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Lake Sturgeon Geographic Range, Distribution, and Migration Patterns in the Saskatchewan River

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Abstract
We examined geographic range, distribution, and migration patterns of Lake Sturgeon Acipenser fulvescens within the largest contiguous section of the Saskatchewan River system in Saskatchewan, Canada. Lake Sturgeon use portions of the North, South, and main-stem Saskatchewan River during the summer months. The Forks area was observed to be an overwintering area. Lake Sturgeon were observed to migrate each year, and all Lake Sturgeon migrated at least once in the 3-year study. Lake Sturgeon were observed to undertake significant migrations (>100 km/year) using all three rivers. Migration initiation date was consistent over the 3-year period, whereas migration return date was more variable and may be linked to river flow rate. No significant differences in distance covered between years were identified, but Lake Sturgeon tended to migrate longer distances in years when flow rates were higher. Finally, the spatial extent of Lake Sturgeon in the Saskatchewan River System appears to be larger than that of many previously studied river and lake populations. This study provides important insights into Lake Sturgeon distribution and migration patterns within large prairie rivers, increasing our basic knowledge of this unique fish species in understudied river systems, and provides important information for conservation within their historic range.

Lake Sturgeon Acipenser fulvescens are among the largest freshwater fish species in North America (Scott and Crossman 1998). Although once widely distributed, anthropogenic stressors such as habitat fragmentation and overharvest are believed to be primarily responsible for population declines (Williams et al. 1989; Rochard et al. 1990; Borman 1997; Auer 2004). Worldwide, all sturgeon species are listed as endangered in part of their ranges, and most in all of their ranges (Birstein et al. 1997; Billard and Lecointre 2001). Saskatchewan River Lake Sturgeon populations were listed as endangered by the Committee on the Status of Endangered Wildlife in Canada in 2006 (COSEWIC 2006). This population has been fragmented due to hydroelectric development along the Saskatchewan River system.

A series of studies by Wallace (1991, 1999) and Wallace and Leroux (1999) assessed Lake Sturgeon populations in the Saskatchewan River downstream from E.B. Campbell Dam in Saskatchewan to Cedar Lake in Manitoba. These studies resulted in several recommendations, including a harvest moratorium, initiation of egg collection and stocking programs,
and efforts to improve habitat by way of flow management. Beyond these studies, little is known about the geographic range, distribution, and migration patterns of Lake Sturgeon populations within Saskatchewan’s borders, particularly the population upstream of E.B. Campbell Dam.

Migration may be an especially important component of sturgeon ecology, allowing them to optimize feeding, avoid unfavorable conditions, and maximize reproductive success (Auer 1996a). Across their range, Lake Sturgeon demonstrate significant variation in the length of their migrations. For example, Lake Sturgeon in the Mattagami River system in northern Ontario have been found to migrate extensively to spawning sites in the spring and to foraging sites in the summer (McKinley et al. 1998). Similarly, populations inhabiting the southern portion of Lake of the Woods and the Rainy River in Ontario moved significantly more during the spring and summer months and are believed to be cued by water temperature (Rusak and Mosindy 1997). Young Lake Sturgeon, such as those from the lower Peshtigo River in Wisconsin, are known to exhibit a seasonal migration pattern as well, where they were found to move more during the warmer months (Benson et al. 2005). Other populations, however, such as those from the Kettle River in Minnesota, remained within a 20-mi (~32-km) reach year-round (Borkholder et al. 2002), and those in the Ottawa River did not move extensive distances (i.e., maximum of 10 km) and exhibited high site fidelity (Haxton 2003). In the upper Mississippi River system, Lake Sturgeon were found to exhibit high site fidelity to certain river areas which are thought to be important foraging sites (Knights et al. 2002). These varied results suggest Lake Sturgeon populations may differ in their life history traits, or habitat availability, making population-specific studies ever more important. Ultimately, inferences on sturgeon movement and migration are limited by the extent to which the population is free to migrate between spawning, foraging, and overwintering locations. Thus, understanding how fish move in fragmented versus unfragmented river systems is important when developing conservation plans.

