acipenser fulvescens* is one of 29 species of sturgeon worldwide and is the only sturgeon species native to the Great Lakes. The native range of lake sturgeon included the Great Lakes basin and St. Lawrence River, the Hudson Bay drainage, and the Mississippi River drainage upstream from northern Mississippi. Lake sturgeons were historically abundant and widespread in the Great Lakes prior to European settlement of the region, but their abundance quickly declined soon after their commercial value was realized (Harkness and Dymond 1961; Houston 1987; Holey et al. 2000). Present lake sturgeon abundance in the Great Lakes is estimated to be less than 1% of historical abundance (Hay-Chmielewski and Whelan 1997) and lake sturgeon is listed as a threatened species by states throughout most of its native range, including Michigan. The lake sturgeon decline resulted in a closure of the commercial fishery in Michigan Great Lakes waters in 1951 and in all United States Great Lakes waters in 1977. Recreational angling regulations are also very restrictive; many waters are closed to recreational harvest, and where harvest is allowed the limit is one fish per angler per season. Minimum size limits vary among waters open to harvest and are intended to keep

exploitation focused on adult fish larger than 1-m in length, except in Lake St. Clair and the St. Clair River where a slot limit protects large fish from harvest.

Several factors led to the decline of lake sturgeon, including overharvest and habitat destruction, and have been described by others (Harkness and Dymond 1961; Houston 1987). The failure of lake sturgeon populations to expand in the decades following the closure of commercial and recreational fisheries is likely due to two primary factors. First, the construction of dams (primarily hydropower) has prevented access to historic spawning habitats on most Great Lakes tributaries, thus greatly reducing or eliminating natural reproduction. In many rivers historically used by spawning lake sturgeons, hydropower dams have been constructed at the downstream end of the first high gradient river stretch upstream from the lake. It is these high gradient riffle habitats that lake sturgeons select for spawning and that are now inaccessible. A good example of a river impacted by hydropower development is the Menominee River. The Menominee River once supported large annual spawning runs of lake sturgeons as well as whitefishes (Coregonines), lake trouts *Salvelinus namaycush*, suckers (*Moxostoma* spp. and *Catostomus* spp.) and likely other species. All of these species were originally able to ascend the Menominee River for many km. However, in 1924 a hydropower dam was completed at the base of a high gradient stretch of river less than 4 km upstream from Lake Michigan. This dam now prevents access to virtually all historic spawning sites in the river. In addition to hydropower dam construction, peaking hydropower dam operation has also likely prevented lake sturgeons from expanding (Auer 1996a). Peaking hydropower operation causes flood and near-drought conditions downstream from hydropower dams, usually within a 24-hr period.

The second factor that has limited lake sturgeon's ability to rebound is their unusual biology. Lake sturgeons do not become sexually mature until they reach 15–20 years age (Roussow 1957; Scott and Crossman 1973), and they spawn intermittently thereafter. Males may spawn annually or every other year, but females spawn once every 3–6 years (Auer 1996a; Smith and Baker 2005). Because of this intermittent spawning, lake sturgeon recruitment is low even when populations are large and considered healthy (Priegel and Wirth 1975; Boreman 1997).

Although it was clear that lake sturgeon abundance was greatly reduced from historic levels, little was known about the current status of lake sturgeon in Michigan's inland and Great Lakes waters prior to 1995. Because of this lack of knowledge and recognizing the need for directed management of lake sturgeon in Michigan, the Department of Natural Resources (DNR), Fisheries Division formed a Lake Sturgeon Committee and charged it with developing a statewide rehabilitation plan. In 1997 the committee published a rehabilitation plan (Hay-Chmielewski and Whelan 1997) and therein called for research to gain a better understanding of the current distribution of lake sturgeon populations in Michigan. Other knowledge gaps identified in the plan included lake sturgeon genetics, life history, minimum viable population size, habitat needs, and contaminant impacts. This study was initiated to address some of the knowledge gaps about lake sturgeon with the expectation that filling these gaps would lead to improved lake sturgeon management decisions.

The specific objectives of this study were to: 1) determine if lake sturgeons were successfully reproducing in selected Upper Peninsula rivers by evaluating if lake sturgeon larvae were being produced; 2) determine early (larval and juvenile) life history of lake sturgeons and identify habitat use of young lake sturgeons in waters where reproduction was occurring; and 3) tag adult lake sturgeons spawning in Sturgeon River (Houghton and Baraga counties) and other rivers to monitor lake sturgeon movement, characteristics of the spawning stock, and degree of spawning-stream fidelity.

During the course of this study, I was privileged to become involved with other investigators on a variety of different projects directed at lake sturgeon and also saw an increase in lake sturgeon research by other investigators. This report is primarily a summary of data collected during the course of my work. However, to provide a more complete understanding of the statewide status of lake

sturgeon I have also included numerous references to data collected during the course of collaborative studies and during studies completed by other investigators between 1996 and 2005.

Study Area

The study area for the work I completed included the entire Upper Peninsula and the northern half of the Lower Peninsula of Michigan. Sites selected for sampling had been identified as waters that were known, or suspected, to have supported lake sturgeon prior to the widespread decline of populations (Hay-Chmielewski and Whelan 1997; Figure 1). Sites I sampled were selected based on their inclusion in the Hay-Chmielewski and Whelan (1997) report, recent lake sturgeon sightings, and location. However, because lake sturgeon researchers have been active throughout Michigan this report covers waters sampled throughout the entire state.

