RECOVERY POTENTIAL ASSESSMENT OF LAKE STURGEON: WESTERN HUDSON BAY POPULATIONS (DESIGNATABLE UNIT 1)

Lake Sturgeon Acipenser fulvescens
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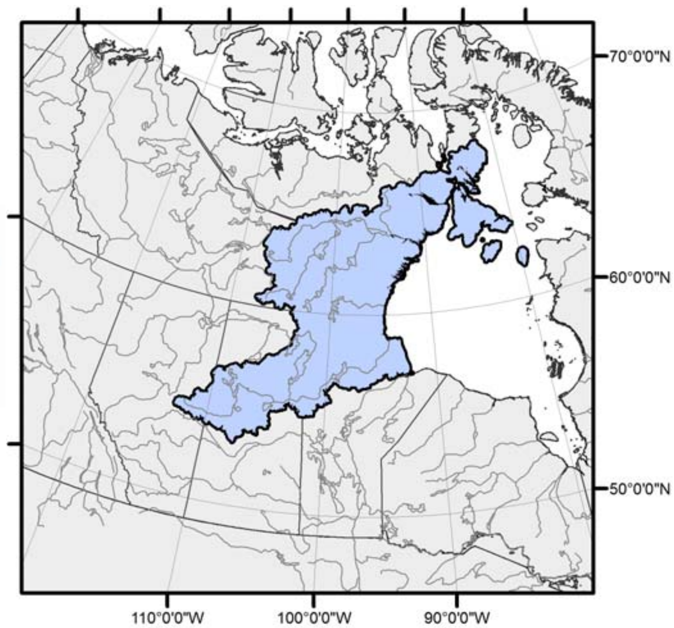

Figure 1. DU1 for Lake Sturgeon (coloured area).

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) 1, the Western Hudson Bay populations, includes the Churchill River system of northern Manitoba and Saskatchewan as the Lake Sturgeon in this region is considered a distinct DU on the basis of their presence in the Western Hudson Bay ecozone, a biogeographically distinct region. COSEWIC assessed and designated DU1 as Endangered as the Lake Sturgeon in this DU declined severely over the past century. Historically, over-exploitation from commercial fisheries was the primary threat, whereas more recently habitat degradation or loss associated with dams/impoundments and other barriers, and domestic/subsistence fisheries, have become the most important threats.

DU1 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 DU1, 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 DU1 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

- Three Management Units (MUs) have been identified for DU1 along the Churchill River: MU1 is located between Kettle Falls and Island Falls Generating Station (GS), MU2 between Island Falls GS and the Missi Falls Control Structure (CS) and MU3 between Missi Falls CS and Hudson Bay.
- The current status, population trajectory and potential for recovery of MU1 are unknown.
- Limited data indicate there are very low numbers of Lake Sturgeon present in MU2; current status is likely critical, trajectory is unknown and potential for recovery is moderate.
- There are estimated to be at least 1,300 adult Lake Sturgeon in MU3; current status is cautious, trajectory is unknown and potential for recovery is low due to habitat limitations.
- Survival and recovery of Lake Sturgeon in DU1 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 DU1 is to protect and maintain healthy, viable populations of Lake Sturgeon in all three MUs within the Churchill River system.
- The most important current threats to survival and recovery of Lake Sturgeon in DU1 are habitat degradation or loss resulting from dams/impoundments and other barriers, and mortality, injury or reduced survival resulting from domestic/subsistence fisheries.
- Mitigation measures that would aid recovery include prevention of mortality, protection of habitat and public education.
- Activities that damage or destroy functional components of habitat or negatively affect key life components of the life cycle pose a very high risk to the survival and recovery of Lake Sturgeon in MU2, high to very high risk in MU1 and a high risk in MU3.

BACKGROUND

Rationale for Assessment

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Lake Sturgeon in DU1 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).

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

DU1 includes the Churchill River system of northern Manitoba and Saskatchewan (Figure 1). Lake Sturgeon may also occur in the river systems north along the western Hudson Bay coast but there are no published reports to substantiate this.

