

Lower Wisconsin River/Lake Wisconsin Lake Sturgeon Annual Update - 2013



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Background

Lake sturgeon (*Acipenser Fulvescens*) are one of Wisconsin's two members of the sturgeon family and the state's largest fish. Some lake sturgeon can weigh over 200 pounds and live over 100 years. During the 2010 spearing season on Lake Winnebago, WI a state record 212 pound, 84 inch lake sturgeon was harvested.

Lake sturgeon prefer large river and lake systems. In Wisconsin, they exist in the Lake Michigan, Lake Superior, and Mississippi River drainages (Becker 1983). They require extensive areas of water, dragging their barbels along the bottom in search of food. Their diet includes insect larvae and other invertebrates, snails, leeches, small mussels, and small fish.

Spawning in Wisconsin typically occurs in late April to early June with water temperatures from 53° to 59°F (Becker 1983). Males arrive at spawning sites before females, often cruising the shallows in groups of 8 or more. Spawning begins as soon as a ripe female enters the group, and several males attend 1 female. Fertilized eggs are adhesive and attach to gravel or rocks until hatching. Females may spawn for 5-8 hours over one or more days (Becker 1983). In the Lake Winnebago system, female lake sturgeon have been reported to mature at total lengths of 130-140 cm (51-55 inches) and ages of 20-25 years and generally spawn every 3-5 years ((Priegel and Wirth 1975, Folz and Meyers 1985, Bruch 1999). In the Winnebago System, male lake sturgeon have been reported to mature at total lengths of 83-114 cm (32-45 inches) and ages of 12-15 years. Males sometimes spawn in consecutive years, but more often spawn every other year (Priegel and Wirth 1975; Folz and Meyers 1985).

By the early 1900's many populations of lake sturgeon throughout their range had been greatly reduced or extirpated as a result of overfishing, habitat loss, the construction of dams, and pollution. Currently, lake sturgeon are recognized by the American Fisheries Society as threatened in North America and listed as Endangered, Threatened, or Special Concern in 19 of 20 states throughout its range (USFWS).

Study Area

The Lower Wisconsin River (LWR), as described in this report, starts at the Kilbourn Dam (Wisconsin Dells, WI) and flows downstream approximately 40 miles through 9,000 acre Lake Wisconsin, and 92 river miles from the PDS Dam to the confluence with the Mississippi River (Figure 1). The Prairie du Sac (PDS) Dam creates the first barrier to fish movement upstream from the Mississippi River. The PDS Dam also separates the LWR lake sturgeon population into two groups. For this reason, in this report, there are

two separate study areas; the Kilbourn Dam/Lake Wisconsin area and the Prairie du Sac Dam area.

The Baraboo River, a major tributary to the LWR, originates near Elroy and flows about 120 miles until its confluence with the Wisconsin River near Portage. The river changes from a gentle winding pace upstream of the town of Baraboo to a fast moving boulder rapids through town.

The Baraboo River has an average annual flow of 383 cubic feet per second. Since the last dam was removed on the Baraboo River in October of 2001, several riverine species that were not present or rare upstream of the first dam were then found upstream of the old dam site within a year of dam removal (Catalano et al. 2007). Although lake sturgeon have not yet been captured during long-term trend monitoring on the Baraboo River (Weigel 2009), an adult lake sturgeon was observed during electrofishing on May 1, 2002 (John Lyons pers. comm.). Unconfirmed reports by Baraboo High School students in the mid-2000s also describe what they saw as sturgeon on the riffle near the Ringling Circus grounds (Dan Fuller pers. comm.).

An account of sturgeon by an early Baraboo area settler does mention a significant spawning event prior to any dam construction (*The History of Sauk County* 521-522):

...a reminiscence of Baraboo's earliest settler, Mr. Archibald Barker, a very remarkable account of a shoal of sturgeons encountered by him in running, in the spring of 1841, the first raft which left the Baraboo. Mr. Barker says: "In Company with Ed Kingsley, going down [the Lower Baraboo Rapids], each on a crib, I halloaed to him to look—that somebody seemed to have made a dam of stones across the river. As we approached we saw it was the backs and tails of fishes. We were soon among them, and found they were sturgeons. I killed three with my handspike. In jumping into the water to get them I was knocked down by others running against my legs. For a short distance the river seemed to be jammed full of them."

Angling Regulations

The LWR supports an annual hook and line fishery for lake sturgeon. Regulations have become more restrictive, responding to an increasing trend in the number of fish harvested from 1991 through 2005 below the Prairie du Sac Dam (Figure 2). Changes include an increase in the minimum size limit from 45 to 50 inches in 1991, alternate year size limits of 50 and 70 inches from 2000 through 2006, and in 2007 a 60-inch minimum was enacted. Prior to 2007, the angling season ran from the first Saturday in September through October 15. The current season runs from the first Saturday in September through the end of September with a season bag limit of 1 fish over 60 inches. Anglers who wish to harvest a lake sturgeon need a fishing license and a valid harvest tag. Anglers who wish to catch and release lake sturgeon may do so during the open season with a fishing license and do not need a harvest tag.

Mandatory harvest registration began in 1983, with length and weight measurements taken. Sex organs have been collected from harvested fish since 1997 to determine the sex ratio and maturity stages of harvested fish. Starting in 2005, dart tags have been placed near the dorsal fin and passive integrated transponder (PIT) tags have been implanted underneath the skull cap; harvested fish are checked for the presence of a PIT tag and dart tag during registration. Mandatory harvest registration is also used to estimate exploitation by dividing the number of lake sturgeon harvested by the number of lake sturgeon estimated in the population. This is a preseason estimate with harvested fish added into the population estimate.

Middle Wisconsin River Restoration

In an effort to return lake sturgeon to its original range in the upper Wisconsin River, juveniles (20 to 45 inches) were transferred from Lake Wisconsin to the Stevens Point Flowage in the summers of 1991 and 1992 by Wisconsin Rapids fisheries personnel. To continue the rehabilitation effort, Wisconsin Rapids personnel started electrofishing below the dam in the spring of 1997 to capture ripe males and females. Typically 12 to 16 lake sturgeon (approx. 2:1 male/female) are held in tanks at the dam powerhouse until stripping of gametes occurs. The fertilized eggs are hatched and raised at the Wild Rose fish hatchery and fingerlings are then stocked in the upper Wisconsin River. Fingerlings and fry are also stocked back into the Wisconsin River below the Kilbourn Dam periodically when surplus fish are available (Table 1).

This report will mainly focus on adult fish and includes: the most recent age and growth data, sex and stage of maturity of harvested sturgeon, a 1981 and 2008 population estimate of the Lake Wisconsin/Wisconsin Dells fishery, annual exploitation and population estimates of the fishery below the Prairie du Sac dam from 2005 through 2012, movement of fall radio-tagged fish downstream from the Prairie du Sac dam, an update on the status of lake sturgeon in the Baraboo River, and stocking in the Baraboo River and LWR..

Current Status

Kilbourn Dam/Lake Wisconsin

Methods

Beginning in 2005, Poynette Fish Management pooled its resources with the existing egg collection operated by the WDNR personnel from Wisconsin Rapids. Two to three bottom type gill nets with 10 to 12 inch stretch mesh, 10 feet deep, and 200 feet long are deployed in deeper water (≥ 15 feet) and fished for approximately 2 hours at a time. Electrofishing effort focuses on the shallower spawning area below the powerhouse and rock island. Total distance and time are not recorded as areas were often electrofished randomly. All fish are measured, weighed, dart tagged in the musculature near the dorsal fin, Passive Integrated Transponder (PIT) tagged beneath the skull cap, and sexed if

possible for both sampling methods. In 2012, sampling occurred from April 16 to April 20 in water temperatures from 51 to 58°F.