Methods

A variety of gears were used to sample lake sturgeons (Table 1 and Appendix 1). The gear used in a particular location was selected based on the life history stage being targeted, the characteristics of the water body being sampled, time of year (i.e., spawning season), and prior experience. For example, lake sturgeons in the Sturgeon River, Houghton County are known to be vulnerable to capture with large dip nets while they are at the spawning grounds (Auer 1996a) and so this was the only method employed for capturing adults there. In contrast, because the status of lake sturgeons in the Tahquamenon River was unknown and there was no prior information about capture techniques there, I sampled with gill nets, drift nets, setlines, and a boomshocker electrofishing boat at various times throughout the open water season. These methods targeted adult and larval lake sturgeons.

Gill nets used when targeting adult lake sturgeons were constructed of monofilament mesh and were 20.3 and 25.4-cm bar mesh size. Each panel was 91.4 m long and 2.4 m tall and each net set consisted of at least one panel of each mesh size. Gill nets used when targeting juvenile lake sturgeons were 18.3-m long, graded-mesh experimental nets consisting of six 3.05-m panels of experimental monofilament stretch mesh measuring 25.4, 38.1, 50.8, 63.5, 76.2, and 101.6 mm. Two 18.3-m gangs were tied together to provide replication of each mesh size for any given set. Gill nets set for adults and juveniles were fished throughout the open water season, were typically set overnight, and in some instances were fished for several consecutive days. When nets were set for consecutive days, they were checked at least once every 24 hours.

Drift nets used to target larval lake sturgeons were bag-style nets constructed of 1600-μm mesh netting and attached to a D-shaped frame. The D-shaped frame opening was 0.36 m^2 and had dimensions of 77 cm across the base and 55 cm high. Net bags were 2.5 m long and had a detachable collection cup at the terminal end of the bag. The detachable cup had 1000-μm mesh and was 31.2 cm long. Dates selected for drift net sampling were based on dates of observed lake sturgeon spawning or on river temperature. Three to six drift nets were fished on the river bottom at points equidistantly spaced across the river at the sampling point. Nets were deployed in the river by personnel in waders, from a small boat, or from bridge crossings, and were fished from approximately 2100 hours until 0000 hours (dusk until 12:00 am). Nets were checked once each hour and contents were sorted at the sampling site.

The bottom trawl used for sampling was a shrimp try net with a 3.05-m (10-ft) headrope, 19-mm (0.75-in) square mesh body, and 6.4-mm (0.25-in) square mesh cod-end liner. Trawl tows were generally 10 min duration in habitats that were typically less than 10 m deep. Trawl tows were targeted at juvenile lake sturgeons and were also focused on stocked lake sturgeons in Ontonagon River.

Setlines were constructed following those used by Thomas and Haas (1999) and were fished overnight for adult lake sturgeons. As with some of the gill-net sets, setlines were occasionally fished for several consecutive nights and were checked at least once every 24 hours. Setlines were baited with a variety of baits including night crawlers, ruffe *Gymnocephalus cernuus*, and round gobies *Neogobius melanostomus*.

A Smith-Root electrofishing boat was used to sample for adult and juvenile lake sturgeons in several locations. The electrofishing control settings varied somewhat depending on the local conditions (i.e., conductivity) but I typically used pulsed direct current (DC) in waters less than approximately 3 m deep.

Fyke nets were set for juvenile lake sturgeons in Indian Lake during 1996. Fyke nets were constructed of 8-mm bar-mesh nylon netting. Leads were approximately 20 m long and nets were set perpendicular to shore in water less than 2 m deep. Fyke nets were set for several days but checked at least once every 24 hours.

Some lake sturgeon data were received from commercial fishers using trap nets to harvest lake whitefish *Coregonus clupeaformis*. Capture data were received from two fishers in Lake Superior and a single commercial fisher in Bay de Noc, Lake Michigan.

Finally, large dip nets (Smith and Baker 2005) were used during visual surveys in several rivers where suitable spawning habitat was located. Visual surveys were conducted by personnel in waders, and when adult lake sturgeons were observed the large dip nets were used to capture fish. Visual surveys typically proceeded in an upstream direction from the downstream end of the suspected spawning habitat and a capture attempt was made on all observed lake sturgeons.

When adult or juvenile lake sturgeons were captured, they were measured for total length (TL), fork length (FL), girth, and weight. In addition, if adults were captured during the spawning season I determined fish gender using the criteria from Auer (1999). Captured lake sturgeon larvae were measured and released. All captured lake sturgeons that were over 37-cm TL were tagged with serially numbered Floy anchor tags. Beginning in 2000 all lake sturgeons larger than 25 cm were also tagged with passive integrated transponder (PIT) tags. The PIT tags were small (14-mm) glass encapsulated tags that had unique 10-digit alphanumeric codes and required an electronic PIT tag reader to detect. All PIT tags were injected under the third or fourth dorsal scute behind the head.

Results and Discussion

Lake Sturgeon Distribution and Population Status

A total of 1,261 adult and juvenile lake sturgeons were captured from 10 of the 19 water bodies sampled (Table 2). Numbers of lake sturgeon captured ranged from 2 in the Millecoquins River to 465 in the lower Menominee River. Lake sturgeon spawning was confirmed in the Sturgeon River (Houghton County), Otter River, Millecoquins River, lower Menominee River, Manistee River, and Black River, although lake sturgeon larvae were only captured in the Sturgeon and Black rivers. Spawning was confirmed by direct observation of fish spawning, capture of ripe fish, or direct observation of lake sturgeon eggs on substrate. The confirmed spawning in the Millecoquins River was restricted to a single male and female pair observed spawning and captured 24 April 1998. No lake sturgeons have been observed or captured in the Millecoquins River since 1998; however, a lake sturgeon mortality was reported to the Newberry DNR office in summer 2001. Lake sturgeon spawning in Otter River was confirmed by the presence of lake sturgeon eggs on river substrate during a visual survey for spawning adults during May 2002.

