RECOVERY POTENTIAL ASSESSMENT OF LAKE STURGEON: RED-ASSINIBOINE RIVERS – LAKE WINNIPEG POPULATIONS (DESIGNATABLE UNIT 4)

Lake Sturgeon Acipenser fulvescens
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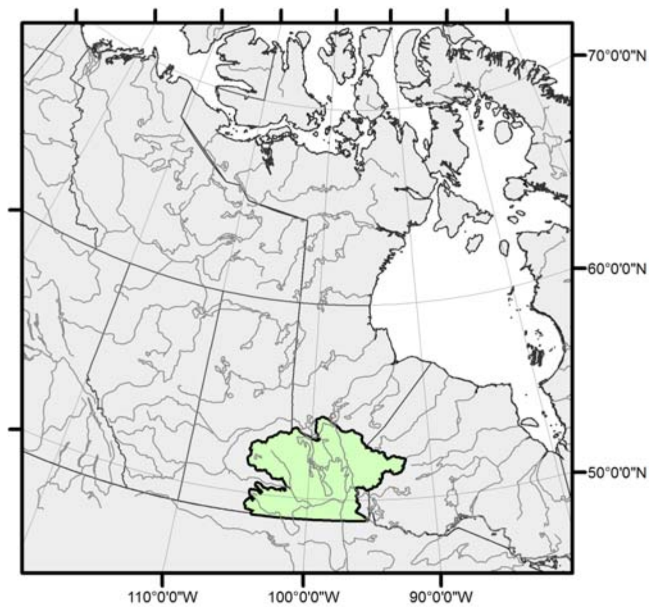

Figure 1. DU4 for Lake Sturgeon (coloured area).

Context:

*The Lake Sturgeon (*Acipenser fulvescens*) was common in nearshore waters across much of Canada in the nineteenth century, but intensive fishing, habitat loss and degraded water quality caused severe reductions in population size or extirpation across their range. Today they remain extant from the North Saskatchewan River in Alberta, to Hudson Bay in the north, and eastward to the St. Lawrence River estuary. In November 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed Lake Sturgeon in Canada. Designatable Unit (DU) 4, the Red-Assiniboine Rivers – Lake Winnipeg populations, includes Lake Sturgeon in the Red and Assiniboine rivers, Lake Winnipeg and all eastern tributary rivers to Lake Winnipeg excluding the Winnipeg River upstream of Pine Falls Generating Station. Lake Sturgeon in this region has been identified as a DU, although there was likely some sub-structuring between those that reside in rivers versus lakes, and across this large and diverse area (COSEWIC 2006). COSEWIC assessed and designated DU4 as Endangered as Lake Sturgeon in this DU declined severely over the past century and a significant portion of their habitat has been degraded or lost, especially in the southern portion of the DU. Historically, over-exploitation from commercial fisheries was probably the primary threat, whereas more recently habitat degradation and loss associated with agriculture, urban development, dam/impoundments and other barriers and industrial activities, and bycatch from the commercial fishery on Lake Winnipeg have become the most important threats.*

DU4 Lake Sturgeon is being considered for legal listing under the Species at Risk Act (SARA). In advance of making a listing decision, Fisheries and Oceans Canada (DFO) has been asked to undertake a Recovery Potential Assessment (RPA). This RPA summarizes the current understanding of the distribution, abundance and population trends of Lake Sturgeon in DU4, along with recovery targets and times. The current state of knowledge about habitat requirements, threats to both habitat and Lake Sturgeon, and measures to mitigate these impacts for DU4 are also included. This information may be used to inform both scientific and socio-economic elements of the listing decision, development of a recovery strategy and action plan, and to support decision-making with regards to the issuance of permits, agreements and related conditions, as per sections 73, 74, 75, 77 and 78 of SARA.

SUMMARY

- Eight Management Units (MUs) have been identified for DU4: MU1 is the Assiniboine River and tributaries upstream of the Portage la Prairie Diversion, MU2 is the Red River and tributaries upstream of Lockport, including the Assiniboine River to the Portage la Prairie Diversion, MU3 is the Red River downstream of Lockport, MUs 4-7 are the Bloodvein, Pigeon, Berens and Poplar rivers, respectively, and MU8 is Lake Winnipeg, including the Winnipeg River below Pine Falls Generating Station (GS).
- Available data and expert opinion indicate that very low numbers of Lake Sturgeon are now present throughout much of DU4.
- The indigenous populations of Lake Sturgeon in MUs 1-3 are extirpated, or functionally extirpated; the current status, trajectory and recovery potential of the stocked fish in MUs 1-3 is critical, increasing and unknown, respectively.
- The current status, trajectory and potential for recovery of MUs 4-7 are unknown except in the Ontario portion of Berens River (MU6) where recent information suggests they are cautious, increasing and high, respectively.
- In MU8, population status is critical, trajectory is unknown and recovery potential is low.
- Survival and recovery of Lake Sturgeon in DU4 depend on maintaining the functional attributes of habitat, including the ecologically-based flow regimes needed for spawning, egg incubation, juvenile rearing, summer feeding and overwintering, as well as migration routes between these habitats.
- The long-term recovery goal for DU4 is to protect and maintain healthy, viable populations of Lake Sturgeon in all MUs within the Red-Assiniboine Rivers – Lake Winnipeg system.
- The most important current threats to survival and recovery of Lake Sturgeon in DU4 are habitat degradation or loss resulting from agriculture, urban development, dams/impoundments and other barriers and industrial activities, and mortality, injury or reduced survival resulting from bycatch from the commercial fishery on Lake Winnipeg.
- Mitigation measures that would aid recovery include including protection of habitat, prevention of mortality and public education.
- Activities that damage or destroy functional components of habitat or key life components of the life cycle pose a very high risk to the survival or recovery of Lake Sturgeon in MUs 1-3 and 8, high to very high risk in MUs 4, 5, 7 and the Manitoba portion of MU6 and moderate risk in the Ontario portion of MU6.

BACKGROUND

Rationale for Assessment

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Lake Sturgeon in DU4 as Endangered in 2006 (COSEWIC 2006) and it is now being considered for listing under the *Species at Risk Act* (SARA). When COSEWIC designates an aquatic species as Threatened or Endangered and the Governor in Council decides to list it, the Minister of Fisheries and Oceans Canada (DFO) is required by the SARA to undertake a number of actions. Many of these actions require scientific information such as the current status of the DU, the threats to its survival and recovery, and the feasibility of its recovery. Formulation of this scientific advice has typically been developed through a Recovery Potential Assessment (RPA). This allows for the consideration of peer-reviewed scientific analyses in subsequent SARA processes, including recovery planning. If listed, decisions made on permitting of harm and in support of recovery planning need to be informed by the impact of human activities on the species, mitigation measures and alternatives to these activities and the potential for recovery. The information and scientific advice provided in this document may be used to inform both scientific and socio-economic elements of the listing decision, development of a recovery strategy and action plan, and to support decision-making with regards to the issuance of permits, agreements and related conditions, as per sections 73, 74, 75, 77 and 78 of SARA.

Species Biology and Ecology

The Lake Sturgeon is a large bottom-dwelling freshwater fish. They can attain over 3 m in length and 180 kg in weight, though they mostly range about 0.9-1.5 m in length and about 5-35 kg in weight (Cleator *et al.* 2010). Females are usually heavier than males.

This species is found in large rivers and lakes usually at depths of 5-10 m or more over mud, clay, sand or gravel substrates in water temperatures within the range of 3-24°C (COSEWIC 2006). The Lake Sturgeon has been described as largely sedentary, making localized (1-20 km) seasonal movements, with high site fidelity except to move over longer distances for spawning. Tagging studies indicate that younger, smaller Lake Sturgeon do not move as far as older, larger individuals (Cleator *et al.* 2010). In DU4, tagging studies involving fry, fingerlings and juvenile fish indicate that young Lake Sturgeon vary from being relatively sedentary to range as far as 500 km, depending on the age of the fish and environmental conditions (Cleator *et al.* 2010).

Sexual maturity (i.e., the age at which spawning is first observed) typically occurs between 14 and 33 years of age in females and between 14 and 22 years in males (Cleator *et al.* 2010). Spawning occurs in May and June, once the river is free of ice and water temperatures are in the range of 11.5-16°C (Cleator *et al.* 2010). Adults move upstream to suitable areas containing rapids or below barriers (e.g., falls or dams) where they typically spawn in swift current near shore with individual spawning females surrounded by several males (Cleator *et al.* 2010). Females may contain between about 50,000 and > 1,000,000 eggs, with heavier individuals producing more eggs. The interval between successive spawnings is estimated to be 3-7 years for females and 2-3 years for males (Cleator *et al.* 2010). Lake Sturgeon scatter their eggs and move quickly downstream after spawning, providing no parental care to the eggs or fry.

The eggs hatch in 5-10 days, depending on water temperature, and remained burrowed in the substrate until the yolk sac is absorbed. The young typically emerge at night within 13-19 days after hatching, and disperse downstream with the current (up to 40 km) before returning to a benthic habitat. By that time they resemble miniature adults and start feeding. Age-0 fish grow rapidly from 1.7-1.8 cm at emergence to approximately 11-20 cm total length (TL) by the end of the first summer (COSEWIC 2006).