In 2005 and 2006 pectoral spines were removed from captured sturgeon, cross sectioned and aged by counting annular growth rings using an Olympus SZX7 stereomicroscope. A correction factor was applied to the 2005 to 2006 von Bertalanffy growth curve to compensate for underestimated ages after age 14 (Bruch et al 2009, von Bertalanffy 1939).

In 2008, a recapture effort was done in Lake Wisconsin to estimate the adult population by gill netting lake sturgeon from October through November. Four gill nets with 10 to 12 inch stretch mesh, 10 feet deep, and either 200 or 300 feet long were fished in deeper water (≥ 15 feet) and lifted after 24 hour soak times. All four nets were set in the upper third of the lake based on past netting from 1978 to 1981. Canadian researchers also gill netting Lake Wisconsin for lake sturgeon during the same time period helped increase the catch by recording marked and unmarked fish and relaying the information. A similar estimate was done from October to November 2009, but too few fish were recaptured to get an accurate estimate. Most likely this was due to a much lower effort with no added outside help as in 2008.

Harvested sturgeon are reported at registration outlets along the Wisconsin River near the Kilbourn Dam and on Lake Wisconsin. All fish are measured, weighed, and checked for dart and PIT tags (2005 to present). Gut/Gonad samples are also taken if the angler is willing to donate them to determine sex and stage of development (1997 to present).

Results

During the spring 2012 netting and electrofishing sample below the Kilbourn Dam, 148 sturgeon were captured from April 16 through April 20. Of the 148 captured, 89 were able to be sexed; 18 females and 71 males, and 61 were tagged in a previous year (Table 2). The average length was 52.6 inches for all fish captured with a range from 29.4 to 75.0 inches, 60.0 inches for females with a range from 52.5 to 75.0 inches, and 53.7 inches for males with a range from 42.7 to 61.0. The average weight was 31.6 lbs. for all fish sampled with a range from 4.5 to 106.0 lbs., 51.2 lbs. for females with a range from 35.0 to 98.5, and 31.7 lbs for males with a range from 16.0 to 52.5 lbs. The length frequency is a reflection of both the adult population available at the spawning site and the gear bias of 10 to 12 inch stretch mesh with the majority of fish between 50 and 60 inches (Figure 3). To date, 1014 lake sturgeon have been tagged in this stretch of river since 2003.

Population Estimates, Harvest, & Exploitation

Following four consecutive springs of tagging sturgeon below the Wisconsin Dells Dam, a population estimate (PE) was completed in the fall of 2008 by recapturing marked fish in Lake Wisconsin with gill nets. Eighty-seven adult lake sturgeon (≥ 50 inches) were captured with a recapture rate of 31%. The Bailey modification of the Peterson formula

estimated 1,597 adult fish after the angling season with a 95% confidence interval of 1,195 – 2,264. A Bailey PE was also done on Lake Wisconsin in 1981 (Larson 1988) for fish 45 inches and larger which estimated 2,868 sturgeon. Using a length frequency to convert the estimate to include only fish 50 inches or greater, the PE changed to 1,512. Given the similarity in the two estimates and recent low harvest numbers (Figure 2), it was concluded that the Wisconsin Dells/Lake Wisconsin fishery is stable.

Harvest on this stretch has changed dramatically since mandatory harvest registration began in 1983. The average number of lake sturgeon harvested from 1983 to 1990 (45 inch minimum) was 68, from 1991 to 2005 (50 inch minimum, excluding 70 inch minimum years) was 24, and from 2007 to 2012 (60 inch minimum years) was 1 (Figure 2). Harvested lake sturgeon from 1983 to 1990 averaged 51.2 inches and 28.1 lbs. and ranged from 45.0 to 72.0 inches, from 1991 to 2005 (only 50 inch min. years) averaged 54.9 inches and 37.2 lbs. and ranged from 50.0 to 71.0 inches, and from 2007 to 2012 averaged 64.2 inches and 51.8 lbs. and ranged from 60.0 to 74.3 inches.

Using the lower 95% confidence limit of 1,195 from the 2008 population estimate, and assuming the population has been stable since the 1981 estimate, during no point from 1990 through 2012 has exploitation exceeded the 5% threshold that the WDNR sturgeon species team recommends to maintain a stable population (WDNR 1998).

Growth

Growth of lake sturgeon aged from 1979 to 1981 in this stretch of the Wisconsin River/Lake Wisconsin appears to be faster until age 38 than those aged from 2005 and 2006 (Figure 4)

The von Bertalanffy age-length equation is

$$l_t = L_{\infty} \left(1 - e^{-K(t-t_0)} \right)$$

For Lake Wisconsin 1979-81 the parameters were

$$\begin{aligned} L_{\infty} &= 64.31 \\ K &= 0.0887 \\ t_0 &= 1.652 \end{aligned}$$

For Lake Wisconsin 2005-06 the parameters were

$$\begin{aligned} L_{\infty} &= 75.5 \\ K &= 0.0513 \\ t_0 &= 2.000 \end{aligned}$$

For Lake Wisconsin 2005-06 with correction factor the parameters were

$$L_{\infty} = 75.5$$

$$K = .0443$$

$$t_0 = 2.000$$

During the 1979 to 1981 survey, a Bausch & Lomb dissecting microscope with 0.7x – 3x magnification was used to age pectoral spines versus a 16x – 112x Olympus SZX7 stereomicroscope during 2005 and 2006. The greatly increased magnification could have accounted for missed annuli especially at older ages.

Sex, Development, & Maturity

See *Sex, Development, & Maturity* section under PDS Dam. Data was combined to bolster numbers.

Prairie du Sac Dam

Methods

Beginning in fall of 2005, gill netting began below the PDS Dam to estimate the population of adult lake sturgeon. Typically four nets with 10 to 12 inch stretch mesh, 10 feet deep, and 200 or 300 feet long are soaked in deeper water (≥ 15 feet) for approximately 2 hours at a time in the tailrace below the PDS Dam. All fish are measured, weighed, dart tagged in the musculature near the dorsal fin, and given a PIT tag beneath the skull cap. In 2012, 10 netting events occurred between October 3 and November 13 with temperatures falling from 60 to 43°F.

In 2005 and 2006 pectoral spines were removed from captured sturgeon, cross sectioned, and aged by counting annular growth rings using an Olympus SZX7 stereomicroscope. A correction factor was applied to the 2005 to 2006 von Bertalanffy growth curve to compensate for underestimated ages after age 14 (Bruch et al 2009, von Bertalanffy 1939).

Harvested sturgeon are reported at registration outlets along the Wisconsin River near the PDS Dam and further downstream. All fish are measured, weighed, and checked for dart and PIT tags (2005 to present). Gut/Gonad samples are also taken if the angler is willing to donate them to determine sex and stage of development (1997 to present).

In October of 2007, 16 adult lake sturgeon were captured below the PDS Dam and implanted with Model F1855 50 MHz radio transmitters made by Advanced Telemetry Systems (Isanti, MN). The transmitters have a 14 hour duty cycle and which extends the battery life to 2024 days (about 5.5 years). Tracking is done by shore and boat using a Cushcraft Co. model PLHC-374 Yagi Antenna and by plane using wire antennas. Tracking area is limited to the Wisconsin River from the PDS Dam downstream to the Mississippi River and the Mississippi River between lock and dam 9 and 10. Although

available funds to track have declined since the project began, an attempt to track by plane or boat is done one to two times monthly from May to September each year. From October to April, an attempt to track sturgeon overwintering within 5 miles of the PDS Dam is done by shore. Periodic plane tracking does occur in winter months, however weather and visibility often make flying by a single propeller plane difficult, dangerous, or sometimes impossible.