Lake sturgeons were also known to be present in the spring in the Carp River and in the St. Mary's River near Sault Ste. Marie (Mackinaw County; R. Greil, Lake Superior State University, personal communication), and were present in Otter Lake (Michigan DNR unpublished data;

Figure 1). Anecdotal reports of commercial lake sturgeon captures have come from other Great Lakes waters including Traverse Bay of Lake Michigan, Saginaw Bay of Lake Huron, Keweenaw Bay of Lake Superior, and Lake Superior waters between Ontonagon and the entrance to the Portage Canal (Figure 1).

Of the 10 waters where lake sturgeons were captured, only three populations appear to be self-sustaining. Larval lake sturgeons were captured in the Black (N = 104) and Sturgeon (Houghton County, N = 695) rivers, and juvenile lake sturgeons were captured in the Menominee River. Larval lake sturgeons averaged 21.4-mm TL and ranged from 16 to 33-mm TL. Larval lake sturgeons were captured as early as 21 May (2001) and as late as 22 June (1997) in the Sturgeon River. Larval sampling in the Black River was confined to 23-24 May 1999 and larvae were captured on both dates. In addition to captured larvae, there was evidence of recent recruitment to the spawning stocks for the Sturgeon River, Black Lake, and Menominee River populations. Small (<110 cm), likely first-time spawning adults have been captured in the Sturgeon River spawning run in recent years (Figure 2). Juvenile lake sturgeons have been captured in Black Lake (Smith and King 2005a; Baker and Borgeson 1999) and in Menominee River; although no larval lake sturgeons were captured from the lower Menominee River. Recent work in the Manistee River has confirmed that lake sturgeon larvae are being produced in that river and older young of the year fish have also been captured in the Manistee River (J. M. Holtgren, Little River Band of Ottawa Indians, personal communication). However, because of the small number of spawning adults (Peterson et al. 2002) there is concern about the long-term viability of the population. Lake sturgeon larvae have also been captured in the Muskegon River (D. Peterson, University of Georgia, personal communication) but the number of larvae captured and the number of spawning adults in the Muskegon River are apparently much lower than in the Manistee River and the long-term viability of this population is also in doubt.

Although adult lake sturgeons were captured or observed in Indian Lake, Millecoquins River, Manistique River, Carp River, and Otter River there are no data suggesting that these populations are reproducing or self-sustaining. The Indian Lake population is small and may be declining. Bassett (1981) captured ripe male and female lake sturgeons in Indian River, but no spawning activity has been documented since 1981. Bassett (1991) captured 15 lake sturgeons during gill-net sampling in Indian Lake, but was unable to calculate a population estimate because no fish were recaptured. In a similar gill-net sampling effort during June 2005, only six lake sturgeons were captured. Two other sturgeons fell out of the nets as they were lifted. The smallest lake sturgeon captured in Indian Lake during 2005 was 104 cm, an indication that natural reproduction has occurred since Bassett's 1991 effort. However, I was unable to document spawning in Indian River by either visual survey or larval drift netting, and sampling for juvenile lake sturgeons was unsuccessful.

The Manistique River population is also apparently small. Gill-net and setline sampling in the river mouth below the dam in Manistique captured two lake sturgeons during April 2003. Both fish were ripe males in spawning condition (milt expressed under slight pressure applied to abdomen), indicating spawning may have been taking place below the dam. However, no eggs were observed and no larvae or juvenile fish were captured in the Manistique River. Lake sturgeons are also known to be present above the Manistique Paper Mill dam and it is possible the fish captured below the dam were produced upstream and moved downstream over the dam. It is also possible that the fish came from Indian Lake, which is connected to the Manistique River via the Indian River just upstream of the Manistique dam.

Recent data gathered by other investigators have confirmed lake sturgeon presence in other rivers. The Grand, St. Joseph, and Kalamazoo rivers (Michigan DNR, unpublished data) and the Muskegon River (D. Peterson, University of Georgia, personal communication) all support lake sturgeons, and the Muskegon and Kalamazoo rivers both have been confirmed as spawning rivers. Small numbers of larval lake sturgeons have been captured in the Muskegon River, demonstrating that natural reproduction has occurred there. However, the number of spawning adults in the Muskegon River is low and there is concern for the future viability of the population.

Juvenile lake sturgeons captured in the Ontonagon River were stocked fish that were introduced to the river in an attempt to reestablish a self-sustaining population. Although the stocking was not part of this study, it was initiated in 1998 after several years of sampling in the Ontonagon River failed to capture any lake sturgeons and the population was assumed to be extirpated. Young of the year lake sturgeons were stocked into the Ontonagon River from 1998 to 2002 and in 2004 (MDNR data); Fisheries Division plans to continue stocking the Ontonagon River until 20 year classes have been added. All stocked lake sturgeons had coded wire tags (CWT) inserted into their snout cartilage. Subsequent sampling in the Ontonagon River and nearby Lake Superior captured juvenile lake sturgeons and all had CWT in the snout or had deformed pectoral fins characteristic of hatchery origin (Filmore 2003).

Lake sturgeons from the Sturgeon River (Houghton County) and Menominee River are in apparent good condition (Figure 3). Length-weight relationships from these two populations are similar to other lake sturgeon populations (Priegel and Wirth 1975). It is interesting to note that the Sturgeon River fish were captured during the spawning run when fish would be expected to weigh more than at other times of the year, yet they weighed less on average than Menominee River fish of the same length (Figure 3). This may be a consequence of differences in productivity between Lake Michigan and Lake Superior.