The sex ratio at birth is assumed to be 1:1, based on data from populations with little or no anthropogenic mortality, but following maturation can favour either females or males as a result of targeted exploitation. Information about survival is limited. In Lake Winnebago during 1936-1952, survival of Lake Sturgeon aged 16-36 years was 0.946 and older than 36 years was 0.866 (Cleator *et al.* 2010). The estimate of survivorship of adult and sub-adult Lake Sturgeon below the St. Lawrence FDR Power Project at Massena, New York, was 0.86 (Cleator *et al.* 2010). Recruitment (i.e., the number of fish which grow into the catchable size range in a year) in populations which are self sustaining is reported to be in the range of 4.7-5.4% (Cleator *et al.* 2010).

There are historic records of Lake Sturgeon living up to 150 years of age. Lifespan today is typically more in the range of 25-50 years, with an average generation time of about 26-30 years (Cleator *et al.* 2010). Shorter average lifespan today may reflect current and/or past effects of harvest.

The Lake Sturgeon follows a benthic generalist feeding strategy. Age-0 fish mostly feed on amphipods and chironomid larvae while the diet of juveniles also includes oligocheates, aquatic insects (e.g., ephemeroptera nymphs, trichoptera larvae), mollusks and fish eggs (Cleator *et al.* 2010). A shift in diet has been reported to occur when Lake Sturgeon reach about 70-80 cm TL, from a diet comprised mainly of soft bodied insects to a wide range of benthic organisms including bivalves or crayfish (Cleator *et al.* 2010). Some pelagic feeding has also been reported. The Lake Sturgeon feeds actively throughout the year, though consumption may decline in the fall and winter.

ASSESSMENT

Historic and Current Distribution and Trends

DU4 includes the Red and Assiniboine rivers and their tributaries, Lake Winnipeg and all eastern tributary rivers to Lake Winnipeg except the Winnipeg River upstream of Pine Falls GS (Figure 1).

Eight Lake Sturgeon MUs have been identified in DU4 (Figure 2): (1) the Assiniboine River and tributaries upstream of the Portage la Prairie Diversion, (2) Red River and tributaries upstream of Lockport, including the Assiniboine River to the Portage la Prairie Diversion, (3) Red River downstream of Lockport (4) Bloodvein River, (5) Pigeon River, (6) Berens River, (7) Poplar River and (8) Lake Winnipeg, including the Winnipeg River below Pine Falls GS. Within each of these MUs there may be one or more spawning stocks.

Loss of populations has likely resulted in a significant decline in Lake Sturgeon distribution in the southern portion of DU4 and recent stocking has been undertaken. Lake Sturgeon currently occurs in all eight MUs and their area of occupancy in DU4 is estimated to be < 250,000 km^2 (COSEWIC 2006).

Cleator *et al.* (2010) contains detailed physical descriptions of each MU.

Assiniboine River and tributaries upstream of the Portage la Prairie Diversion (MU1)

The Lake Sturgeon was historically resident in the Assiniboine River and its tributaries upstream of the Portage la Prairie Diversion. The lower reaches of the Little Saskatchewan River was an important spawning tributary (Cleator *et al.* 2010). Spawning also may have occurred in the Souris River and Qu'Appelle Rivers, including Pasqua, Echo, Mission, Katepwa, Crooked and Round lakes. By the time the Portage la Prairie Diversion and Shellmouth Dam were constructed in 1970, the Lake Sturgeon had been extirpated in MU1 (Table 1). Stocking was undertaken in the Assiniboine River between 1996 and 2008 from the Saskatchewan River (DU2), Nelson River (DU3) and Winnipeg River (DU5) (Cleator *et al.* 2010). Since 2007, anglers have reported catching and releasing Lake Sturgeon between Brandon and the Little Souris River (Cleator *et al.* 2010). There have been recent arrivals of fish species, including Lake Sturgeon, from downstream areas in the Assiniboine River to the Qu'Appelle River (Cleator *et al.* 2010.). While there are a few known historical spawning sites on the Assiniboine River (e.g., Waggle Springs and Brandon Rapids), fish passage past barriers that have been constructed in this MU would be required to allow Lake Sturgeon access to additional suitable spawning habitat (e.g., Little Saskatchewan River, Souris River).

Red River and tributaries upstream of Lockport, including the Assiniboine River to the Portage la Prairie Diversion (MU2)

Historically, the Lake Sturgeon was present in the Red River basin (Cleator *et al.* 2010). They were reported to migrate up the Pembina River, prior to construction of the Walhalla Dam, and the Roseau River (COSEWIC 2006, Cleator *et al.* 2010). They likely spawned there and in the Rat, La Salle and Seine rivers. By the mid-1900s, the Lake Sturgeon was virtually extirpated from MU2. Stocking on the U.S. side of the Red River drainage has been underway since 1997 and there have been a few recent anecdotal reports of Lake Sturgeon being observed or caught in the Red River by Manitoba anglers (Cleator *et al.* 2010). Stocking also occurred in the lower Assiniboine River near Whitehorse Plains in 1997 (Cleator *et al.* 2010).

Red River downstream of Lockport (MU3)

Historically, the Lake Sturgeon was present in the Red River basin but virtually extirpated from MU3 by the mid-1900s (Cleator *et al.* 2010). Several fish species currently found in the Red River near Selkirk use the lower reaches of Cooks Creek for spawning and nursery habitat during the spring and summer seasons (Cleator *et al.* 2010). Lake Sturgeon also likely used the creek for spawning habitat. Since the mid-1970s, a few Lake Sturgeon have been caught between Lockport and Netley Creek (Cleator *et al.* 2010). Stocking on the U.S. side of the Red River drainage has been underway since 1997 (Cleator *et al.* 2010).

Bloodvein River (MU4)

The Lake Sturgeon is reported to occur in MU4 (Cleator *et al.* 2010) but no historic scientific information is available.

Pigeon River (MU5)

The Lake Sturgeon is reported to occur in MU5, near the mouth of the Pigeon River and upstream in the vicinity of Round Lake (Cleator *et al.* 2010, DFO 2010), but no historic scientific information is available.

Berens River (MU6)

The Lake Sturgeon is reported to occur in the Manitoba portion of MU6 (Cleator *et al.* 2010) but no historic scientific information is available. On the Ontario side, the historic distribution of the Lake Sturgeon was extensive. Today, the Lake Sturgeon is reported to occur in Berens Lake, the Berens River system and Pikangikum Lake (Cleator *et al.* 2010). There are no dams, control structures or impoundments in the region so Lake Sturgeon habitat remains intact including historic spawning locations. Recent tagging results showed that Lake Sturgeon use the Berens system below Mikami Falls which is likely a natural barrier to upstream movements (Cleator *et al.* 2010).

Poplar River (MU7)

The Lake Sturgeon is reported to occur in MU7 (Cleator *et al.* 2010) but no historic scientific information is available.

Lake Winnipeg, including the Winnipeg River below Pine Falls GS (MU8)

The Lake Sturgeon occurred in Lake Winnipeg (MU8) historically and they are still present though at significantly reduced numbers. Several fish species found in Lake Winnipeg including Lake Sturgeon are present in the Winnipeg River below the Pine Falls GS but no historical information is available for this portion of MU8. The Lake Sturgeon was reported to occur historically in the Dauphin, Brokenhead, Icelandic rivers and other tributaries of Lake Winnipeg but no recent information is available for these waterbodies.

Historic and Current Abundance and Trends

The Lake Sturgeon was reported to be historically abundant in Lake Winnipeg until a commercial fishery was established in Lake Winnipeg in 1885 (Cleator *et al.* 2010). Historic sizes of Lake Sturgeon populations in the rivers within DU4 are poorly known though large spawning populations were reported in the Assiniboine (or its tributaries), Red and Roseau rivers (COSEWIC 2006). Historical evidence indicates that tributaries to the Red and Assiniboine rivers fulfilled spawning and early life history requirements however did not support resident populations. Over the past century, the Lake Sturgeon has virtually disappeared from much of the southern portion of DU4 due to a history of intermittent over-exploitation, combined with the construction of dams that blocked migration routes (COSEWIC 2006).

Today, the Lake Sturgeon is occasionally observed or captured in the Assiniboine River (MU1), Red River (MUs 2 and 3) and Lake Winnipeg (MU8). There is no evidence of naturally-reproducing populations and Lake Sturgeon stocked in recent years will not be old enough to reproduce for another decade. The rivers along the east side of Lake Winnipeg that contain Lake Sturgeon (MUs 4-7) likely continue to support modest numbers (COSEWIC 2006) though current status and trajectory of Lake Sturgeon are generally unknown except for the Ontario portion of MU6 which is thought to be cautious and increasing, respectively. The one location in DU4 where Lake Sturgeon may be relatively common and their population stable is Round Lake on the Pigeon River in MU5. The overall number of mature individuals in DU4 is unknown but probably less than 1,000 (COSEWIC 2006).

The current conservation status, based on the precautionary framework (see Cleator *et al.* 2010 for explanation), of each of the MUs in DU4 was evaluated on the basis of available information and expert opinion (Table 1).

Assiniboine River and tributaries upstream of the Portage la Prairie Diversion (MU1)

In the Assiniboine River, photos taken in 1938 revealed that "spawning Lake Sturgeon was so thick at Waggle Springs [south of Shilo] that you could walk across the river on their backs" (Cleator *et al.* 2010). Photographic evidence indicates that the Lake Sturgeon used to frequent the lower reaches of the Little Saskatchewan River for spawning purposes (Cleator *et al.* 2010). In the Qu'Appelle area, fishing activity was always common after the 1880s but Lake Sturgeon catches were not reported in government records from the 1920s (or earlier) or in discussions with local people. Lake Sturgeon may not have been abundant there historically due to intermittent flows (Cleator *et al.* 2010). By 1970, the Lake Sturgeon had been extirpated in MU1 (Table 1).

