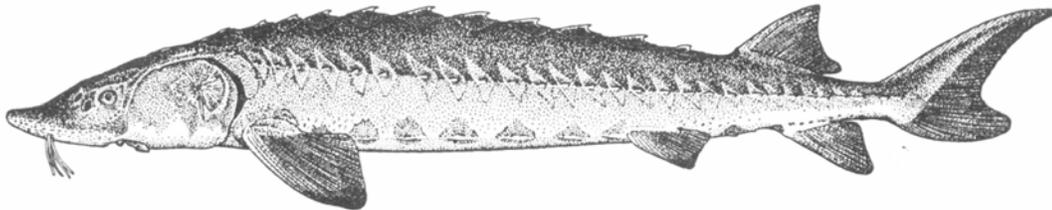


COSEWIC
Assessment and Update Status Report

on the

Lake Sturgeon
Acipenser fulvescens

in Canada



Western Hudson Bay populations – ENDANGERED

Saskatchewan River populations – ENDANGERED

Nelson River populations – ENDANGERED

Red-Assiniboine Rivers-Lake Winnipeg populations – ENDANGERED

Winnipeg River-English River populations – ENDANGERED

Lake of the Woods-Rainy River populations – SPECIAL CONCERN

Southern Hudson Bay-James Bay populations – SPECIAL CONCERN

Great Lakes-Upper St. Lawrence populations – THREATENED

2006

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA



COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

Please note: Persons wishing to cite data in the report should refer to the report (and cite the author(s)); persons wishing to cite the COSEWIC status will refer to the assessment (and cite COSEWIC). A production note will be provided if additional information on the status report history is required.

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Previous report:

Houston, J.J.P. 1986. COSEWIC status report on the lake sturgeon *Acipenser fulvescens* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-32 pp.

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The status report to support the May 2005 COSEWIC re-assessments of the Lake Sturgeon (*Acipenser fulvescens*) (Western populations, Lake of the Woods- Rainy River populations, Southern Hudson Bay-James Bay populations, Great Lakes-Upper St. Lawrence populations) was not made available following the 2005 assessment.

In November 2006, COSEWIC reassessed again the Lake Sturgeon (*Acipenser fulvescens*) (Western Hudson Bay populations, Saskatchewan River populations, Nelson River populations, Red-Assiniboine Rivers-Lake Winnipeg populations, Winnipeg River-English River populations, Lake of the Woods-Rainy River populations, Southern Hudson Bay-James Bay populations, Great Lakes-Upper St. Lawrence populations). The status report was then finalized following the COSEWIC 2006 reassessment.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215

Fax: 819-994-3684

E-mail: COSEWIC/COSEPAC@ec.gc.ca

<http://www.cosewic.gc.ca>

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Lake sturgeon — Drawing by Anker Odum, from Scott and Crossman (1998) used with permission.

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COSEWIC Assessment Summary

Assessment Summary – November 2006

Common name

Lake sturgeon – Western Hudson Bay populations

Scientific name

Acipenser fulvescens (DU1)

Status

Endangered

Reason for designation

A precipitous > 98% decline from 1929-1939 has been followed by a slow, steady decline in the Churchill River to the point that records of mature individuals are almost non-existent in the past five years. Historically, overexploitation probably was the primary threat; more recently, dams are probably the most important threat.

Occurrence

Saskatchewan, Manitoba

Status history

The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Western populations" unit was designated Endangered. In November 2006, when the Western populations unit was split into five separate populations, the "Western Hudson Bay populations" unit was designated Endangered. Last assessment based on an update status report.

Assessment Summary – November 2006

Common name

Lake sturgeon – Saskatchewan River populations

Scientific name

Acipenser fulvescens (DU2)

Status

Endangered

Reason for designation

Seventy-six of 111 historic sites in Saskatchewan and Alberta have been lost and there has been an 80% decline reported in the Cumberland House area from 1960-2001. A 50% decline from 1998 to 2003 has also been reported in the lower Saskatchewan River from Cumberland House to The Pas in Manitoba.

Occurrence

Alberta, Saskatchewan, Manitoba

Status history

The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Western populations" unit was designated Endangered. In November 2006, when the Western populations unit was split into five separate populations, the "Saskatchewan River populations" unit was designated Endangered. Last assessment based on an update status report.

Assessment Summary – November 2006**Common name**

Lake sturgeon – Nelson River populations

Scientific name

Acipenser fulvescens (DU3)

Status

Endangered

Reason for designation

Portions of this designatable unit sustained large commercial fisheries from the early to mid-1900s, during which time there were dramatic declines in landings. More recently, a fishery at Sipiwesk Lake exhibited an 80-90% decline in landings from 1987-2000; and groups of 5-6 spawning fish were observed in the Landing River in 1990 compared to 100s observed several decades ago. Historically, overexploitation probably was the primary threat; more recently, dams probably are the most important threat.

Occurrence

Manitoba

Status history

The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Western populations" unit was designated Endangered. In November 2006, when the Western populations unit was split into five separate populations, the "Nelson River populations" unit was designated Endangered. Last assessment based on an update status report.

Assessment Summary – November 2006**Common name**

Lake sturgeon – Red-Assiniboine Rivers – Lake Winnipeg populations

Scientific name

Acipenser fulvescens (DU4)

Status

Endangered

Reason for designation

A very large commercial fishery existed between the late 1800s and early 1900s. Since then (i.e. in the last 3-5 generations), the species has virtually disappeared from the Red-Assiniboine River and Lake Winnipeg. This was primarily the result of overfishing, although dams probably also affect remnant populations.

Occurrence

Saskatchewan, Manitoba and Ontario

Status history

The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Western populations" unit was designated Endangered. In November 2006, when the Western populations unit was split into five separate populations, the "Red-Assiniboine rivers – Lake Winnipeg populations" unit was designated Endangered. Last assessment based on an update status report.

Assessment Summary – November 2006**Common name**

Lake sturgeon – Winnipeg River – English River populations

Scientific name

Acipenser fulvescens (DU5)

Status

Endangered

Reason for designation

Historically, populations in this designatable unit supported a large commercial fishery. However, there are limited historical and recent data. The limited recent data available show that populations are declining in the Winnipeg River above Seven Sisters Dam, and essentially have disappeared below the dam. Historically, overexploitation probably was the primary threat; now dams and poaching probably are the most important threats.

Occurrence

Ontario, Manitoba

Status history

The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Western populations" unit was designated Endangered. In November 2006, when the Western populations unit was split into five separate populations, the "Winnipeg River – English River populations" unit was designated Endangered. Last assessment based on an update status report.

Assessment Summary – November 2006**Common name**

Lake sturgeon – Lake of the Woods – Rainy River populations

Scientific name

Acipenser fulvescens (DU6)

Status

Special Concern

Reason for designation

Historically, populations in this designatable unit supported a substantial commercial fishery. Although this led to a severe decline, recovery has been sustained since 1970. Dams have not impeded access to important stretches of suitable habitat, but do restrict immigration from the adjacent Winnipeg River.

Occurrence

Ontario

Status history

The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Lake of the Woods – Rainy river populations" unit was designated Special Concern. Status re-examined and confirmed in November 2006. Last assessment based on an update status report.

Assessment Summary – November 2006

Common name

Lake sturgeon – Southern Hudson Bay – James Bay populations

Scientific name

Acipenser fulvescens (DU7)

Status

Special Concern

Reason for designation

There are limited population data available for populations in this designatable unit and there have been declines in habitat and possibly abundance for some population components related to exploitation and the multitude of dams. The increased access to relatively unimpacted populations and the likelihood of increased hydroelectric development in some areas are causes for concern for this designatable unit.

Occurrence

Manitoba, Ontario, Quebec

Status history

The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Southern Hudson Bay – James Bay populations" unit was designated Special Concern. Status re-examined and confirmed in November 2006. Last assessment based on an update status report.

Assessment Summary – November 2006

Common name

Lake sturgeon – Great Lakes – Upper St. Lawrence populations

Scientific name

Acipenser fulvescens (DU8)

Status

Threatened

Reason for designation

A very large commercial fishery existed in the Great Lakes between the mid-1800s and early 1900s (i.e. 2-3 generations ago) during which time populations of this species were reduced to a small fraction of their original size, and appear to be still at very low levels. Populations appear to be declining in parts of the Ottawa River, and disappearing from many of its tributaries due to dams. There has been a recent decline in the population in the St. Lawrence River probably due to over-exploitation despite recovery efforts. The direct and indirect effects of dams, chemical control of sea lamprey, contaminants and invasive species currently threaten populations.

Occurrence

Manitoba, Ontario, Quebec

Status history

The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Great Lakes - Upper St. Lawrence populations" unit was designated Special Concern. Status re-examined and designated Threatened in November 2006. Last assessment based on an update status report.



COSEWIC
Executive Summary

Lake Sturgeon
Acipenser fulvescens

Species information

Description

The sturgeon family (Acipenseridae) contains 24 species, five of which are found in Canadian waters. Four of these are anadromous (spending part of the life cycle in freshwater and part in marine environments) and one, the lake sturgeon, is found only in fresh water. This species is one of Canada's largest freshwater fishes with an extended snout, ventral mouth with four pendulous barbels, and a body covering of hard scutes and smaller denticles, rather than scales. This species reaches an age in excess of 100 years, lengths of up to 3 m and weights up to 180 kg.

Designatable units

Based on the freshwater ecological areas used by COSEWIC and published genetic studies, eight designatable units were identified:

Western Hudson Bay (DU1);
Saskatchewan River (DU2);
Nelson River (DU3);
Red-Assiniboine Rivers – Lake Winnipeg (DU4);
Winnipeg River – English River (DU5);
Lake of the Woods – Rainy River (DU6);
Southern Hudson Bay – James Bay (DU7); and
Great Lakes – Upper St. Lawrence (DU8).

Habitat

Habitat requirements

The lake sturgeon exists, for the most part, as a freshwater species, being found rarely in brackish water in larger rivers with access to the sea. Lake sturgeon are generally found in the shallow areas of lakes or larger rivers, moving into smaller rivers to spawn. They are a benthic (bottom dwelling) species that feeds over substrates of

mud, sand or gravel. Lake sturgeon usually are found at depths of 5-10 m, but are found consistently in water deeper than 10 m in the Winnipeg River. Lake sturgeon are found in areas where water velocity does not exceed 70 cm/sec. Spawning sites usually are fast-flowing waters of 0.6-5 m in depth over hardpan clay, sand, gravel, rubble, cobble or boulders. Young-of-the-year have been observed resting on sand bars.

Habitat trends

Habitat degradation and fragmentation from dam construction, including impoundments, have led to the loss of spawning sites and suitable rearing habitat throughout many parts of its range. Industrial pollution, agricultural runoff and siltation also have degraded and eliminated lake sturgeon spawning sites throughout its Canadian range.

Biology

General

The lake sturgeon is a large, long-lived, late-maturing species. Females generally are larger than males; however, there is a downward trend in size and age of both sexes wherever lake sturgeon are harvested.

Reproduction

Age at sexual maturity varies, but generally ranges from 18-20 years for males and 20-28 years for females. On average, males spawn every second year, and females every fourth to sixth year, in the spring when water temperatures reach 10-18°C. Fecundity depends on size of the female; the number of eggs laid ranging from 50,000 to in excess of 1,000,000. The eggs hatch in 7-10 days and the larvae are negatively buoyant until formation of the swim bladder, about 60 days post-hatch. Larval drift occurs at night and begins about 2 weeks after the first spawning activities.

Survival

Larval and juvenile mortalities are high and few survive to adulthood. Adult mortality is low in areas not impacted by anthropogenic influences. Laboratory studies suggest that environmental modifications, through changes in habitat, could alter the type and quantity of food available and, consequently, have a detrimental effect on lake sturgeon survival.

Physiology

Lake sturgeon are adapted to water temperatures ranging from 3-24°C and can utilize, at least temporarily, habitats with suboptimal levels of oxygen. Lake sturgeon

have been reported from Canadian estuaries and occasionally enter the brackish waters of Hudson Bay and Gulf of St. Lawrence.

Movements/Dispersal

Seasonal movements are not well known, but lake sturgeon probably move from shallower to deeper waters to avoid warmer temperatures in summer, returning to the shallows when temperatures decline in winter. Movements seem limited except for spawning migrations that can exceed distances of over 100 km; however, strong site fidelity is thought to occur with many spawning fish returning to the same sites year after year, although the occasional fish may wander from lake to lake to spawn.

Nutrition and interspecific interactions

Lake sturgeon feed on a wide variety of benthic fauna depending on seasonal and spatial availability as well as the nature of the benthos over which lake sturgeon feed. Adult lake sturgeon have few natural predators, for example, the incidence of lamprey scarring is rare in the Great Lakes and St. Lawrence River. Larval and juvenile lake sturgeon are preyed upon by other fish species. A number of parasites have been reported; however, none seem to be limiting lake sturgeon populations.

Behaviour/Adaptability

Lake sturgeon do not adapt readily to change, whether from exploitation or from habitat alterations.

Population sizes and trends

Within the last 3 generations (generation time for sturgeon is in the order of 35 to 54 years), lake sturgeon populations were severely reduced and in some cases extirpated in the southern part of the range primarily as a result of commercial overexploitation. More recently, some southern populations have shown some signs of recovery, but with the possible exception of Lake of the Woods and the St. Lawrence River, to nowhere near their historic level of abundance. Other southern populations remain at remnant levels, or are extirpated. Little historic and recent data on population sizes are available for northern populations around Hudson and James bays. The data available do suggest that unexploited northern populations may be relatively stable, but that exploited populations show the same pattern of decline as evidenced elsewhere throughout the range.

Limiting factors and threats

Limiting factors for lake sturgeon probably are related to climate, hydrology, and water temperature and chemistry. Threats include overexploitation (including poaching), dams, contaminants, habitat degradation and introduced species.

Special significance of the species

The lake sturgeon is one of the largest freshwater fish species in Canada. It, like all sturgeons, is a living fossil, and retains the cartilaginous skeleton and shark-like caudal fin of its ancestors of the Devonian period. In North America, lake sturgeon were scorned by the early settlers as a nuisance species, but commercial markets for smoked, dried, and fresh fish quickly developed after 1860 and peaked by 1900. In addition to its value as food, including caviar, the sturgeon was a source of oil, leather and isinglass (Harkness and Dymond 1961). The lake sturgeon always has been of special significance to Native peoples. Elders report that the sturgeon was a primary food source and was used in its entirety: five kinds of meat were obtained and other important products produced included containers made from skins, glue from swim bladders, paint binding agents, scrapers from scutes, and arrowheads from tail bones. To the Aboriginal groups of the eastern forests, the nutritional, material and spiritual significance of the sturgeon was analogous to the relationship between bison and tribes of the western plains. Lake sturgeon are long-lived and are thought to have a strong site fidelity for spawning and other habitat requirements making them sensitive indicators of the health of aquatic environments.

Existing protection or other status designations

The management of lake sturgeon and its habitat in Canada is through regulations pursuant to the *Fisheries Act*. Throughout its range in Canada, the lake sturgeon commercial, recreational and Aboriginal fisheries have been subject to special regulation. Currently, all 24 species of sturgeon in the world, including lake sturgeon, are considered to be at risk, and are listed on Appendix II of the Convention for International Trade in Endangered Species of Wild Fauna and Flora (CITES).



COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2006)

| | |
|------------------------|---|
| Wildlife Species | A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years. |
| Extinct (X) | A wildlife species that no longer exists. |
| Extirpated (XT) | A wildlife species no longer existing in the wild in Canada, but occurring elsewhere. |
| Endangered (E) | A wildlife species facing imminent extirpation or extinction. |
| Threatened (T) | A wildlife species likely to become endangered if limiting factors are not reversed. |
| Special Concern (SC)* | A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats. |
| Not at Risk (NAR)** | A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances. |
| Data Deficient (DD)*** | A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction. |

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



| | |
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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

**Update
COSEWIC Status Report**

on the

Lake Sturgeon
Acipenser fulvescens

in Canada

T.A. Dick
R.R. Campbell
N.E. Mandrak
B. Cudmore
J.D. Reist
J. Rice
P. Bentzen
P. Dumont

2006

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SPECIES INFORMATION

Name and classification

Class: Actinopterygii
Order: Acipenseriformes
Family: Acipenseridae
Genus: *Acipenser*
Scientific name: *Acipenser fulvescens* Rafinesque 1817 (Nelson *et al.* 2004)
Common name: English: Lake Sturgeon (Nelson *et al.* 2004)
French: *esturgeon jaune* (Nelson *et al.* 2004)

Other common names:

English: Rock, Common, Red, Ruddy, Ohio, Shell-back, Bony, Freshwater, Smooth-back, Rubbernose, Black, Dog Face, Bull-nosed and Great Lakes Sturgeon.
French: camus for adults; escargot, maillé and charbonnier for juveniles.

The phylogeny and biogeography of the sturgeon family (Acipenseridae) have been reviewed by Bemis *et al.* (1997) and Choudhury and Dick (1998). The family contains 24 species, five of which are found in Canadian waters (Scott and Crossman 1998). Four of these species are anadromous (spending part of the life cycle in freshwater and part in marine environments) and one, the lake sturgeon (Figure 1), lives almost exclusively in freshwater and is one of Canada's largest freshwater fish (white sturgeon, *Acipenser transmontanus*, may attain greater size, but some populations may be anadromous). Roussow (1955a) recognized two forms or morphs, brown or lake sturgeon, *A. fulvescens acutirostris*, and the black or rock sturgeon, *A. f. obtusirostris*; however, these subspecific names are not valid as they have been used for forms of *A. ruthenus* Linnaeus 1758 and are unavailable as names for all other species (Eschmeyer 2005).

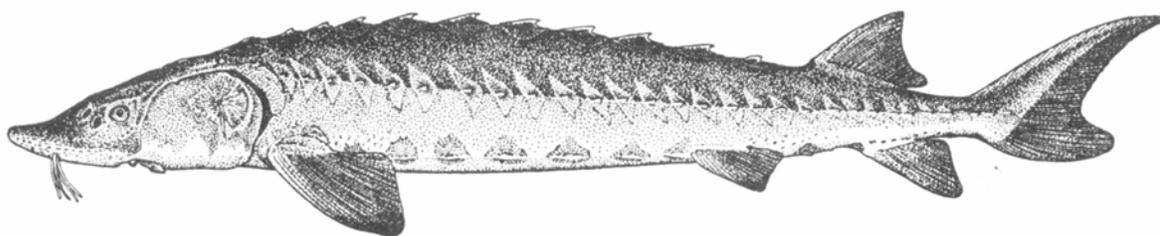


Figure 1. Lake sturgeon, *Acipenser fulvescens*, 76 cm; St. Lawrence River, Leeds County, Ontario, May 19-20, 1968. ROM 25887. Drawing by Anker Odum, from Scott and Crossman (1973) used with permission.