Lake Sturgeon Tag Return Data

Lake sturgeons captured and tagged during spawning in the Sturgeon River have been recaptured in subsequent years in the Sturgeon River and also in the open waters of Lake Superior as far west as Chequamegon Bay and as far east as Whitefish Point (Figure 4). Fish recapture data from Lake Superior were provided by commercial fishers, Michigan DNR, and Wisconsin DNR; fish were recaptured in commercial trap nets or gill nets. The majority of recaptures in the Sturgeon River have been male lake sturgeons (N = 24) that have been recaptured once. Four female lake sturgeons have been recaptured at the Sturgeon River spawning site. No lake sturgeons captured and tagged at the Sturgeon River spawning site have been recaptured spawning in other rivers, and no lake sturgeons captured and tagged during spawning in other rivers have subsequently been captured during spawning in the Sturgeon River. Recapture data as well as recent genetic analysis of lake sturgeon (DeHaan 2003; K. Scribner, Michigan State University, unpublished data; B. May, University of California at Davis, unpublished data) confirmed that lake sturgeons have high site fidelity to specific spawning rivers and that they return to their river of origin to spawn upon reaching sexual maturity.

Other lake sturgeon recapture data and published reports (Auer 1999) showed that lake sturgeons traveled extensive distances in the Great Lakes. A lake sturgeon captured and tagged in the lower Menominee River in August 1996 during this study was harvested by an angler in the Mississagi River, Ontario in June 1998. It had traveled a minimum distance of 400 km (250 miles). It is not possible to determine the fish's natal river because it was captured during summer at both sites. Fish originally captured and tagged in the lower Menominee River during this study have been recaptured throughout the Green Bay/Bay de Noc system, indicating that fish from the Menominee River utilized the entire area of Green Bay during non-spawning periods.

One lake sturgeon captured in spawning condition on 16 May 2002 in the lower Manistique River was recaptured in Green Bay near the Peshtigo River mouth on 28 May 2005 by a commercial fisher. This fish was in spawning condition when originally captured in the Manistique River. Two lake sturgeons originally captured and tagged by the Wisconsin DNR in Lake Winnebago and the Wolf River, Wisconsin were also recaptured in Green Bay. One of these lake sturgeons was captured in a commercial whitefish trap net near the mouth of the Cedar River, Michigan in May 2005 and in May 2006 was captured again in a gill net in Saginaw Bay, Lake Huron (A. Kowalski, United States Fish and Wildlife Service, personal communication). The second fish washed up on the east shore of Big

Bay de Noc in August 2005 and was reported to the Escanaba DNR office. Both of these fish passed over and through a series of dams and locks on the Lower Fox River to reach Lake Michigan.

Although lake sturgeon tagging has been occurring in Lake Michigan, Lake Huron, and Lake Superior drainages for a number of years there have been only two reports of fish making an inter-basin migration (discussed above). Because of the documented long-range movements of lake sturgeon (Auer 1996b, 1999), it is likely that as lake sturgeon research continues such inter-basin movements will be documented with greater frequency.

Early Life History

Because larval lake sturgeon production was only documented in two waters (Black River and Sturgeon River, Houghton County) investigating early life history proved difficult. Larval drift data collected from the Sturgeon River demonstrated that larvae drift as much as 61 km downriver (Auer and Baker 2002), although the number of sturgeons captured declined with distance downstream. Larval drift data collected during the course of this study were combined with data collected by Dr. Nancy Auer (Michigan Technological University) from 1992–97 and published (Auer and Baker 2002) in the Proceedings of the 4th International Sturgeon Symposium. Drifting larval lake sturgeons in the Upper Black River were captured 11 km downstream from the spawning site and immediately upstream of Black Lake, indicating some proportion of larvae likely drift out into Black Lake prior to settling out of the drift (Smith and King 2005b). Lake sturgeon spawning in the Upper Black River is limited to the lower 11 km of river by Kleber and Tower dams (Baker and Borgeson 1999). It is possible that prior to the construction of these dams spawning lake sturgeons migrated further upstream and larval lake sturgeons drifted to the lower river but not into Black Lake. More detailed characteristics of larval lake sturgeon drift have been summarized in Auer and Baker (2002) and Smith and King (2005b).

Juvenile and young of the year lake sturgeons also proved difficult to catch, likely because they are so rare. Young of the year lake sturgeons were captured in the Sturgeon River only during July and August although sampling continued through December (Holtgren and Auer 2004). Benson et al. (2005) were able to capture young lake sturgeons in the Peshtigo River, Wisconsin only from June to October although sampling continued into November. Smith and King (2005b) also captured young lake sturgeons in the Upper Black River immediately upstream from Black Lake. In all these studies, young of the year fish were captured over substrates of sand or sand mixed with small gravel. Results from these studies suggest that young lake sturgeons spend most of the first summer in the lower stretches of spawning rivers but may leave the rivers late in their first summer. In the case of Black Lake, it is not clear if young of the year fish captured in the river had settled there from larval downstream drift or if these fish had ascended the river from Black Lake. Some larval lake sturgeons appeared to drift into Black Lake (Smith and King 2005b). Filmore (2003) sampled stocked young of the year and juvenile lake sturgeons in the lower Ontonagon River and noted fish were typically captured in deep pools. Radio telemetry of juvenile fish in the Ontonagon River indicated that fish used the lower river as well as Lake Superior. Filmore (2003) and Benson et al. (2005) noted that young of the year lake sturgeons were more active after dark.