In an attempt to re-establish an Assiniboine River population, approximately 16,500 Lake Sturgeon fry, fingerlings, juveniles and adults were stocked between 1996 and 2008 from DUs 2, 3 and 5 (Cleator *et al.* 2010). Between 1998 and 2002, anglers reported catches of more than 280 Lake Sturgeon, ranging in total length from 20-100 cm, in a 20-km stretch between Brandon and the Little Souris River. Since 2007, angler catches have increased and Lake Sturgeon over 140 cm total length have been caught and released (Cleator *et al.* 2010). The indigenous population of Lake Sturgeon in MU1 is extirpated while the current status and trajectory of the stocked population is thought to be critical and increasing (Table 1), respectively, though there is no evidence yet for reproduction.

Red River and tributaries upstream of Lockport, including the Assiniboine River to the Portage la Prairie Diversion (MU2)

The Lake Sturgeon was reported to be historically abundant in the Red River basin until the late 1880s and virtually extirpated by the mid-1900s (Cleator *et al.* 2010). A 20-year Lake Sturgeon stocking program in the U.S. portion of the Red River drainage began in 2002 with the goal of releasing 34,000 fingerlings and 600,000 fry annually through 2022 from the Rainy River stock (DU6) (Cleator *et al.* 2010). In addition, in 1997 and 1998 the Minnesota Department of Natural Resources (MNDNR) stocked 378 Lake Sturgeon from the Rainy River (fish aged 4-10 years) in Big Detroit Lake and Ottertail River (Cleator *et al.* 2010). Since 1998, a small number of Lake Sturgeon have been observed or caught in MU2, including nine individuals that had been tagged and released by MNDNR in the Ottertail River (Cleator *et al.* 2010).

Historically, the Lake Sturgeon was known to occur in tributaries of the Red River. In 1880, some Lake Sturgeon caught in the Pembina River "at the rapids above the Missouri Trail" in Manitoba measured 5 feet (1.5 m) in length (Cleator *et al.* 2010). Since that time, fish passage above the Walhalla dam has been blocked and presumably the Lake Sturgeon is no longer found in the Manitoba portion of the river. Historical information indicates the Roseau River was a significant spawning stream (COSEWIC 2006). First Nations elders maintained that the Lake Sturgeon was so plentiful that one could nearly walk across the river on their backs during the June spawning run (Cleator *et al.* 2010). The largest Lake Sturgeon caught in Manitoba, a female estimated to be 150 years old and full of roe, was caught in the Roseau River east of Dominion City in 1903 (COSEWIC 2006). Construction of a dam downstream of Dominion City blocked Lake Sturgeon migration up the Roseau River until 1996 when it was modified to facilitate fish passage. Studies conducted in the Roseau River since the 1970s, which targeted other species, have not resulted in incidental catches of Lake Sturgeon (Cleator *et al* 2010). Historically, Lake Sturgeon likely spawned in the Rat, La Salle and Seine rivers but has not been captured incidentally during various fish surveys conducted in those waterbodies in the past 40 years (Cleator *et al.* 2010).

In the Assiniboine River downstream of the Portage la Prairie Diversion, 200 juvenile (18+ cm) Lake Sturgeon, likely from the Winnipeg River (DU5), were stocked near Whitehorse Plains in October 1997 (Cleator *et al.* 2010).

The indigenous population of Lake Sturgeon in MU2 is functionally extirpated while the current status and trajectory of the stocked population is thought to be critical and increasing (Table 1), respectively, though there is no evidence yet for reproduction.

Red River downstream of Lockport (MU3)

Only a few incidental catches of Lake Sturgeon has been reported between Lockport and Netley Creek since the mid-1970s in spite of considerable angling effort in the lower Red River (Cleator *et al.* 2010). The two largest fish measured about 199 cm in total length and likely were born before construction of the Lockport Dam. Of the incidental catches taken between 1998 and 2005, 11 had been tagged and released by MNDNR in the Ottertail River (Cleator *et al.* 2010). Four Lake Sturgeon were recorded in a creel census conducted on the Red River at Lockport during 2008 (Cleator *et al.* 2010). No incidental or inventory catches of Lake Sturgeon have been documented for Cooks Creek (Cleator *et al.* 2010). The indigenous population of Lake Sturgeon in MU3 is functionally extirpated while the current status and trajectory of the stocked population is thought to be critical and increasing (Table 1), respectively, though there is no evidence yet for reproduction.

Bloodvein River (MU4)

The Lake Sturgeon is harvested by aboriginal communities but no population estimates are available (Cleator *et al.* 2010). The current population status and trend in MU4 are unknown (Table 1).

Pigeon River (MU5)

The Lake Sturgeon is harvested by aboriginal communities but no population estimates are available except for Round Lake where an estimated 800-1,000 Lake Sturgeon reside, with very few spawning females (Cleator *et al.* 2010). The current overall population status and trend in MU5 are unknown (Table 1).

Berens River (MU6)

In the Manitoba portion of MU6, the Lake Sturgeon is harvested by aboriginal communities but no population estimates are available (Cleator *et al.* 2010). The current population status and trajectory are unknown (Table 1).

The Lake Sturgeon was commercially harvested extensively in the Ontario portion of MU6 throughout the 1930s-1950s and finally ended in the 1970s. Since then, there has been little recreational pressure and some subsistence fishing from First Nations. The subsistence harvest is considered to be limited at this time. Recently-collected length-age data from that region indicate that Lake Sturgeon there are still recovering from the negative impacts of an historical commercial harvest as most of the fish captured were small (0.50-1.38 m TL) (Cleator *et al.*

2010). Based on the available data, the current status of Lake Sturgeon in the Ontario portion of MU6 is thought to be cautious (Table 1). With limited harvest pressure and no other known threats, it is postulated the population trajectory may be increasing.

Poplar River (MU7)

The Lake Sturgeon is harvested by Aboriginal communities but no population estimates are available (Cleator *et al.* 2010). The current population status and trend in MU7 are unknown (Table 1).

Lake Winnipeg, including the Winnipeg River below Pine Falls GS (MU8)

A commercial Lake Sturgeon fishery was established in Lake Winnipeg in 1885. A history of over-exploitation followed (Cleator *et al.* 2010), resulting in severe population declines. For example, between 1898 and 1905, annual catches in excess of 200,000 kg, with a maximum annual harvest of 445,110 kg, were taken. Since the early 1970s, annual fish surveys have been conducted in the north and south basins of Lake Winnipeg but no Lake Sturgeon was collected. While these studies targeted other fishes, the standard index gillnets used (i.e., 2-5¼ in. mesh) should have caught juvenile Lake Sturgeon if they had been present in the areas sampled. Three Lake Sturgeon have been reported in Lake Winnipeg (two fish under 2 kg and one fish about 15 kg) over the past 28 years (COSEWIC 2006). An additional three fish have been reported from the Hecla Island area in recent years (Cleator *et al.* 2010). Between 1998 and 2005, anglers have reported catching seven Lake Sturgeon which were tagged and released by MNDNR in the Ottertail River. The Lake Sturgeon is present in the Winnipeg River below the Pine Falls GS. The current population status in MU8 is critical and trend is unknown (Table 1).

Information to Support Identification of Critical Habitat

The earliest age-0 stage, from hatch to first feeding (about 7-10 days), is assumed to be critical for survival and recovery of Lake Sturgeon but research on this life stage is only now underway. Age-0 fish have been captured in a variety of habitat types, from shallow water to depths > 10 m, substrates comprised of clay, sand and gravel/cobble, and water velocities of 0.1-0.3 $m \cdot s^{-1}$ (Cleator *et al.* 2010). Finer substrate types, like clay and sand, are reported to be preferred habitat for juvenile Lake Sturgeon as they contain larger amounts of small benthic prey, however they have also been found in areas of coarse-sand and pea-sized gravel. Juveniles use water depths ranging from 3-6 m to > 14 m and currents of 0.25-0.50 $m \cdot s^{-1}$ (Cleator *et al.* 2010). Depth was shown to be the primary abiotic factor influencing habitat selection in juveniles from the Winnipeg River (Cleator *et al.* 2010). The habitat requirements of young Lake Sturgeon appear to be more restricted, thus availability of suitable habitat may be more limiting for age-0 and early juvenile life stages, than for adults. Adult life stages tend to be more plastic, adapting to various habitat conditions (Cleator *et al.* 2010). In Round Lake (in MU5), adults and juveniles use the same areas but larger fish use a larger portion of the lake (Cleator *et al* 2010).

Tagging studies have documented that Lake Sturgeon movements are complex. Some individuals may move substantial distances away from core areas and then return weeks or months later, while others will remain in the core area or leave and not return. Regardless, many or most Lake Sturgeon groups demonstrate a preference for certain areas, at least in riverine environments, that contain hydraulic features characterized by transition from high-current velocities to slower velocities (e.g., the confluence of the main river channel with a tributary). These local changes in size and shape of the river result in depositional substrates where silt accumulates, providing good habitat for invertebrates which, in turn, provides good feeding habitat for Lake Sturgeon. In riverine environments, adults generally prefer water depths of ≥ 5 m with moderate water flow (< 0.6 $m \cdot s^{-1}$), and appear to avoid areas with high current velocity, except during spawning (Cleator *et al.* 2010).