In the present study we examine the range, distribution, and migration patterns of Lake Sturgeon within the largest remaining contiguous section (span of river unobstructed by dams) of the Saskatchewan River (designatable unit D2; COSEWIC 2006) encompassing management unit MU1 (M. S. Pollock, Water Security Agency, personal communication). The population in this river section is restricted by three barriers to movement: Gardiner Dam on the South Saskatchewan River, Bighorn Dam on the North Saskatchewan River (in Alberta), and Francois Finlay Hydroelectric Dam on the main stem of the Saskatchewan River. The potential for future hydroelectric development exists, and an understanding of which river reaches are most important for Lake Sturgeon movement ecology is therefore an important consideration to make in order to minimize threats to the Saskatchewan River Lake Sturgeon population. Furthermore, more research is needed to understand Lake Sturgeon ecology in the Saskatchewan River in general, specifically with regards to geographic distribution, migration patterns, and extent of movement.

STUDY OBJECTIVES

The objectives of this study were to (1) locate the geographic regions used by Lake Sturgeon, including summer and overwintering areas used by Lake Sturgeon in the Saskatchewan River, (2) identify the timing and duration of Lake Sturgeon spring migration and their return to the wintering grounds; and (3) evaluate the extent of movement by Lake Sturgeon.

STUDY SITE

The North and South Saskatchewan rivers originate in the Canadian Rockies in northern Alberta and at the confluence of the Bow and Oldman rivers in southern Alberta, respectively. The Saskatchewan River main stem is formed by the confluence (known as “The Forks”) of the North Saskatchewan River and the South Saskatchewan River in central Saskatchewan, flowing into Hudson Bay via Lake Winnipeg and the Nelson River.

The study epicenter was located at the confluence of the North and South Saskatchewan rivers. Initial angling and trotline surveys revealed that this area contained large numbers of individuals and may represent an important area for Lake Sturgeon. Telemetry surveys were therefore concentrated in an area around the confluence. Specifically, radiotelemetry surveys carried out in the region defined by Hague Ferry on the South Saskatchewan River, Cecil Ferry on the North Saskatchewan River, and Wapiti Valley on the main stem of the Saskatchewan River (approximately 300 km in length; Figure 1).

METHODS

Lake Sturgeon Capture and Tagging

Lake Sturgeon were captured by either angling or trotlines left to soak for 24 h with number 7 Snell hooks baited with a 2 × 6-cm fish filet (primarily Shorthead Redhorse *Moxostoma macrolepidotum*). Once captured, Lake Sturgeon were placed in a holding tank until radio tag implant surgery. Lake Sturgeon selected for surgery were placed in a bath containing tricaine methasulfonate (MS-222) at a concentration of 50 mg/L until sedated. Once sedated, morphometric data (including length, mass, and girth) were collected. Abdominal incisions were made approximately 30–40 cm posterior of the pectoral fins. Incisions were approximately 5–8 cm in length followed by a small hole placed approximately 1 cm posterior of the main incision site. Radio tags were implanted within this incision site. Incisions were then closed with nonwicking,
inert suture materials (polydioxanone). Vetbond was applied to the incision to secure suture knots and prevent water from entering the body cavity. Lake Sturgeon were then placed back into the holding tank and were released into the river upon showing signs of recovery, including the ability to right themselves when overturned and response to tactile stimulation.

Sixty Lake Sturgeon were tagged from the fall 2009 field season to summer 2012. All tags were purchased from Advanced Telemetry Systems (ATS) and were divided into three sizes. Lake Sturgeon were implanted with the largest radio tags that did not exceed 2% of their body weight (Jepsen et al. 2002). Lake Sturgeon weighing 10 kg or more were implanted with a large (162-g) tag containing a D cell battery (part number F1860B) lasting 3 to 5 years. Lake Sturgeon weighing between 5 and 10 kg were implanted with a medium (87-g) tag containing a C cell battery (part number F1855B) lasting 1 to 2 years. Lake Sturgeon weighing between 2 and 5 kg were implanted with a small (27-g) tag containing an AA cell battery (part number F1850B).