In the springs of 2011 and 2012, four larval drift nets were deployed approximately 0.33 miles downstream from the dam on a shallow sand/gravel flat. The drift nets were a D-shape frame (76.2 cm wide x 53.3 cm high; Research Nets, Bothell, WA), with a cable bridle attached to rings on the frame. Every net had a 3.4 m long and 1.6 mm mesh bag that trailed behind the frame, with a grommeted frame collar and nylon cup collar to fit a removable collecting bucket (333 μ m mesh). Nets were fished at depths between 1.5 and 3.5 feet of water and checked every 2 hours from 10pm to 2am. River velocity was also taken at each net sit. Nets were fished for two nights in 2011 (May 24 and June 1) and three nights in 2012 (April 24 through 26).

Results

During the fall 2012 netting sample below the PDS Dam, 156 sturgeon were captured during 10 sample dates from October 3 to November 13 (not including recaptures). The average length was 54.4 inches with a range from 34.3 to 68.3 inches. The sex was not determined because fish were captured in the fall. The average weight was 34.6 lbs. with a range from 5.0 to 90.0 lbs. The length frequency is a reflection of both the adult population available that overwinter at the PDS Dam and the gear bias of 10 to 12 inch stretch mesh with the majority of fish between 48 and 60 inches (Figure 5). To date, 514 lake sturgeon have either been tagged below the PDS Dam or were previously tagged above the dam and were then captured below.

Population Estimates, Harvest, & Exploitation

Gill netting below the PDS Dam was initiated in fall of 2005 in order to estimate population size and exploitation. This was triggered by a concern over increasing harvest numbers during 50 inch size limit years (Figure 2). Fall adult (≥ 50 inches) population estimates (Schnabel 1938 modification of the Peterson method) from 2005 through 2010 showed a decline in the population (Figure 6). However, the last two years have shown an increase (Figure 6). Exploitation in 2005 was 26.1%, well above the 5% safe threshold (Figure 6, Preigel & Wirth 1975, WDNR 1998). Since the 60 inch minimum size limit was put into effect in 2007, exploitation hasn't exceeded 8.4% and has averaged 5.1%. It appears that 10 to 12 inch stretch mesh has sampled fish effectively in the years 2005 to 2012 from about 48 to 61 inches with marked decreases in efficiency above and below this size range (Figure 7).

Harvest below the PDS Dam has changed over time since mandatory harvest registration began in 1983 (Figure 2). The average number of lake sturgeon harvested from 1983 to 1990 (45 inch minimum) was 20, from 1991 to 2005 (50 inch minimum, excluding 70

inch minimum years) was 39, and from 2007 to 2012 (60 inch minimum years) was 8 (Figure 2). Harvested lake sturgeon from 1983 to 1990 ranged from 45.0 to 74.0 inches and averaged 51.3 inches (weights not taken), from 1991 to 2005 (only 50 inch min. years) ranged from 50.0 to 71.5 inches and averaged 55.7 inches and 35.6 lbs., and from 2007 to 2012 ranged from 60.0 to 72.0 inches and averaged 63.3 inches and 48.0 lbs.

Growth

Insufficient data from fish younger than 11 years of age made it difficult to create a suitable von Bertalanffy growth curve for lake sturgeon below the PDS Dam. Average length at age can still be used and can be compared to the Lake Wisconsin 1979-81 von Bertalanffy growth curve (Figure 8).

Sturgeon that were vulnerable to harvest, under the previous regulation, during a 50 inch minimum size limit were about 20 years old (Figure 8). Under the current size limit of 60 inches, fish are protected from harvest until approximately 34 years old (Figure 8).

Sex, Development, & Maturity

Starting in 1997, reproductive organs from harvested lake sturgeon on Lake Wisconsin, the Kilbourn and PDS Dams, and lower Wisconsin River were collected at registration stations in order to determine the sex and describe the development of those fish. The majority of the fish harvested were fully developed males and females (Table 3). F4 (black egg) females represent 46% of the female harvest and M2 (fully developed) males represent 65% of the males harvested, as classified by Bruch et al (2001) (Table 3).

In Lake Winnebago, 50% of female lake sturgeon mature at age 27 or about 55 inches (Bruch 2008). For lake sturgeon below the PDS Dam, average length at age 27 is 55 inches, and the average length at age 34 is about 60 inches (Figure 8). If the maturity schedule for the PDS Dam is similar to that of Lake Winnebago, then under the current regulation, mature females would be protected for 7 years or about 2 spawning cycles from 55 inches to 60 inches.

Fishery Source & Movement

The source of the lake sturgeon population below the Prairie du Sac is not entirely known. Some evidence suggests that there is the potential for natural recruitment. Anglers below the PDS Dam have observed porpoising lake sturgeon in the spring, which is common of spawning lake sturgeon. Also, gonads analyzed from harvested lake sturgeon below the PDS Dam indicate that over half of the fish present in the fall would have been developed enough to spawn the following spring (Table 2). However, active spawning, much less a successful spawn, has never been confirmed below the PDS Dam.

Other evidence supports that at least some fish are moving upstream from the Mississippi River. A radio tracking study in 1997 and 1998 by the United States Geological Survey (USGS) found fall upstream movement by 5 of 16 fish tagged in Pool 10 of the

Mississippi River to the PDS Dam, with a return to Pool 10 following the spring spawning period (Knights et al. 2002). Also, one of five lake sturgeon tagged in Pool 10 by WDNR personnel from Prairie du Chien in the fall of 2005 was recaptured by this study at the PDS Dam in 2012.

Significant downstream movement over the PDS Dam was also noted by a WDNR lake sturgeon study during 1978 through 1981 on Lake Wisconsin. Of approximately 1,900 fish that were tagged (16 inches and larger), 12 were recaptured by commercial fisherman in Pool 10 of the Mississippi River by 1981, and 5 additional fish had been captured by 1985 (Larson 1988). From June 1980 to June 1981, 12 sturgeon (25 to 38 inches) were raked off the trash rack at the PDS Dam; 8 dead and 4 alive (Larson 1988). There have also been 16 fish during this study that had been tagged below the Kilbourn Dam or in Lake Wisconsin that were later recaptured below the PDS Dam.

Some of the sturgeon captured in the fall below the PDS dam may permanently reside in the lower Wisconsin River. From 2005 to 2012, PIT tag recaptures of fish marked at the PDS Dam of up to 20% (recapture divided by those marked) were observed from one year to the next during fall gill netting (Table 4). A few lake sturgeon have been recaptured in multiple years and in one case an individual was captured and recaptured every year from 2005 to 2012.

Other lake sturgeon may swim as far the next barrier. On April 4, 2012, WNDNR fisheries crews working on the Chippewa River in downtown Eau Claire captured a sturgeon that was tagged on October 12, 2010 below the PDS Dam. That fish was recaptured approximately 275 river miles distant from its original tagging location only 18 months after it was initially tagged.

To provide further insight on movement behavior, in October of 2007 sixteen adult lake sturgeon were implanted with 50 MHz radio transmitters and have been tracked by airplane, boat, and shore since their release directly below the Prairie du Sac dam. From the time of release through mid-April 2008, 15 sturgeon remained within 2.5 miles of their release location. On April 22, 2008 10 radio tagged sturgeon were heard, by yagi antenna, near the Prairie du Sac dam, which included 4 fish that had previously been overwintering 2.5 miles downstream. Six days later only one fish remained within 2.5 miles of the dam. On May 5 and 6, 2008 radio tracking was done by boat and yagi antennae from the Prairie du Sac dam downstream 92 miles to the Mississippi River in order to ground truth radio tracking by plane. Only two fish were found in the Wisconsin River. Subsequent flights throughout the summer along the Wisconsin Riverway and Mississippi River between lock and dam 9 and 10, found sturgeon using the lower end of the Wisconsin River, and the Mississippi River. As of February 2012, 12 of the 16 fish have returned at some point to the PDS Dam area of the Wisconsin River and 8 have been recaptured (Table 5). The tags have a 14 hour duty cycle, which helps prolong the battery life to about five and a half years. This should make the transmitters audible through the spring of 2013.