The Lake Sturgeon is thought to move to deeper waters during warmer periods and return to shallower waters when temperatures decline. This may reflect seasonal or diel changes in distribution and also may vary by waterbody. Migration is functionally linked to movement between the adult feeding and spawning habitat. Open connections between these habitats are necessary, as adults may be required to migrate considerable distances to find suitable spawning habitat.

Adults typically spawn in late spring, in water temperatures of 11.5-16°C in high-gradient reaches of large rivers, often below rapids or dams, with current velocities of 0.5-1.3 $m \cdot s^{-1}$, water depths of 0.5-10 m, and over substrates of cobble, boulders, coarse gravel, hardpan, or sand (Cleator *et al.* 2010). Cascades and/or suitable water flows are necessary to keep the eggs and newly-hatched young healthy yet prevent them from being carried downstream before larval drift occurs. Seasonal and annual changes in flow may affect fidelity to specific spawning and feeding areas. A number of actual spawning sites are known for DU4 (Cleator *et al.* 2010).

Not as much is known about the habitat preferences of Lake Sturgeon during winter. One study reported that adults spend the winter at water depths of 6-8 m (max. 20 m) and water velocities ≤ 0.2 $m \cdot s^{-1}$ (max. 0.4 $m \cdot s^{-1}$), over silt and sand substrate (Cleator *et al.* 2010). Juveniles tended to congregate at approximately the same depths, substrate types and flow velocities, although some were observed at flow velocities as high as 0.4-0.6 $m \cdot s^{-1}$ (Cleator *et al.* 2010).

In summary, maintaining the functional attributes of habitat, including the ecologically-based flow regimes, needed for spawning, egg incubation, juvenile rearing, summer feeding and overwintering, as well as migration routes between these habitats, is critical to the survival and recovery of Lake Sturgeon. The current distribution of Lake Sturgeon in the Red and Assiniboine rivers and some tributaries (DU4) is fragmented by dams and barriers which negatively affect spawning habitat. In addition, channelization and alterations to stream morphology and flow have reduced available habitat for all life stages. Rivers on the east side of Lake Winnipeg remain un-impacted by development. It is essential that conditions that optimize the survival and recovery of Lake Sturgeon be maintained in DU4, especially during the spawning and incubation periods.

Residence

SARA defines a *residence* as “a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating”. Residence is interpreted by DFO as being a *constructed* place (e.g., a spawning redd). The Lake Sturgeon does not change its physical environment or invest in a structure during any part of its life cycle, therefore no biological feature of this species meets the SARA definition of residence as interpreted by DFO.

Recovery Targets

The long-term recovery goal for DU4 is to protect and maintain healthy, viable populations of Lake Sturgeon in all MUs on the Assiniboine-Red rivers – Lake Winnipeg system. To reach this goal, each MU must have at least 413 spawning females each year (i.e., 4,130 adults) and at least 1,193 ha of suitable riverine habitat or 2,386 ha of suitable lake habitat[1]. The aim is to reach these population and distribution objectives within three generations (i.e., 3 x 36 years = about 108 years) (Cleator *et al.* 2020). If undertaken, this recovery target would achieve a significant reduction in the probability of extinction of Lake Sturgeon in DU4. If a less precautionary recovery target is chosen, the number of spawning females per year would be reduced and years to recovery increased accordingly.

Re-establishing indigenous populations is the preferred goal to retain the original genetic profile. This is not possible in MUs 1-3 where no indigenous Lake Sturgeon remain, or very few in MUs 2 and 3, thus returning them to those MUs requires stocking.

The MVP modelling uses vital rates as inputs, and it is important to note that there are uncertainties associated with these vital rates. For example, the vital rates data may not have been specific to the DU being modelled, recent unpublished data may not be available or assumptions used in the model (e.g., a balanced sex ratio) may not accurately represent current conditions for that DU. Additionally, the recovery target may not reflect historic Lake Sturgeon abundance before over-exploitation and habitat degradation or loss began. In spite of uncertainty around the model output, its results are still useful and provide a recovery target to work towards. The model can be updated once new information comes available.

Modelling indicates that when current abundances are assumed to be 10% of the recovery target, times-to-recovery range from about 20 years to around 95 years (i.e., about 1-3 generations), depending on the recovery actions implemented (Cleator *et al.* 2010) (Figure 3). Recovery timeframes diminish if Lake Sturgeon spawning periodicity is shorter or reproductive effort is higher than expected and, conversely, will lengthen if spawning periodicity is longer or reproductive effort is lower than expected. Without recovery actions, time to recovery would be significantly longer.

The recovery potential and importance to recovery of each of the eight Lake Sturgeon MUs in DU4 was evaluated on the basis of available information and expert opinion (Table 1). The status of the indigenous populations in MUs 1 (Assiniboine River), 2 (Red River above Lockport) and 3 (Red River below Lockport) are extirpated (or functionally extirpated), therefore their recovery potential is nil as is their importance to recovery[2]. No genetic data for indigenous populations in DU4 is available, thus it is not known if the Lake Sturgeon in this DU was genetically distinct from others. Lake Sturgeon from DUs 2, 5 and 6 had, and may still have, the potential to move into DU4. So stocking using Lake Sturgeon from another DU may still have conservation value for recovery of DU4. Potential for recovery of the non-indigenous (stocked) Lake Sturgeon in MUs 1-3 is unknown as the stocked fish have not yet reached maturity. Currently, barriers also limit the ability of Lake Sturgeon in MU1 to migrate to historical spawning sites in tributaries. The Red River is a larger river system than the Assiniboine and flows directly into Lake Winnipeg. For these reasons, MU1 is considered to be of low importance to recovery while MUs 2 and 3 are moderate. Low numbers of stocked fish and barriers to spawning areas in some tributaries suggest that recovery will be protracted in MUs 1-

[1]Population viability analysis of stage-structure demographic matrices was used to determine recovery targets (Cleator *et al.* 2010). Minimum viable population (MVP) was defined as the number of adults necessary to achieve a 99% probability of persistence of Lake Sturgeon over 250 years, given a probability of catastrophe (50% decrease in the abundance of all life stages in one year) of 14% per generation, and assuming a balanced sex ratio, 5-year spawning periodicity and a sufficient number of juveniles to support the adult population goal.

[2]Henceforth, unless otherwise stated in this document, “recovery” in MUs 1-3 will refer to the recovery of Lake Sturgeon based on stocking from other DUs rather than recovery of DU4 (i.e., indigenous) Lake Sturgeon.

3. The recovery potential and importance to recovery of MUs 4, 5, 7 (Bloodvein, Pigeon and Poplar rivers) and the Manitoba portion of MU6 (Berens River) are unknown. In the Ontario portion of MU6, recovery potential is thought to be high though importance to recovery is unknown. Not enough is known about MUs 4-7 to determine time to recovery. The potential for recovery of Lake Sturgeon in MU8 (Lake Winnipeg) is likely low because they are taken as bycatch in the commercial fisheries for other species on the lake. However, given the central location of Lake Winnipeg within the Nelson River Drainage Basin, the importance of MU8 to recovery of Lake Sturgeon in DU4 is high. Recovery in this MU is expected to be protracted.

Threats to Survival and Recovery

Mortality, injury or reduced survival resulting from fishing activities can pose a threat to Lake Sturgeon. The commercial harvest of Lake Sturgeon in DU4 ended in 1988 following a long intermittent history which began in 1876 (Cleator *et al.* 2010). Catches in excess of 200,000 kg were taken from Lake Winnipeg between 1898 and 1905. Since 1970, commercial catches averaged less than 100 kg. The aboriginal harvest of Lake Sturgeon in DU4 by First Nations for subsistence, cultural and ceremonial purposes continues on a limited basis. Any Lake Sturgeon caught in Manitoba while fishing recreationally must be released. In Ontario, since 2009 there has been a zero recreational catch for Lake Sturgeon and any caught while recreational fishing for other species must be released. In the Berens system in Ontario, the Lake Sturgeon was heavily exploited by a commercial fishery between the late 1930s and 1970s. A small subsistence fishery by the community of Pikangikum continues; it is unknown whether other First Nations in the region fish Lake Sturgeon for subsistence. Subsistence harvesting may be occurring in the Manitoba portion of the Berens and Bloodvein rivers, and in the Pigeon and Poplar rivers, but the level of harvest is unknown. Poaching has been identified as a potential concern in DU4 (COSEWIC 2006). Although the current levels of legal harvesting through the subsistence fishery are low, and poaching has not been confirmed for this DU, the removal of juveniles and adults affects recovery (Cleator *et al.* 2010). The existing commercial net fishery for other species on Lake Winnipeg poses a significant threat to recovery as juvenile and adult Lake Sturgeon are susceptible to the gear.

Annual rates of harvest for Lake Sturgeon are not available for this DU. Regardless, it is worth noting that annual harvest rates that are thought to be sustainable for Lake Sturgeon are typically 5% or less (Cleator *et al.* 2010). A guideline developed for rehabilitation of Lake Sturgeon in the State of Michigan, for populations that currently exist, specifies maintaining fishing mortality below 3% for an expanding population and below 6% to maintain Lake Sturgeon abundance (Cleator *et al.* 2010).