FIGURE 1. Lake Sturgeon locations between May and October 2010, 2011, and 2012. Telemetry surveys routes included (1) from Hague Ferry to The Forks, (2) from Cecil Ferry to Wapiti Valley, and (3) from The Forks to Wapiti Valley. [Figure available in color online.]
Transriver Radiotelemetry Surveys

Three river reaches were surveyed by boat to investigate the geographic range and distribution of Lake Sturgeon. These routes included (1) the South Saskatchewan River between Hague Ferry and The Forks, (2) the North Saskatchewan River between Cecil Ferry and Wapiti Valley, and (3) the Saskatchewan River between The Forks and Wapiti Valley (Figure 1). Although every effort was made to consistently survey the above reaches on a weekly basis, logistical constraints resulted in some modification of the above routes (less than 10% of the time). We located radio-tagged Lake Sturgeon from May through October in 2010, 2011, and 2012. Radiotelemetric surveys were carried out to track and locate individual Lake Sturgeon using a receiver–data logger provided by ATS (Model R4500C). Surveys were carried out by heading downstream of each launch site. When a Lake Sturgeon was detected, its location was determined by closing in on the area of the river that gave the strongest signal and its Universal Transverse Mercator (UTM) coordinates were recorded with a GPS unit (Garmin; Model 72H).

Radiotelemetry Towers

Three remote radiotelemetry towers were set up on the river to allow for continuous monitoring of Lake Sturgeon within the tower transmission range in order to aid in the investigation of the timing and duration of seasonal migration. All towers contained a receiver–data logger provided by ATS (Model R4500C), a 12-V deep-cycle marine battery, and two antennas. Towers were placed at (1) The Forks, (2) Horseshoe bend, and (3) Fort à La Corne (Figure 1). Locations were selected based on three criteria: known Lake Sturgeon congregations, areas of high elevation that allowed for reception over a large area, and readily available road or trail access.

Geographic Analysis

Spatial distribution data were analyzed using ArcGIS (ESRI 2011) by overlaying UTM locations for tagged Lake Sturgeon on geospatially linked maps provided by GeoBase (Canadian Council on Geomatics). Lake Sturgeon overwintering locations and river use data were qualitatively analyzed based on the location within the river where they were found.

Temperature and Flow Rate Data

Temperature and flow rate data were measured at the North Saskatchewan River at Prince Albert (data station identification 05GG001). Daily average air temperature and river flow rate data were obtained from Environment Canada (http://climate.weather.gc.ca/ and http://www.wateroffice.ec.gc.ca/, respectively). This station was selected because it measures flow rate on the North Saskatchewan River, which most closely resembles natural (unregulated) river flow rates in this system.

Statistical Analysis

Migration timing, duration, and distance covered.—Lake Sturgeon were defined as having left the overwintering grounds the first time they were located outside the overwintering area (the geographical region where Lake Sturgeon resided during the winter months; \( n = 29 \) in 2010; \( n = 15 \) in 2011; \( n = 12 \) in 2012). In order to be classified as initiating a migration, Lake Sturgeon had to be located within the overwintering area (verified by telemetry towers) and migrate outside this region during the summer (verified by boat surveys). Lake Sturgeon considered to have returned when detected within the overwintering area once again (\( n = 20 \) in 2010; \( n = 14 \) in 2011; \( n = 7 \) in 2012). In order to be classified as returning from migration, Lake Sturgeon had to be located outside of the overwintering area at some point during the summer (i.e., migrate) and eventually return to and remain at the overwintering site. Migration duration was defined as the interval between migrating initiation and return to the overwintering area (\( n = 20 \) in 2010; \( n = 9 \) in 2011; \( n = 4 \) in 2012), where only Lake Sturgeon that were classified as both initiating and returning from migration in a single season were included. Migration distance was defined as the cumulative distance covered during the migration period (\( n = 22 \) in 2010; \( n = 23 \) in 2011; \( n = 8 \) in 2012) and included all Lake Sturgeon tracked for a full season, even those Lake Sturgeon that we were not able to track back to the overwintering site. Sample sizes decreased over time due to tag expiration, tag failure, and mortality, and may have decreased due to emigration as well. Mean migration initiation date, return date, migration duration, and distance covered as well as SEs were calculated for the above-mentioned Lake Sturgeon. In all cases, the residuals were not normally distributed and transformations did not normalize these distributions, so differences in migration timing (initiation and return), migration duration, and distance covered were compared using Kruskal–Wallis H-tests. Post hoc tests were run using Tukey–Kramer honestly significant difference (HSD) post hoc tests on ranks. All analyses were performed in JMP (version 9.0.1; JMP 1989–2007).