The Churchill River is 1,609 river km in length, from its headwaters near the eastern edge of central Alberta to where it empties into Hudson Bay in northeastern Manitoba, and consists of a series of lakes interconnected by riverine sections containing numerous sets of rapids. Operation of the Island Falls GS in Saskatchewan beginning in 1930 and the Missi Falls Control Structure (CS), and associated Churchill River Diversion, in 1976 potentially fragmented the distribution of Lake Sturgeon in DU1. However, it is not known if this is the case, as there were natural barriers at the dam locations that may have restricted Lake Sturgeon movements. The Churchill River Diversion allowed Lake Sturgeon to move into the Burntwood and Nelson rivers thereby potentially opening up new habitat.

Three Lake Sturgeon MUs, separated from each other by man-made barriers, have been identified in DU1 (Figure 2): (1) from Kettle Falls to Island Falls GS, (2) from Island Falls GS to Missi Falls CS and (3) the lower Churchill River below Missi Falls CS. MU1 is about 112 river km in length, MU2 is 430 km and MU3 is 440 km. Within each of these MUs there may be one or more spawning stocks.

Scientific knowledge of the historic and current distribution of Lake Sturgeon within DU1 is, at best, limited. The Lake Sturgeon currently occurs in all three MUs and the area of occupancy is estimated to be < 300,000 km^2, though the trend in area, extent or quality of habitat is unknown (COSEWIC 2006).

Kettle Falls – Island Falls GS (MU1)

Little or no historic scientific information is available for Lake Sturgeon in MU1. In recent decades, there have been reports of Lake Sturgeon as far upstream as Kettle Falls on the Churchill River and Atik Falls on the Reindeer River (Cleator *et al.* 2010).

Island Falls GS – Missi Falls CS (MU2)

Historically, Lake Sturgeon were reported near the community of Sandy Bay (Saskatchewan), which is located near a trading post called “Sturgeon House” that was in operation around 1800 (Cleator *et al.* 2010). In the Manitoba portion of MU2, Lake Sturgeon were fished between Duck and Pukatawagan Lakes in the 1920s and later in the Churchill-Granville-Opachuanoa region (Cleator *et al.* 2010). In the past decade, two Lake Sturgeon were caught in test nets at Sandy Bay (Cleator *et al.* 2010).

Lower Churchill River below Missi Falls CS (MU3)

Lake Sturgeon are known to occur in the vicinity of the confluence of the Churchill and Little Churchill rivers (Cleator *et al.* 2010), but no historic scientific information is available.

Historic and Current Abundance and Trends

Lake Sturgeon in this DU declined severely over the past century as a result of over-exploitation. The historic landings data indicate that Lake Sturgeon throughout the Churchill River declined by over 90%, possibly by more than 98%, between the 1920s and 1939 as a result of over-exploitation (COSEWIC 2006). For example, one historical Lake Sturgeon harvest record of 14,425 kg (marketed weight) from 1937 is reported for the Churchill River somewhere in Saskatchewan (Cleator *et al.* 2010). Population characteristics indicate that DU1 has been subject to over-exploitation and not recovered.

The current conservation status, based on the precautionary framework (see Cleator *et al.* 2010 for explanation), of each of the MUs in DU1 was evaluated on the basis of available information and expert opinion (Table 1).

Kettle Falls – Island Falls GS (MU1)

No historical harvest records for Lake Sturgeon specific to MU1 are available. In recent decades, very small numbers have been caught by local fishers (Cleator *et al.* 2010). The current population status and trajectory of Lake Sturgeon in MU1 are unknown (Table 1).

Island Falls GS – Missi Falls CS (MU2)

Historical and recent records for Lake Sturgeon are more common for MU2 than MU1. By the 1980s, it was believed that Lake Sturgeon in this MU belonged to a remnant population and the most recent information available shows the few Lake Sturgeon reported are very large and probably very old. The status and population trend of Lake Sturgeon in MU2 are critical and unknown, respectively (Table 1).

Lower Churchill River below Missi Falls CS (MU3)

There are estimated to be at least 1,300 mature individuals in the lower Churchill River on the basis of a mark-recapture study conducted within a 28 km reach, at the confluence of the Churchill and Little Churchill rivers, in 2003 (Cleator *et al.* 2010). The status and population trajectory of Lake Sturgeon in MU3 are cautious and unknown, respectively (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).

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. Spawning is known to occur in the Little Churchill River.