Holtgren and Auer (2004) also conducted radiotelemetry studies with juvenile and sub-adult lake sturgeons in Portage Lake, which receives the Sturgeon River and is a known habitat for lake sturgeons. Lake sturgeons in Portage Lake occupied waters less than 16 m deep over substrates of sand or sand and mud. Movement of some radio-tagged fish was related to light intensity as two fish moved to shallower water at night and back to deeper water during daylight. Lake sturgeons were never associated with submerged aquatic vegetation. These results are consistent with those found by Benson et al. (2005) for the Peshtigo River, Wisconsin lake sturgeon population. Young of the year lake sturgeons in the Peshtigo River were captured or located (via telemetry) over sand substrates in

relatively shallow water (<2 m deep) and left the lower river for Green Bay as water temperatures cooled in late summer and early fall. Smith and King (2005a), using telemetry to study juvenile lake sturgeon movements and habitat use in Black Lake, also concluded that juvenile lake sturgeons used sand and silt and organic substrates. Some juvenile lake sturgeons have also been captured in Menominee River, but no data on habitat use are available for that population.

Summary

Although lake sturgeons are still widely distributed across Michigan, it is apparent that lake sturgeon abundance is far below historical levels and that some populations have been extirpated from rivers that historically supported spawning. There is little evidence of natural reproduction from most existing populations. Also, current lake sturgeon abundance and distribution do not satisfy the goal set for lake sturgeon management in Michigan (Hay-Chmielewski and Whelan 1997), which is to conserve and rehabilitate self-sustaining lake sturgeon populations to the point that the species can be de-listed as a threatened species. It is apparent that lake sturgeon populations exist in waters not sampled during the course of this study. Occasional sightings of lake sturgeon have come from the Rifle River and the Saginaw River and its tributaries. Survey efforts in these and other waters would enhance our ability to manage lake sturgeon statewide.

Based on the work presented here and research being conducted by others around the state, there are currently four populations that can be considered self-sustaining and perhaps expanding (Sturgeon River, Menominee River, Black Lake, and St. Clair River-Lake St. Clair). The population found in Lake St. Clair-St. Clair River is undoubtedly the largest population in Michigan (Thomas and Haas 2004) and is considered robust enough to allow a more liberal recreational harvest than other Michigan populations (one fish per angler per year, slot size limit of 42 to 50 inches, open season from 16 July to 30 September, and mandatory registration of harvested fish). Recent changes in habitat quality (hydropower dam relicensing, water quality improvements, etc.) have likely enhanced natural reproduction in other waters (e.g., Manistee River) but populations remain extremely small and in need of active management. Remaining populations are considered to be at risk for further declines and harvest is either not allowed or severely limited (Black Lake). Because lake sturgeon populations in Michigan are greatly reduced from historic levels, are extirpated from many rivers where they formerly occurred, and may not be reproducing in rivers where they currently occur, rehabilitating lake sturgeon will require not only the continued protection of existing remnant populations but also will likely require supplementation of existing populations and reintroduction to waters where lake sturgeon have been extirpated.

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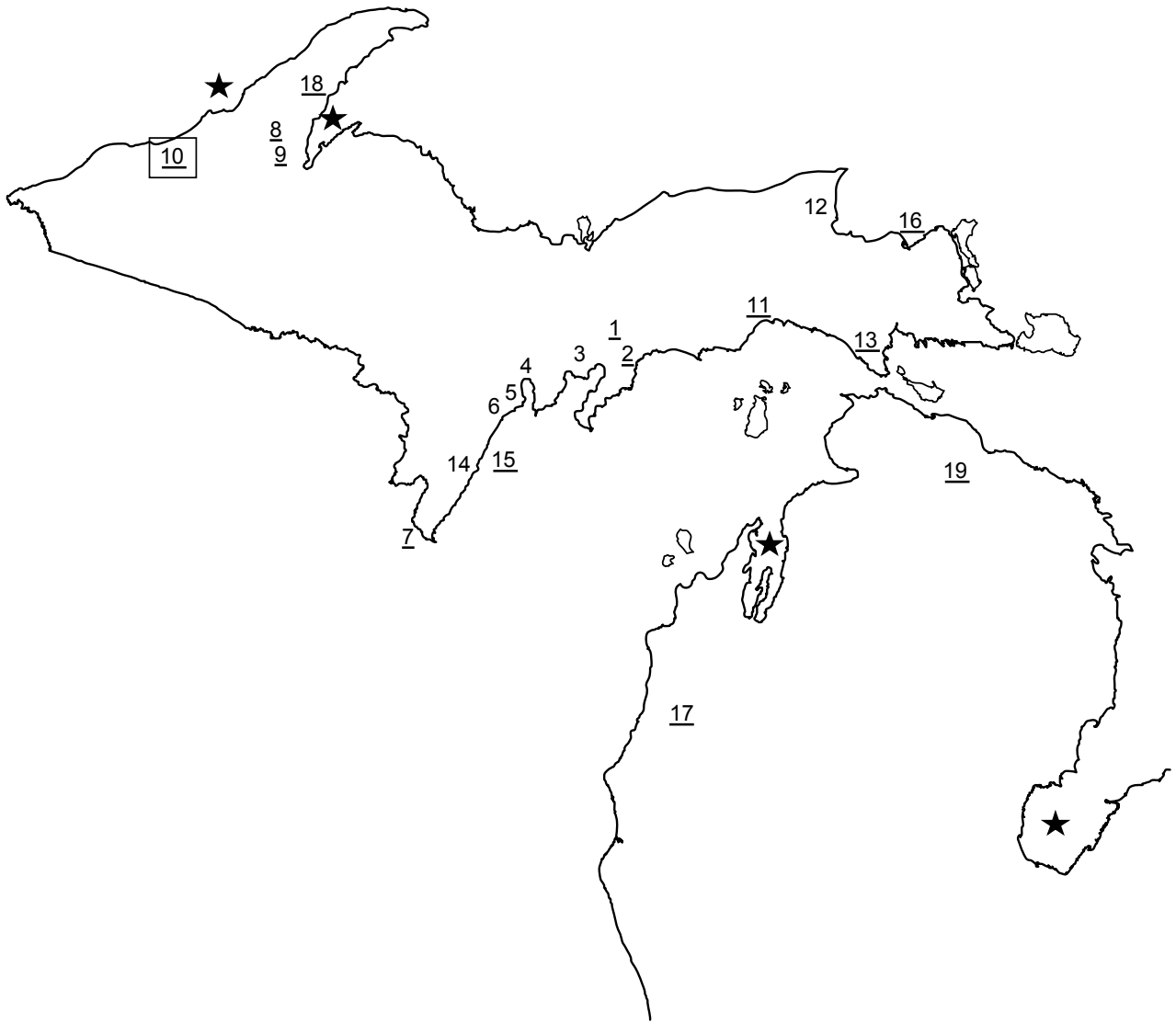