Spawning & Larval Netting

Although sexually mature males and females have been confirmed below the PDS dam, spawning has never been documented anywhere on the lower Wisconsin River. Spawning can occur at depths that are not visible by an observer (especially in the turbid waters of the Wisconsin River), which may explain why there are no reports of spawning fish.

In the springs of 2011 and 2012, four larval drift nets were deployed approximately 0.33 miles downstream from the dam on a shallow sand/gravel flat. River velocity ranged from 1.08 to 3.45 ft/sec. No larval lake sturgeon were found in either year.

Baraboo River

Although the Baraboo River may not have the characteristics and capacity to hold and support its own population of lake sturgeon, it could be an important spawning area for adults in the Kilbourn Dam/Lake Wisconsin segment of the Lower Wisconsin River.

The Baraboo River has been stocked with lake sturgeon twice (2010 and 2012; Table 1). Although the 2010 stocking was a surplus stocking, it did spark a discussion in the sturgeon species team meeting about the possibility of a stocking plan for reintroduction of lake sturgeon into the system. In 2012, 490 large fingerlings were implanted with PIT tags and released in the Baraboo River. Half of these fish were released in the city at Haskins Park, and the other half upstream of the city off of Hatchery Road. If and when recaptured, these fish have the potential to provide a wealth of information.

Discussion

The lake sturgeon fishery in Lake Wisconsin and the Wisconsin River upstream to the Kilbourn Dam seems to be stable given the similarity in the adult population estimates from 1981 and 2008. Since 1990, annual harvest on this stretch has not exceeded 33 fish and in the last 6 years only 9 total fish have been harvested. Using the conservative lower 95% confidence limit of 1,195 from the 2008 population estimate, and assuming the population has been stable since the 1981 estimate, during no point from 1990 through 2012 has exploitation exceeded 5%.

There is, however, little if any information on sub-adult lake sturgeon in any stretch of the Wisconsin River. An effort should be made from the Kilbourn Dam to the PDS Dam to locate areas that may be critical to young of the year lake sturgeon, as well as to estimate their abundance. Since sturgeon are unique in that they are long lived and slow to mature, information on all life stages would be important.

The PDS fishery appears to be recovering from high exploitation. Increasing the minimum size limit to 60 inches has decreased the exploitation below the PDS Dam from a high of 26.1% in 2005 to an average of 5.1% since 2007. Population estimates have been increasing over the last two years as well, but should continue to be monitored.

There are still many questions about the PDS Dam area fishery that need to be addressed such as:

1. What is the source of recruitment for the lake sturgeon population below the PDS Dam?

We do know that:

- a. There is downstream movement of sturgeon over the PDS Dam.
- b. Sturgeon move throughout the lower Wisconsin River and use the Mississippi River.
- c. Thus far drift netting below the PDS Dam has yielded no larval sturgeon.

According to studies on the Sturgeon River in Michigan and the Peshtigo River in Wisconsin, larval drift sampling lasted from 2 to 5 weeks following an estimated hatch date (Auer and Baker 2002, Benson et al. 2006). Thus far only minimal sampling has occurred with two days sampled in 2011 and three in 2012. With a heavy spring work load and low staff numbers, it is difficult to find time or staff available to devote more effort toward larval netting. A specific project would need to be undertaken in order to adequately sample the larval drifting period.

2. What is the entire adult population (as opposed to fall PDS Dam pool population) of sturgeon that is considered to use the lower Wisconsin River.

Simple population estimates will not adequately describe the adult population of lake sturgeon that utilize the Lower Wisconsin River because of immigration, emigration, time constraints, and angling mortality (legal and illegal). A more elaborate system such as Program Mark can include a robust set of parameter estimates that could better describe the population of adult lake sturgeon.

3. What is amount of exchange throughout the Wisconsin and Mississippi Rivers?

Identifying a potential genetic difference between a Mississippi and Wisconsin River stocks would help identify the source of the fall PDS dam fishery. Genetic samples from lake sturgeon in the Kilbourn Dam/Lake Wisconsin segment of the Wisconsin River as well as from a Mississippi River source would need to be compared to fish from below the PDS Dam.

An effort should be made to sample the earlier life stages of lake sturgeon below the PDS Dam and in the lower Wisconsin River to learn more about their abundance, growth, and mortality. The current aging/growth data below the PDS Dam does not allow for an accurate growth curve. The youngest fish aged below the dam is 11 and the shortest fish measured is 27.8 inches. A variable panel bottom gill net varying from 6 to 10 inch stretch mesh could be used to capture smaller lake sturgeon. It is understood that there could be sampling challenges with finding concentrations of younger sturgeon and with capturing non-target species. A thorough literature search and review is advised prior to purchase and implementation. Testing to determine soaking time, the number of nets to

run, and location of nets should be done on a smaller scale to determine possible problems before full sampling is done.

Large lake sturgeon (≥ 60 inches) are thought to be uncommon, but none the less exist in the Lower Wisconsin River. Gill nets are inherently a size biased way of sampling and because of this, the number of fish outside of the bias (especially very large fish) may be under sampled and thus the population estimate would be lower. Currently 10, 11, and 12 inch stretch mesh is used in single panel bottom gill nets. It appears as though fish between 48 and 61 inches are sampled fairly well using this size, however, there is a steep drop off after 61 inches (Figure 7). A larger, and possibly variable-paneled, mesh such as 13, 14, or 15 inch stretch mesh could be used to capture larger fish and help round out the population estimate.

Mature, fully developed lake sturgeon that congregate below the PDS Dam from fall to the following spring are searching out suitable spawning habitat. The area below the Kilbourn Dam has already been identified as a viable spawning area, so safe upstream passage through the PDS Dam would reconnect a segment of the Lower Wisconsin River that may not have a suitable spawning habitat.

The state of Wisconsin has fishable (angling) populations of lake sturgeon on the Chippewa, Flambeau, Jump, Menomonie, St. Croix, and Wisconsin Rivers, Butternut, Yellow, and Little Yellow Lakes, and the Danbury Flowage. There are also several bodies of water that have populations of lake sturgeon that don't have angling seasons such as, but not limited to the Milwaukee, Mississippi, and Baraboo Rivers. Currently the annual budget to manage all of these populations of lake sturgeon is \$50,000. A local and statewide economic impact of the lake sturgeon angling season would help gauge the importance of the fishery. For example, the sturgeon spearing season on the Lake Winnebago System only averages 8 days in length, but the annual economic impact to the Winnebago area is \$3.5 million dollars (Kendall Kamke personal communication).

The removal of the last dam on the Baraboo River in 2001 reconnected 120 miles of river that had been dammed for over 150 years. An account by an early Baraboo area settler described a significant sturgeon spawn occurring in 1841 on the Baraboo River, prior to any dam construction. This indicates that the Baraboo River did, at one point, contribute to the Wisconsin River fishery. There have been unconfirmed reports of sturgeon using the river in spring near the Ringling Brothers grounds in the city of Baraboo, and an observation of an adult sturgeon by a WDNR researcher on May 1, 2002 near the same area. Although it appears as though lake sturgeon have already been recolonizing the Baraboo River, it is unknown how many use it or if there is any spawning taking place. Because sturgeon are long lived, late maturing, and thought to imprint, a long term stocking plan could help the Baraboo River spawning run of lake sturgeon to recover. Since lake sturgeon have already been seen using the Baraboo Rapids, continuing to stock the river with PIT tagged fall fingerlings should be done to determine the impact of stocked fish versus recolonizing fish. The current stocking guidelines for rehabilitation are 80 fingerlings/mile or 40 yearlings/mile annually for a duration of 25 years.