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 of ≤ 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 distribution of Lake Sturgeon in DU1 was almost certainly affected by the construction and operation of the Missi Falls CS and associated diversion. While access to Lake Sturgeon habitat may have increased in MU2, MU3 underwent significant dewatering in 1976-77 which almost certainly caused a decline in the quantity and quality of Lake Sturgeon habitat there. It is essential that conditions that optimize the survival and recovery of Lake Sturgeon be maintained in DU1, 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 DU1 is to protect and maintain healthy, viable populations of Lake Sturgeon in all MUs within the Churchill River system. To reach this goal, each MU must have at least 586 spawning females each year (i.e., 5,860 adults) and at least 974 ha of suitable riverine habitat or 1,948 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 DU1. If a less precautionary recovery target is chosen, the number of spawning females per year would be reduced and years to recovery increased accordingly.

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 three Lake Sturgeon MUs in DU1 was evaluated on the basis of available information and expert opinion (Table 1). In MU1, the potential for recovery of Lake Sturgeon and the importance of the MU to recovery in DU1 are both unknown as there is no scientific knowledge currently available (Table 1). No population estimate is available for MU2 but local knowledge and test netting indicates that it currently contains only a few Lake Sturgeon, thus recovery should be possible albeit slow. The potential for recovery is thought to be moderate and importance of MU2 to recovery high. MU3 likely contains at least 1,300 adult Lake Sturgeon but the population trajectory is unknown. The lower Churchill River below Missi Falls CS underwent significant dewatering since 1976-77 as a result of the Diversion. Recovery of Lake Sturgeon in MU3 may not be possible due to low

[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.

flows, thus recovery potential is low, but the importance of MU3 to recovery in DU1 is thought to be high (Table 1).

Threats to Survival and Recovery

Mortality, injury or reduced survival resulting from fishing activities can pose a threat to Lake Sturgeon. In DU1, the Lake Sturgeon was commercially fished intermittently during the first half of the twentieth century, after which catches declined and only sporadic catches were reported despite continued fishing effort. The high market value and vulnerability of Lake Sturgeon to the fishery led to over-exploitation from which they have not recovered. Aboriginal subsistence fishing may still occur throughout most of the DU but harvest records are not available. Sport fisheries also continue but any captured individuals must be released. Although the current levels of legal harvesting may be low, Lake Sturgeon populations are sensitive to the removal of juveniles and adults (Cleator *et al.* 2010).

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).

The Island Falls GS and Missi Falls CS have been in operation in DU1 for decades. Island Falls GS, located near Sandy Bay, began operation in 1930. The Missi Falls CS, at the eastern end of Southern Indian Lake (Manitoba), went into operation in 1976 causing the lake to increase about 3 m in depth and about 85% of the water that normally flowed into Southern Indian Lake and out through the Churchill River to be diverted into the Burntwood and Nelson rivers system (Cleator *et al.* 2010) (Figure 2). The Churchill River Diversion resulted in significant dewatering of MU3 (below the Missi Falls CS), from 33,000 cubic feet per second (cfs) to approximately 500 cfs, and mercury contamination in the lower reaches of MU2 (above the CS) resulting from the flooding of terrestrial vegetation (DFO 2010). The proposed Wintego Dam project in Saskatchewan, which would impound the Churchill River upstream of its confluence with Reindeer River (MU1), may still be under consideration. A proposed GS at Granville Falls (MU2), on the upper Churchill River above Granville Lake, may also be considered in the future.

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. Larger structures, like hydroelectric dams, can also cause direct mortality, injury or reduced survival by entrainment[2], impingement[3] and fish passing downstream through the turbines. However, the intakes of most hydroelectric GSs are covered by bars or grates spaced such that they prevent passage of adult Lake Sturgeon through turbines.

In summary, the most important current threats to survival and recovery of Lake Sturgeon in DU1 are habitat degradation or loss, resulting from dams/impoundments and other barriers, and mortality, injury or reduced survival resulting from domestic/subsistence fisheries (Table 2). The

[2]Entrainment occurs when fish eggs and larvae are taken into a facility's water-intake systems, pass through and back to the water body.
[3]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 DU1. 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 DU1 is most sensitive to harm on early adults, followed by late adults, late juveniles, early juveniles and age-0 (in decreasing order) (Cleator *et al.* 2010). These results highlight the importance of reducing mortality on, and maximizing survival of, adults and late juveniles as the key to recovering this DU. However, the potential for improving survival of 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.

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).

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 DU1, as identified in Table 2, are shown below.

Mitigations and alternatives

Habitat degradation or loss: dams/impoundments and other barriers

- Adjust water management operating conditions of dams/impoundments and other barriers 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.