Description

Sturgeons, as a group, are little altered from their ancestral form. They are cartilaginous, dorso-ventrally flattened bottom-dwelling fishes. Conspicuous external bony scutes are very pronounced on larval and juvenile sturgeon, but are less pronounced in larger fishes, as they become embedded in the body wall. Lake sturgeon have a ventral mouth, a pointed snout and four pendulous barbels that are used to sense the environment and to locate food (Harkness and Dymond 1961). They also are characterized by a heterocercal tail and ganoid scales along the caudal fin (Scott and Crossman 1998). Generally, lake sturgeon are dark to light brown or grey in colour on the back and sides, with a lighter coloured belly, but other names using a colour designation include red, ruddy or black with the black sturgeon often referred to as river sturgeon by Aboriginal Elders. Older lake sturgeon generally are a uniform brown colour, while younger sturgeon may have irregular black patches on a brown background. They have a characteristic large, thick-walled swim bladder that helps maintain buoyancy. However, unlike other fishes where the swim bladder develops within the first few days post-hatch, formation of the lake sturgeon swim bladder occurs up to 60 days post-hatch (T.A. Dick, Department of Zoology, University of Manitoba, Winnipeg, MB; unpublished data). On hatching, lake sturgeon have a rounded head end, lack a snout and mouth parts and are negatively buoyant. As the snout develops, mouthparts and microscopic teeth form (Dick 1995).

The largest lake sturgeon recorded was taken in the Roseau River of Manitoba, weighing 185 kg and was estimated to be 4.6 m in length (Waddel 1970; Stewart and Watkinson 2004). The oldest lake sturgeon recorded, caught in Lake of the Woods, Ontario, was determined to be 154 years old and weighed 94 kg (Mackay 1963). Today, the largest lake sturgeon usually are less than 40 kg (Scott and Crossman 1998).

Designatable units

The identification of designatable units in lake sturgeon was assessed based on the four criteria identified by COSEWIC (2003).

Criterion 1) Named Subspecies or Varieties

Lake sturgeon are morphologically diverse and some colour variants have been formally named to the subspecific level; however, these subspecies are not considered to be valid (Scott and Crossman 1998). Numerous local names imply great phenotypic difference, but no formal studies have been conducted. Observations have confirmed the traditional knowledge of Elders that black sturgeon are more common in rivers, and the off-white phenotype occurs with greater frequency in lakes and river mouths (H. Mackay, Elder, Berens River, MB; personal communication). According to Elders, the off-white phenotypes are rare, and the white phenotype is even rarer occurring at a rate of one fish in 20,000 (R. Bruch, Wisconsin Department of Natural Resources Oshkosh, WI; personal communication). This phenotype now may be absent from many Canadian populations due to population declines, fragmentation and extirpations.

To date, these rare white phenotypes have been found only in the Pigeon and Winnipeg rivers (Dick, *et al.* 2003). Clearly, traditional and local knowledge indicates that phenotypic differences have been observed for a long time between river and large lake populations, but these probably represent differences at the level of life history types rather than formal subspecies. Therefore, no formal basis exists for designatable units at the subspecific level.

Criterion 2) Units Identified as Genetically Distinct

Studies of mitochondrial DNA (mtDNA) variation in lake sturgeon have revealed low haplotype diversity. Guénette *et al.* (1993) detected three restriction site haplotypes in a study of lake sturgeon from Quebec. Haplotype frequencies did not differ significantly among the sites in the St. Lawrence River drainage (St. Lawrence River, Ottawa River, Lac des Deux Montagnes), or between these sites and the Waswanipi River in the James Bay drainage, possibly because sample sizes were small (8-12 fish per location). Ferguson *et al.* (1993) also detected two mtDNA haplotypes in the Moose River basin (James Bay drainage) in Ontario. Haplotype frequencies did not vary significantly among several locations in the drainage, including the Mattagami, Groundhog and Abitibi Rivers, but were significantly different in the North French River, suggesting the presence of a distinct population in this tributary. Ferguson and Duckworth (1997) used the same approach to study mtDNA variation across a much broader geographic region, including Moose River basin and Waswanipi River (James Bay drainage), Lower Nelson River and Rainy River (Hudson Bay drainage), and 10 locations in the Great Lakes – St. Lawrence drainage ranging from the Sturgeon River (Lake Superior) to Québec City. Again, two haplotypes accounted for the great majority of samples; southern populations were made up almost exclusively of haplotype 1, whereas the three northern populations (Waswanipi, Moose and Lower Nelson Rivers) exhibited a mix of haplotypes 1 and 2. The authors suggested this distribution of haplotypes reflected differential dispersal of sturgeon from two glacial refugia, Mississippian (haplotype 1) and Missourian (haplotype 2).

Studies of variation at nuclear microsatellite loci have detected much more diversity within and among lake sturgeon populations. For example, a recent study of variation at three microsatellite loci found that populations of lake sturgeon from the Saskatchewan, Nelson, Winnipeg and Rainy rivers represent genetically distinguishable populations (Robinson and Ferguson 2001; M. Robinson, Department of Zoology, University of Guelph, Guelph, ON; personal communication). The three microsatellite loci exhibited moderately high levels of polymorphism, with 7-10 alleles per locus and mean expected heterozygosities within population samples of 0.60-0.74. Pairwise population differentiation tests based on genic and genotype frequencies, and pairwise F_{ST} tests detected significant differences ($p < 0.001$) between the river systems tested, but not between samples within river systems (Robinson and Ferguson 2001). Estimates of pairwise F_{ST} between river systems ranged from 0.016 between the Nelson and Winnipeg Rivers to 0.110 - 0.178 between Lake of the Woods and locations in the Saskatchewan River (Table 1).

Table 1a. Genetic characteristics of microsatellite loci analyzed in adult lake sturgeon from Canadian Rivers. Populations are listed by province; all locations for Saskatchewan are in the Saskatchewan River system. N_{FISH} refers to the number of fish analyzed per locus per population. H_{OBS} and H_{EXP} refer to the observed and expected frequencies of heterozygotes [reproduced from Robinson and Ferguson (2001) by permission].

| Locus & Characteristic | Populations Sampled | | | | | | | | | Totals |
|---|---------------------|----------|-----------|-------------|--------------|--------------|---------------|------------|-----------|---------|
| | Ontario | | Manitoba | | | Saskatchewan | | | | |
| | L. Woods | Rainy R. | Nelson R. | Winnipeg R. | Sask. R. Pas | Torch River | Bigstone Rap. | C. Angling | The Forks | |
| AFU 68 | | | | | | | | | | |
| N_{FISH} | 25 | 40 | 50 | 50 | 33 | 14 | 24 | 46 | 40 | 322 |
| N_{ALLELES} | 4 | 6 | 5 | 5 | 4 | 4 | 6 | 5 | 5 | |
| Size Range (bp) | 115-135 | 115-135 | 115-139 | 111-135 | 115-135 | 115-135 | 111-135 | 111-135 | 111-135 | 111-139 |
| H_{OBS} | 0.1600 | 0.1429 | 0.3800 | 0.5000 | 0.6061 | 0.4286 | 0.6538 | 0.5200 | 0.5750 | |
| H_{EXP} | 0.3224 | 0.3176 | 0.5012 | 0.4800 | 0.6979 | 0.7064 | 0.6677 | 0.5800 | 0.7423 | |
| AFU 68b | | | | | | | | | | |
| N_{FISH} | 25 | 42 | 50 | 50 | 33 | 14 | 26 | 50 | 40 | 330 |
| N_{ALLELES} | 6 | 7 | 7 | 8 | 7 | 5 | 7 | 8 | 6 | |
| Size Range (bp) | 168-196 | 168-196 | 160-202 | 160-202 | 160-202 | 160-188 | 160-192 | 160-202 | 160-192 | 160-202 |
| H_{OBS} | 0.7600 | 0.6667 | 0.8000 | 0.8000 | 0.6061 | 0.5000 | 0.5769 | 0.6600 | 0.5500 | |
| H_{EXP} | 0.7168 | 0.7443 | 0.7470 | 0.7762 | 0.7048 | 0.5293 | 0.5104 | 0.6074 | 0.5538 | |
| SPL 120 | | | | | | | | | | |
| N_{FISH} | 25 | 42 | 50 | 50 | 33 | 14 | 26 | 50 | 40 | 330 |
| N_{ALLELES} | 7 | 6 | 8 | 6 | 5 | 5 | 5 | 5 | 5 | |
| Size Range (bp) | 252-288 | 252-284 | 248-288 | 252-284 | 252-284 | 252-284 | 252-284 | 252-284 | 252-284 | 248-288 |
| H_{OBS} | 0.8800 | 0.6667 | 0.8000 | 0.8000 | 0.8788 | 0.7857 | 0.8077 | 0.8200 | 0.6250 | |
| H_{EXP} | 0.7884 | 0.7236 | 0.7946 | 0.7412 | 0.7897 | 0.7007 | 0.7700 | 0.7900 | 0.7355 | |
| MEAN H_{OBS} | 0.6000 | 0.4921 | 0.6600 | 0.7000 | 0.6970 | 0.5714 | 0.6795 | 0.6667 | 0.5833 | |
| MEAN H_{EXP} | 0.6092 | 0.5952 | 0.6809 | 0.6658 | 0.7308 | 0.6455 | 0.6494 | 0.6591 | 0.6787 | |

Table 1b. Pairwise F_{ST} comparisons between sturgeon population samples.

Population samples are coded as follows: NR = Nelson River, MB, DU3; WR = Winnipeg River, MB, DU5; SC = Saskatchewan River Centre Angling, SK, DU2; SF = Saskatchewan River Forks, SK, DU2; SP = Saskatchewan River Pas, MB, DU2; BR = Saskatchewan River Bigstone Rapids, SK, DU2; LW = Lake of the Woods, ON, DU6; RR = Rainy River, ON, DU6 [reproduced from Robinson and Ferguson (2001) by permission].

| | WR | SC | SF | SP | BR | LW | RR |
|----|---------|---------|---------|---------|---------|---------|---------|
| NR | 0.0163* | 0.0200* | 0.0572* | 0.0285* | 0.0591* | 0.0423* | 0.0171* |
| WR | - | 0.0461* | 0.0974* | 0.0499* | 0.0958* | 0.0624* | 0.0397* |
| SC | - | - | 0.0146 | 0.0030 | 0.0081 | 0.1096* | 0.0660* |
| SF | - | - | - | 0.0097 | 0.0004 | 0.1630* | 0.1176* |
| SP | - | - | - | - | 0.0064 | 0.1066* | 0.0821* |
| BR | - | - | - | - | - | 0.1780* | 0.1353* |
| LW | - | - | - | - | - | - | 0.0062 |

*=Significant at Bonferonni (Rice, 1989) adjusted $p < 0.001786$.

McQuown *et al.* (2003) examined lake sturgeon from six locations in the St. Lawrence/Great Lakes region and the Mattagami River in the Hudson Bay drainage using seven microsatellite loci. Based on a multivariate factor analysis of Nei's (1972) genetic distance they identified three distinct groups: (1) Mattagami; (2) Menominee/Wolf (Lake Michigan-Wisconsin); and (3), St. Lawrence/Des Prairies/Niagara/Erie (lower Great Lakes).

Welsh and McClain (2004) expanded on the McQuown *et al.* (2003) study by analyzing the same samples plus samples from additional locations in Lakes Superior, Huron and Erie with a total of 13 microsatellite markers. This study revealed extensive structuring of sturgeon populations; most locations differed significantly from other spawning locations. Several major groupings were evident, although the group affinities of some populations varied depending on the method of analysis used. The Mattagami River and Rainy River (Hudson Bay drainage) appeared divergent from all St. Lawrence/Great Lakes populations ($F_{ST} = 0.13 - 0.25$). Sturgeon populations within Lake Superior appeared highly diverse and clustered in three groups. One group, the Bad and White Rivers (southern Lake Superior), was relatively divergent from all other Great Lakes populations ($F_{ST} = 0.09 - 0.17$). Three northern Lake Superior tributaries, the Kaministiquia, Black Sturgeon and Pic Rivers formed a distinct cluster in a factorial correspondence analysis, but showed loose affinities with the Mattagami/Rainy and Bad/White clusters in a neighbour-joining analysis of Cavalli-Sforza & Edwards chord distances (see Figures 2 and 3). Two other Lake Superior rivers, the Batchawana and Goulais Rivers, clustered with populations from the other Great Lakes and St. Lawrence River. Within this last group, genetic differentiation was weaker ($F_{ST} = 0.01 - 0.08$) and not significant in all pairwise comparisons, and there was no consistent relationship between genetic distance and geographic distance separating populations; for example, samples from the St. Lawrence River and Rivière Des Prairies (a St. Lawrence tributary) clustered with the Wolf and Menominee Rivers from Lake Michigan (Figures 2, 3).

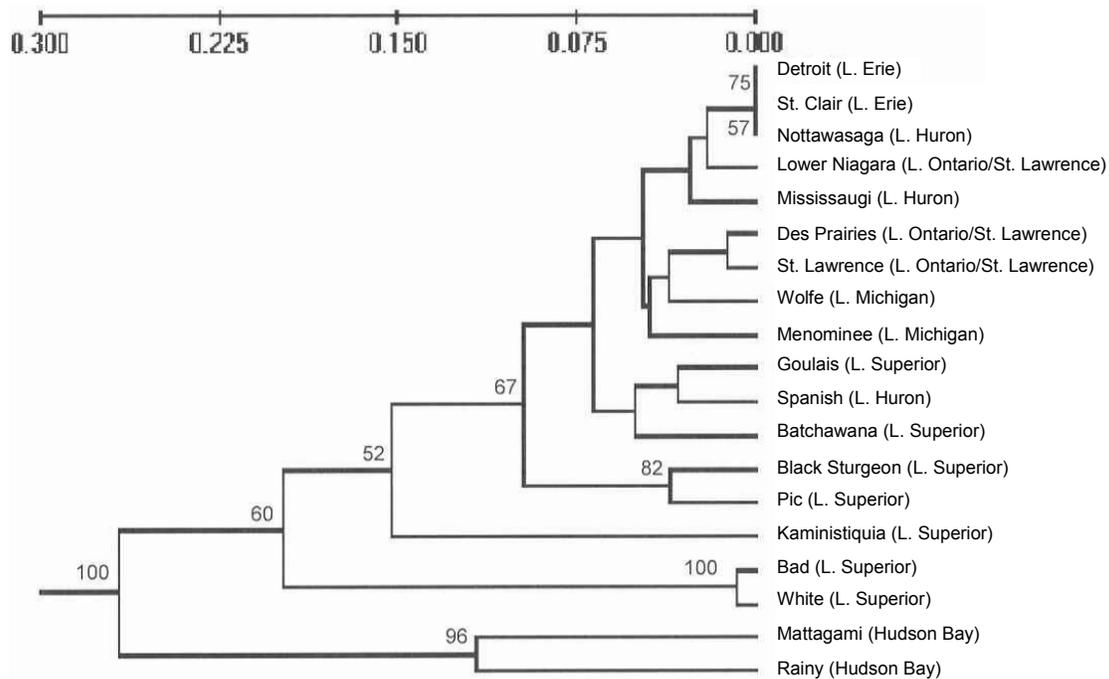


Figure 2. UPGMA tree showing genetically similar groups, based on Nei's unbiased genetic distance (1978). The top scale represents genetic distance values. Numbers correspond to bootstrap values, or the percentage of trees (out of 1000) where the corresponding split in the tree is confirmed. Only bootstrap values greater than 50% are displayed.

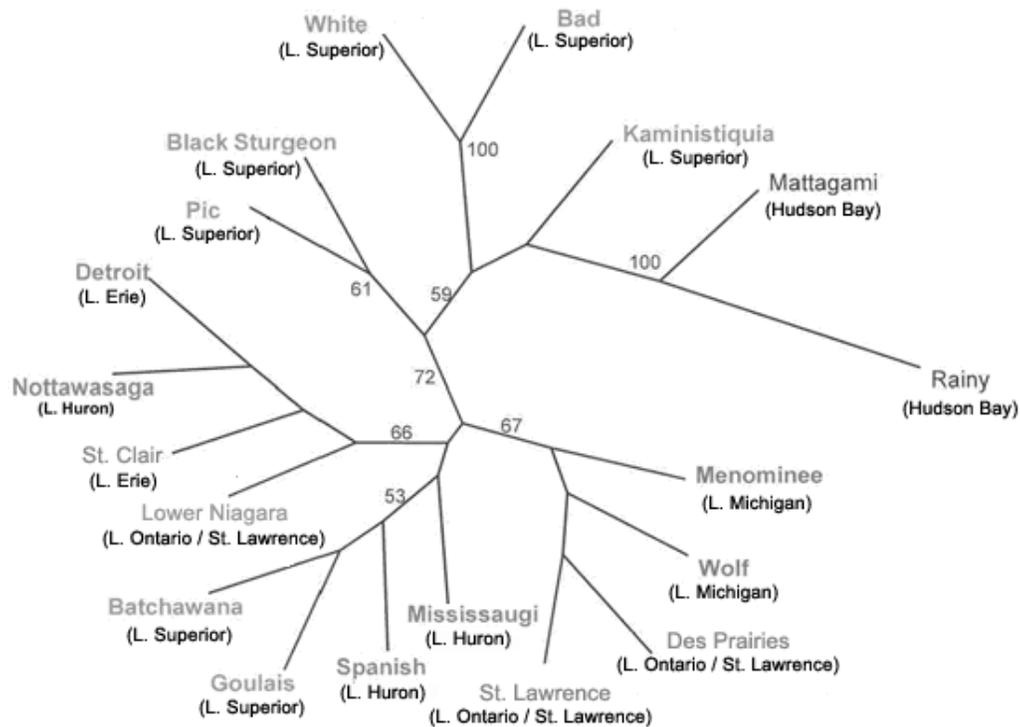


Figure 3. Neighbour-joining tree showing genetically similar groups, based on Cavalli-Sforza and Edwards (1967) chord distance. This tree results from an approach similar to the one used to generate Figure 2 above; however, there are differences between the genetic distance measures and the assumptions used in tree construction. Numbers correspond to bootstrap values, or the percentage of trees (out of 1000) where the corresponding branch on the tree is confirmed. Only bootstrap values greater than 50% are displayed (adapted from Welsh and McLean 2004).

The studies noted above used different suites of genetic markers and surveyed different portions of the geographic range of lake sturgeon. No study has examined lake sturgeon from all river basins or areas within the geographic range of the species with a common set of genetic markers. Inherited traits such as morphology, life history and/or behaviour also can be used to support designatable units under this criterion. Unfortunately, appropriate studies across the geographic range of lake sturgeon are also lacking; however, Fortin *et al.* (1993) suggested that populations probably differ by watershed and that there also may be differentiation of sympatric populations in larger watersheds, a suggestion consistent with the results of the genetic studies cited above.