Table 1. Lake Sturgeon stocked in the Baraboo River, Wisconsin River, and Lake Wisconsin from 1998 through 2012.

Waterbody Name	Year	Strain (Stock)	Age Class	Number Fish Stocked	Avg Fish Length (IN)	Source Type	Mark
BARABOO RIVER	2010	WIS. RIVER	SMALL FINGERLING	6100	1.4	DNR HATCHERY	
BARABOO RIVER	2012	WIS. RIVER	LARGE FINGERLING	490	9.54	DNR HATCHERY	PIT Tag
LAKE WISCONSIN	2000	LAKE WIS.	FRY	87771	0.5	DNR HATCHERY	
LAKE WISCONSIN	2001	LAKE WIS.	FRY	28782	0.4	DNR HATCHERY	
LAKE WISCONSIN	2002	WIS. RIVER	LARGE FINGERLING	4950	5.5	DNR HATCHERY	
WISCONSIN RIVER	1998	WIS. RIVER	FRY	30000		DNR HATCHERY	
WISCONSIN RIVER	1999	WIS. RIVER	LARGE FINGERLING	3793	5	DNR HATCHERY	
WISCONSIN RIVER	2000	WIS. RIVER	FRY	114831			
WISCONSIN RIVER	2001	LAKE WIS.	LARGE FINGERLING	6548	2.8	DNR HATCHERY	
WISCONSIN RIVER	2003	WIS. RIVER	FRY	137906	0.6	DNR HATCHERY	
WISCONSIN RIVER	2003	WIS. RIVER	YEARLING	9	12	DNR HATCHERY	
WISCONSIN RIVER	2003	WIS. RIVER	SMALL FINGERLING	700	3.2	DNR HATCHERY	
WISCONSIN RIVER	2004	WIS. RIVER	SMALL FINGERLING	4973	4	DNR HATCHERY	
WISCONSIN RIVER	2012	WIS. RIVER	LARGE FINGERLING	2642	7.52	DNR HATCHERY	

Table 2. The number of lake sturgeon PIT tagged each year, the number recaptured in following years, and the number of days sampled below the Kilbourn Dam from 2003 through 2012.

Tagged		Days Sampled	# Recaptured								
Year	Number		2004	2005	2006	2007	2008	2009	2010	2011	2012
2003	6		0	1	0	0	0	1	0	1	0
2004	12			0	2	0	0	1	0	2	1
2005	152	6			13	13	10	13	9	15	5
2006	244	5				12	17	15	16	23	18
2007	165	7					9	18	10	13	10
2008	90	6						11	3	7	8
2009	100	6							3	5	12
2010	62	3								3	2
2011	96	4									5
2012	87	5									
Total			0	1	15	25	36	59	41	69	61

Table 3. Sex and stage of development of harvested lake sturgeon on Lake Wisconsin and the Wisconsin River from 1997 through 2005 (development classification by Bruch et al 2001).

Inch class	Female						Male		
	F1	F2	F3	F4	F5	F6	M1	M2	M3
50	5						3		1
51	3	3		1			2	5	2
52	1	1		6		1	4	6	1
53	1	2		2		1	1	6	
54	6			1			1	1	
55	4	2		7		4	1	7	
56		1		7				4	
57	3			5				1	
58	1			4		1		2	
59	1			3				1	
60		1		1		1		1	
61		2		1		1			
62	1			1			1		
63				2					1
64		1		1					
65	1			1		1			
66						2	1		
67									
68				2		1		1	
Total	27	13	0	45	0	13	14	35	5
<p>Female (3-6 yr cycle)</p> <p>F1 Early developing or re-developing F2 Early yellow egg stage F3 Late yellow egg stage F4 Black egg stage (ripe) will spawn next spring F5 Spawning female (spring) F6 Spent recovering female</p> <p>Male (1-3 yr cycle)</p> <p>M1 Developing male M2 Fully developed male (will spawn next spring) M3 Spent/recovering male</p>									

Table 4. The number of lake sturgeon PIT tagged each year, the number recaptured in following years, and the number of days sampled below the Prairie du Sac Dam from 2005 through 2012.

Tagged		Days Sampled	# Recaptured						
Year	Number		2006	2007	2008	2009	2010	2011	2012
2005	142	16	29	25	19	28	15	12	19
2006	88	15		11	12	9	11	9	5
2007	44	10			1	2	3	5	6
2008	75	8				4	5	9	12
2009	50	9					1	5	6
2010	41	9						1	6
2011	49	9							5
2012	85	10							
Total			29	36	31	43	35	41	59

Table 5. Profile of 16 radio transmitter tagged lake sturgeon re-released below the Prairie du Sac Dam on the Wisconsin River in October of 2007.

Transmitter (50MHz)	Sex	At time of release			Est.	FLOY Tag	PIT tag	Recaptured since radio tagged?
		Development stage	Length (in)	Weight (lb)	Age (2008)			
21	Male	M2	55.0	44.5		897	985121002609721	No
61	Female	F2	64.0	59.0		931	985121002025698	No
81	Female	F4	58.0	39.0	27	524	470255513C	Yes
101	Male	M2	53.5	27.0		520	985121002039598	No
121	Female	F4	56.0	40.5		899	985121001395718	Yes
141	Female	F4	58.0	45.5		898	985121002605706	No
161	Male	M2	56.0	31.0		900	985121001841048	Yes
181	Female	F4	58.0	44.0		929	985121002047971	No
201	Male	M2	55.5	32.5		515	985121002027095	No
221	Male	M2	56.0	34.0		930	985121001925200	Yes
241	Female	F4	63.0	48.0	31	927	454B333D39	Yes
261	Male	M2	55.0	33.5	27	926	4549757E2A	No
281	Male	M1	52.0	28.0		932	985121002604184	Yes
301	Female	F4	52.0	31.5	25	21	46143B3F09	No
321	Female	F4	56.0	37.0		887	985121001920071	Yes
341	Female	F4	59.0	44.0	26	928	45493F7F58	Yes

Table 6. Detections of 16 radio transmitter tagged lake sturgeon in the Lower Wisconsin River (LWR) and Mississippi River previously re-released below the Prairie du Sac Dam on the Wisconsin River in October of 2007.

Transmitter (50MHz)	# of times detected in the LWR	# of times detected in the Miss. River	Last known location	Date of LKL
21	23	0	Behind Ace hardware Sauk City	11/23/2011
61	11	0	Middle of Spillway 200yds So.	09/14/2009
81	14	2	East Shoreline at PDS Dam	10/12/2010
101	14	0	West Side at PDS Dam	04/30/2008
121	15	0	PDS Dam	12/13/2012
141	3	0	Wing Dam	11/07/2007
161	21	3	Behind Ace hardware Sauk City	12/13/2012
181	14	0	VFW Landing	04/29/2008
201	14	3	Near Hwy 18 on Miss. River	07/30/2008
221	17	1	Behind Ace hardware Sauk City	11/23/2011
241	18	0	Behind Ace hardware Sauk City	04/04/2011
261	28	1	PDS Dam	12/13/2012
281	13	0	At PDS Dam	10/03/2012
301	22	0	Downstream of Ferry Bluff	09/10/2009
321	21	1	PDS Dam	10/12/2010
341	17	1	At PDS Dam	10/24/2012