Many dams, barriers and other structures are present throughout the southern portion of DU4. On the Assiniboine River the primary ones include the Shellmouth Dam and the Portage la Prairie Diversion. Both were built in 1970 for flood control and are also used for irrigation purposes. Two dams are located in or near Brandon, one of which is associated with a Manitoba Hydro Thermal Generating Station (TGS) which has been in operation since 1958 and the City of Brandon's Third Street Dam which has been in operation since 1962. Currently, a fishway is proposed to facilitate passage at the Third Street Dam and the rock weir at the TGS has been breached and allows passage. On the Red River, St. Andrews Lock and Dam, at Lockport, was constructed for navigation purposes and officially went into operation in 1910. Just downstream is the Selkirk TGS, with no dam, which has been in operation since 1960. In 1968, construction of an artificial flood control waterway for the City of Winnipeg was completed. The 47 km diversion channel, known as the Red River Floodway, is used during extreme flood emergencies to divert some flow from the Red River (MU2) around the eastern side of Winnipeg and discharge it back into the Red River near Lockport (MU3). The floodway gates in the Red

River have the potential to block fish movement upstream during periods of operation. More frequent use of the Floodway to control water levels in the Red River is now being considered (DFO 2010). To the south of Manitoba, work began in 1997 to remove dams or make them passable to Lake Sturgeon, in the Red River in North Dakota and Minnesota, in an effort to restore connectivity in the Red River basin.

Dams and control structures elsewhere have been shown to alter the natural flow regime and fragment habitat resulting in degradation and/or loss of Lake Sturgeon habitat, loss of genetic diversity, reduced spawning success, reduced prey availability and mortality (Cleator *et al.* 2010). Dam construction can extirpate local Lake Sturgeon populations (Cleator *et al.* 2010) by preventing fish from accessing spawning areas and stranding fish between impassable barriers. Fish near a TGS can be entrained into the inflow pipe or may be exposed to thermal shock from the plume of heated cooling water discharged at the outflow pipe(s), especially during winter. During the 1980s, one or more fish kills occurred in winter near the outflow from the Selkirk TGS in Cooks Creek due to abrupt changes in thermal regime resulting from operation of the TGS (Cleator *et al.* 2010). Fish screens and operational changes at this TGS have mitigated these threats. The Brandon TGS uses cooling towers which prevent this from occurring. Although there are no hydroelectric dams in DU4, agricultural and urban water intakes have the potential to cause entrainment[3] and impingement[4] mortality.

Other human activities have also contributed to the degradation of Lake Sturgeon habitat in DU4. The construction of drainage ditches has created unfavourable conditions for Lake Sturgeon by increasing water flows and suspended sediments during spawning, and reducing flows afterwards in juvenile feeding habitat, in the Roseau and other rivers within the historic range of Lake Sturgeon in DU4 (COSEWIC 2006). In addition, channelization and alterations to stream morphology have resulted in negative impacts to critical physical habitat for most life stages. Water quality has deteriorated over the past century in MUs 1-3, due to urban and agricultural development along the full length of the rivers, and in Lake Winnipeg (MU8) from a variety of human activities (e.g., nutrient inputs from land-use practices) throughout the drainage basin. The overall effect of construction and operation of dams, barriers and other structures as well as habitat alteration is that Lake Sturgeon habitat has been fragmented, degraded or lost, and injury or mortality to Lake Sturgeon increased, throughout the southern portion of DU4.

As a result of extirpation (or functional extirpation) of Lake Sturgeon in MUs 1-3, stocking of fry, fingerlings and older fish from other DUs (DUs 2, 5 and 6) has been undertaken. The genetic make-up of Lake Sturgeon in these MUs is unknown. Thus, stocking in MUs 2 and 3 can be viewed as possible genetic contamination, if some indigenous Lake Sturgeon remained in those MUs, or as an initiation of recovery action from a variety of sources and genetic compositions.

In recent years, a proposal has been discussed to build a new hydro corridor and/or road along the east side of Lake Winnipeg. If this goes ahead, there is potential for easier access to the four rivers that flow into the east side of Lake Winnipeg and, thus, the possibility of increased fishing pressure and habitat degradation or loss.

In summary, the most important current threats to survival and recovery of Lake Sturgeon in DU4 are habitat degradation or loss resulting from agriculture, urban development, dams/impoundments and other barriers and industrial activities, and mortality, injury or reduced survival resulting from bycatch from the commercial fishery on Lake Winnipeg (Table 2). The

[3]Entrainment occurs when fish eggs and larvae are taken into a facility's water-intake systems, pass through and back to the water body.
[4]Impingement occurs when fish are trapped or pinned by the force of the intake flow against the intake.

likelihood and severity of individual threats may vary by MU. All other threats that have been identified for other DUs in Canada are relatively unimportant or their impacts are unknown in DU4. The timeframe and impacts of climate change are unknown.

Limiting Factors for Population Recovery

The Lake Sturgeon possesses several intrinsic or evolved biological characteristics that make this species susceptible to over-exploitation and habitat changes and may naturally influence or limit potential for recovery: (1) slow growth and late maturation, (2) intermittent spawning intervals, (3) specific temperature, flow velocities and substrate requirements to ensure uniform hatching and high survival of eggs and (4) high fidelity to spawning areas. The early age-0 stage (transition from larvae to exogenous feeding) is a critical life stage for Lake Sturgeon.

Mitigation, Alternatives and Enhancements

The Lake Sturgeon in DU4 is most sensitive to harm on early adults, followed by late juveniles, late adults, early juveniles and age-0 (in decreasing order) (Cleator *et al.* 2010). These results highlight the importance of reducing mortality on adults and late juveniles (e.g., from fishing) as the key to recovering this DU, and indicate that any recovery measures that maximize survival of these stages will increase the likelihood of, or shorten the time to, recovery (Cleator *et al.* 2010). Fishing mortality, one of the main causes of population decline in the southern portion of DU4, has been largely eliminated in MUs 1-3 over the past few decades. Reducing mortality on adults and late juveniles is important in MUs 1-3 where survival and recovery of Lake Sturgeon are dependent on stocked fish reaching reproductive age and successfully reproducing. It is particularly important in MU8 (Lake Winnipeg) where bycatch from commercial fisheries is thought to be highly detrimental to the survival and recovery of Lake Sturgeon.

While elimination of mortality to early adults and late juveniles can produce significant improvements in recovery timeframes, the potential for improving survival of early adults is low relative to the potential in age-0 and young juveniles (Table 3). Therefore the possibility of implementing recovery strategies that improve age-0 and juvenile survival (e.g., habitat rehabilitation) should also be considered. For example, conservation stocking using fish from the same genetic stock has the potential to improve survival of age-0 and young juvenile fish so long as it also addresses potential impacts on genetic variability, artificial selection and transmission of disease from cultured to native fish. Conservation stocking should be undertaken only after careful consideration and as part of a comprehensive conservation stocking strategy for the DU, not a substitute for other effective mitigation or alternate measures outlined in this document. In DU4, measures that improve age-0 and juvenile survival are particularly important in MUs 1-3 where Lake Sturgeon survival and recovery depend on the survival of young stocked fish and their future reproductive success.

Fertility rates in both early and late adult stages are less sensitive to perturbation (Cleator *et al.* 2010). Regardless, continuous and intense recruitment failure caused by blocking spawning migration by dams and barriers or habitat degradation can still produce more apparent population constraints than adult mortality (Cleator *et al.* 2010). Complete blockage of spawners at barriers can eradicate a population in a generation from continuous reproductive failure and strong site fidelity for spawning (Cleator *et al.* 2010). Reduced access to suitable spawning habitat in MUs 1-3 and deteriorated water quality in MUs 1-3 and 8 potentially threaten the reproductive success of Lake Sturgeon in this DU.

Table 4 provides an inventory of possible mitigation measures, alternatives and enhancements to anthropogenic activities that pose threats to Lake Sturgeon survival and recovery. Mitigations, alternatives and enhancements for the most important threats for DU4, as identified in Table 2, are shown below.

Mitigations and alternatives

Habitat degradation or loss: agricultural activities

- Prevent significant sedimentation, especially during winter or spring.
- Minimize release of contaminants.
- Prevent significant changes in water temperature, total gas pressure, salinity or nutrient concentrations.
- Prevent removal of substrates of coarse gravel, cobble, boulders, hardpan or sand in known or suspected spawning areas.
- Prevent significant changes in water flow, especially during spring (when spawning and rearing occur).
- Advocate proper drainage (properly maintained functional drains will reduce direct loading to streams).
- Protect spawning and rearing habitat.
- Rehabilitate habitat in key areas to mitigate habitat degradation or loss of important habitat (e.g., spawning sites) and to improve age-0 and juvenile survival.

Habitat degradation or loss: urban development

- Enforce discharge limits on potential pollutants (e.g., effluent from water treatment plants, pollution point sources).
- Improve effluent from water treatment plants.
- Increase protection during work permit reviews.
- Rehabilitate habitat in key areas to mitigate habitat degradation or loss of important habitat (e.g., spawning sites) and to improve age-0 and juvenile survival.
- Protect spawning and rearing habitat.

Habitat degradation or loss: dams/impoundments and other barriers

- Adjust water management operating conditions of dams/impoundments and other barriers (e.g., weirs) for those currently in place and those planned in the future to optimize the survival and recovery of Lake Sturgeon, especially during the spawning and incubation periods.
- Rehabilitate habitat in key areas to mitigate habitat degradation or loss of important habitat (e.g., spawning sites) and to improve age-0 and juvenile survival.
- Ensure design of new dams and modernization of existing dams does not jeopardize the survival and recovery of Lake Sturgeon (e.g., consider possible need for fish passage).
- Protect spawning and rearing habitat.

Habitat degradation or loss: industrial activities

- Prevent significant sedimentation, especially during winter or spring.
- Minimize release of contaminants.
- Prevent significant changes in water temperature, total gas pressure, salinity or nutrient concentrations.