Because of their fragmented nature, the genetic studies carried out to date on lake sturgeon provide no specific prescription for designatable units across the range of the species, but they do suggest at least one important generality. Populations occurring in different major drainages appear invariably to be genetically distinct from each other. Within drainages, the situation becomes more complex, with evidence of multiple genetically distinguishable populations within some drainages (e.g. Moose River, Saskatchewan/Nelson/Winnipeg/Rainy River complex, Lake Superior), but weak or no differentiation across regions as broad as the lower Great Lakes-St. Lawrence.

Therefore, designatable units could reasonably be defined at the level of major drainages, with the understanding that recognizable sub-units occur within at least some drainages, and that additional genetic information could result in the identification of even more units, or the elevation of particular sub-units to DU status. At the other extreme, arguments could be made for minimal, biologically significant differentiation of units within the species with one or, at best, two groups being recognized [i.e. the species in the first, and the likelihood of two glacial refugial forms in the second instance (see Ferguson and Duckworth 1997)], although definitive studies for the latter option are lacking.

Criterion 3) Units Separated by Major Range Disjunction

Excluding isolation on a local basis as a result of presence in different drainage basins, there are no disjunctions apparent in the geographic range of this species in Canada (Scott and Crossman 1998). Thus, this criterion cannot be used to differentiate designatable units.

Criterion 4) Units Identified as Biogeographically Distinct

Lake sturgeon are found in four of the 14 aquatic ecozones (AE) recognized for Canadian fresh waters (COSEWIC 2003; Figure 4). These are: AE 3 – Southern Hudson Bay-James Bay, AE 4 – Saskatchewan-Nelson, AE 5 – Western Hudson Bay, and AE 10 – Great Lakes-Upper St. Lawrence. Therefore, at least four recognizable designatable units are present within the lake sturgeon range based on this criterion alone.

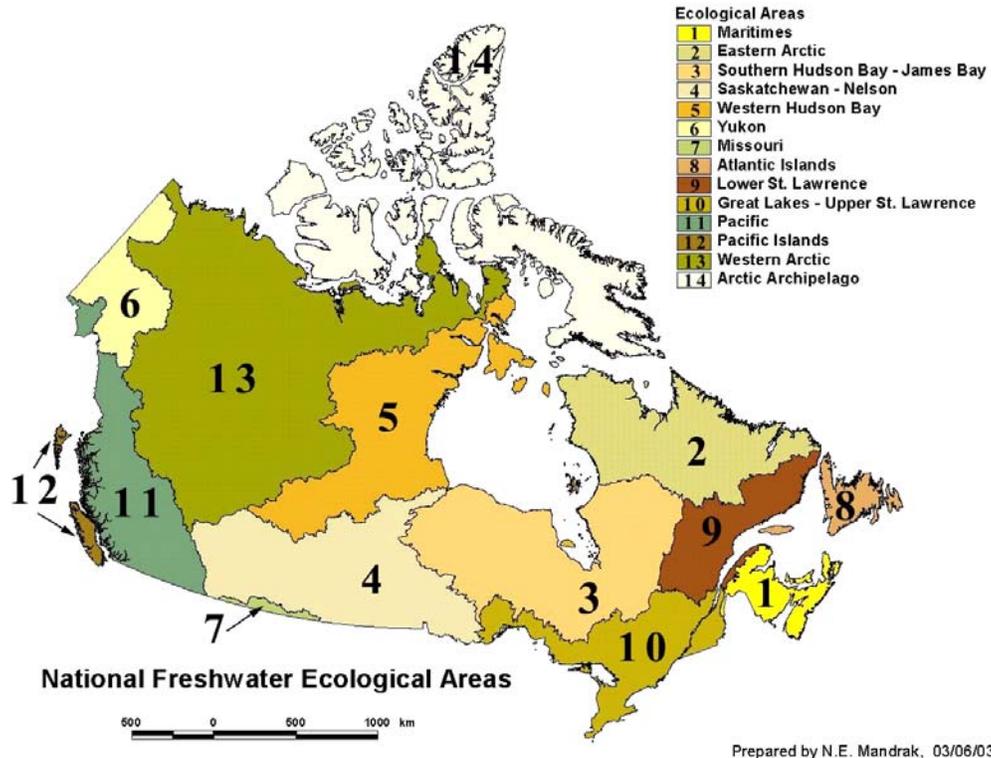


Figure 4. COSEWIC National Freshwater Ecozones (COSEWIC 2003).

Available genetic evidence for lake sturgeon supports the primary separation of designatable units based upon ecozones and tends to further differentiate some units within several of the ecozones. Evidence for designating units within the ecozones is limited primarily by the lack of appropriate studies that include samples from distinct sub-basins of the ecozones. In available studies, a hierarchy of differences typically is found with samples from geographically close locations being less distinct than those from more distant locations within the same river basin. This is consistent with the knowledge available for other freshwater fish species for which better data and sampling coverage exists. Probably, despite the likelihood of long-distance migrations in unimpeded river systems, significant sub-structuring of lake sturgeon occurs within each of the major units designated below. Therefore, eight distinct designatable units are identified (Table 2, Figures 5, 6), but many more undoubtedly are present:

1. Western Hudson Bay;
2. Saskatchewan River;
3. Nelson River;
4. Red-Assiniboine Rivers-Lake Winnipeg;
5. Winnipeg River-English River;
6. Lake of the Woods-Rainy River;
7. Southern Hudson Bay-James Bay; and
8. Great Lakes-Upper St. Lawrence.

Table 2. Structure and composition of designatable units of lake sturgeon.

| DU Ecozone Criterion | | DU (Ecozone + Genetics) | | |
|---|---|--|---|-----------|
| Name | Composition | Name | Composition | DU Number |
| A. Western Hudson Bay | Churchill, and any related rivers in NW/NE Manitoba | Western Hudson Bay | Churchill River | 1 |
| B. Saskatchewan/Nelson/Assiniboine/Red/Churchill Rivers/L. Winnipeg | Saskatchewan/Nelson/Assiniboine/Red/Churchill Rivers including all drainages to L. Winnipeg, Lake of the Woods and all related southern NW drainages of Ontario (Rainy, Winnipeg, etc.) | Saskatchewan River | Saskatchewan R upstream of L. Winnipeg; all drainages west to east-central Alberta | 2 |
| | | Nelson River. | Nelson R. downstream of L. Winnipeg, and all related drainages to Nelson | 3 |
| | | Red-Assiniboine Rivers - Lake Winnipeg | L. Winnipeg, Red, Assiniboine and all eastern tributary rivers to L. Winnipeg (excluding Winnipeg R.) | 4 |
| | | Winnipeg River-English River | Winnipeg R. upstream to Kenora, English-Wabigoon river system | 5 |
| C. Southern Hudson and James Bay | All drainages of northwestern Quebec, Ontario and northeastern Manitoba that drain to Hudson/James bays | Lake of the Woods-Rainy River | All Rainy River, Lake of the Woods tributaries upstream of Kenora | 6 |
| | | Southern Hudson Bay-James Bay | All drainages of Quebec and northern Ontario to Hudson/James bays; Gods and Hayes rivers of northeastern Manitoba | 7 |
| D. Great Lakes/Upper St. Lawrence | All drainages to and including the Great Lakes and L. Nipigon then eastwards to include all tributary systems to St. Lawrence River | Great Lakes- Upper St. Lawrence | All drainages to and including the Great Lakes and St. Lawrence River | 8 |

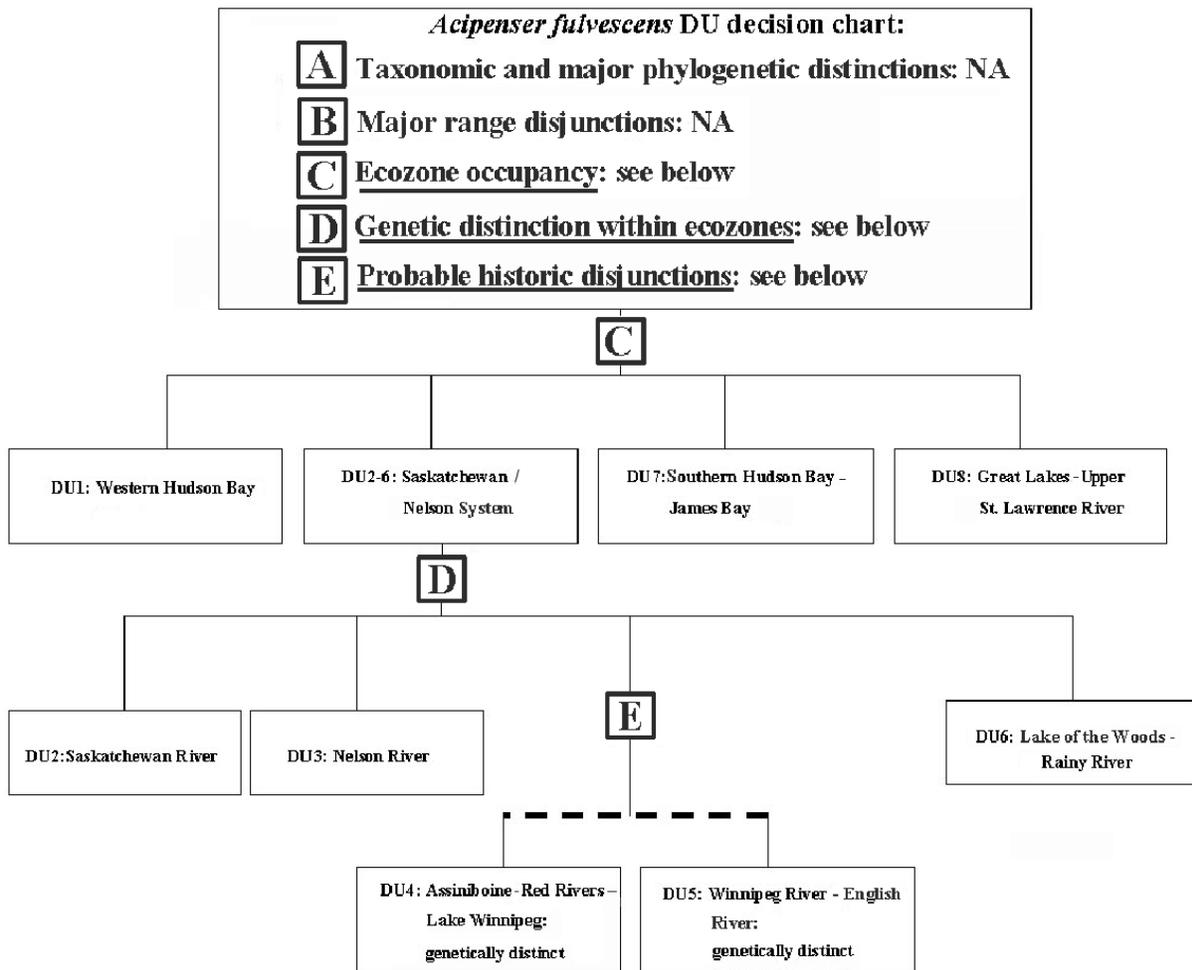


Figure 5. Flow diagram of decisions made in establishing designatable units (DU) in lake sturgeon, *Acipenser fulvescens*. The top box identifies the major criteria (A-C) used to establish DUs using the stepwise procedure in Taylor (2005) and the criteria in the COSEWIC S&P Manual. NA = “not applicable” for decision making (no evidence or data not available). In this chart, DUs were first identified by occupancy in distinctive freshwater ecozones (criterion C) and resulted in DU1, 2-6, 7, and 8. Subsequently, some DUs (e.g., DUs 2, 3, 5, and 6) were established by the presence of significant genetic differentiation within ecozones. DU4 is recognized as distinct from DU5 owing to the presence of dams near the Winnipeg River outlet to Lake Winnipeg that reinforce a probable historical disjunction due to impassable rapids - a hypothesis requiring testing genetically.

Notes: Genetic distinction (criterion D) is based on significant pairwise differences ($P < 0.001$, 3 loci) in microsatellite DNA allele frequencies between DUs 2, 3, 5, and 6. All sample sizes within DUs at least 50 (Robinson and Ferguson 2001). Further details are provided in the status report.

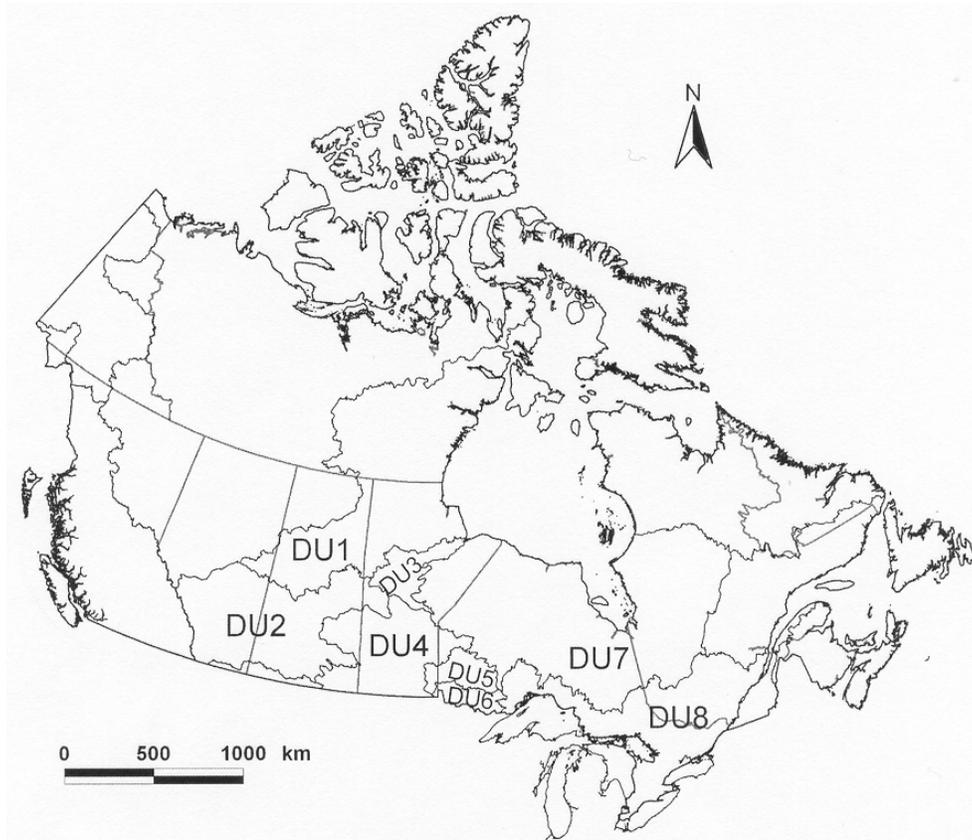


Figure 6. The designatable units used in this report. Dark lines represent divisions between ecozones used by COSEWIC. Light lines represent subdivision of ecozone into further designatable units based on available genetic information. DU1 - Western Hudson Bay; DU2 - Saskatchewan River, DU3 - Nelson River; DU4 - Red-Assiniboine rivers-Lake Winnipeg; DU5 - Winnipeg River-English River; DU6 - Lake of the Woods-Rainy River; DU7 - Southern Hudson Bay-James Bay; DU8 - Great Lakes-Upper St. Lawrence.

The above units are described as follows:

DU1 - Western Hudson Bay

Based upon presence in the Western Hudson Bay ecozone (Criterion 4, COSEWIC Aquatic Ecozone 5), lake sturgeon of the Churchill River system of northern Manitoba and Saskatchewan (Figure 7) are considered a distinct designatable unit (DU1).

DU2 - Saskatchewan River

Fish within the Saskatchewan-Nelson ecozone are distinct at this level (Criterion 4, COSEWIC Aquatic Ecozone 4); however, existing genetic studies (Robinson and Ferguson 2001) indicate that fish from the Saskatchewan River upstream of the Grand Rapids Dam at Lake Winnipeg (Figure 7) comprise a distinct population (Criterion 2) within this ecozone that logically includes all immediate drainages to this system in western Manitoba, central Saskatchewan, and east-central Alberta.

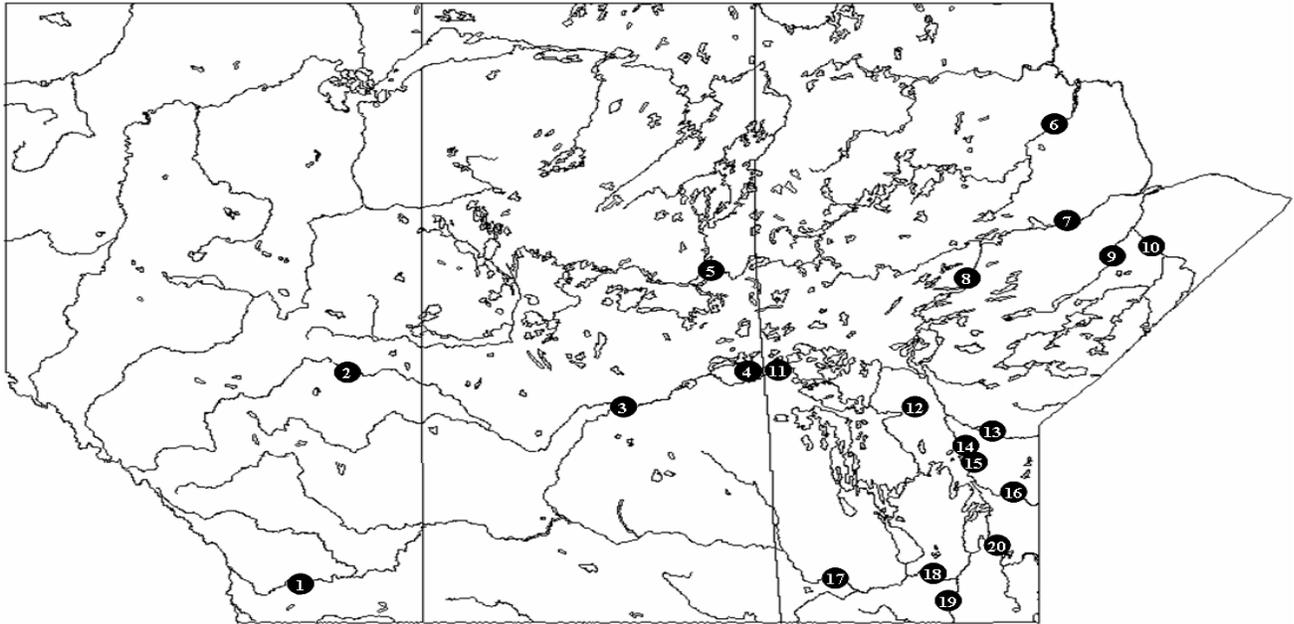


Figure 7. Lake sturgeon sites in Alberta, Saskatchewan and Manitoba referred to in text. 1. South Saskatchewan River; 2. North Saskatchewan River; 3. Forks of the Saskatchewan; 4. Cumberland House, Saskatchewan River; 5. Sandy Bay, Upper Churchill River; 6. Lower Churchill River; 7. Landing River, Nelson River; 8. Sipiwesk Lake, Nelson River; 9. Hayes River; 10. Gods River; 11. The Pas, Saskatchewan River; 12. Lake Winnipeg; 13. Poplar River; 14. Berens River; 15. Pigeon River (Round Lake); 16. Bloodvein River; 17. Brandon, Manitoba; 18. Assiniboine River; 19. Red River; 20. Winnipeg River.