Figure 1.–Map showing approximate locations sampled for lake sturgeon. Numbers correspond to water bodies listed in Table 1. Waters where lake sturgeons were captured or are known to be present are underlined and Great Lakes waters where lake sturgeons were occasionally captured by commercial and tribal fishers are indicated by stars. The Ontonagon River (10) is a reintroduced population and indicated by a box.

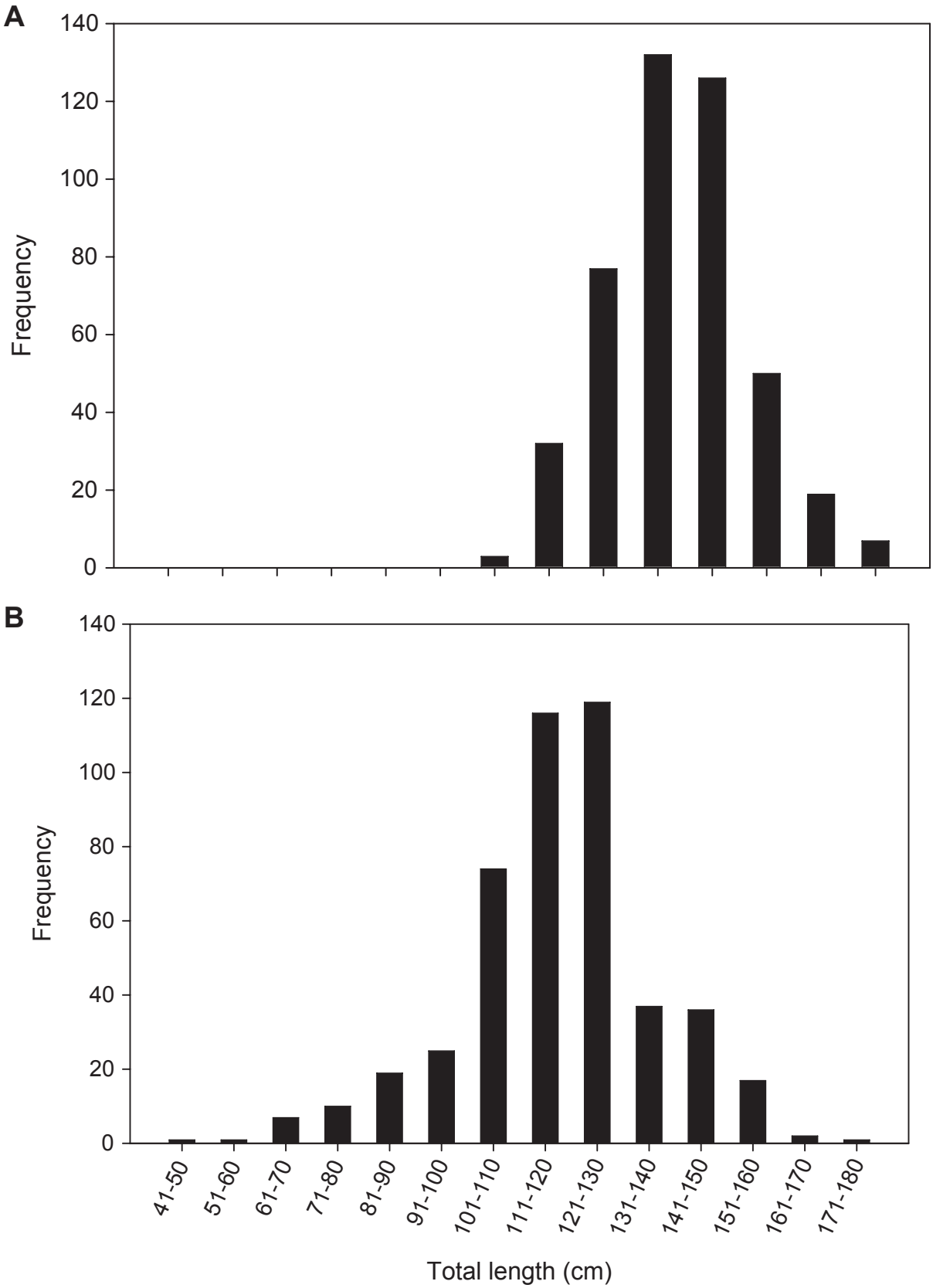

Figure 2.–Length-frequency (TL) of lake sturgeons captured during the spawning runs in the Sturgeon River (A) and during all open water months in the Menominee River (B).