Spatial extent.—We used ArcMap 10 to determine the amount of river used by Lake Sturgeon over a 3-year period using relocations from May 2010 though October 2012. Home range of an individual fish is most often defined as the distance between the most upstream and the most downstream relocations or “extent of movement” (Young 1996; Barth et al. 2011; Alexiades et al. 2012; Broadhurst et al. 2012). We calculated extent of movement to allow for a comparison to the existing sturgeon spatial extent literature. Analysis was conducted for all Lake Sturgeon that were tracked for at least one full season. This resulted in data from 32 individuals being used in the analysis.
RESULTS

Geographic Range and Distribution

Lake Sturgeon made use of all three rivers (North Saskatchewan, South Saskatchewan, and Saskatchewan River main stem), with The Forks area providing a common wintering ground (Figure 1). Specifically, the region below The Forks (up to 12 km downstream) was observed to be a wintering area for a population that uses a much larger part of the Saskatchewan River watershed during the summer months. Lake Sturgeon were found over the entire extent of the survey routes but were most often located near The Forks region and along the main stem of the Saskatchewan River (Figure 1).

Migration Timing, Duration, Distance Covered, and Spatial Extent

A summary of migration initiation and return dates, migration duration, and distance covered during 2010, 2011, and 2012 is given in Table 1. A comparison of the timing of the annual migration taken by Lake Sturgeon revealed no significant difference in migration start date (Kruskal–Wallis: $H_2 = 0.90, N = 56, P = 0.636$). Return to the overwintering area, however, was found to be significantly different between years (Kruskal–Wallis: $H_2 = 11.83, N = 41, P = 0.003$). A Tukey–Kramer HSD post hoc test on ranks found significant differences in migration return date between 2010 and 2011 ($P = 0.013$) and between 2010 and 2012 ($P = 0.004$), but not between 2011 and 2012 ($P = 0.568$), although a clear trend is noted. Days spent away from overwintering grounds was also found to differ between years (Kruskal–Wallis: $H_2 = 10.43, N = 33, P = 0.005$). A Tukey–Kramer HSD post hoc test on ranks found significant differences between 2010 and 2011 ($P = 0.007$) and between 2010 and 2012 ($P = 0.036$), but not between 2011 and 2012 ($P = 0.981$). No significant differences in distance covered between years were identified (Kruskal–Wallis: $H_2 = 0.243, N = 53, P = 0.778$). Over the 3-year period, the average extent of movement for all individuals was 92 km ($\pm$64 km; range = 1–273 km). Extent of movement over the 3-year period for individuals with $>20$ observations averaged 103 km ($\pm$64 km; range = 9–273 km).

DISCUSSION

Lake Sturgeon used The Forks area in the Saskatchewan River extensively during the summer and almost exclusively during winter. Several other studies have shown that confluence areas may create depositional environments that provide sturgeon with suitable foraging habitat (Chiasson et al. 1997; Knights et al. 2002; Thomas and Hass 2002). Chiasson et al. (1997) showed that river substrates dominated by small particles contained the largest number of invertebrates, which are an important prey for Lake Sturgeon (Peterson et al. 2007). Knights et al. (2002) and Thomas and Hass (2002) proposed that depositional transition zones, characterized by decreases in velocity due to changes in river morphometry, result in favorable foraging habitat for Lake Sturgeon. This may be true of The Forks region as well, as we often located Lake Sturgeon within deep holes up to 12 km downstream of the confluence of the North and South Saskatchewan rivers. This finding suggests The Forks area may be particularly important for Saskatchewan River Lake Sturgeon populations.

Migration initiation date did not vary between years, but migration return date was different between years. In several other studies, sturgeon migration has been linked to both temperature and river flow rate (Auer 1996b; Rusak and Mosindy 1997; Paragamian and Kruse 2001). Local temperature was relatively similar between years during the study, where temperature increased from $\sim$5–10°C in early May to $\sim$18–22°C by mid-July and decreased to freezing conditions again by the end of October. Migration initiation date, which was similar across years, therefore appears to be linked to temperature. River flow rate, on the other hand, exhibited some marked differences between 2010, 2011, and 2012 that may account for some of the observed variability in migration return dates over this time period. Specifically, the timing and intensity of late-season (July–August) peak flow rates, and ensuing flow rate decreases, differed between years. Late-season maximum flow rate was 554 m$^3$/s on July 23, 2010; 674 m$^3$/s on July 22, 2011; and 910 m$^3$/s on August 3, 2012. These differences in late-season peak flow rates resulted in differences in the timing at which flow rates returned to baseline levels. In 2010, mean migration return date was August 18 when flow rate had reached 228 m$^3$/s. However, higher flows the following year delayed the date at which flow rates decreased to comparable levels, and mean migration return date for Lake Sturgeon in 2011 was more than 3 weeks later, on September 5, when flow had decreased to 229 m$^3$/s. Late-season peak flow rate in 2012 was even later and more intense than the previous 2 years, which resulted in flow rates reaching baseline levels even later. In 2012, mean migration return date was September 16, when