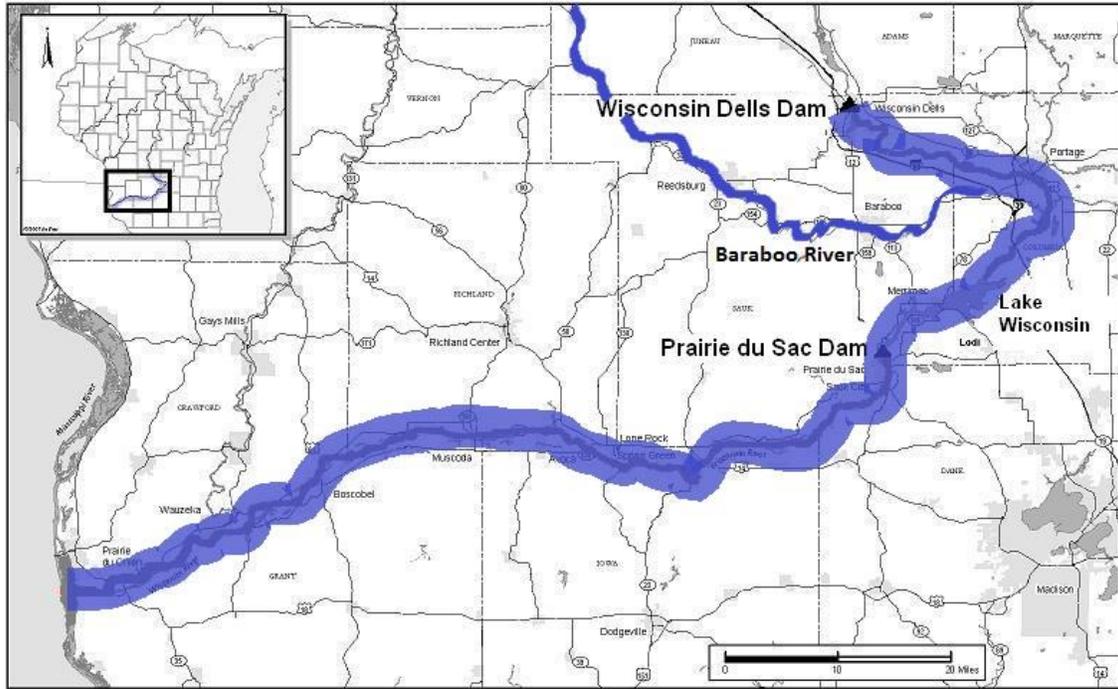


Figure 1. Lake sturgeon study area map along the Wisconsin River including Lake Wisconsin and Baraboo River.

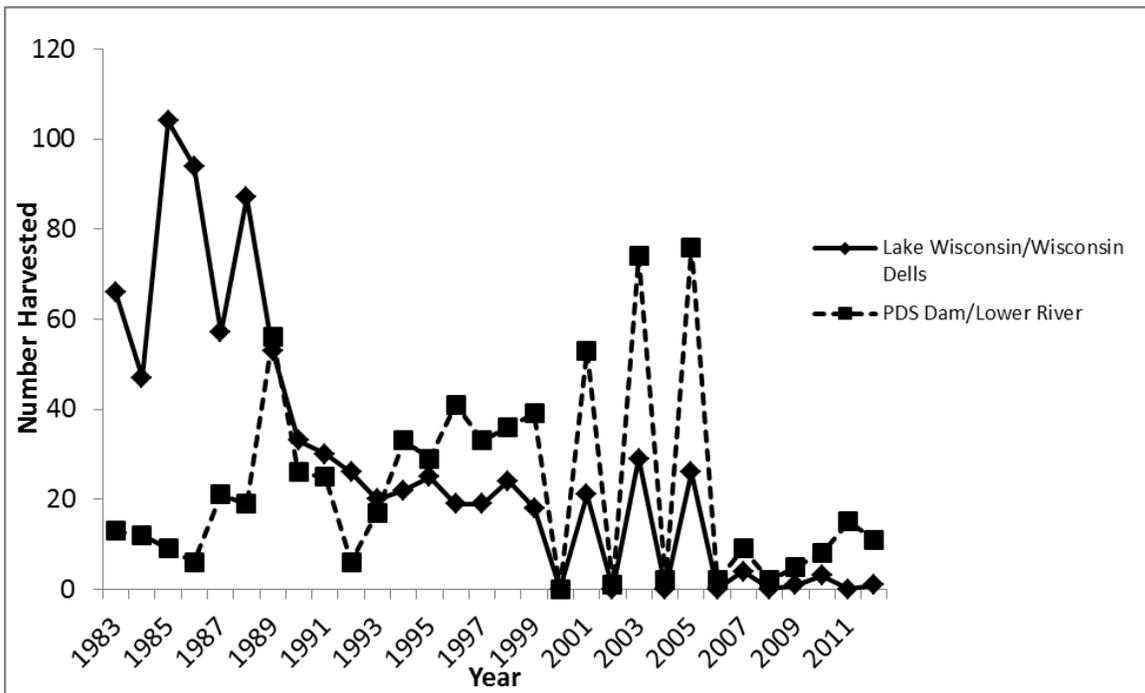


Figure 2. Annual lake sturgeon harvest at the Prairie du Sac Dam/Lower Wisconsin River and Lake Wisconsin to the Wisconsin Dells Dam from 1983 through 2012. Diamond markers represent Lake Wisconsin to the Wisconsin Dells Dam and the box markers represent the Prairie du Sac Dam and Lower Wisconsin River.

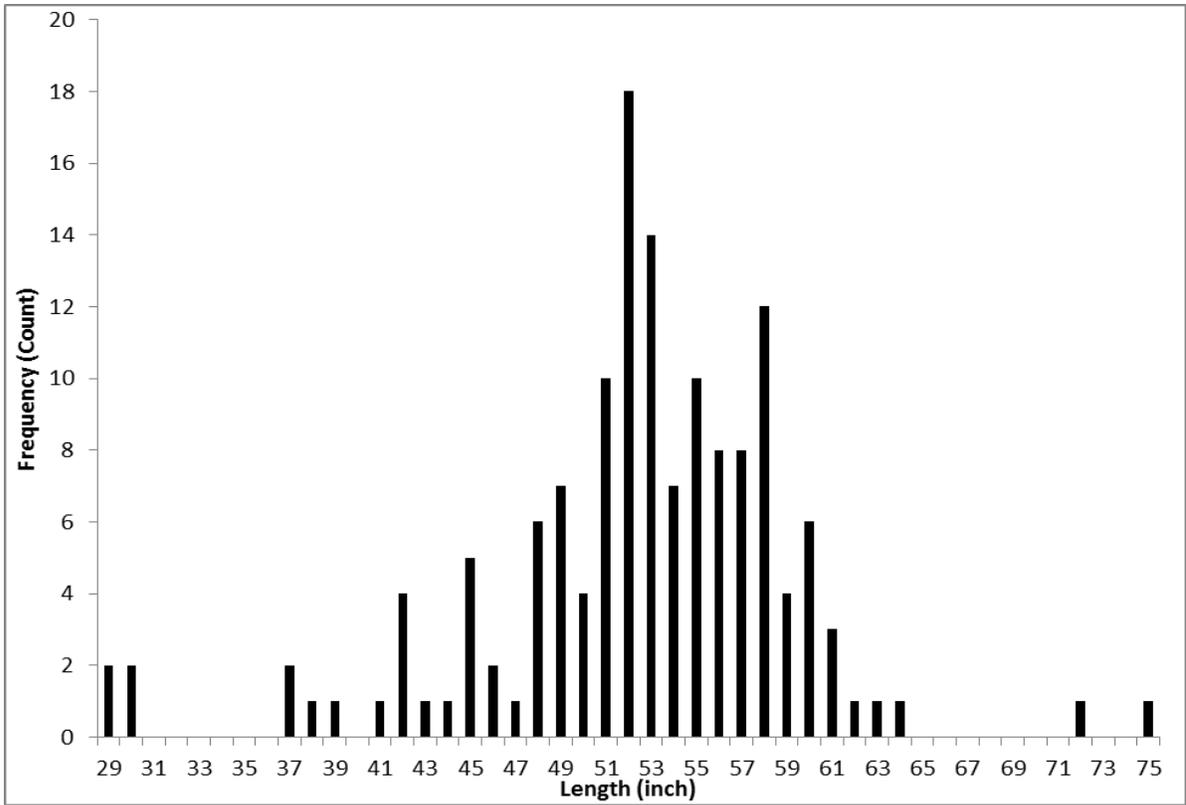


Figure 3. Size distribution of lake sturgeon captured by 10 and 12 inch stretch mesh gill nets and electrofishing from April 16 to April 20, 2012 below the Kilbourn Dam, Wisconsin River, WI.