DU3 - Nelson River

Fish from the Nelson River, downstream of Lake Winnipeg to the Hudson Bay coast, comprise a genetically distinct group (Robinson and Ferguson 2001) that includes all immediate drainages to this system (Figure 7) in northeastern Manitoba (Criterion 2). Telemetry studies carried out on the Nelson River by Manitoba Hydro from 1986-1992 suggest that lake sturgeon are fairly sedentary within the river and movements are related to routes between spawning and foraging habitat (MacDonell 1992).

DU4 Red - Assiniboine Rivers-Lake Winnipeg

Although genetic studies conducted to date (Robinson and Ferguson 2001; Robinson pers. comm.) have not included samples from the south-central areas of Manitoba (primarily due to the absence of extant populations), lake sturgeon from Lake Winnipeg, including such tributaries as the Bloodvein, Pigeon, Poplar, and Berens rivers (lake sturgeon were never known from Lake Winnipegosis or Lake Manitoba) as well as the Red-Assiniboine, and Roseau rivers (Figure 7) probably constitute a designatable unit distinct from those indicated above (DU3), although some sub-structuring is likely within this large and diverse area, and also between lacustrine and riverine fish, if such represent distinct life history types. Most of the large spawning populations once

associated with distinct regions within this area (e.g. Assiniboine, Red and Roseau rivers) are lost, and recent stocking and recovery efforts may have mixed fish from several sub-basins into different areas. Thus, appropriate testing of population structuring among putative groups within DU4 probably is impossible.

DU5 Winnipeg River-English River

Fish from the Winnipeg River system of southeastern Manitoba are genetically distinct from those of the Saskatchewan and Nelson rivers, and thus constitute a designatable unit (DU5). Other southern and eastern Lake Winnipeg tributaries are included in DU4, but the fish in the Winnipeg River, the largest tributary of Lake Winnipeg, were historically isolated from those in Lake Winnipeg by the Lower Pine Falls and Great Falls (Figures 7, 8). In addition a number of dams (Figure 8) have further segmented the population with little mixing occurring for almost 100 years (W. Lysack, Manitoba Conservation, Winnipeg, MB; personal communication). The English River is likewise segmented by a series of rapids and falls and dams (Figure 8).

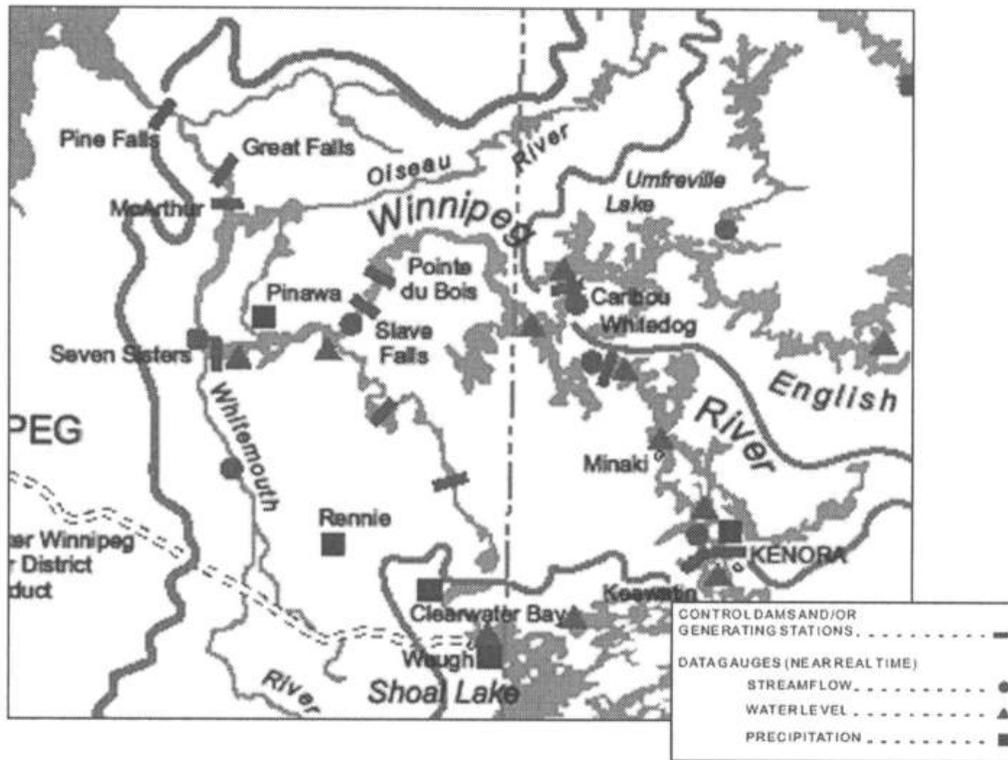


Figure 8. Water control within the Winnipeg River watershed (lower reaches).

| | | |
|-------------|-----------------------------|-----------|
| Hydro dams: | Pinawa | 1906-1951 |
| | Pointe du Bois | 1911 |
| | Great Falls | 1923 |
| | Seven Sisters & Slave Falls | 1931 |
| | Pine Falls | 1951 |
| | McArthur | 1954 |

DU6 Lake of the Woods-Rainy River

Although genetically distinct at one level from fish from the Winnipeg River, the distinction for fish from the Rainy River system of Ontario is also considered to be biologically significant at this time, even though this system ultimately drains into the Winnipeg River. Falls and dams along the Winnipeg River (Figure 7), particularly the Norman Dam located at the mouth of the river, impede passage of sturgeon from Lake of the Woods and prevent upstream movement (Martin Erickson, Fish Habitat Specialist, Manitoba Water Stewardship, Fisheries Branch, Winnipeg, MB, personal communication). According to McAughey (Scott McAughey, Ontario Ministry of Natural Resources, Kenora, Ontario; personal communication) it is unlikely the predam rapids at Norman prevented movement of lake sturgeon. However, falls lower down on the system probably did.

Thus, fish from Rainy River System of northwestern Ontario (Figures 7-9), including those from Lake of the Woods, are provisionally included in DU6. There are no genetic data available for the populations of lake sturgeon upstream of the Rainy River within this designatable unit (Rainy Lake, Seine River, Namakan Reservoir, Namakan River, Little Turtle Lake, Lac La Croix, Loon Lake, Sturgeon Lake, Russell Lake, Tanner Lake and the Maligne River).

DU7 Southern Hudson Bay-James Bay

Fish within the Southern Hudson Bay and James Bay ecozone are widely distributed among many large river systems of northeastern Manitoba, northern Ontario and northwestern Quebec (Figure 9), and are distinct from those found in the Great Lakes basin. DU7 includes lake sturgeon from the Gods and Hayes rivers of northeastern Manitoba although, based on tagging studies (Barth and MacDonnell 1999), these probably mix with fish in the estuary shared by these rivers and the Nelson River. Populations from all three river systems are not very extensive however (see Population sizes and trends below). In Quebec, the eastern limit of distribution of the lake sturgeon in these drainage basins coincides with the eastern limits of the ancient Tyrell Sea and of the glacial lake Ojibway-Barlow. Natural falls and longitudinal gradient of the rivers probably stopped its progression eastward during the last deglaciation period.

Although many of the populations residing in individual rivers across the ecozone probably are genetically distinct from one other, evidence is limited at best. The genetic work that has been conducted to date has tended to focus upon samples from tributary river systems within a basin and these, statistically, were not significantly different in most cases. Therefore, until more comprehensive evidence is available, all lake sturgeon from this ecozone are included in DU7.

DU8 Great Lakes-Upper St. Lawrence

Fish within the Great Lakes-Upper St. Lawrence ecozone are genetically distinct from those found in southern Hudson Bay drainages (Figure 9), and probably also are

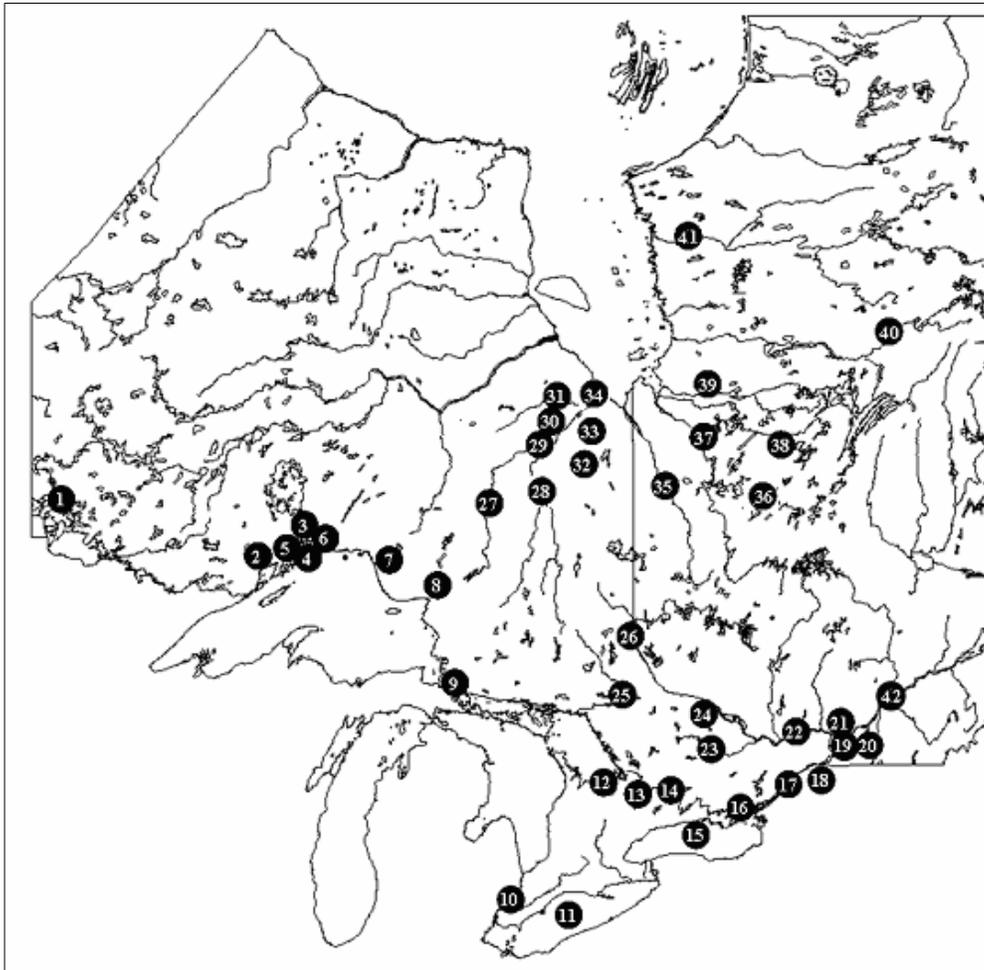


Figure 9. Lake sturgeon sites in Ontario and Quebec referred to in text.

1. Lake of the Woods, Rainy River; 2. Kaministiquia River; 3. Nipigon River; 4. Nipigon Bay;
5. Black Sturgeon River; 6. Gravel River; 7. Big Pic River; 8. Michipoten River; 9. Goulais River;
10. Lake St. Clair; 11. Lake Erie; 12. Huron Bay; 13. Lake Simcoe; 14. Trent River;
15. Lake Ontario; 16. Salmon River; 17. St. Lawrence River; 18. Massena, New York;
19. Lac St. François; 20. Lac St. Louis; 21. Lac Des Deux Montagnes; 22. Ottawa River;
23. Madawaska River; 24. Bonnechère River; 25. Lake Nipissing; 26. Timiskiming;
27. Missinaibi River; 28. Groundhog and Matagami rivers; 29. Kenogami River; 30. Cheepash River;
31. Kwatabochegon River; 32. Abitibi River and Otter Falls; 33. North French River;
34. Moose River; 35. Harricana River; 36. Waswanipi River; 37. Nottaway River;
38. Broadback; 39. Rupert River; 40. Eastmain River; 41. La Grande River; 42. Lac St. Pierre.

distinct from those in western drainages, although specific tests of the latter hypotheses have not been conducted. Available evidence suggests the likelihood of several designatable units within this area. Fish from Lake Superior, including those of Lake Nipigon and all related drainages, are generally distinct from populations in the lower Great Lakes; however, two Lake Superior populations (Batchawana, Goulais) grouped with populations from Lake Huron, and the lower Great Lakes-St. Lawrence. Therefore,

the populations in the Great Lakes-Upper St. Lawrence ecozone are considered to be a single designatable unit. More comprehensive genetic studies will be needed to clarify the biologically significant sub-structuring within this ecozone, and probably will lead to the identification of additional designatable units in the ecozone.

DISTRIBUTION

Global range

Historically, the North American distribution of lake sturgeon ranged from western Alberta eastward to the St. Lawrence drainage of Quebec, and from the southern Hudson Bay drainage southward to lower Mississippi drainage in northern Mississippi and Alabama (Figures 10-11). Few freshwater fish species had a wider geographic range in North America. Currently, it is presumed to be reduced in distribution and abundance throughout most of its historic range in the United States.

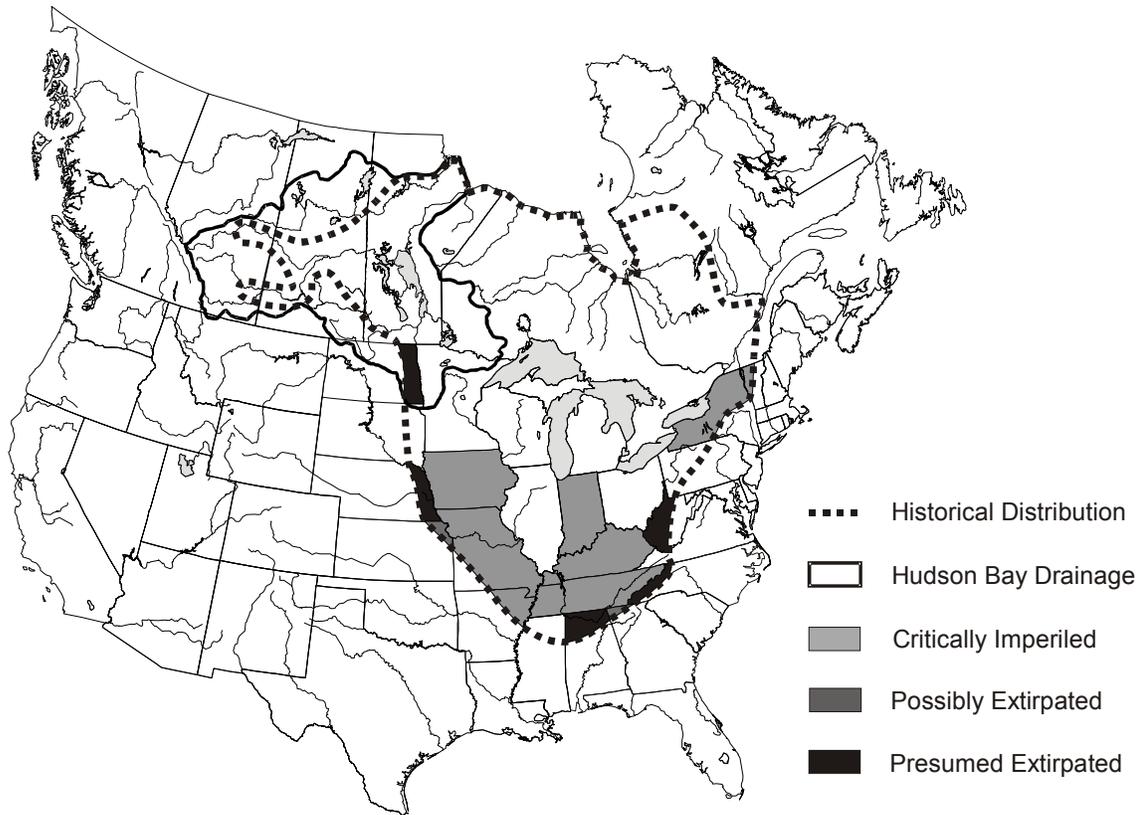


Figure 10. Historic distribution of lake sturgeon in North America. The Hudson Bay drainage is delineated. American states are shaded according to their NatureServe status.

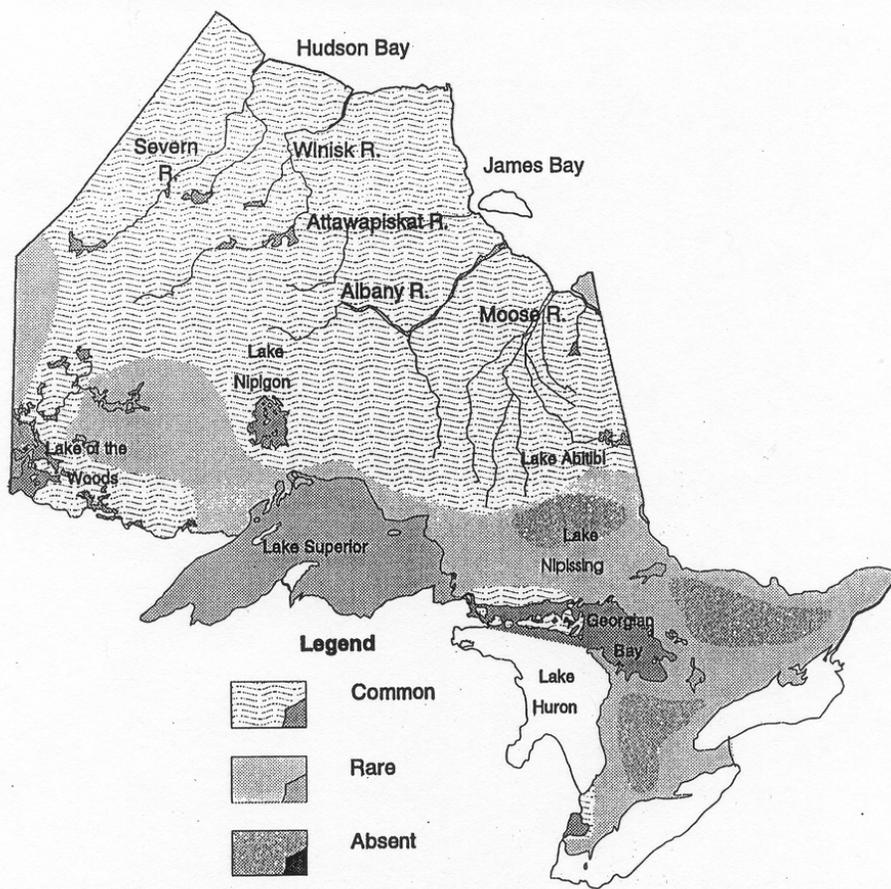


Figure 11. Historic lake sturgeon distribution in Ontario indicating the main river systems of northern Ontario [adapted from Ferguson and Duckworth (1997)].