- Prevent removal of substrates of coarse gravel, cobble, boulders, hardpan or sand in known or suspected spawning areas.
- Prevent significant changes in water flow, especially during spring (when spawning and rearing occur).
- Rehabilitate habitat in key areas to mitigate habitat degradation or loss of important habitat (e.g., spawning sites) and to improve age-0 and juvenile survival.
- Protect spawning and rearing habitat.

Mortality, injury or reduced survival: fishing

- Immediate release of bycatch to promote survivability.
- Examine ways and means of altering commercial net fisheries to reduce impacts on recovering Lake Sturgeon populations (e.g., trapnets versus gillnets, netting off the bottom, area closures such as limiting fishing near river mouths, close fishery).
- Regulate or encourage fishing practices that improve fish survival for catch-and-release fisheries, such as cutting lines of deeply-hooked fish, tight-line fishing, and minimizing "playing" and handling of hooked fish.
- Consider closure (e.g., conservation closures, closed seasons and areas), or at least reduce mortality, for adults through the use of legal size limits.
- Educate the public about the importance of Lake Sturgeon and what measures they can take to prevent over-exploitation.
- Ensure effective enforcement of regulations.

Habitat degradation or loss: forestry and mining exploration/extraction

- Prevent significant sedimentation, especially during winter or spring.
- Minimize release of contaminants.
- Prevent significant changes in water temperature, total gas pressure, salinity or nutrient concentrations.
- Prevent removal of substrates of coarse gravel, cobble, boulders, hardpan or sand in known or suspected spawning areas.
- Prevent significant changes in water flow, especially during spring (when spawning and rearing occur).
- Protect spawning and rearing habitat.
- Rehabilitate habitat in key areas to mitigate habitat degradation or loss of important habitat (e.g., spawning sites) and to improve age-0 and juvenile survival.

Enhancements

The following population enhancements could be considered supplementary measures to the mitigations and alternatives indicated above.

- Enhance age-0 and young juvenile survival through a conservation stocking program that does not introduce disease or reduce the genetic fitness of naturally-reproducing Lake Sturgeon.

Allowable Harm

Modelling analyses for DU4 indicate that once the main causes of population decline are removed, the minimum recovery efforts for individual vital rates that would be necessary to reverse declines in abundance would be approximately 4.3-27.2% increments in adult survival, 11.3-27.3% in juvenile survival, 29.6% in age-0 survival and 59.4-91.9% in fertility rates (Table 3). It is not feasible to increase survival rates sufficiently for late adults and fertility rates for early and late adults to achieve recovery (Table 3).

While modelling allowable harm at the DU level provides useful information, careful examination of conditions within an MU is necessary to fully assess the level of risk posed by harm from human-induced mortality and habitat modifications. Available data and expert opinion indicate that the current status of MUs 1-3 is critical (Table 1) and that recovery is not possible without mitigation, alternatives or enhancements such as stocking. Thus, activities that damage or destroy functional components of habitat or key life components of the life cycle (e.g., spawning, recruitment and survival) pose a very high risk to survival or recovery of any remaining Lake Sturgeon populations in those three MUs, at least until there is evidence that the stocked fish have become successfully established (e.g., successful reproduction). The status of MU8 is also critical and current levels of harm appear to be too high, so harmful activities pose a very high risk to survival or recovery there too. As current status and trend of MUs 4, 5, 6 (Manitoba portion) and 7 is unknown, harmful activities may pose a high to very high risk to survival or recovery. In the Ontario portion of MU6, the status of Lake Sturgeon is cautious and trajectory is thought to be increasing. Harmful activities pose a moderate risk to populations there. Allowable harm in DU4 should be assessed on a case-by-case basis, keeping in mind the cumulative effects of all threats to the DU, to ensure that survival and recovery of Lake Sturgeon are not jeopardized.

Research activities should be allowed if they are beneficial to the species and would not jeopardize the survival or recovery of an MU.

Data and Knowledge Gaps

The relationship between key life history stages and habitat in DU4 needs to be better understood, as does the current level of domestic harvest. Obtaining reliable estimates of population size, population growth rate and harvest in each MU, including harvest from commercial bycatch in MU8, is a high priority. Surveys are needed to identify where spawning and feeding occur and whether access to, and the quantity and quality of spawning habitat, for individual MUs is sufficient. The habitat needs of age-0 and juvenile Lake Sturgeon should be better understood. Determination of the impact of altered flow regimes and other environmental factors on egg, larval and juvenile survival, and corresponding mitigation measures would be useful. The additive or cumulative effects of multiple dams/impoundments and barriers on Lake Sturgeon populations also should be investigated. MVP modelling needs to be updated as new knowledge about vital rates is obtained for each MU. Genetic profiling of individual MUs in DU4 is needed for comparison with source populations used for stocking.

Sources of uncertainty

Age estimates made using a longstanding technique (i.e., counting growth increments on pectoral fin spine cross sections) were recently found to underestimate the true age of fish older than 14 years and error increased with age. The average difference was -4.96 ± 4.57 years, and ranged from +2 to -17 years (Cleator *et al.* 2010). A correction factor has been developed to correct existing age estimates obtained using this method, though validation studies are needed to determine whether there are differences among populations.

Some uncertainties may exist regarding the Lake Sturgeon vital rates used in the MVP modelling. For example, the vital rates data may not have been specific to the DU being modelled, recent unpublished data may not be available or assumptions used in the model (e.g., a balanced sex ratio) may not accurately represent current conditions for that DU.

Assessing population size for Lake Sturgeon is difficult given the behaviour and ecology of the species. This makes it difficult to determine whether recovery targets are being met.

CONCLUSIONS

Eight MUs have been identified for DU4: MU1 is the Assiniboine River and tributaries upstream of the Portage la Prairie Diversion, MU2 is the Red River and tributaries upstream of Lockport, including the Assiniboine River to the Portage la Prairie Diversion, MU3 is the Red River downstream of Lockport, MUs 4-7 are the Bloodvein, Pigeon, Berens and Poplar rivers, respectively, and MU8 is Lake Winnipeg, including the Winnipeg River below Pine Falls GS.

Over the past century, the range and numbers of Lake Sturgeon in DU4 severely declined primarily as a result over-exploitation from commercial fisheries and a significant portion of their habitat has been degraded or lost, especially in the southern portion of the DU. Limited data indicates that low numbers of Lake Sturgeon are now present throughout much of the DU.

Available data and expert opinion indicate that the current status of MUs 1-3 is critical though their population trajectories are increasing due to stocking. The current status, trajectory and potential for recovery of MUs 4-7 are unknown except in the Ontario portion of Berens River (MU6) where recent information suggests they are cautious, increasing and high, respectively. The status and population trajectory of MU8 is critical and unknown, respectively.

Survival and recovery of Lake Sturgeon in DU4 depend on maintaining the functional attributes of habitat, including the ecologically-based flow regimes, needed for spawning, egg incubation, juvenile rearing, summer feeding and overwintering, as well as migration routes between these habitats. It is essential that conditions that optimize the survival and recovery of Lake Sturgeon be maintained, especially during the spawning and incubation periods.

The long-term recovery goal for DU4 is to protect and maintain viable populations of Lake Sturgeon in all MUs within Assiniboine-Red rivers – Lake Winnipeg system. To reach this goal, each MU must have at least 413 spawning females each year (i.e., 4,130 adults) and at least 1,193 ha of suitable riverine habitat or 2,386 ha of suitable lake habitat. The aim is to reach these population and distribution objectives within three generations (i.e., about 108 years). If a less precautionary recovery target is chosen, the number of spawning females per year would be reduced and years to recovery increased accordingly. Re-establishing indigenous populations is the preferred goal to retain the original genetic profile. This is not possible in MUs 1-3, where no indigenous Lake Sturgeon remain, or very few in MUs 2 and 3, thus returning them to those MUs requires stocking.

The most important current threats to survival and recovery of Lake Sturgeon in DU4 are habitat degradation or loss resulting from agriculture, urban development, dams/impoundments and other barriers and industrial activities, and mortality, injury or reduced survival resulting from bycatch from the commercial fishery on Lake Winnipeg. The likelihood and severity of individual threats may vary by MU. The timeframe and impacts of climate change are unknown.

A variety of mitigation measures and alternatives could be implemented to aid in the survival and recovery of Lake Sturgeon in DU4 including protecting spawning and rearing habitat, minimizing activities that cause habitat degradation or loss, rehabilitating habitat in key areas and reducing impacts of the commercial net fishery on Lake Winnipeg to Lake Sturgeon. Conservation stocking using fish from the same genetic stock may be a useful enhancement tool as part of a comprehensive conservation stocking strategy for the DU and when combined with mitigation measures and alternatives.

Activities that damage or destroy functional components of habitat or key life components of the life cycle pose a very high risk to the survival or recovery of Lake Sturgeon in MUs 1-3 and 8, high to very high risk in MUs 4, 5, 7 and the Manitoba portion of MU6 and moderate risk in the Ontario portion of MU6. Research activities should be allowed in DU4 if they are beneficial to the species and would not jeopardize the survival or recovery of an MU.

OTHER CONSIDERATIONS

There are several jurisdictions involved in the management and recovery of Lake Sturgeon in DU4 including the governments of Saskatchewan, Manitoba and Ontario and DFO.