Mortality, injury or reduced survival: fishing

- Immediate release of bycatch to promote survivability.
- 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.

<u>Enhancements</u>

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 DU1 indicate that once the main causes of population decline are removed, maximum allowable harm should not exceed reductions of 1.0-1.3% in adult survival, 1.8-3.3% in juvenile survival, 6.1% in age-0 survival or 7.4-23.7% in fertility rates (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. There is no known published scientific information for MU1 thus activities that damage or destroy functional components of habitat or negatively affect key life components of the life cycle (e.g., spawning, recruitment and survival) could pose a high to very high risk to survival or recovery of any remaining Lake Sturgeon populations. Available data and expert opinion for MU2 indicate the current status of Lake Sturgeon is critical and population trajectory is unknown, thus harmful activities pose a very high risk to survival or recovery. In MU3, the current status is cautious as dewatering may limit the availability of habitat. The population trajectory and levels of harvest are unknown, so it is not known whether the present harvest is sustainable. Given the paucity of data, harmful activities could pose a high level of risk to survival or recovery in MU3. Allowable harm in DU1 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 DU1 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 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.

Sources of Uncertainty

Age estimates for Lake Sturgeon 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

Three MUs have been identified for DU1: MU1 is located between Kettle Falls and Island Falls GS, MU2 between the Island Falls GS and Missi Falls CS and MU3 between the Missi Falls CS and Hudson Bay.

Over the past century, Lake Sturgeon in DU1 declined significantly in number primarily as a result of over-exploitation from commercial fisheries and degradation or loss of a significant portion of their habitat, especially in the lower Churchill River, as a result of dams/impoundments and other barriers. Limited data indicate there are very low numbers of Lake Sturgeon now present in MU2, and possibly MU1. There are estimated to be at least 1,300 adults in MU3.

Available data and expert opinion indicate the current conservation status of MU1 is unknown, MU2 is critical and MU3 is cautious. Population trajectories of all three MUs are unknown. The potential for recovery in MU1 is not known while MU2 is thought to be moderate and MU3 is low as a result of habitat limitations.

Survival and recovery of Lake Sturgeon in DU1 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 DU1 is to protect and maintain healthy, viable populations of Lake Sturgeon in all MUs within the Churchill River system. To reach this goal, each MU must have at least 586 spawning females each year (i.e., 5,860 adults) and at least 974 ha of suitable riverine habitat or 1,948 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.

The most important current threats to survival and recovery of Lake Sturgeon in DU1 are habitat degradation or loss resulting from dams/impoundments and other barriers, and mortality, injury or reduced survival resulting from domestic/subsistence fisheries. 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 DU1 including protection of spawning and rearing habitat, minimizing activities that cause habitat degradation or loss, rehabilitating habitat in key areas and reducing impacts of the domestic/subsistence fishery 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 negatively affect key life components of the life cycle pose a very high risk to the survival or recovery of Lake Sturgeon in MU2, high to very high risk in MU1 and a high risk in MU3. Research activities should be allowed in DU1 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 DU1 including the governments of Manitoba and Saskatchewan and DFO.