Canadian range

The distribution of lake sturgeon in Canada includes rivers of Hudson Bay, the Great Lakes, and inland lakes and rivers of Alberta, Saskatchewan, Manitoba, Ontario and Quebec (Figures, 7-12). In the northern part of its Canadian distribution, it ranges (at least) from the Churchill River on the west side of Hudson Bay in the northwest, to the La Grande River on the east side of Hudson Bay in the northeast (Harkness and Dymond 1961; Scott and Crossman (1998). Gruchy and Parker (1978), Scott and Crossman (1998), and Stewart and Watkinson (2004) give the northern distribution limit on the west side of Hudson Bay as the Seal River, based on Harkness and Dymond (1961). However, Harkness and Dymond (1961) provide no evidence of records for the Seal River and there is uncertainty as to its ever being present north of the Churchill River. The Royal Ontario Museum and the Museum of Nature do not possess any lake sturgeon specimens from the Seal River (B. Franzin, Environmental Science Division, Department of Fisheries and Oceans, Freshwater Institute, Winnipeg, MB; D. MacDonell, North/South Consultants, Winnipeg, MB; personal communications).

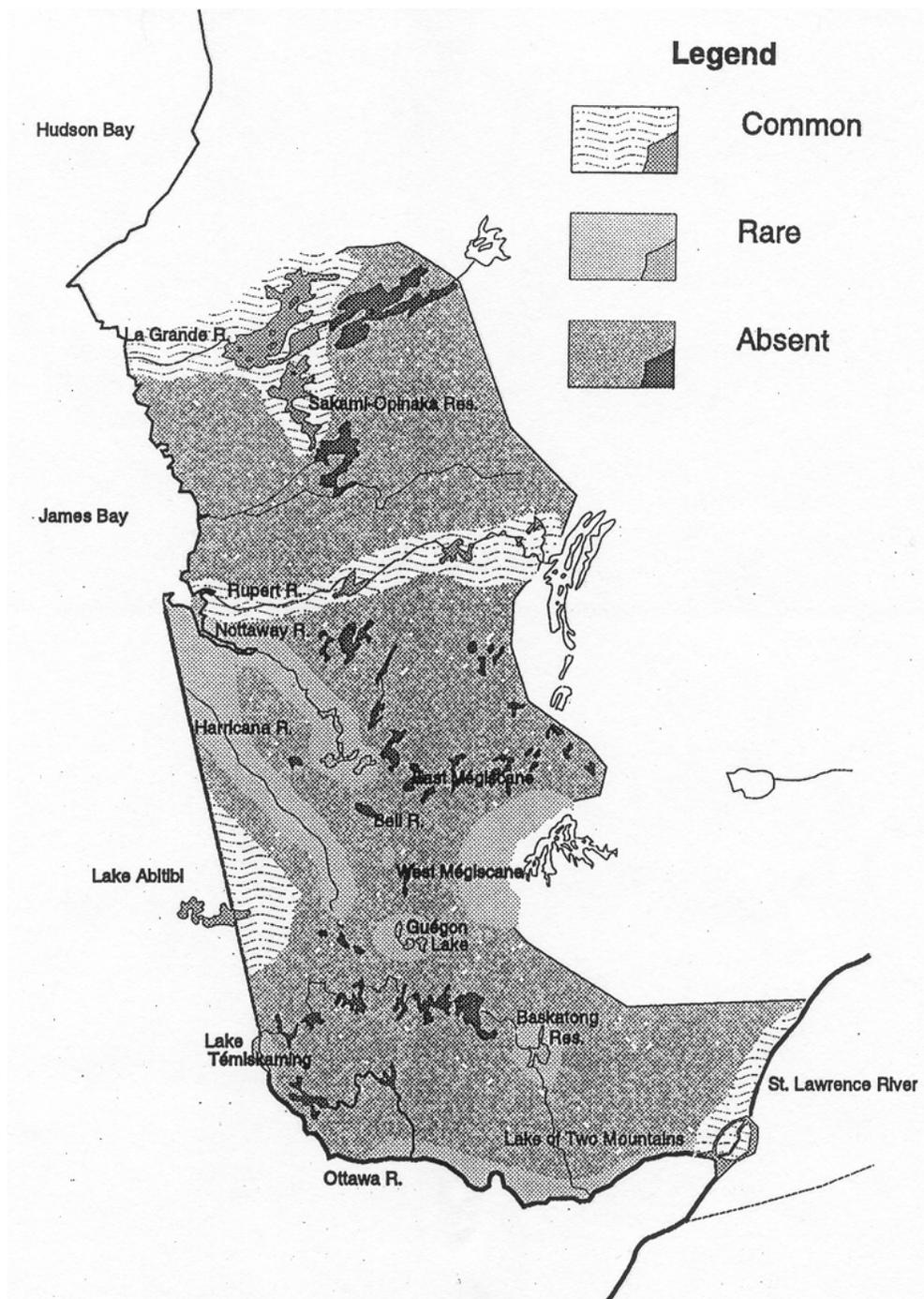


Figure 12. Historic lake sturgeon distribution in Quebec, indicating rivers in northern Quebec [adapted from Ferguson and Duckworth (1997)].

In the southern part of its Canadian distribution, the species ranges from the South Saskatchewan River in western Alberta (McLeod *et al.* 1999) to the St. Lawrence River at Saint-Roch-des-Aulnaies, about 125 km downstream from Québec City, in the east (Scott and Crossman 1998). The lake sturgeon is also present in the lower sections of the larger rivers draining into the St. Lawrence River west of the salt water (e.g. L'Assomption, Richelieu, Saint-François, Saint-Maurice, Batiscan, Chaudière rivers). Atlantic and lake sturgeon co-occur in the upper part of the St. Lawrence River, from Lake Saint-Pierre to the limits of fresh water.

HABITAT

Habitat requirements

Historically, lake sturgeon were reported from large rivers and lakes (e.g. such as the Great Lakes, Lake Winnipeg, Sipiwesk Lake, the large inland delta on the Saskatchewan River at Cumberland House, Saskatchewan) and near the mouths of large rivers (Dick and Macbeth 2003). It is important to note that the concentration of lake sturgeon at the mouths of rivers is a short-term occurrence during spawning, and that for the remainder of their life they typically are dispersed in large lakes or river systems.

Recent detailed information on habitat use by lake sturgeon is limited. Adults are found in large rivers and lakes, generally at depths of 5-10 m over substrates of mud, clay, sand or gravel (Lane *et al.* 1996b; Page and Burr 1991, Nilo 1996). They consistently are found at depths greater than 10 m in the Winnipeg River (Erickson, pers. comm.). Lane *et al.* (1996b) indicated that, for Great Lakes populations, lake sturgeon usually were associated with silt substrate, while infrequently associated with gravel or sand substrates. Substrate type is considered to be important, since they feed on benthic (bottom dwelling) invertebrate fauna. However, studies by Choudhury *et al.* (1995) found sturgeon also fed on pelagic (living in the water column as opposed to on the bottom) *Daphnia*, and other studies have found that some individual sturgeon spent up to 70% of their time in the water column suggesting that some pelagic feeding occurs (Dick 2004). Seyler (1997a) reported that lake sturgeon habitat utilization was low where velocities exceeded 70 cm/sec.

Spawning habitats are fast-flowing waters, usually below waterfalls, rapids, or dams, over hardpan clay, sand, gravel, rubble, cobble or boulders (Lane *et al.* 1996c). In the Des Prairies River, these habitats are covered by a mix of fine- to medium-size gravel to boulders (LaHaye *et al.* 1992). Spawning also may occur on flat shelving sedimentary rock or freshly deposited riprap along river shores (Dick, unpubl. data). Most of the rivers used for spawning have falls that restrict upstream migrations; therefore, spawning sites for lake populations of sturgeon often are limited. LaHaye *et al.* (1992) found that lake sturgeon in the Montréal area used a wide variety of hard substrates for spawning and, depending on hydrological conditions, may utilize artificial spawning sites. Depth of water at spawning sites is quite variable, but usually is

between 1 and 6 m of water (LaHaye *et al.* 1992; Lane *et al.* 1996c; Scott and Crossman 1998). Females have been observed spawning in 1 m of water at Landing River, northern Manitoba, and in the Embarrass River, Wisconsin (Dick 2004). Manny and Kennedy (2002) described spawning habitats in depths ranging between 9 and 12 m in the connecting channels between lakes Huron and Erie. A large (3.6 ha) site has been recently discovered in the Lachine Rapids (St. Lawrence River) at Montréal. Egg deposition was found to be maximal in deep transparent water (up to 7 m), under average velocity in the water column between 1 and 2 m/s, over fine to average size gravel, with a mix of rocks and big rocks (La Haye *et al.* 2004). Ripe females have been captured in depths up to 10 m in the Winnipeg and Pigeon rivers below major rapids and falls, but usually in back eddies just off the main current (Dick 2004). Haxton (2006) reported similar findings in the Ottawa River, below the Chats Generating Station where spawning fish were taken on the side of the main channel where flows were not as great. Barth and MacDonnell (1999) observed sturgeon spawning below rapids in the Weir River, a tributary of the Nelson River in northern Manitoba in 1997 and 1998. Spawning location varied between years as a result of flow conditions dictated by a combination of Weir River discharge and Nelson River stage (i.e. volume and rate of flow in terms of what is happening as a result of the annual flood cycle, which varies in time and extent from year to year in relation to several factors such as rain and snowfall).

The habitat reported for young-of-the-year (YOY) varies. They have been reported as resting on sand bars, fine gravel and cobble (Peake 1999). Seyler (1997a) reported YOY over smooth sand and gravel substrates in less than a metre of water. Lane *et al.* (1996a) indicated that YOY preferred 2.5 - 5+ m of water, were always associated with sand and silt, frequently associated with rubble and gravel, and infrequently associated with vegetation. In the lower Peshtigo River (a Lake Michigan tributary), YOY lake sturgeon used areas with sand substrates, low current velocities, and macroinvertebrate assemblages dominated by dipterans. Movement patterns indicated that declines in water temperature during fall months prompted fish to move downstream. With the exception of fall migration, home-range was found to be small (less than 500 m of longitudinal river length), with fish remaining in the same locations for several days to weeks. YOY showed greater activity after dark (Benson *et al.* 2005). In Black Lake (Michigan), two distinct mean depths (nearshore and deep offshore habitats) were used by yearling lake sturgeon, while juveniles utilized deep, flat-bottomed offshore habitat. Yearlings were associated with sand and organic substrate types, and juveniles with organic substrate types (Smith and King 2005).

In the St. Lawrence River, during fall, juvenile catch occurred more frequently at stations over bottoms of clay and gravel, in shallow depths (3-6m), and in areas with moderate water current (0.25-0.5 m/s). During summer, they were found in deeper water (6.1 to 9.0 m) and at higher current speed (0.5 to 0.75 m/s). Higher catch per unit of effort occurred on gravel substrate (Nilo 1996).

Habitat trends

The importance of habitat loss to lake sturgeon populations is not well documented; the loss of habitat was considered far less important than overfishing in their decline. In fact, many of the populations were reduced to remnant populations prior to major environmental perturbations affecting lake sturgeon habitat. Since these historic population crashes, prairie river systems have undergone extensive habitat degradation due to decreased flows and water quality as a result of irrigation and the construction of dams. Fluctuating flow in the Cumberland delta, resulting from the construction of a dam on the Saskatchewan River, has negatively impacted lake sturgeon populations downstream of the dam. Construction of the Lockport Dam on the Red River for navigation purposes, and the alteration of the annual flow regime to maximize storage of water in the spring on the Assiniboine River, probably has affected the potential for spawning runs in these rivers. In other rivers, like the Roseau, construction of drainage ditches has increased water flow and suspended sediments in the spring during spawning times, but reduced flows following spring flooding. This has led to reduced juvenile feeding habitat as a result of lower water levels following spawning. Generally, impoundments have altered flows and limited pristine habitat (Figure 13). Studies on the Winnipeg River indicate that lake sturgeon distribution, especially of juveniles, is positively correlated with unaltered river habitat (Dick 2004). The Moose River basin is one of the most fragmented river systems in North America, but the overall impact on the region's lake sturgeon populations is unknown (Seyler 1997a). The combined impacts of overexploitation, increased industrialization, pollution, species invasions and habitat loss in the Great Lakes region make it difficult to establish current cause and effect relationships in lake sturgeon populations.

Habitat fragmentation is a major concern for this long-lived migratory fish that utilizes a variety of habitats throughout its life (Robitaille *et al.* 1988, Auer 1996a). In the St. Lawrence River, recent experimental fishing data confirm that the Lac Saint-François sturgeon group, upstream of Lac Saint-Louis, considered as depleted in the 1940s (Cuerrier and Roussow 1951), the 1960s (Joliff and Eckert 1971) and the 1980s (Dumont *et al.* 1987), is still at very low abundance. Tagging studies in the 1940s indicate that lake sturgeon was then able to migrate along the St. Lawrence River, from the limits of the brackish waters up to at least Brockville (Ontario) (Roussow 1955b). Depletion of the Lac Saint-François lake sturgeon group can likely be attributed to the combined effects of the gradual construction of dams at both extremities of the lake between 1912 and 1958 (Morin *et al.* 1998) and to the overfishing of the residual stock.

BIOLOGY

General

Several good descriptions of the morphology of lake sturgeon are found in Harkness and Dymond (1961), Houston (1987) and Scott and Crossman (1998). The original populations of lake sturgeon had some very large individuals, and specimens

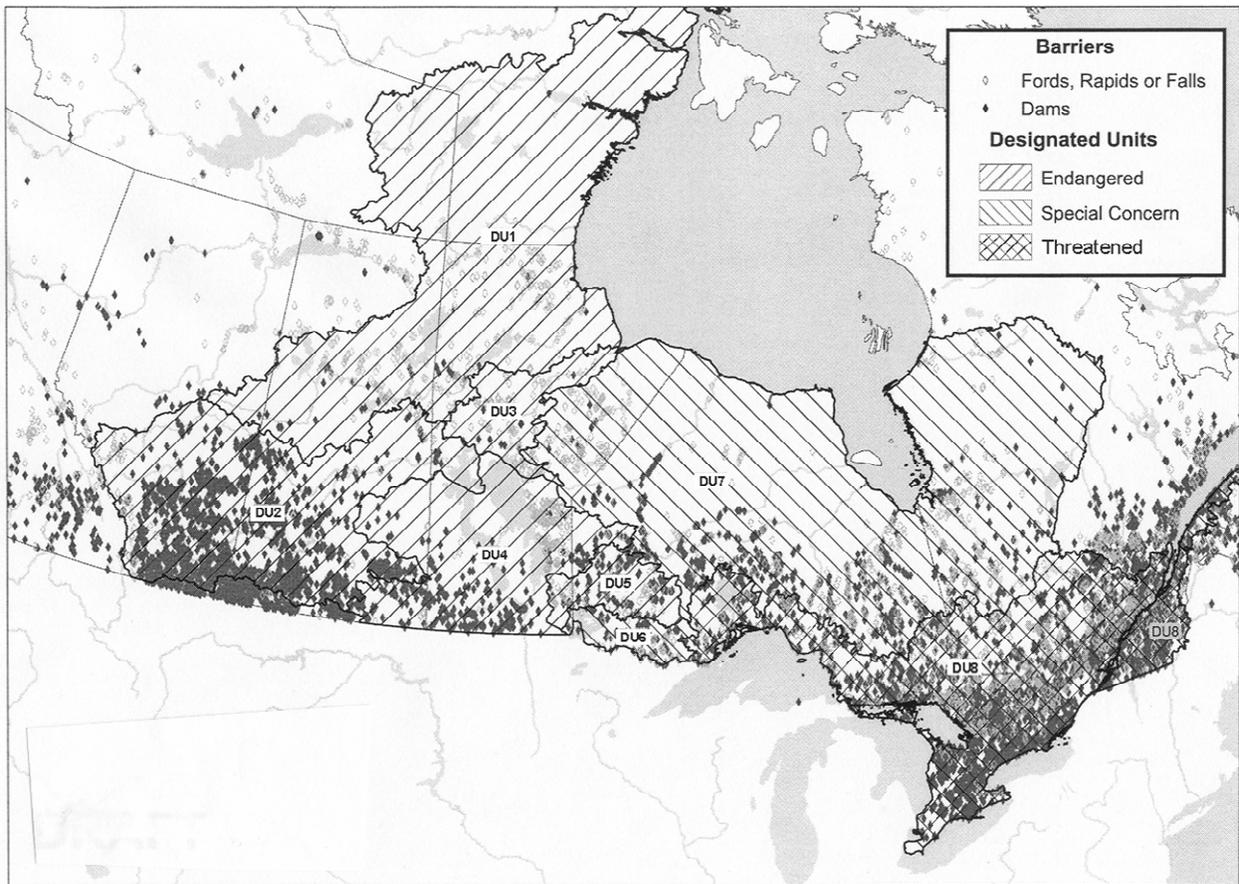


Figure 13. Locations of dams and barriers within lake sturgeon range in Canada (map courtesy Ron Hempel).

weighing in excess of 100 kg were not uncommon in the early 20th century. Female lake sturgeon are usually larger than males (Harkness and Dymond 1961; Mosindy and Rusak 1991), but if females are heavily exploited, males may become larger (Bruch, pers. comm.). A downward trend in size and age of both sexes is evident wherever lake sturgeon are harvested (e.g. Dumont *et al.* 1987; Patalas 1988; Sopuck 1987; Wallace 1991).

Reproduction and growth

Since eggs take several years to develop in lake sturgeon, there is a difference between the age or size at maturity (with eggs under development) and age at first spawning (actual deposition of eggs – sexual maturity). Age at (sexual) maturity of lake sturgeon varies. Sexual maturity in females occurs between 14 to 33 years of age, but more often at 21 to 26 years of age, while in males, it occurs at age 8 to 12 years, but may take up to 22 years (U.S Fish and Wildlife Service (2006). Harkness and Dymond (1961) reported age at sexual maturity for males ranged from 14 to 22 years and females from 14 to 33 years. Studies using a gonad index at Cumberland House,

Saskatchewan, found that females begin to spawn somewhere between 26 to 30 years of age (Dick, unpubl. data). Wallace (1991) noted similar results in the Saskatchewan River, with females maturing around 25 years of age at weights of 13.6 kg and lengths of 1.3 m, and males maturing earlier at smaller sizes. In lakes Saint-Pierre and Saint-Louis, the female median size and age at maturity are 1.3 m and 27 years, respectively (Goyette *et al.* 1987; Gu nette *et al.* 1992). Similar ages of maturity were noted for females in the Timiskaming area (D. Nadeau, Regional Biologist, Quebec Wildlife and Parks, Rouyn-Noranda, QC; personal communication). Harkness (1923) tabulated weight/length at age data for fish from Lake Nipigon where individuals at the age of maturity were about 0.8-1 m in length and weighed around 4.5 to 5.5 kg. The mean weight of 1 m sturgeon in Rainy Lake was recently estimated to be 5.97 kg (Adams *et al.* 2006), comparable to 6.1 kg for Lake of the Woods/Rainy River (Fortin *et al.* 1996).