SOURCES OF INFORMATION

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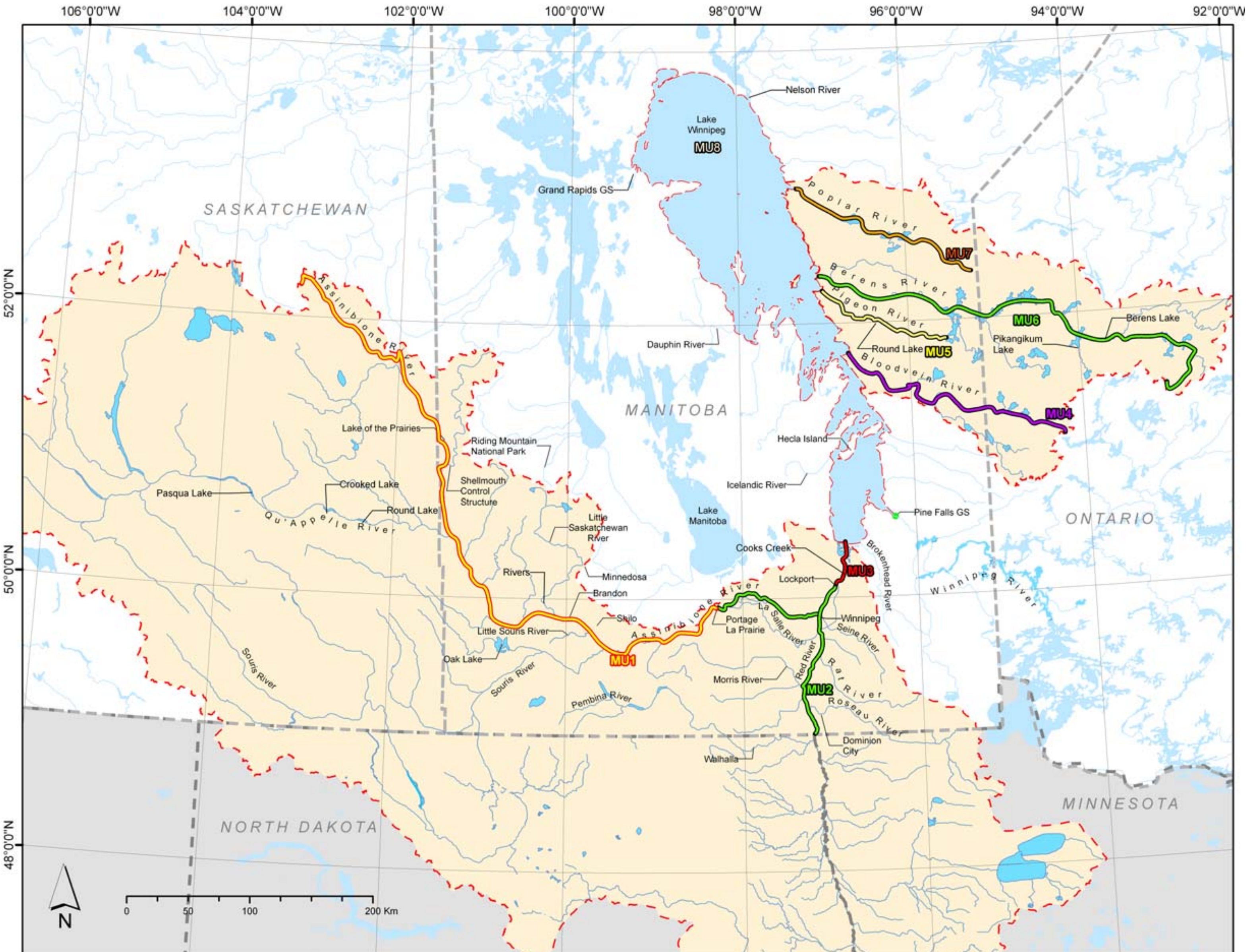

Figure 2. DU4 (shaded, and Lake Winnipeg) showing locations of MUs and place names mentioned in the text.

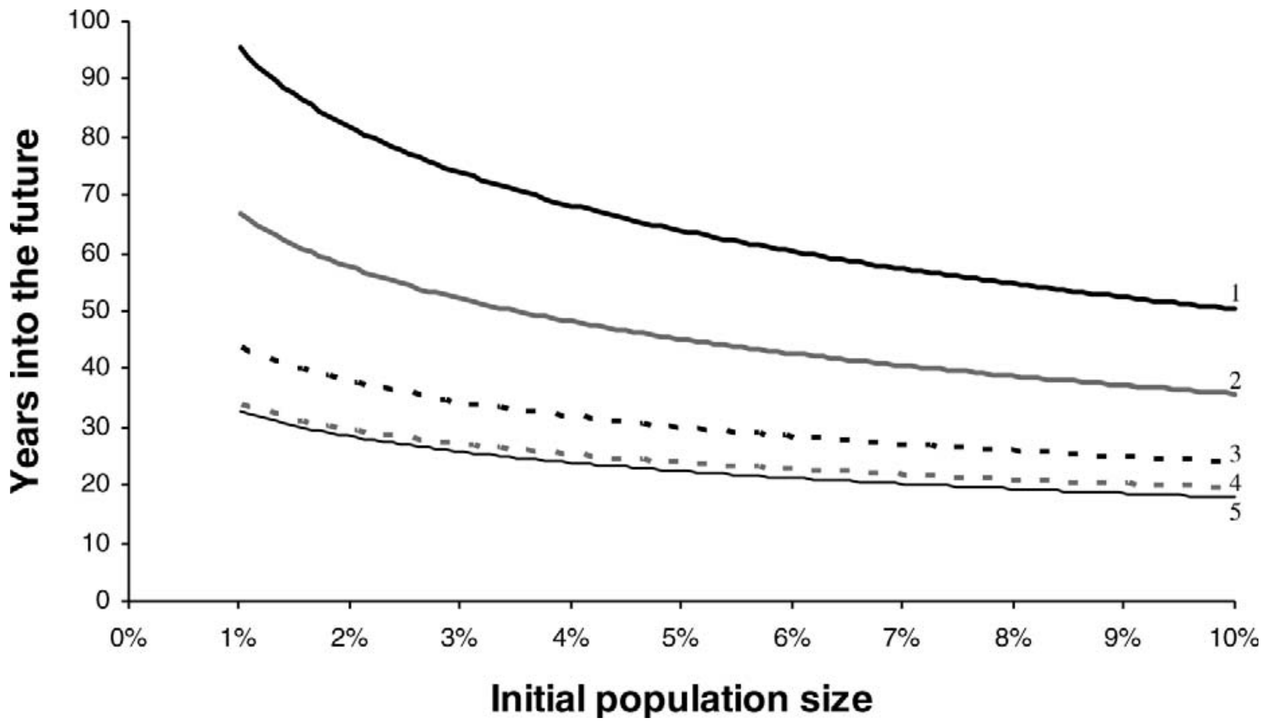

Figure 3. Stochastic projections of times to recovery for Lake Sturgeon based on initial population size (i.e., percentage of MVP) under five different recovery scenarios. Strategy 1 (solid black line) was the maximization of the survival rates of early adults, strategy 2 (solid grey line) added a 10% increase in the survival rates of late juveniles, strategy 3 (black dotted line) added a 20% increase in the survival rates of age-0 and early juveniles, strategy 4 (dotted grey line) added the maximization of the survival rate of late adults, while strategy 5 (black dashed line) added a 20% increase in fertility. Initial population size is expressed as a percentage of the recovery target (from Figure 8 in Vèlez-Espino and Koops 2009, as cited in Cleator et al. 2010).

Table 1. Assessment of the current conservation status, population trajectory, overall importance to species recovery and recovery potential of the eight Lake Sturgeon Management Units (MUs) in the Red-Assiniboine rivers – Lake Winnipeg system. Conservation status was based on the best available information and Precautionary Framework (see Cleator et al. 2010 for explanation); population trajectory was rated as Nil, Unknown, Stable, Increasing or Decreasing using COSEWIC criteria – 3 generations; importance to species recovery evaluates the importance of the MU to the overall recovery of Lake Sturgeon within DU4. For example, if a DU contained only one Lake Sturgeon MU whose conservation status was considered to be Healthy, then its importance to species recovery would be rated High as catastrophic loss of that MU would result in extirpation of the DU. Recovery potential is based on a combination of current conservation status and current threats status. In MUs where the original indigenous population was extirpated (e.g., MU1), recovery is Nil though stocking from another DU will allow Lake Sturgeon to return to the waterbody. Importance to species recovery and recovery potential were rated as Nil, Low, Moderate, High or Unknown; Ind=Indigenous, St=Stocked.

MU	Location	Conservation status	Population trajectory	Importance to DU recovery	Recovery potential
1	Assiniboine River and tributaries upstream of the Portage la Prairie Diversion	Extirpated (Ind) Critical[1] (St)	Nil (Ind) Increasing[2] (St)	Nil (Ind) Low[3] (St)	Nil (Ind) Unknown (St)
2	Red River and tributaries upstream of Lockport, including the Assiniboine River to the Portage la Prairie Diversion	Functionally Extirpated (Ind) Critical[1] (St)	Virtually Nil (Ind) Increasing[2] (St)	Nil (Ind) Moderate[3] (St)	Nil (Ind) Unknown (St)
3	Red River downstream of Lockport	Functionally Extirpated (Ind) Critical[1] (St)	Virtually Nil (Ind) Increasing[2] (St)	Nil (Ind) Moderate[3] (St)	Nil (Ind) Unknown (St)
4	Bloodvein River	Unknown	Unknown	Unknown	Unknown
5	Pigeon River	Unknown[4]	Unknown[4]	Unknown[4]	Unknown[4]
6	Berens River	Unknown (MB) Cautious (ON)	Unknown (MB) Increasing (ON)	Unknown (MB) Unknown (ON)	Unknown (MB) High (ON)
7	Poplar River	Unknown	Unknown	Unknown	Unknown
8	Lake Winnipeg, including Winnipeg River below Pine Falls GS	Critical	Unknown	High	Low

[1]The stocked fish have not yet reached reproductive age.
[2]As a result of stocking programs in the MU or upstream of the MU, not reproduction.
[3]Stocking occurs and has value to species recovery in DU4.
[4]Data are available for Round Lake on the Pigeon River (see Cleator *et al.* 2010).