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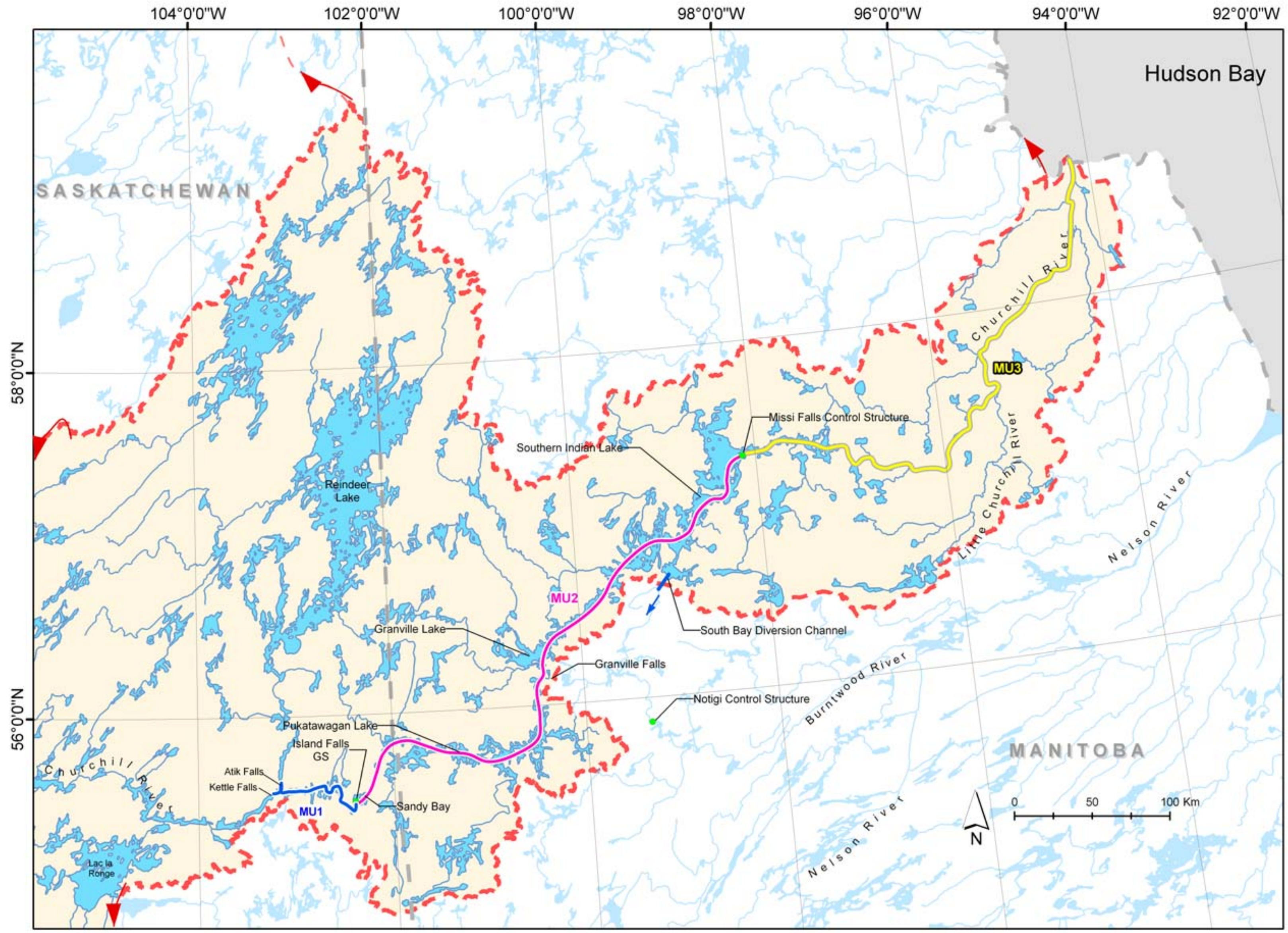

Figure 2. Churchill River system (shaded) within DU1 showing locations of MUs and place names mentioned in the text.