Houston (1987: Table 1) provided approximate age and size of sexual maturation for six populations in Quebec, Ontario, Manitoba and Wisconsin. Mosindy and Rusak (1991) used a maturity index based on mean weighted age at onset of sexual maturity for male and female spawners and found that mature males (average age 16.8 years) spawn every 2.2 years and mature females (average age 25.8 years) spawn every 3.75 years in Lake of the Woods. Wallace (1991) noted that females spawn every 4 to 8 years and males every 2 years in the Saskatchewan River. In the St. Lawrence River, spawning periodicity is estimated at 1 to 3 years for males and is likely higher than 4 years for females (Fortin *et al.* 2002).

Lake sturgeon congregate on, or close to, the spawning site at temperatures of 7-10 C, and spawn during May and early June at 9-18 C (Scott and Crossman 1998; Fortin *et al.* 2002; Erickson, pers. comm.). Males arrive first, and individual spawning females have been observed surrounded by 2-8 males in fast waters near shore (Dick, unpubl. data; Bruch and Binkowski 2002). During the spawning act, the males respond to cues from the female to participate in 2-4 spawning bouts during which a relatively small number of eggs (947-1444) are released into a cloud of sperm (Bruch and Binkowski 2002). The total number of eggs varies from ~50,000 in a 5.2 kg female to over 1,000,000 in very large fish (Scott and Crossman 1998). Harkness and Dymond (1961) reported that two 50 kg females averaged ~650,000 eggs each, roughly 9000 to 15,000 eggs per kg of body weight (U.S. Fish and Wildlife Service 2006). Fecundity has been measured for 18 females caught in Quebec from the 1940s to the 1970s. Fecundity varied between 48,420 to 670,450 eggs for females between 0.9 and 2.0 m. It is related to length ($\text{Log}_{10} F = 3.70214 \text{ Log}_{10} \text{ TL (in cm)} - 2.62905$; $R^2 = 0.90$) and weight ($F = 11921.2 + 13079.6 W \text{ (in kg)}$; $R^2 = 0.94$) (Cuerrier 1966, Fortin *et al.* 1992, 2002). According to these relations an average size mature female of 1.3 m on the Des Prairies River spawning ground produces 170,000 eggs. Preliminary observation in the Des Prairie River indicated that, to maximize egg to larvae survival, the average female requires between 13 to 48 m² of spawning area (Fortin *et al.* 2002).

MacDonnell (1998) and Barth and MacDonnell (1999) observed spawning in the Weir River in 1997 and 1998. In 1997 spawning occurred from 14 - 24 June at water

temperatures of 11 – 17°C. Eggs were collected downstream of the rapids where the sturgeon were believed to have spawned until 25 June and larvae were first noted on 24 June (MacDonnell 1998). In 1998 spawning occurred between 8 May and 12 June at water temperatures of 16.5 – 17°C. A decrease in water temperature between 28 May and 5 June delayed spawning (Barth and MacDonnell 1999). Eggs were captured below the rapids where the sturgeon were believed to have spawned from 9 – 16 June and larvae were captured from 14 – 26 June.

In the Des Prairies River, between 1982 and 1999, spawning activity occurred during the second to the fourth week of May at temperatures varying between 12 and 17° C and lasted from 8 to 19 days (Fortin *et al.* 2002). Generally two peaks of spawning activity (as measured by catch per unit of effort of spawners and egg deposition) were observed. This bimodality is not related to water temperature or to river discharge and recapture data from multiple years suggest some fidelity of lake sturgeon to the first or second spawning period. Spawners of the first peak are generally larger than those of the second peak (Fortin *et al.* 2002).

In the St. Lawrence River mainstem spawning is delayed by about 2 weeks, as the water warms more slowly than in its tributaries (LaHaye *et al.* 2004).

Egg incubation requires 7-10 days in water temperatures of 13-15°C; after hatch, the negatively buoyant larvae move relatively little in the water column (U.S. Fish and Wildlife Service 2006). Upon absorption of the yolk sac, loss of the intestinal plug and elongation of the snout, the larvae begin to feed (Dick 1995). They remain negatively buoyant until the swim bladder starts to form about 60 days post-hatch (Dick 1995).

The sex ratio is more or less 1:1 at birth but, following maturation, begins to widen in favour of females (Mosindy and Rusak 1991; Fortin *et al.* 1993). This may be explained by the greater longevity of females (Probst and Cooper 1954; Dumont *et al.* 1987). Fortin *et al.* (1993) found that by the age of maturation (20-29 years) in southern Quebec, the female:male ratio was in the order of 2:1 and by age 40, it was 6:1. Mosindy and Rusak (1991) found a similar increase in Lake of the Woods.

The young-of-the-year (YOY) grow rapidly reaching 15-20 cm by the end of the first summer. Juvenile lake sturgeon grow more rapidly in length than in weight during the first five years of life (Scott and Crossman 1998). It has been observed that the body shape of wild and cultured lake sturgeon becomes deeper with faster weight gains relative to increases in length (Dick 2004). After about 5 years, the rate of weight gain usually increases and the rate of gain in length decreases: the two rates become more uniform after the onset of sexual maturity when weight gain becomes even more rapid relative to increase in length (Scott and Crossman 1998). Royer *et al.* (1968) found that the growth of sturgeon in the Saskatchewan River generally was faster than that reported for Quebec and Ontario, but slower than in Wisconsin.

Power and McKinley (1997) demonstrated that there is a latitudinal gradient in growth rates with declines in weight and length at age at higher latitudes, but the

difference is inverse when adjusted for thermal opportunity (total degree-days > 5°C, i.e., number of days in the year where the temperature exceeds 5°C). This counter-gradient partially compensates for reduced growth opportunities in more northern populations and may be genetic, selecting to reduce size-selective, over-wintering mortality (Power and McKinley 1997).

Fortin *et al.* (1996) studied the determinants of variations of growth in length and body condition of lake sturgeon on 32 lakes and river systems covering most of the distribution of the species. Growth decreased with mean annual air temperature and latitude but was generally faster in the western part of the distribution area. Condition decreased with latitude in the east but remained relatively stable in the west.

Survival

Little is known regarding the natural mortality of juveniles or larger lake sturgeon. Wallace (1991) indicated that the total annual mortality rate in the lower Saskatchewan River was in the order of 4.8% around 1963 and increased to 18.9% by 1980, while annual recruitment was in the order of 3.5%. Adams *et al.* (2006) calculated the total annual mortality for lake sturgeon in Rainy Lake from 1965 to 1984 to be 4.7%, for ages 18 – 39. Throughout this period a commercial harvest on the U.S. side of the lake was in operation and harvest levels declined from 1007 kg in 1964 to zero from 1974 to 1978, but then averaged 345 kg annually from 1979 to 1990. Most researchers agree that the maximum mortality rate should not exceed 5%, since recruitment in the few self-sustaining populations is in the order of 4.7 to 5.4% (Sunde 1961; Priegel 1973; Priegel and Wirth 1975; Baker 1982). MacDonnell (1998) indicated that tagging studies in the Nelson River in 1997 suggest a mortality rate of 3.5% and expressed a concern regarding the sustainability of the harvest in the domestic fishery.

Historically, the typical lifespan of lake sturgeon was believed to be in the neighbourhood of 55 years for males and 80 to 150 years for females (U.S. Fish and Wildlife Service 2006). However, in exploited populations, most sexually mature sturgeon seen today are less than 2 m in length and 36 kg in weight, although a few larger, and fewer still, very large sturgeon, are occasionally reported (Dumont *et al.* 1987; Scott and Crossman 1998;). Studies on natural populations of lake sturgeon in western Canada (Choudhury and Dick 1993) and elsewhere (Magnin 1966) found that females live considerably longer than males, average lifespans being in the order of 55 years for males and 80 years for females, although older fish have been collected. In the past 25 years, maximum age and weight observed in the St. Lawrence River commercial harvest were 96 years and 90 kg.

There is no evidence for reproductive senescence; for example, the largest and perhaps the oldest fish ever caught in Manitoba was estimated to be 150 years old, measured 4.6 m, weighed 184.6 kg, and was “full of caviar” (Stewart and Watkinson 2004: 46; Figure 14).



Figure 14. A 184.6 kg female lake sturgeon measuring 4.6 m, caught in the Roseau River, MB in 1903. The age of the fish was estimated to be 150 years, and it was reported to be full of roe. Original photograph by George Barraclough, now in the collection of the Franklin Museum, Dominion City.

Given the mean ages at which males and females reach the onset of sexual maturity as stated above (16.8 years of age for males and 25.8 years for females), and an average life span of 55 to 80 years, the natural average generation time (average age of parents of a cohort) would be in the order of 35 to 54 years. The average age of fish in unexploited populations may have been even greater since there are records of fish of up to 150 years of age (Scott and Crossman 1998; Stewart and Watkinson 2004). The average today would appear to be more in the range of 25 to 50 years giving an average generation time in the range of 26 to 30 years (see Fortin *et al.* 1996; Scott and Crossman 1998). The average age of fish from the study of Adams *et al.* (2006) in Rainy Lake would be in the order of 19 to 24 years and the oldest fish

captured was 59 years old. Generation times at, or near, the mean age of the onset of sexual maturity are indicative of stress.

Plohman *et al.* (2001a,b) compared plasma samples from wild caught lake sturgeon to plasma and other tissues from lake sturgeon reared under controlled conditions and fed diets of different nutrient quality. These studies found that nutritionally poor diets decreased the levels of thyroid hormone and reduced growth. This suggests that environmental modifications through changes in habitat could alter the type and quantity of food available and, consequently, have a detrimental effect on sturgeon survival.

Physiology

Lake sturgeon are adapted to water temperatures ranging from near 0 to 24°C. Laboratory studies indicate that cultured juvenile and young adults continue to grow at temperatures of 4-6°C, and that growth continues even when temperatures change by as much as 8°C (in a range of 12 - 20°C), over periods as short as 24 hrs (Dick *et al.* 2002). Cultured fry and larval lake sturgeon grow rapidly at temperatures up to 25°C, but juvenile lake sturgeon grow most rapidly at 22°C. However, there is a tendency for buoyancy disorders (i.e. floating and rolling onto their dorsal surface) at higher temperatures ($\geq 22^\circ\text{C}$). Lake sturgeon reared at 15 - 19°C did not exhibit this disorder. Optimal survival was observed between 14-17°C and incipient mortality at 20°C (Wang *et al.* 1985).

Traditional knowledge of Elders and observations of lake sturgeon feeding in shallow areas during the summer months indicate that they can utilize habitats with suboptimal levels of oxygen, at least for feeding (Dick, unpubl. data). Lake sturgeon have been known to survive several hours out of water in the bottom of a boat (Mackay, pers. comm.).

In laboratory studies, lake sturgeon juveniles grew normally at 12 ppt salt water for 3 months and 18 ppt for 2 weeks (Dick, unpubl. data). Lake sturgeon have been reported from the estuaries of the Nelson, Gods and Hayes rivers (D. Macdonald, Manitoba Conservation, Thompson, MB; personal communication) and occasionally enter the brackish waters of Hudson Bay and Gulf of St. Lawrence (Page and Burr 1991; LeBreton and Beamish 1998).

Movements/Dispersal

Seasonal movements are not well known, but lake sturgeon probably move from shallower to deeper waters in warmer temperatures, returning to the shallows when temperatures decline in the fall. Other than that, movement appears to be limited, with the exception of spawning migrations (Fortin *et al.* 1993). Spawning migrations of over 100 km have been recorded (Scott and Crossman 1998). However, there is thought to be strong site fidelity with spawning fish returning to the same sites year after year, although the occasional fish may wander from lake to lake to spawn (Swanson *et al.*

1991; Rusak and Mosindy 1997). In the Moose River, juveniles and adults appear to occupy the same areas and there is no evidence of juvenile dispersion (Seyler 1997a). Radio telemetry and tag-recapture data from the Weir River indicate that lake sturgeon congregate near spawning sites in late spring in relation to water temperature and flow regimes and disperse throughout the Nelson River system, moving as far upstream as dams and power generating facilities will allow (MacDonnell 1998). Lake sturgeon from the Hayes River may also utilize the Weir River for spawning (Barth and MacDonnell 1999).

Barth and Murray (2005), based on studies in the Nelson River from 2001 – 2003, suggested that in spring, lake sturgeon (both spawners and non-spawners) are attracted to areas of higher water velocity and spawning fish move upstream to potential spawning areas. Some non-spawners may accompany spawners, but usually remain down river. The lake sturgeon move downstream to deeper, lower water velocity habitats for the summer. Relocation data (Barth and Murray 2005) suggest that lake sturgeon make frequent localized movements (1 – 20 km) during the summer in association with feeding, and in the fall, move to areas of deep, medium-velocity habitats to overwinter. Results of the four-year study also indicated that most lake sturgeon exhibit site fidelity; although they frequently make localized movements, they demonstrated a preference for certain areas (Barth and Ambrose 2006). Borkholder *et al.* (2002) and Knights *et al.* (2002) have documented similar findings.

In the Lake Winnebago system larval lake sturgeon drift downstream 9 to 30 days post-hatch (Kempinger 1988) and lake sturgeon fry have been located 40 km downstream of hatch sites (Seyler 1997a). In the Des Prairie River, larval drift generally occurs at night and lasts 14 to 30 days, between the third week of May and the third week of June (La Haye *et al.* 1992, 2004; D'Amours *et al.* 2001; Fortin *et al.* 2002; Garceau and Bilodeau 2004).

Radio and sonar tagging studies indicate that lake sturgeon of earlier life stages do not move as far as that reported for some larger, older individuals (Mosindy and Rusak 1991; Swanson *et al.* 1991; Smith and King 2005; Benson *et al.* 2005). Seyler (1997a) found that young lake sturgeon move little over a year. This also was evident from studies in Round Lake, a small lake on the Pigeon River, Manitoba, where tagged sturgeon did not leave the lake, and near Numao Lake on the Winnipeg River (Dick 2004). Populations upstream and downstream from Sipiwesk Lake on the Nelson River did not seem to mix as tagged fish showed little movement between the regions (Macdonald, pers. comm.). Rusak and Mosindy (1997) observed segregation of lake and river populations based on the commencement of spawning migrations and winter habitat preferences in the absence of physical barriers in the Lake of the Woods.

In the Quebec part of the St. Lawrence River, mark-recapture experiments indicate that, with the exception of spawning migrations which are extensive, movements are restricted (Magnin and Beaulieu 1960; Dumont *et al.* 1987; Fortin *et al.* 1993). In this system, lake sturgeon occur in large numbers in small localized sites, and this condition increases their vulnerability to fishing and to any degradation of these local habitats

(filling, dredging, toxic outflows, etc.). Some lake sturgeon seem to form stable groups; for example, on at least three occasions, pairs of fish tagged simultaneously were recaptured together (Dumont *et al.* 1987).

Size and age distribution of juveniles in the experimental samples (mostly age 2 to 8) and of subadults in the commercial harvest samples suggests that, in the Quebec part of the St. Lawrence River system, lake sturgeon are mainly produced in the upper part of the system. Larvae drift downstream of the main spawning area of the Des Prairies River towards the lower part and gradually colonize the river along a downstream-upstream gradient. Most of the juvenile concentrations are found in the lower part, between the fresh water of the Lac Saint-Pierre archipelago and the estuarine brackish waters near Iles d'Orléans (Dumont *et al.* 2000a). In the upper section, in Lac Saint-Louis, males and females are longer, heavier and older and almost half of the females (45%) are maturing. In the most downstream commercial fishing sector, lake sturgeon are smaller, lighter and younger and only 2.4% of the females are maturing. Intermediate values are observed in the two median fishing sectors (Dumont *et al.* 1997; Dumont *et al.* 2006). These observations suggest that most individuals in a population may be more localized than previously thought, and that there is some natural separation of populations in the absence of physical barriers. They also suggest use of different parts of the river by different life stages.

During the major growth period, adult and juvenile lake sturgeon generally are thought to frequent shallow areas of lakes and rivers 4.6 - 9.2 m in depth (Scott and Crossman 1998). However, Choudhury *et al.* (1995) suggested that juveniles may stay in the river for several years, especially in systems where adults migrate substantial distances to spawn. In contrast, there was no evidence of migration in Round Lake (on the Pigeon River in Manitoba) and, while both adults and juveniles frequented the same areas of the lake, the larger fish utilized more of the lake (Dick 2004).

Nutrition and interspecific interactions

Larval lake sturgeon feed on invertebrates about 400 to 500 μm in size, moving to larger invertebrates as they grow (Dick *et al.* 2002). Thibodeau (1997) examined the gut contents of 797 larvae (<20 mm) caught in drift nets in Des Prairies River. Only 18 had begun exogenous feeding, but prey could be observed in only six of them, consisting of small chironomid larvae and amphipods. Very little is known about the food, growth and habitat of YOY during summer in the St. Lawrence system. The upper estuary is the only site where summer and fall YOY lake sturgeon (120-180 mm TL from July to September) have been captured in significant numbers in the St. Lawrence River. Nilo *et al.* (2006) and Guilbard (2002) observed that they feed mostly on amphipods and chironomid larvae.

In the St. Lawrence River, diet of juvenile lake sturgeon is highly diversified and composed of at least 75 taxa, of which more than 50 were found to comprise more than 5% of the diet in individual fish. This probably reflects both the high diversity and density of the benthic fauna of this system [$\sim 2400 \text{ g/m}^2$ compared for example to $< 100 \text{ g/m}^2$ in Northern Ontario watersheds (Beamish *et al.* 1998; Nilo *et al.* 2006)]. The most

exploited prey are amphipods, aquatic insect larvae, molluscs and oligochaetes. Fish and microcrustaceans are also eaten, but in much smaller proportions (Mongeau *et al.* 1982; Nilo *et al.* 2006). Prey composition varied according to sampling site and period, and to fish size. Diet composition is only partly determined by benthos (molluscs, oligochaetes, burrowing insects larvae) availability, suggesting that there is a positive selection for drifting prey (amphipods and ephemeropteran nymphs). The tendency of juvenile lake sturgeon to aggregate locally (Dumont *et al.* 1987; Nilo 1996) cannot be fully explained by their food habits, which include prey species that are widely distributed throughout the St. Lawrence River. Other factors certainly affect the juvenile lake sturgeon distribution in this river. In the upper estuary, Atlantic sturgeon and lake sturgeon use the same major prey in different proportions (Guilbard. 2002). A comparative morphometric study of the digestive tract suggests that the thicker gizzard wall of the lake sturgeon facilitates access to hard preys, while for Atlantic sturgeon a longer intestine and a higher development of the spiral valve favour chemical digestion (Guilbard 2002). Zebra mussels (*Dreissena polymorpha*) have been found in the digestive tract of lake sturgeon but is not a preferred prey item (Guilbard 2002; Nilo *et al.* 2006).