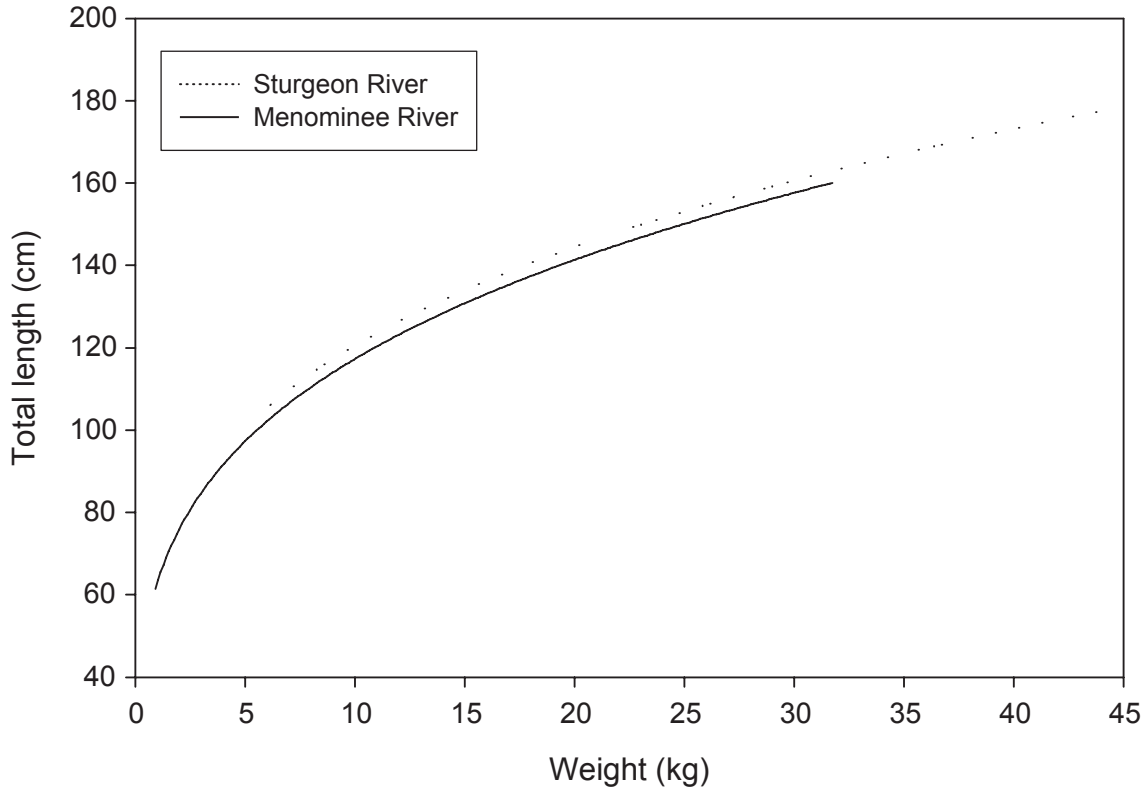

Figure 3.–Length-weight relationships for lake sturgeons captured in the Sturgeon River and Menominee River. Data from Sturgeon River fish were collected only during spawning periods and data from Menominee River fish were collected from May to October.