<table>
<thead>
<tr>
<th>Year</th>
<th>Migration initiation (date)</th>
<th>Migration return (date)</th>
<th>Migration duration (d)</th>
<th>Distance covered (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>May 19 (2) [May 11–Jun 2]</td>
<td>Sep 5 (6) [Jul 7–Oct 12]</td>
<td>121 (6) [97–154]</td>
<td>210 (52) [7–1,126]</td>
</tr>
</tbody>
</table>
flow rate had decreased to 204 m$^3$/s. These results suggest that the end of Lake Sturgeon summer migration may be triggered by decreasing flow rates, as Saskatchewan River Lake Sturgeon show remarkable consistency in migration return behavior when evaluated on the basis of flow rates alone. It is also worth noting that Lake Sturgeon covered larger distances in 2011 relative to the other 2 years, and maximum distance covered in 2011 (1,126 km) was more than three times larger than the maximum distance covered during 2010 (307 km) or 2012 (363 km). Record flow rates were recorded in the Saskatchewan River in 2011, reaching a maximum of 2,100 m$^3$/s on June 26—a flow rate more than twice the maximum recorded during 2010 (1,010 m$^3$/s on June 18) and 2012 (790 m$^3$/s on June 19). Together, these results suggest migration timing and distance covered during migration by Lake Sturgeon in the Saskatchewan River system may be linked to river flow rates.

At approximately 100 km, Lake Sturgeon spatial extent in the Saskatchewan River system appears to be larger than many previously studied river and lake populations (Rusak and Mosindy 1997; McKinley et al. 1998; Gerig et al. 2011). Other river populations tend to exhibit smaller extents of movement, ranging from 7.5 to 13.3 km in St. Mary’s River, Michigan (Gerig et al. 2011), ~10 km in the Ottawa River (Haxton 2003), and between 56 and 97 km in the upper Mississippi River (Knights et al. 2002). It is difficult to directly compare extent of movement between systems as the number and frequency of impoundments restricting movement vary and the majority of studies focus on mainly lake populations (Rusak and Mosindy 1997; Auer 1999; Adams et al. 2006). Area use by Lake Sturgeon is likely to fluctuate significantly between years due to the complex multiyear sturgeon life cycle and associated variations in habitat use (Auer 1996a; Boase et al. 2011). For example, though most of the Lake Sturgeon in this study would be considered adults, Barth et al. (2011) found juvenile Lake Sturgeon had very high site fidelity and smaller ranges than adult Lake Sturgeon and often do not move far from core areas, suggesting that younger Lake Sturgeon or those that are not in a spawning year may exhibit much smaller ranges.

The Saskatchewan River Lake Sturgeon population is the most geographically widespread population in western Canada and the most genetically representative group of the ancestral Missourian population that recolonized the western half of their range at the end of the Pleistocene glaciations, representing a unique evolutionary relic (Kjartanson 2009). A resident Lake Sturgeon population (i.e., overwintering population) within other portions of the Saskatchewan River system has never been documented in Saskatchewan. This is of particular importance for two reasons: (1) if a resident Lake Sturgeon population does not exist in other areas of the Saskatchewan River, it places even greater importance on The Forks site with respect to protection and recovery; and (2) if Lake Sturgeon become listed under the Species At Risk Act, locating all population centers will be crucial to recovery and survival. This study strengthens our understanding of Saskatchewan River Lake Sturgeon spatial distribution and movement patterns, and thus may prove to be fundamental to their management and continued persistence within Saskatchewan and western Canada. Further work exploring Lake Sturgeon geographic distribution and movement patterns along the North Saskatchewan River, which spans more than 1,250 km from Bighorn Dam in the Canadian Rockies downstream to The Forks, would be very insightful.

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REFERENCES