Adult lake sturgeon consume a wide range of benthic organisms (Harkness and Dymond 1961). The type of food consumed depends on seasonal and spatial availability as well as the nature of the benthos over which sturgeon feed (Harkness and Dymond 1961; Mosindy and Rusak 1991). Choudhury and Dick (1993) reported the percent of food items in the total diet of individual lake sturgeon from several commercial fisheries: ephemeropteran naiads (23-67.4% of ingested prey), chironomid larvae (7.7-45.4%), trichopteran larvae (1.9-9.1%), gammarids (0-18.9%), *Orconectes* spp. (7.7-26.4%), bivalves (7.7-13.6%), hirudineans (0-11.3%) and fishes (0-3.8%). In Lake of the Woods, mayfly larvae and crayfishes represented nearly 70% of the food items found in commercially harvested sturgeon; chironomids, fingernail clams and small minnows also were present (Mosindy and Rusak 1991). Sculpins, sticklebacks and other small benthic fish species have been reported in the diet, and fish eggs may be consumed infrequently (Harkness and Dymond 1961; Mosindy and Rusak 1991). Choudhury and Dick (1993) reported two lake sturgeon with fully distended stomachs containing numerous yellow perch (*Perca flavescens*) egg masses.

There is no evidence that adult lake sturgeon have natural predators, but historically they may have been vulnerable to black bear (*Ursus americanus*) while spawning in shallow waters in high concentrations. Commercial fishermen believed that parasitic lampreys [sea lamprey (*Petromyzon marinus*) and silver lamprey (*Ichthyomyzon unicuspis*)] were responsible for the poor condition of some fish as lamprey scars were found on most adult fish in the Great Lakes (Harkness and Dymond 1961) prior to sea lamprey control in the 1950s. However, more recently, the incidence of lamprey scarring is rare and in one study not a single scar was found among over 3000 individuals examined (L. Mohr, Ontario Ministry of Natural Resources, Owen Sound, Ontario, personal communication). Similar observations were also made in 2004 in the St. Lawrence River commercial catch. Vladykov (1985) reported an incidence of 61 silver lampreys attached to a single lake sturgeon caught in 1961 in the

St. Lawrence River. The total weight of these lampreys (120 g) was only a small fraction of the 16 kg host sturgeon.

YOY are the most likely stage to be preyed upon by other fish species. Walleye (*Sander vitreus*) were reported to have lake sturgeon in their stomachs in the Abitibi River (Seyler 1997c), and the predation of 2.5 - 5 cm larval sturgeon by 9 - 12 cm yellow perch and 15 cm northern pike (*Esox lucius*) has been documented in laboratory studies (Dick, unpubl. data).

A number of parasitic trematodes, acanthocephalans, nematodes and cestodes have been reported from lake sturgeon (Harkness and Dymond 1961). Choudhury and Dick (1993) reported 19 parasite species from lake sturgeon and Choudhury *et al.* (1995) reported 10 parasite species in lake sturgeon from near the southern limits of its current range (Lake Winnebago, Wisconsin). Some of these parasites are common in other fishes with similar feeding patterns and habitat preferences, while other parasites are associated only with the sturgeons, indicating a strong phylogenetic relationship and specificity at the host family level. The coelenterate parasite, *Polypodium hydriforme*, infects the mature ova of lake sturgeon destroying the egg (Dick *et al.* 1991). This parasite has been reported from the United States, but has been reported in Canada only from the Rainy, Winnipeg, Nelson and Saskatchewan rivers; however, it probably occurs in other parts of Canada as well (Dick *et al.* 1991).

Behaviour/Adaptability

It is clear that lake sturgeon do not adapt readily to change, whether from fishing pressure or habitat alterations. Constructed barriers on streams restrict the movements of large, mature lake sturgeon; however, the importance of these barriers, if local spawning habitat remains intact, is unknown. Studies on tagged juveniles and adults indicated that most individuals do not move great distances and that the integrity of local habitat appears to be essential for survival (Dick 2004). Laboratory studies on the movements of wild and cultured lake sturgeon in the same location indicate that over a 10-day period, wild and cultured lake sturgeon moved over the same substrates and fed on the same natural food items (Dick 2004). Lake sturgeon have been reared successfully from hatch and have been returned to the wild as yearlings or older fish. This approach has been successful in the Assiniboine River near Brandon, but has proven difficult to monitor on the Winnipeg and Nelson rivers (Dick, unpubl. data). A major landslide occurred along the Ouareau River in March 1990 in the single lake sturgeon spawning ground of this river. Despite the fact that at least two thirds of the spawning substrate has been buried and that the flow regime has been deeply modified, the spawning site was still used and none of the alternative sites contained eggs or larvae (La Haye *et al.* 1990).

POPULATION SIZES AND TRENDS

The assessment of sustainability of populations should consider effective population size (Reiman and Allendorf 2001), not just total numbers. A population whose effective population size is too small (< 50) becomes susceptible to inbreeding depression. A population of at least 500 mature individuals is considered necessary to maintain adaptive genetic variation, assuming a population with equal sex ratios and equal contribution of all adults to the next generation. This has important implications for lake sturgeon as in many populations, sex ratios may be unequal, not all individuals breed every year, and there may be variance in the age of maturity (Earle 2002). Therefore effective population sizes for the DUs may be substantially smaller than total population estimates or censuses.

As fisheries population estimates have substantial uncertainty and risk of extinction is serious and potentially irreversible, the preconditions for the application of precaution are met. In such circumstances it is customary to adopt the lower 95% confidence limit for a population estimate as the basis for status assessment. This practice corresponds to recommended practices in fisheries population dynamics as well (Richards and Maguire 1998).

Historic and geographic trends

There are several reports on the decline of lake sturgeon populations in Canada (Harkness and Dymond 1961; Houston 1987; Dick and Choudhury 1992). It is uncertain when commercial exploitation of the species commenced, but there are records of Isinglass sales to the Hudson Bay Company at Norway House, Manitoba from 1832 to 1892 (MacDonell 1997, 1998). Commercial harvest for caviar production was initiated in Sandusky, Ohio in 1855 (Harkness and Dymond 1961), and Canadian waters of the Great Lakes were opened to commercial sturgeon fishing in 1879 (Prince 1905). Within a short time, populations of lake sturgeon throughout the Great Lakes and in the surrounding waterbodies on both sides of the International Border were reduced to less than 1% of their former numbers (Hay-Chmielewski and Whelan 1997). As European settlement expanded and infrastructure was developed, prices rose and the sturgeon-rich waters of northwestern Ontario and Manitoba were opened to commercial operators. The collapse of these fisheries followed the pattern of their southern counterparts. As populations in northwestern Ontario and Manitoba began to collapse, commercial harvesting relocated to populations of previously unexploited rivers and lakes (Brousseau 1987; Houston 1987; Sopuck 1987; Patalas 1988). Wherever lake sturgeon have been fished, the result has been the same: a relatively high initial yield followed by a sudden decline to very low levels, which persist thereafter (Harkness and Dymond 1961). This pattern is consistent with life history traits of slow growth and late maturation, and high commercial value products. Commercial catch records demonstrate that lake sturgeon populations over most of their historical range were severely depleted or extirpated by the early 20th century (Tables 5 and 6), and most have not recovered, except in the central and eastern parts of the range where some commercial and recreational fisheries in Ontario and Quebec remain (Tables 3-6).

Table 3. Total harvest (kg) by year for lake sturgeon in Quebec. Totals for the 1987 to 1998 period are estimates based on a formula using export values. For example, in 1999 lake sturgeon were worth \$3.49/kg¹. Totals for the subsequent years are based on landings declarations².

| Year | Total Harvest (kg) |
|------|--------------------|
| 1987 | 245,200 |
| 1990 | 222,232 |
| 1991 | 216,813 |
| 1992 | 222,102 |
| 1993 | 224,934 |
| 1994 | 261,831 |
| 1995 | 251,606 |
| 1996 | 198,388 |
| 1997 | 197,245 |
| 1998 | 215,834 |
| 1999 | 192,512 |
| 2000 | 126,394 |
| 2001 | 126,188 |
| 2002 | 110,150 |
| 2003 | 83,042 |
| 2004 | 81,298 |
| 2005 | 74,501 |

¹ Danielle Hébert (Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec) and Laurette Gagnon (Statistical Services, Fisheries and Oceans Canada, <http://www.dfo.mpo.gc.ca>).

² Marcel Bernard (Ministère des Ressources naturelles et de la Faune du Québec).

In Ontario, lake sturgeon still occur in 38 of the old 47 Ontario Ministry of Natural Resources (OMNR) administrative districts. They are common in 10, rare in 28 and absent from 9 (Brousseau 1987). Kerr (2002) lists the Ontario waters currently known to contain lake sturgeon; however, the relative abundance of sturgeon is not provided. The species is reported from 13 lakes/reservoirs and 25 streams/rivers in the south-central region, from 16 lakes/reservoirs and 46 streams/rivers in the northeast region and from 95 lakes/reservoirs and 30 streams/rivers in the northwest region (Kerr 2002: Figure 1). Landings of 6000 kg of lake sturgeon were reported from the commercial fishery during 2000 (Table 4) compared to the hundreds of thousands of kg harvested annually in the late 1800s and early 1900s (Brousseau 1987; Houston 1987). However, most of the fish harvested recently were not from populations that supported the historic commercial fisheries. Most of those populations have failed to recover from the exploitation of the late 19th and early 20th centuries. The commercial harvest is < 0.1% of that reported in 1895 and has declined by over 80% since 1964 (Brousseau 1987).

At the same time, recreational angling has increased. Since 1984, recreational yields from this fishery have surpassed the commercial harvest (Brousseau 1987) and still are increasing where populations are abundant enough to support angling.

Table 4. Commercial landings of lake sturgeon (tonnes) from Ontario¹.

| Location | Year | | | | | | |
|--|------|------|------|------|------|------|------|
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Lake Ontario | - | - | - | - | - | - | - |
| Lake Erie | 1 | - | 1 | - | 1 | 1 | 1 |
| Lake St. Clair | | | | | | | |
| Lake Huron: Main Basin | 3 | 3 | 4 | 4 | 3 | 4 | 4 |
| : Georgian Bay | - | - | - | - | - | - | - |
| : North Channel | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| Eastern Lake Superior | - | - | - | - | - | - | - |
| Western Lake Superior | - | - | - | - | - | - | - |
| Northern inland lakes including Lake Nipigon | 4 | 1 | 1 | 1 | 1 | 1 | - |

¹ Laurette Gagnon (Statistical Services, Fisheries and Oceans Canada; <http://www.dfo.mpo.gc.ca>). Data came from the Ontario Commercial Fishers Association, Blenheim, Ontario.

Table 5. Duration, maximum and minimum commercial harvest of lake sturgeon from Canadian waterbodies.

| Waterbody | First Year | Last Year | Maximum | | Minimum kg |
|---|------------|---------------|---------|------|------------|
| | | | kg | Year | |
| Lake Ontario ¹ | 1879 | 1920 | 46,909 | 1882 | 454.5 |
| Lake Erie ¹ | 1879 | 1964 | 277,090 | 1887 | 454.5 |
| | 1879 | 1945 | 41,818 | 1879 | 909 |
| Lake Huron ¹ | 1879 | 1943 | 379,227 | 1886 | 2,727 |
| Lake Superior ¹ | 1885 | 1904 | 55,000 | 1902 | 454.5 |
| Lake Simcoe ² | 1881 | 1915 | 13,182 | 1902 | 454.5 |
| Lake of the Woods ³ | 1892 | 1930 | 111,484 | 1895 | 454.5 |
| Lake Nipissing ⁴ | 1900 | 1930 | 75,000 | 1903 | 1,400 |
| Lake Winnipeg ⁵ | 1885 | 1920 | 446,136 | 1900 | 3,409 |
| Nelson River ⁶ | 1907 | 1910 | 11,682 | 1909 | 4,091 |
| Sipiwesk Lake ⁶ | 1917 | 1918 | 68,182 | 1917 | 30,909 |
| | 1921 | 1929 | 66,364 | 1924 | 1,818 |
| | 1937 | 1946 | 13,636 | 1938 | 2,636 |
| | 1953 | 1959 | 14,045 | 1954 | 4,318 |
| Cumberland House, Saskatchewan River ⁷ | 1900 | - | 15,500 | 1928 | 2,700 |
| Ottawa River ⁸ | - | 1907 | 28,840 | 1898 | 6,500 |
| Lake St. Francis ⁸ | - | 1969 (native) | 8,700 | 1964 | 1,600 |
| Lake St. Louis ⁸ | | 1976 (native) | 39,750 | 1972 | 15,360 |
| St. Lawrence River ⁹ (Quebec) | 1920 | 2005 | 245,700 | 1995 | 5,540 |

¹ Baldwin *et al.* 1978;

² McCrimmon and Skobe 1970;

³ Mosindy and Rusak 1991;

⁴ Brousseau 1987;

⁵ Harkness 1980;

⁶ Sopuck 1987;

⁷ Wallace 1991;

⁸ Houston 1987;

⁹ See Figure 15 in this document.

Table 6. Duration, maximum and minimum combined lake sturgeon harvest (kg) in Canadian and American waters (data only include years when both countries were involved in the commercial fishery).

| Lake | Lake Area (km ²) | Year | Maximum | | Minimum kg |
|--------------------------------|------------------------------|------|-----------|-------------------|------------|
| | | | Kg | Year | |
| Ontario | 19,550 | 1890 | 26,090 | 1920 | 909 |
| Erie ¹ | 25,670 | 1885 | 2,357,727 | 1921 | 3,636 |
| Huron ¹ | 59,830 | 1885 | 473,181 | 1951 [@] | 6,818 |
| Michigan ¹ | 57,750 | 1879 | 1,745,454 | 1956 [@] | 455 |
| Superior ¹ | 82,000 | 1885 | 108,118 | 1919 | 3,636 |
| St. Clair ¹ | 1,270 | 1879 | 495,909 | 1908* | 16,363 |
| Lake of the Woods ² | 3,846 | 1895 | >800,000 | 1926 | <1,000 |

[@]State of Michigan waters closed to commercial sturgeon fishing from 1920-1950.

*After 1908, the American portion of Lake St. Clair did not yield more than 227 kg of fish/year so was not recorded as a contribution to the lake's harvest data after this time (i.e. only the Canadian production after 1908 on Lake St. Clair).

¹Baldwin *et al.* 1978; ²Mosindy and Rusak 1991.

Catches reported from Quebec over an extended time differ from the history of other commercially fished lake sturgeon populations in Canada. With the exception of the Second World War period, declared landings since 1920 were generally over 50 tons (and yields over 0.5 kg/ha) [Figure 15]. During this period, fisheries in parts of Quebec did not follow the scenario observed in other areas where initial, relatively high yields were followed by quick, rapid and prolonged declines. However, the catch records prior to 1983 for the Quebec part of the St. Lawrence River are considered inaccurate and must be seen as minimal (Dumont *et al.* 1987). Therefore, the true pattern of catches prior to the mid-1980s is uncertain; however, Fortin *et al.* (1993) and Dumont *et al.* (2000) estimated that between 15,000 to 30,000 sturgeon were harvested annually during the 1980s and 1990s.

Many lake sturgeon populations in DUs 6 and 8 are also shared with the United States. Therefore, these populations could be affected by management activities and harvesting activities that occur outside of Canadian waters. Trends in Canadian waters could be influenced by the population dynamics and movement of lake sturgeon in adjacent U.S. waters.

Population trends by designatable unit

Western Hudson Bay (DU1)

Skaptason (1926) reported landings of up to 46,000 kg/yr for lake sturgeon from the Churchill River in the early 1920s, as well as the presence of lake sturgeon in the upper Churchill River at Granville and Indian lakes. Landings from 1939 to the late 1960s from the Churchill-Granville-Opachuanua region ranged from 100 to 530 kg/yr (Lysack, pers. comm.). However, lake sturgeon catches thereafter dropped off and only

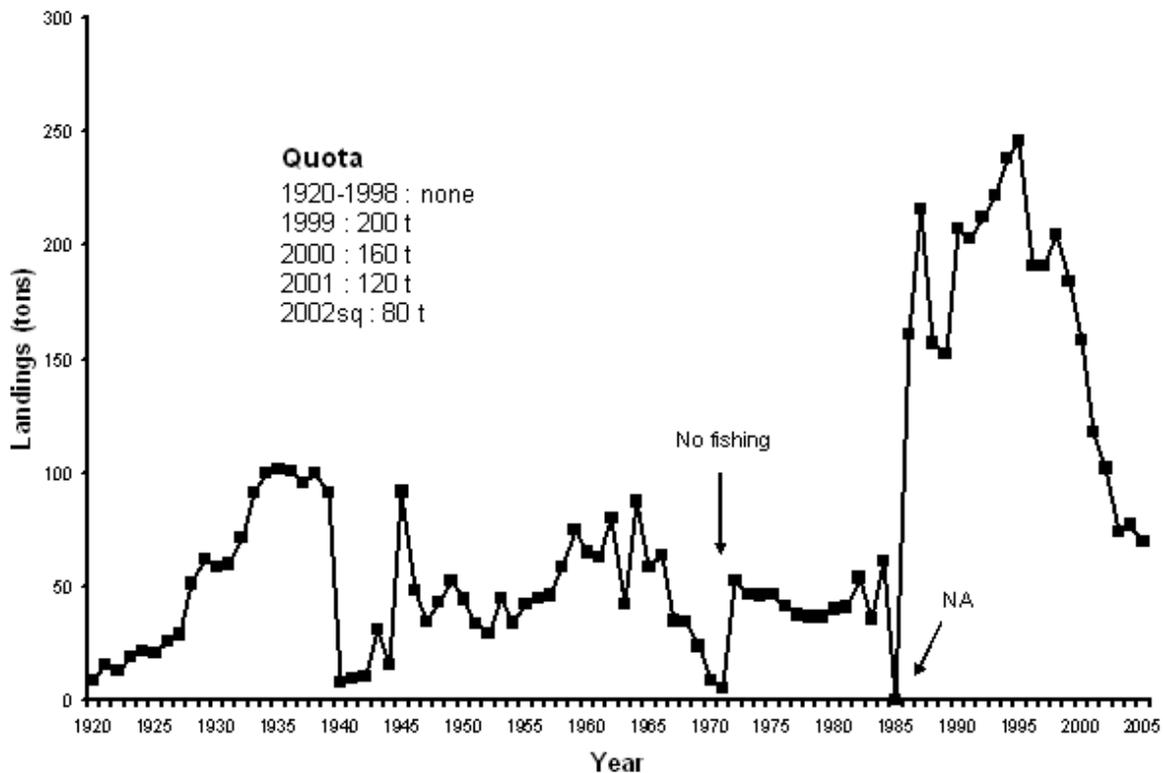


Figure 15. Declared lake sturgeon commercial landings in the Quebec part of the St. Lawrence River (1920-2005). Landings data adapted from Robitaille *et al.* (1988) and from Marcel Bernard (unpublished data). NA = Not Available.

sporadic catches were reported [1967 to 1968 (13 kg/yr), 1976 to 1977 (145 kg/yr), and 1986 to 1987 (70 kg/yr)], despite continued effort to fish for lake sturgeon (SERM 1996). Landings data suggest that the apparent availability of sturgeon had declined by over 98% between the 1920s and 1939. The few sturgeon reported are very large and probably very old (two in the last 5 years from the Upper Churchill River at Sandy Bay, Saskatchewan); the population is believed to be a remnant, but no other recent information on this population is available (Wallace, pers. comm.).