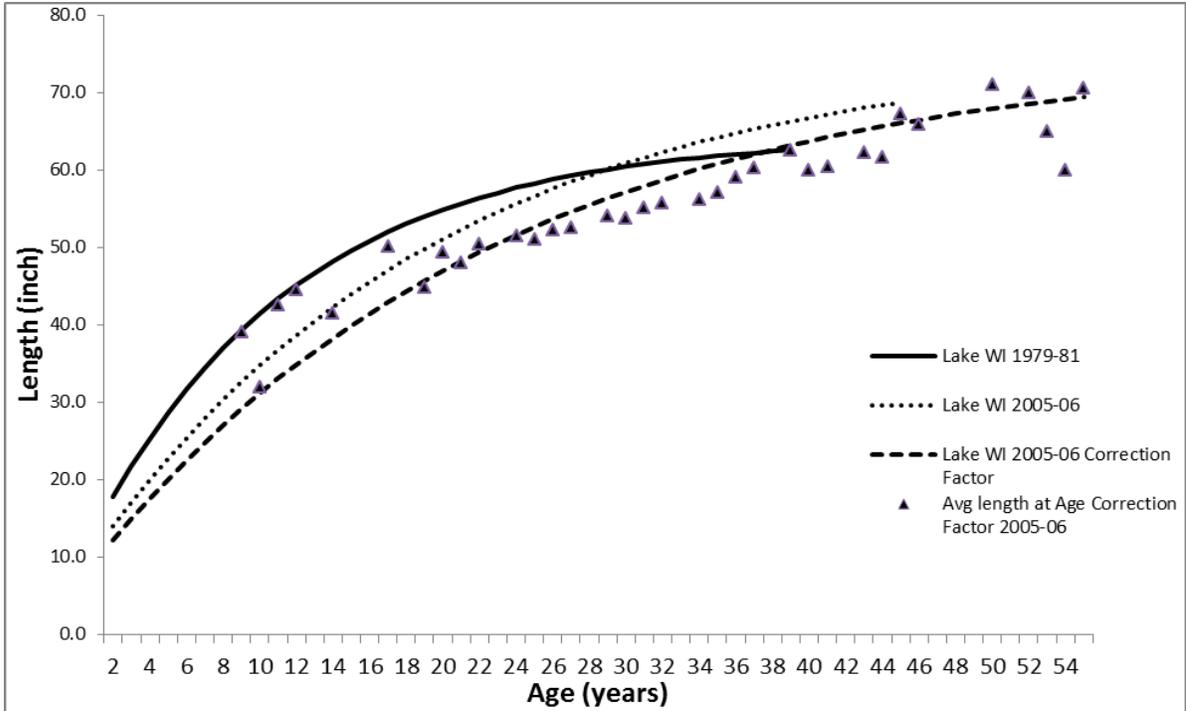


Figure 4. Lake sturgeon length at age and von Bertalanffy growth curves for Lake Wisconsin aged fish from 1979 through 1981 and from 2005 and 2006. A correction factor was applied to the 2005 and 2006 aged fish and growth curve after age 14 (Bruch et al. 2009). The solid line represents a von Bertalanffy curve for Lake Wisconsin from 1979 through 1981. The dotted line represents a von Bertalanffy curve for Lake Wisconsin from 2005 and 2006. The dashed line represents a von Bertalanffy curve for Lake Wisconsin 2005 and 2006 with a correction factor applied after age 14. The triangle markers represent the mean length at age for Lake Wisconsin from 2005 and 2006 with a correction factor applied after age 14 (Bruch et al 2009).

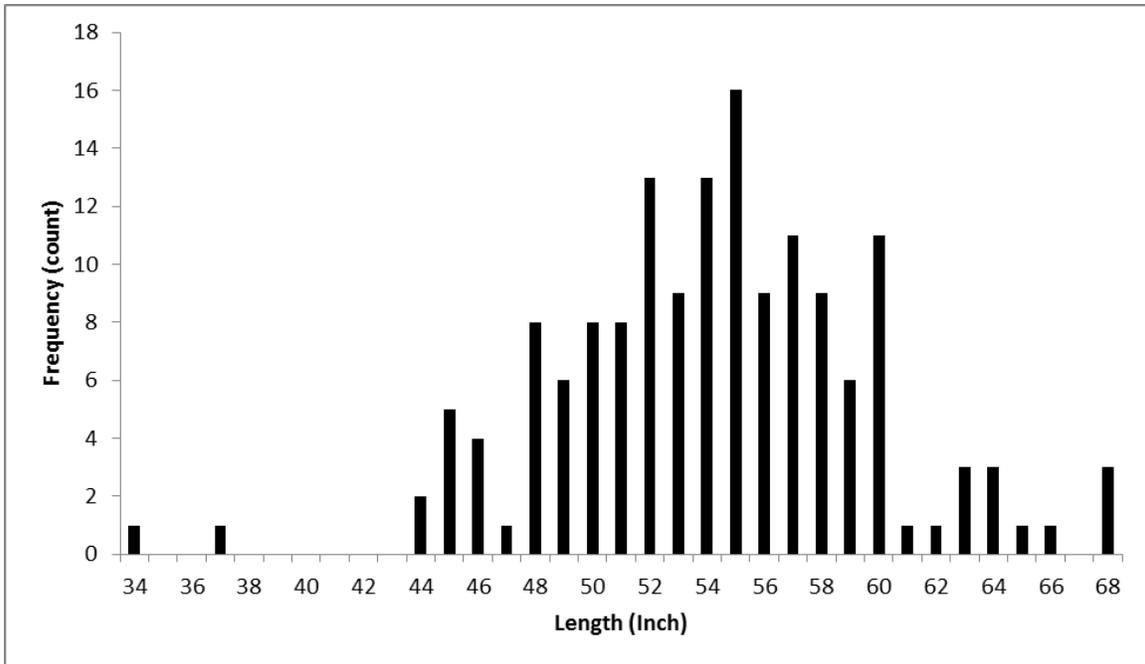


Figure 5. Size distribution of lake sturgeon captured by 10 and 12 inch stretch mesh gill nets from October 3 through November 13, 2012 below the Prairie du Sac Dam, Wisconsin River, WI.