Table 2. Current status of threats to Lake Sturgeon in DU4 by Management Unit (MU), defined in terms of the likelihood of occurrence followed by the level of severity, based on current knowledge of the MUs and the areas in which they occur. (0=Nil, L=Low, M=Moderate, H=High, U=Unknown). The most important threats are highlighted. Note: In cases where a man-made barrier occurs at the start (upstream end) of an MU, it is included in the MU. For example, Pine Falls GS on the Winnipeg River and Grand Rapids GS on the Saskatchewan River are included in MU8.

THREATS	Assiniboine River	Red River, upstream of Lockport	Red River, downstream of Lockport	Bloodvein River	Pigeon River	Berens River	Poplar River	Lake Winnipeg
	MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8
Mortality, injury or reduced survival								
Entrainment, impingement and turbine mortality (e.g., from hydroelectric dams and other barriers, urban or irrigation intakes)	H,L	H,L	H,L	0,0	0,0	0,0	0,0	L,L
Population fragmentation (e.g., from dams/impoundments and other barriers)	M,L	0,0	M,L	0,0	0,0	0,0	0,0	0,0
Fishing: commercial net (bycatch)	0,0	0,0	0,0	0,0	0,0	0,0(MB) L,L(ON)	0,0	H,H
Fishing: domestic / subsistence	L,H	L,M	L,M	L,U	L,U	M,L	L,U	H,U
Fishing: recreational / commercial tourism	H,L	H,L	H,L	H,L	U,U	L,L	H,L	H,U
Fishing: illegal harvest	L,H	U,U	U,U	U,U	U,U	L,M	U,U	H,U
Habitat degradation or loss[1]								
Dams/impoundments and other barriers (e.g., hydroelectric dams or water control structures)	H,M	H,M	H,M	0,0	0,0	0,0	0,0	H,L
Industrial activities (including oil and gas, and pulp and paper)	H,M	H,M	H,M	0,0	0,0	0,0	0,0	H,L
Forestry exploration/ extraction	0,0	L,L	0,0	L,0	0,0	H,M	L,0	H,L
Mining exploration/extraction	0,0	L,L	0,0	H,U	H,U	H,M	H,U	0,0
Agricultural activities	H,H	H,H	H,H	0,0	0,0	0,0	0,0	H,M
Urban development	H,M	H,H	H,H	H,L	H,L	L,L	H,L	H,L
Sturgeon culture								
Genetic contamination	0,0[2]	H,U[3]	H,U[3]	L,U	L,U	L,U	L,U	H,U
Disease	H,U	H,U	H,U	L,U	L,U	L,U	L,U	H,U
Non-indigenous and invasive species	H,U	H,U	H,U	H,U	H,U	H,U	H,U	H,U
Climate change[4]	U,U	U,U	U,U	U,U	U,U	U,U	U,U	U,U

[1]Examples: changes in flow regime, water temperature, concentrations of sediments, nutrients and contaminants, habitat structure and cover, food supply and migration/access to habitat, surface hardening and pollution.
[2]The indigenous population is extirpated thus stocked fish pose no risk of genetic contamination.
[3]If some indigenous Lake Sturgeon remain, they may be subject to genetic contamination from stocked fish, however since the Red River stock is functionally extirpated, recovery without stocking from other genetic sources is not possible.
[4]Examples: changes in water temperature, patterns of precipitation, river morphology and hydrology.

Table 3 Minimum recovery effort and maximum allowable harm with respect to annual survival and fertility of Lake Sturgeon in DU4 based on results of modelling (Vélez-Espino and Koops 2009, as cited in Cleator et al. 2010). Minimum recovery effort indicates the minimum increase in vital rates necessary to stabilize or stimulate population growth. Maximum allowable harm indicates the maximum reduction in survival or fertility rates in a population that can occur while still allowing the population to recover, once the main causes of population decline are removed. These percentages are not additive.

Vital Rates	Minimum Recovery Effort	Maximum Allowable Harm
Age-0 survival	29.6%[1]	0%
Early juvenile survival	27.3%[1]	0%
Late juvenile survival	11.3%[1]	0%
Early adult survival	4.3%[1]	0%
Late adult survival	27.2[1] (11.4%[2])	0%
Early adult fertility	91.9[1] (20.4%[2])	0%
Late adult fertility	59.4[1] (7.7%[2])	0%

[1]Value generated by the stochastic-generic model, which incorporated values for DUs 2, 4 and 5, resulting in a more precautionary value than was produced by the stochastic DU4 model.
[2]Maximum proportional increase possible, thus it is not feasible to increase this vital rate sufficiently for recovery.

Table 4. Possible mitigations and alternatives to threats to ensure that activities (including structures) do not jeopardize the survival and recovery of Lake Sturgeon.

Threats	Mitigations and Alternatives	Life stage enhanced
Habitat degradation or loss[1]		
Dams/impoundments and other barriers	Follow ecologically-based flow regimes for key life stages to optimize conditions especially during spawning, incubation and larval drift periods	Age-0[2], eggs
	Protect spawning and rearing habitat at new and existing dams and other barriers	Age-0[2], eggs
	Select the most appropriate design option for new structures, or those being modernized, to enhance survival and recovery	All
	Rehabilitate habitat in key areas	All
Industrial activities (including oil and gas), forestry and mining exploration/extraction	Prohibit activities that cause significant sedimentation especially during winter or spring	Age-0[2], eggs
	Prohibit activities that cause removal of substrates in known or suspected spawning areas	Age-0[2], eggs
	Prohibit activities that cause significant changes in water flows especially during spring	Age-0[2], eggs
	Prohibit activities that cause significant changes in water temperature, total gas pressure, salinity or nutrient concentrations	All
Agricultural activities	Prohibit activities that cause significant sedimentation especially during winter or spring	Age-0[2], eggs
	Prohibit activities that cause removal of substrates in known or suspected spawning areas	Age-0[2], eggs
	Prohibit activities that cause significant changes in water flows especially during spring	Age-0[2], eggs
	Prohibit activities that cause significant changes in water temperature, total gas pressure, salinity or nutrient concentrations	All
	Minimize release of contaminants	All
Urbanization	Enforce discharge limits on potential pollutants	All
	Improve effluent from water treatment plants	All
	Increase protection during work permit reviews	All
	Protect spawning and rearing habitat	Age-0[2], eggs
	Rehabilitate habitat in key areas	All

[1]Examples: changes in flow regime, water temperature, concentrations of sediments, nutrients and contaminants, habitat structure and cover, food supply and migration/access to habitat, surface hardening and pollution.

[2]Age-0 survival could also be enhanced through conservation stocking (see Mitigation, Alternatives and Enhancements section for explanation).

Table 4. (Continued)

Threats	Mitigations and Alternatives	Life stage enhanced
Mortality, injury or reduced survival		
Entrainment, impingement and turbine mortality (e.g., from hydroelectric dams and other barriers, urban or irrigation intakes)	Provide protection measures to exclude Lake Sturgeon from passing through facility intakes	All
	Provide effective upstream and downstream passage[3]	All
	Select the most appropriate design option for new structures, or those being modernized, to enhance survival and recovery	All
Population fragmentation (e.g., from dams/impoundments and other barriers)	Prevent any additional fragmentation	All
	Provide effective upstream and downstream passage[3] at new dams and modernization of existing dams if necessary	Age-0[2], eggs
	Remove barriers to migration to known historical spawning sites or provide effective upstream or downstream fish passage at current barriers if necessary	Age-0[2], eggs
	Rehabilitate habitat in key areas	All
Fishing[4]	Regulate or encourage practices that improve fish survival	Late juvenile, both adult stages
	Ensure immediate release of bycatch	All juvenile and adult stages
	Close fishing by season and/or area, or modify fishing practises	All juvenile and adult stages
	Improve public education	Late juvenile, both adult stages
	Ensure effective enforcement of regulations	Late juvenile, both adult stages
Sturgeon culture		
Genetic contamination	Develop effective and controlled stocking policy/plan	All
	Ensure broodstock, fertilized eggs and/or larval fish are from the same genetic stock	All
Disease	Monitor for bacteria and viruses	All
Non-indigenous and invasive species[5]		
	Monitor non-indigenous and invasive species	All
	Ban use of live bait	All
	Establish measures to prevent introduction or spread	All
Climate change[6]		
	Monitor environmental changes	All

[3]Examples: construction of a fishway, partial dismantling or removal of barriers.
[4]Commercial net (bycatch), domestic/subsistence, recreational/commercial tourism and illegal harvest.
[5]Examples: Common Carp (*Cyprinus carpio*), Zebra Mussels (*Dreissena polymorpha*), Rainbow Smelt (*Osmerus mordax*) and Rusty Crayfish (*Orconectes rusticus*).
[6]Examples: changes in water temperature, concentrations of sediments, nutrients and contaminants, habitat structure and cover, food supply and migration/access to habitat, surface hardening and pollution.

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