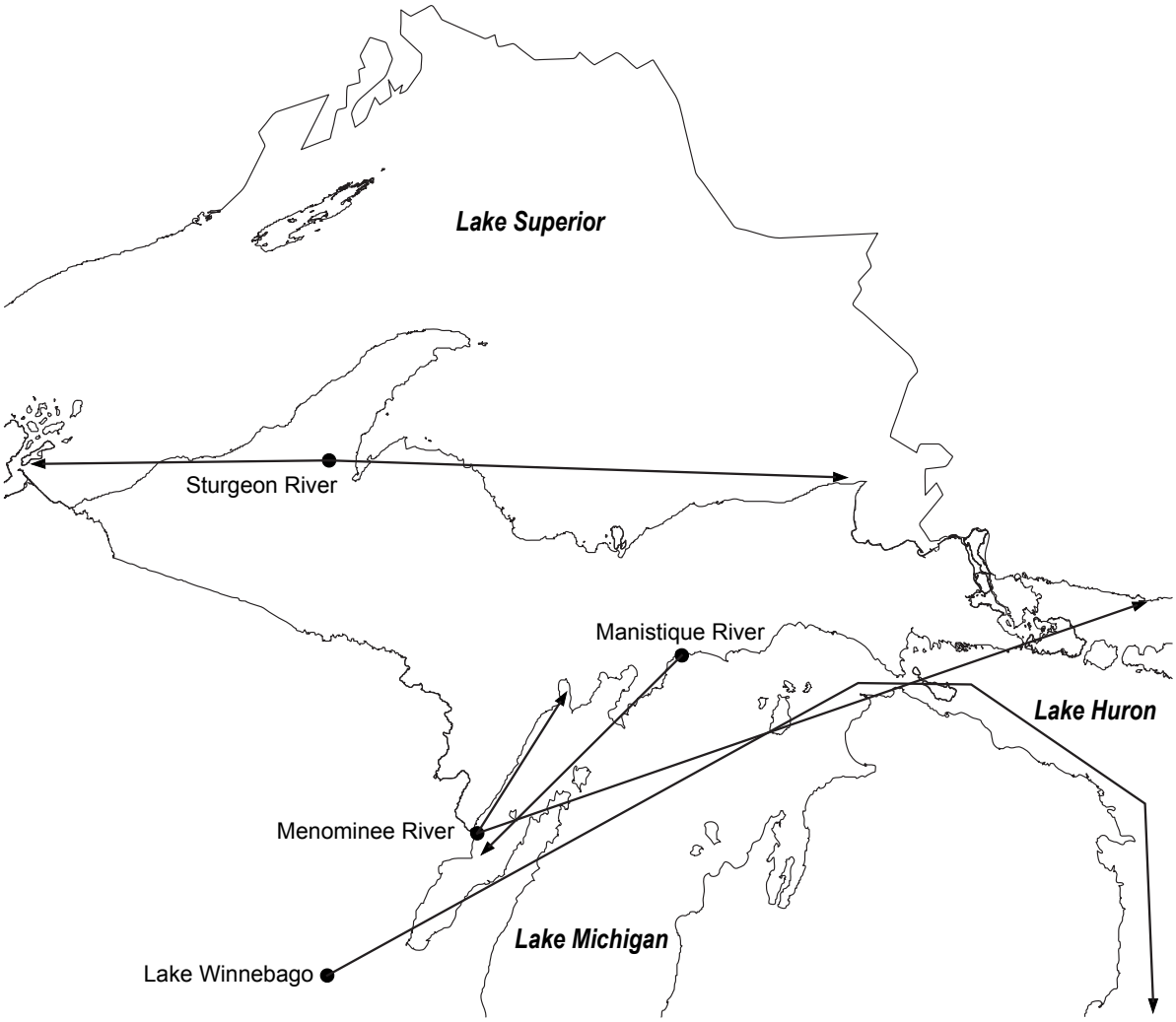

Figure 4.–Map of upper Great Lakes with arrows indicating direction and approximate maximum extent of movement documented for lake sturgeon from labeled source waters.

Table 1.–Summary of water bodies sampled for lake sturgeon and gears used (parenthetical numbers correspond to numbers on Figure 1).

Water sampled	Life stage targeted	Gears used [a]
Indian River (1)	Adult, larva	BS, DN, VS
Indian Lake (1)	Adult, juvenile	FN, GN
Manistique River below dam (2)	Adult, larva, juvenile	GN, SL, DN, VS, BS
Sturgeon River (Delta Co.) (3)	Adult, larva	DN, SL, VS
Whitefish River (4)	Adult, larva	BS, DN
Escanaba River (5)	Adult	BS, GN
Ford River (6)	Larva	DN
Lower Menominee River (7) below last dam	Adult, larva, juvenile	BS, DN
Otter River (8)	Adult, egg	VS, DN
Sturgeon River (Houghton Co.) (9)	Adult, larva, juvenile	VS, DN
Ontonagon River (10)	Adult, larva, juvenile	BS, GN, SL, DN, TL
Millecoquins River (11)	Adult, larva	VS, DN
Tahquamenon River (12)	Adult, larva	BS, DN, GN, SL
Carp River (Mackinaw Co.) (13)	Adult, larva	DN, VS
Cedar River (14)	Adult, larva	DN, VS
Green Bay (15)	Adult, juvenile	GN, CTN, TL
Whitefish Bay, Lake Superior (16)	Adult, juvenile	CTN
Manistee River (17)	Adult	BS
Portage Lake (18)	Adult, juvenile	GN, SL
Black River/Black Lake (19)	Adult, larva	GN, TL, DN, VS

[a] BS = boomshocker, DN = larval drift net, FN = fyke net, GN = gill net, SL = setlines, VS = visual survey w/ dip nets, TL = trawl, CTN = commercial trap net

Table 2.–Summary of waters where lake sturgeon juveniles or adults were captured.

Water sampled	Number of lake sturgeon captured	TL range of captured fish (cm)
Sturgeon River (Houghton County)	446	106–178
Menominee River	465	50–171
Millecoquins River	2	158–180
Manistique River	2	115–118
Black River/Black Lake	339	75–193
Ontonagon River	110	14–66
Manistee River	6	154–180
Whitefish Bay/eastern Lake Superior	31	86–147
Green Bay	87	35–196
Indian Lake	6	104–165

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Appendix 1.–Sampling effort data for waters sampled during this study. Numbers in parentheses correspond to locations identified in Figure 1.

Water body	Years sampled (1996–2005)	Gill net [a]	Drift net [b]	Boomshocker	Trawl [d]	Fyke net [b]	Setline [e]	Visual survey [f]	Commercial trap net [g]
Indian River (1)	96–99		12	3				4	
Indian Lake (1)	96–99, 04	24				80			
Lower Manistique River (2)	96–00, 03–05	20	15	6			1100	6	
Sturgeon River (Delta Co.) (3)	96, 03–05	20	12				1100	8	
Whitefish River (4)	96, 03–05		11	6					
Escanaba River (5)	96, 03–05	20		6					
Ford River (6)	98–99		6						
Lower Menominee River (7)	96–05		9	13					
Otter River (8)	02–04		9					6	
Sturgeon River (Houghton Co.) (9)	96–05		267					62	
Ontonagon River (10)	97–99, 01–05	24	7	4	25		800	2	
Millecoquins River (11)	97–99		14					4	
Tahquamenon River (12)	96–99	6	9	2			200		
Carp River (Mackinaw Co.) (13)	96–98		10					3	2
Cedar River (14)	97, 03–05		6					6	
Green Bay (15)	03–05	28			19				300
Whitefish Bay, Lake Superior (16)	98, 02								
Manistee River (17)	97			2					
Portage Lake (18)	97–03	20					600		
Black River/Black Lake (19)	97–05	110	58		16			14	

[a] net-nights
[b] net-hours
[c] boat-days
[d] number of 10-minute trawl tows
[e] hook-nights
[f] days surveyed
[g] net-days (24 hours)