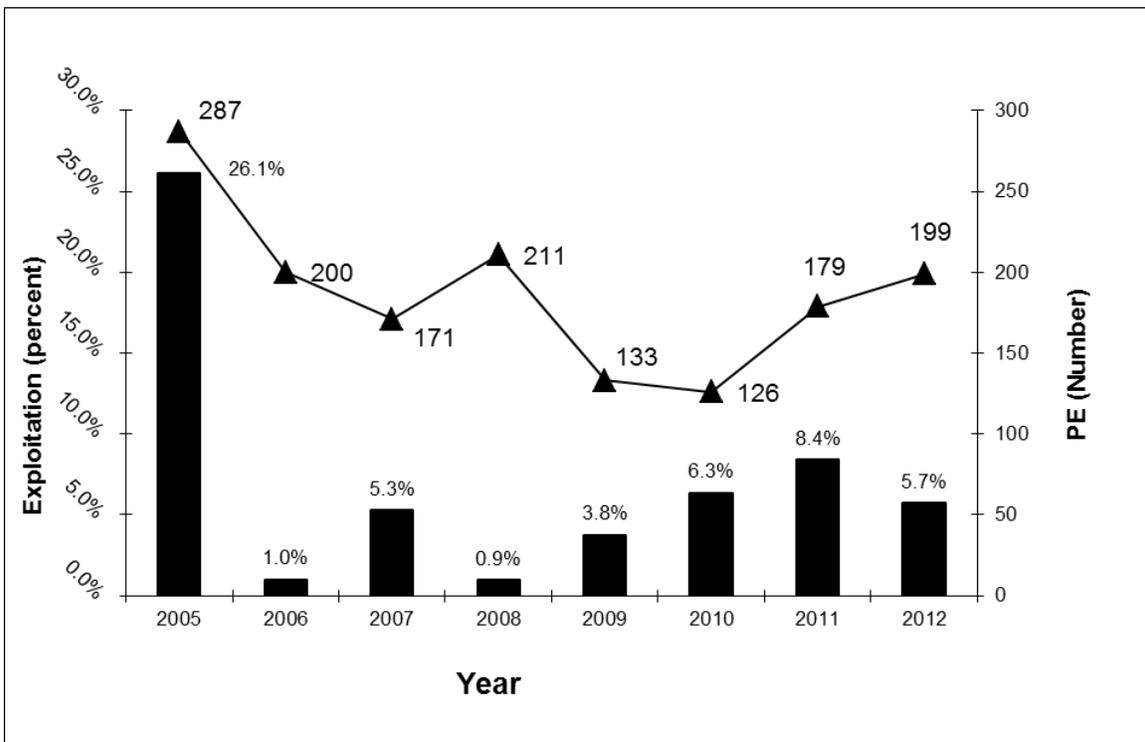


Figure 6. Adult lake sturgeon Schnabel (1938) population estimates and exploitation from the Wisconsin River below the Prairie du Sac Dam and lower river from 2005 through 2012.

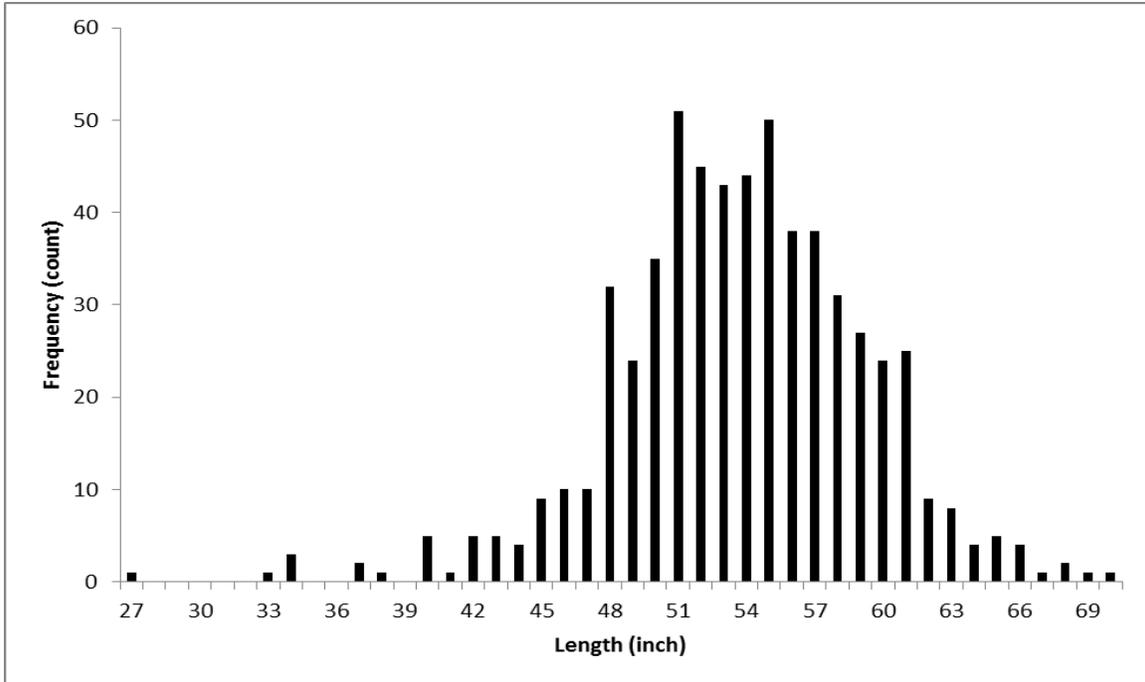


Figure 7. Size distribution of lake sturgeon captured by 10 and 12 inch stretch mesh gill nets below the Prairie du Sac Dam from 2005 through 2012 (this does not include recaptured individuals).

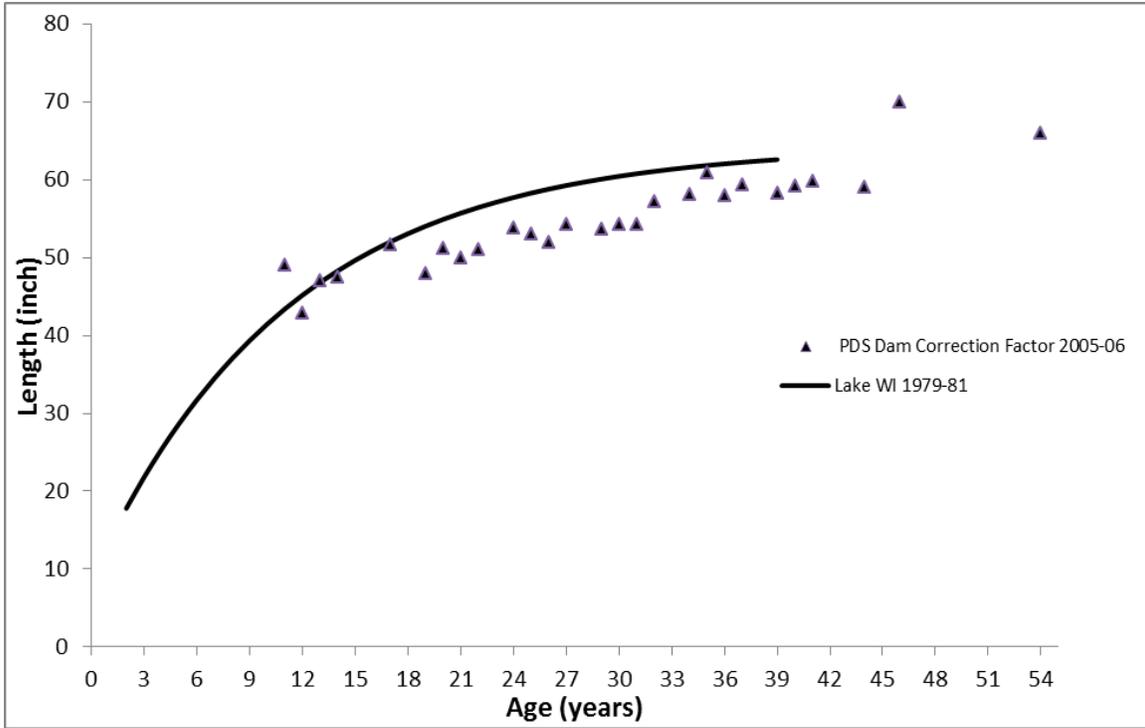


Figure 8. Lake sturgeon length at age and von Bertalanffy growth curves for Lake Wisconsin aged fish from 1979 through 1981 and from the average length at age for the PDS Dam in 2005 and 2006. A correction factor was applied to the 2005 and 2006 aged fish after age 14 (Bruch et al. 2009). The solid line represents a von Bertalanffy curve for Lake Wisconsin from 1979 through 1981. The triangle markers represent the mean length at age at the PDS Dam from 2005 and 2006 with a correction factor applied after age 14 (Bruch et al. 2009).

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