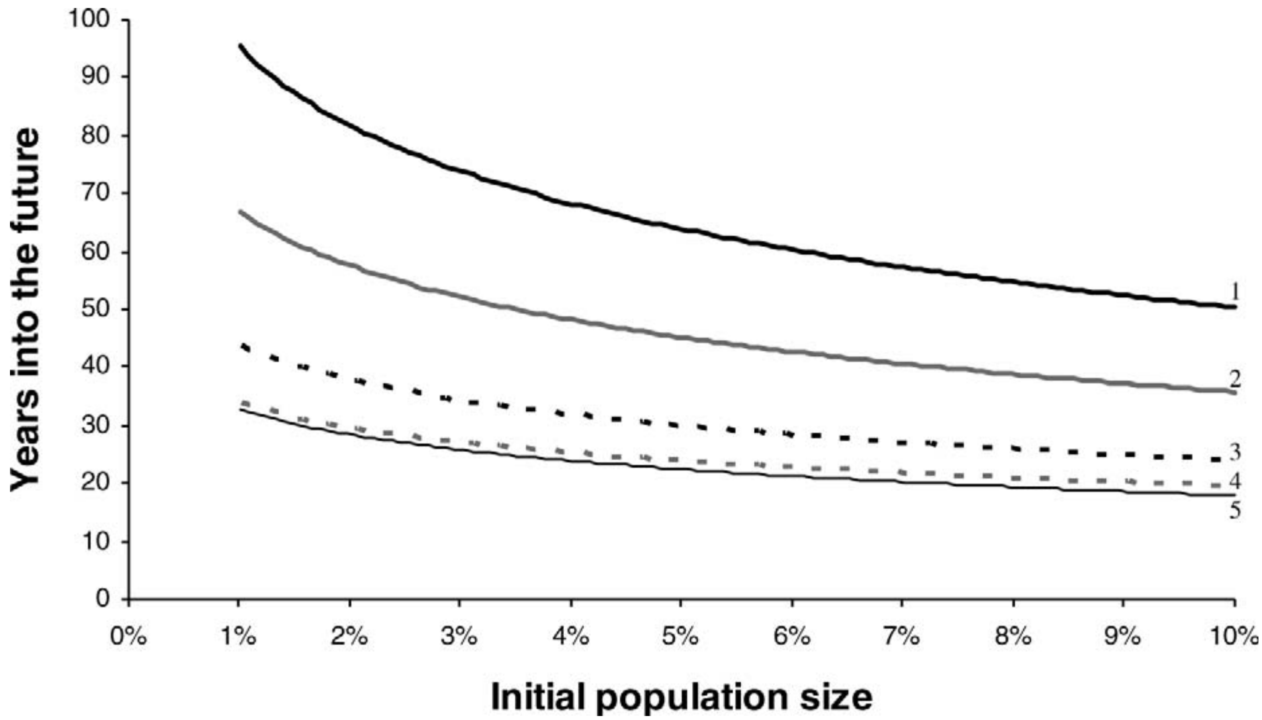

Figure 3. Stochastic projections of times to recovery for Lake Sturgeon based on initial population size (i.e., percentage of MVP) under five different recovery scenarios. Strategy 1 (solid black line) was the maximization of the survival rates of early adults, strategy 2 (solid grey line) added a 10% 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 three Lake Sturgeon Management Units (MUs) in the Churchill River 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 Unknown, Stable, Increasing or Decreasing; importance to species recovery evaluates the importance of the MU to the overall recovery of Lake Sturgeon within DU1. 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. Importance to species recovery and recovery potential were rated as Nil, Low, Moderate, High or Unknown.

MU	Location	Conservation status	Population trajectory	Importance to DU recovery	Recovery potential
1	Kettle Falls – Island Falls GS	Unknown	Unknown	Unknown	Unknown
2	Island Falls GS – Missi Falls CS	Critical	Unknown	High	Moderate
3	Lower Churchill River below Missi Falls CS	Cautious	Unknown	High	Low

Table 2. Current status of threats to Lake Sturgeon in DU1 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, Island Falls GS is included in MU2.

THREATS	Kettle Falls – Island Falls GS	Island Falls GS – Missi Falls CS	Lower Churchill River below Missi Falls CS
	MU1	MU2	MU3
Mortality, injury or reduced survival			
Entrainment, impingement and turbine mortality (e.g., from hydroelectric dams and other barriers, urban or irrigation intakes)	L,L	L,L	L,L
Population fragmentation (e.g., from dams/impoundments and other barriers)	L,L	L,L	L,L
Fishing: commercial net (bycatch)	0,0	0,0	0,0
Fishing: domestic / subsistence	L,M	L,M	H,M
Fishing: recreational / commercial tourism	0,L	L,L	L,L
Fishing: illegal harvest	U,L	L,L	L,L
Habitat degradation or loss[1]			
Dams/impoundments and other barriers (e.g., hydroelectric dams or water control structures)	L,L	H,M[2]	H,H
Industrial activities (including oil and gas, and pulp and paper)	0,0	L,L	L,L
Forestry exploration/ extraction	L,L	L,L	L,L
Mining exploration/extraction	L,L	L,L	L,L
Agricultural activities	0,0	L,L	L,L
Urban development	0,0	L,L	L,L
Sturgeon culture			
Genetic contamination	L,L	L,L	L,L
Disease	L,L	L,L	L,L
Non-indigenous and invasive species	L,L	L,L	L,L
Climate change[3]	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]Includes effects of mercury contamination resulting from the flooding of terrestrial vegetation upstream of the Missi Falls CS.
[3]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 DU1 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%	6.1%
Early juvenile survival	27.3%	3.3%
Late juvenile survival	11.3%	1.8%
Early adult survival	4.3%	1%
Late adult survival		1.3%
Early adult fertility		7.4%
Late adult fertility		23.7%

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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Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2010. Recovery potential assessment of Lake Sturgeon: western Hudson Bay populations (Designatable Unit 1). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/048.