Mark-recapture and larval drift studies conducted in 2003 at the confluence of the Churchill and Little Churchill rivers provide a population estimate of 1812 ± 508 adult sturgeon (MacLean and Nelson 2005). This may however be an overestimate of the number of adult fish, as the assumptions applied in their (MacLean and Nelson 2005) Petersen single census estimate equation included that the captured fish were all adults, and that the population is stable and unexploited. The population is subject to subsistence harvest by Cree Nation peoples of the area (Tataskweyak, War Lake, Fox Lake, and York Factory Cree Nations), who are interested in a sustainable domestic fishery. The extent of subsistence usage is not known, nor is the degree of consistency

of the subsistence fishery over the past decades. Of the 366 fish captured, ranging in size from 0.4-1.4 m (fork length) in length and 5.7 to 24.7 kg in weight, fish over 0.8 m fork length were taken as mature and included in the estimation. However, other reports (see Biology section) indicate many fish of this size would still be immature. Moreover, the low mean weight and age suggest that this is a population with no large, older mature fish, an indication of stress, and perhaps overexploitation.

In summary, historic landings information indicate a decline of over 90% between the 1920s and 1940s, with no evidence of subsequent substantial increase. Life history traits of harvested lake sturgeon in the 2000s are consistent with a population that has been subject to severe overexploitation and has not recovered. The only available population estimate, for part of one watershed in the DU, estimates between 1300 and 2300 adults, but may be biased upward.

Saskatchewan River (DU2)

There are early records of sturgeon, undoubtedly *A. fulvescens*, taken in the North Saskatchewan River and adjacent tributaries. For example, Moodie (1965, p. 59) noted a statement in a book by G.M. Grant that “sturgeon up to 10 kg (“25 pounds”) were caught in the Sturgeon River as late as 1872 by men of the Sandford Fleming expedition” (Nelson and Paetz 1992). Sturgeon no longer ascend this tributary as water levels now are too low to support a population (J. Nelson, Department of Zoology, University of Alberta, Edmonton, AB; personal communication).

In Alberta, a 1986 estimate for the population of the South Saskatchewan River was 510 potential spawners (those > 20 years of age). Assuming an equal sex ratio, and females spawning every 4 to 7 years, there would be 36 to 63 female sturgeon spawning per year in the Alberta portion of the South Saskatchewan River (Alberta Sustainable Resource Development 2002). The Alberta portion of the North Saskatchewan River has an estimated 190 mature fish (Alberta Sustainable Resource Development 2002). Again, assuming an equal sex ratio, and females spawning every 4 to 7 years, there are probably less than 100 mature females and only about 14 - 25 spawning females spawning annually in the North Saskatchewan River.

Although historic population levels are unknown and both populations have experienced significant declines in numbers, there are signs of positive recruitment (Nelson and Paetz 1992). However, the number of spawning fish remaining in each sub-population may be below the critical number required for genetic or demographic viability (Alberta Sustainable Resource Development 2002). The North Saskatchewan River has about 2.5 lake sturgeon per kilometre. In the summer of 2002, boat electrofishing (4.01 hours) near Medicine Hat on the South Saskatchewan River yielded 8 lake sturgeon, and an additional 13 lake sturgeon observed (age and size information not indicated), from a total sample of 821 fishes representing 17 species (D. Watkinson, Central and Arctic Region, Department of Fisheries and Oceans, Winnipeg, MB; personal communication).

Little is known about populations in the Saskatchewan River upstream of the E.B. Campbell Dam to the Alberta border. Historically, there were a total of 111 sites where lake sturgeon were known to occur in the Saskatchewan River watershed: 30 in the South Saskatchewan, 48 in the North Saskatchewan and 33 in the Saskatchewan (Smith 2003). Recent surveys indicate that lake sturgeon occurrences are now regularly reported from only 7 sites on the South Saskatchewan, 16 on the North Saskatchewan, and 12 on the Saskatchewan River, a loss of 76 sites (Smith 2003). Lake sturgeon are still present in Tobin Lake and at the Forks of the Saskatchewan (J. Durbin, Saskatchewan Environment, Regina, SK; personal communication), and anglers reported catches at several sites along both rivers, although the recreational fishery has been closed since 1996 (Smith 2003). In the summer of 2002, boat electrofishing (4.01 hours), downstream of Prince Albert on the North Saskatchewan River failed to find any lake sturgeon (Watkinson, pers. comm.). Boat electrofishing in large, deep, turbid rivers may not be effective in producing catches of lake sturgeon (Golder 1999). However, the method has been used successfully for lake sturgeon in shallow, less turbid waters such as those in the 2002 study area, and according to Kempinger (1996) is the most effective way to sample YOY.

In 1885 the typical weight of fish taken in Saskatchewan was in the order of 5 to 30 kg (Houston 1987). Angling records from the 1990s indicate that the typical weight of fish caught now ranges from 0.1 to 14 kg, although fish up to 30 kg and larger are still taken occasionally (Smith 2003). Similarly, test netting indicates that average size of sturgeon is much less than that earlier in the 20th century (Smith 2003).

Skaptason (1926) reported a quota corresponding to nearly 30,000 kg for lake sturgeon from the Saskatchewan River (from Cumberland Lake downstream to Lake Winnipeg at Grand Rapids), although total population size was not estimated. In 1960, prior to construction of the E.B. Campbell Dam, it was estimated that there were about 10,000 to 16,000 lake sturgeon, 8.2 kg and larger, in the Cumberland area (Wallace 1991). By 2001, there were estimated to be < 1300 sturgeon, 8.2 kg and larger, in the Saskatchewan River from the E.B. Campbell Dam in Saskatchewan to The Pas in Manitoba including the delta at Cedar Lake (Smith 2003; R. Wallace, Saskatchewan Environment, Saskatoon, SK, personal communication; Lysack unpubl. data). Therefore, this population has declined by more than 80% in 40 years, and even more than that in the last 80 years. Mark-recapture estimates indicate that the remaining lake sturgeon populations on the Saskatchewan River between Cumberland House, Saskatchewan and Cedar Lake, Manitoba may have declined by 50% since 1998 (Lysack, pers. comm.; Smith 2003).

Findlay *et al.* (1995) and Findlay (1995) report that the decline at Cumberland House became noticeable in the 1980s and Catch Per Unit Effort (CPUE) declined by 88% between 1982 and 1993. A similar decline at The Pas, Manitoba began in the mid-1970s and within 10 years, CPUE and harvest statistics declined by 93% (Findlay 1995). A study conducted on the lower Saskatchewan River between The Pas and Cumberland House in 2000 (Bretecher and MacDonell 2001) yielded only 3 lake sturgeon with a CPUE of 0.002 (sturgeon/yard/day), which was similar to that reported

by Wallace and Leroux (1999), but much lower than the CPUE for Alberta sections of the Saskatchewan River (0.029), or the CPUE for Ontario rivers (0.011) [Saylor 1997a,b]. Analysis of age-sex distributions for the Cumberland House harvest indicated a shift in the size-age composition of the catch between 1954 and 1965, during construction of the E.B. Campbell Dam, toward smaller, younger fish and that the trend was evident into the 1990s (Wallace 1991). Using a gonad index, Dick (unpubl. data) found that 97% of the lake sturgeon from the last commercial sturgeon fishery at Cumberland House were pre-spawners or juveniles.

Lake sturgeon harvest surveys conducted at Cumberland House and The Pas during the summers of 2000 and 2001 (North/South Consultants 2002) indicated a variety of fishing pressures that included 30 groups of anglers, 27 groups of domestic fishers, one group of commercial fishers and two fishing derby groups (all groups were accompanied by at least one First Nations member). The estimated harvest was 319 sturgeon annually for 2001 and 2002 with a CPUE of 0.0004/angler/hour. This harvest produces an estimate of an exploitation rate of 12.3%, which is unsustainable (North/South Consultants 2002). This may be an underestimate of exploitation rate because the survey methodology may not account for all domestic/subsistence use. Domestic/subsistence use is not reported systematically, but may be at a scale to present a concern for the sustainability of the Saskatchewan River lake sturgeon population (Brectecher and MacDonell 2001).

In summary, all estimates of population status in this DU suggest major reductions from the 1920s to the 1960s and 1970s, but these declines are difficult to quantify. Since the 1970s, there has been a further decline of as much as 80% in estimates of the populations comprising this DU. Current density estimates from a variety of sources are consistently very low, and estimates of the numbers of breeding females in various river branches do not exceed a few dozen spawners annually. The information on age and size composition of components of this DU are also consistently indicative of a population that has been affected by heavy exploitation and habitat disruptions for a long period, although recruitment to the populations is still occurring.

Nelson River (DU3)

Lake sturgeon are found throughout the Nelson River from Lake Winnipeg to Hudson Bay. Commercial fisheries established in 1907 initiated a pattern of exploitation followed by collapse and closure of the fishery. The fishery was opened and closed for periods of 4 - 9 years on at least 3 occasions between 1932 and 1970. In 1991 it was finally decided that commercial fishing on the Nelson was not sustainable and the remaining commercial fisheries were subsequently curtailed. Local domestic fisheries persist, however (MacDonnell 1995). Information on populations and harvests from the upper Nelson River are presented in Macdonald (1998).

A population estimate for lake sturgeon in the region of Sipiwesk Lake in the Nelson River drainage in 2000 was 1200 adults with a high proportion of males (Macdonald, pers. comm.). In the past, this area provided most of the commercial

harvest within the Nelson River (Sopuck 1987). Compared to initial population estimates of 12,000 lake sturgeon by Sunde (1961), or even the corrected estimates of 6,000 sturgeon for 1987 (Sopuck 1987), the population has declined by 80 - 90% between 1987 and 2000 (Macdonald, pers. comm.), and more than 90% since 1960. Current population estimates may be reduced even further as a substantial number of lake sturgeon were harvested from Sipiwesk Lake during the summer of 2000. Choudhury and Dick (1993), using a gonad index, found that 87% of the lake sturgeon from the last commercial sturgeon fishery in Sipiwesk Lake were pre-spawners or juveniles.

Impoundment of the Nelson River for hydroelectric generation has isolated sturgeon into a series of reservoirs and this fragmentation may be one of the major limiting factors for sturgeon in the Nelson system (Horne and Baker 1993).

About 500 fish were recorded in the area below the Limestone Dam on the Nelson River in 1998, but this concentration of lake sturgeon may be atypical. The large concentration may be related to changes in flows below Limestone Dam because flows drop at night and during the weekends as electrical demand drops, and/or it may be due to the large natural flow fluctuations observed on the Weir River (Macdonald, pers. comm.). However, the river below the dam is the longest stretch (100 km) of unimpounded water on the river and the lake sturgeon in this section may represent perhaps the last true riverine stock on the river (MacDonnell (1995). The Cross Lake and Playgreen Lake stocks are probably extirpated (Manitoba Department of Natural Resources 1994).

Studies conducted on the Lower Nelson at the Weir River, a tributary of the Nelson downstream of Limestone Dam and rapids, and the only known spawning location on the lower Nelson (MacDonnell 1997), during the 1990s indicate that lake sturgeon are still using the area, and that fish from the Hayes River may also utilize this as a spawning area (Barth and MacDonnell 1999). Catches varied from year to year from a low of 26 (15 adults) in 1994 (MacDonnell 1995), to a high of 355 (215 adults) in 1996 (MacDonnell 1997). Immature lake sturgeon made up about 30 – 40 % of the catch except in 1998 when immatures made up only 9.5% of the 232 fish (Macdonnell 1995, 1997, 1998; Barth and MacDonnell 1999). Small numbers of eggs (672 in 1997 and 82 in 1998) and larvae (< 100 annually) were collected in larval drift studies. Annual variation in catch is probably related to lake sturgeon spawning periodicity. The largest fish captured measured 1.6 m in length, weighed 30 kg, and was aged at 43 years. Throughout the study period, length and weight of the largest fish in the sample each year ranged from 1.4 to 1.6 m in length and 17.3 to 30 kg in weight (MacDonnell 1995, 1997, 1998, Barth and MacDonnell 1999). The lack of older, larger fish and low numbers of larvae are suggestive of a stressed population with low recruitment.

In 1990, several groups of 5 to 6 spawning sturgeon were observed at Landing River, a tributary of the Nelson River. This compares with reports of hundreds of lake sturgeon spawning at the site several decades ago (Macdonald, pers. comm.).

Sixty-nine lake sturgeon were captured and tagged in the Gull Lake area (between Split and Stevens lakes) in northern Manitoba during an intensive monitoring program in 1998. An additional 350 were tagged in a series of studies conducted in the Gull Lake area between 2001 and 2004 as part of an aquatic monitoring and environmental impact assessment program in relation to a proposed development of a hydroelectric generating station at Gull Rapids (upstream end of Stevens Lake) on the Nelson River. Spring gillnetting from 2001 to 2004 resulted in catches of 139 (2001) to 335 (2003) lake sturgeon annually (Barth and Mochnacz 2004; Barth 2005; Barth and Murray 2005; Barth and Ambrose 2006). The largest lake sturgeon caught was 1.54 m in length and weighed 54 kg. Although not aged, this fish was probably over 40 years of age. The 338 fish surveyed in 2004 ranged in length from 0.9 to 1.5 m and 5.4 – 31.3 kg in weight. The spring gillnetting in 2003 and 2005 indicated that about 18-19% of the fish captured were in spawning or post-spawning condition (Barth and Ambrose 2006) with about 80% immature or non-spawners. Few larvae were taken in larval surveys and fall netting resulted in the capture of only 3 lake sturgeon in 700 hours of fishing effort (Barth 2005). As in the case of the Weir River studies the population demographics suggest a stressed population with poor recruitment.

In summary, historic commercial landings data indicated large but unquantified declines in abundance of this DU since the first quarter of the 1900s. For the period since population estimates have become available for components of this DU, estimates of the largest component declined 80-90% from the early 1960s to the late 1990s, and have declined further thereafter. Dams in the river system have fragmented the population into largely isolated components, some of which appear to have been extirpated. All components that have been studied show few spawners annually, few eggs and larvae, a low proportion of mature sturgeon in samples, and a small maximum size of the mature sturgeon that are found.

Red-Assiniboine Rivers-Lake Winnipeg (DU4)

Large commercial fisheries for lake sturgeon once existed on Lake Winnipeg (Table 5). The largest single year catch of lake sturgeon was 446,136 kg, taken in 1900. Extensive sampling of fish populations in Lake Winnipeg has been conducted from the early 1970s to the present, using gill nets with a stretched mesh size ranging from 7.5 cm to 12.5 cm. Sampling consisted of 30 stations sampled twice a year from the early 1970s until the early 1980s. From the early 1980s to the present, sampling continued at four sites in each of the north and south basins of Lake Winnipeg where survey nets are set in conjunction with the commercial fisheries for other species. These surveys have not collected any lake sturgeon (K. Campbell, Manitoba Conservation, Gimli, MB; personal communication), and during the past 28 years, only three lake sturgeon have been observed in Lake Winnipeg, two under 2 kg and one about 15 kg (Campbell, pers. comm.).

Little is known about lake sturgeon populations in the Assiniboine River other than that they have virtually disappeared. There is no evidence of a naturally reproducing population in the Assiniboine River. Stocking of lake sturgeon in the Assiniboine River

was undertaken between 1996 and 2002 by Manitoba Conservation and the Brandon Wildlife Association to determine the survival of fry (4000 stocked) and fingerlings (4156 stocked) produced in the lake sturgeon culture program of Manitoba Conservation. Extensive electrofishing (1995 to 2002) between the Red River and the City of Brandon has failed to detect any sturgeon, although the area close to Brandon was sampled only once. Most electrofishing was conducted further downstream near the crossing of Highway 34 and between Portage la Prairie and Winnipeg. Additional sampling was done upstream of Brandon near the confluence with the Qu'appelle River (Franzin, pers. comm.). Between 1998 and 2002, anglers reported catching over 280 lake sturgeon (lengths 20-100 cm) from the Assiniboine River in a 20-km stretch between Brandon and the Little Souris River (S. Matowski, Manitoba Conservation, Winnipeg, MB; personal communication), but it has not been established if these fish originated from natural reproduction or stocking. Lake sturgeon were also stocked in the Assiniboine River above the city of Winnipeg in 1997 (Dick, unpubl. data). Lake sturgeon remained in the vicinity of the stocking site due to cold water that fall, but no lake sturgeon were caught in the Assiniboine River, from the mouth to a few km upstream of the stocking site, by boat electrofishing in June 1998. Only one of these tagged lake sturgeon was recovered, at the mouth of the Red River (Dick, unpubl. data). There is no evidence of an extant, reproducing population in the Assiniboine River.

Local newspapers have reported angler catches of two lake sturgeon from the Red River below the St. Andrew's Dam at Lockport in the last several years (Lysack, pers. comm.). One of the two fish was taken in the Red River in 1996 and measured 199 cm in length, setting a Manitoba angling record. The second fish, caught sometime later, measured within 5 cm of the other and may have been the same fish as this was a catch-and-release fishery. Given their size, they probably were born prior to the construction of the dam at Lockport. Between 1975 and 2002, only a few lake sturgeon captures were reported from 8.1 million angling hours on the Red River between Lockport and Netley Creek (Lysack 1986; Dick and Lysack, unpubl. data). No sturgeon were collected in the Red River from Lake Winnipeg to the American border during three boat electrofishing surveys in fall 2002, and spring and summer 2003 (Watkinson, pers. comm.).

Since 1997, Minnesota Department of Natural Resources and White Earth Indian Reservation have been releasing lake sturgeon into the U.S. waters of the Red River Drainage (Aadland *et al.* 2005). To date 375 adults, 3482 yearlings and 18,000 fingerlings (in 2002) have been released as part of a 20-year introduction plan that will see an annual release of 34,000 fingerlings and 600,000 fry (MN DNR 2002, as cited in Aadland *et al.* 2005). These fish are from Rainy River stock, which according to MacDonnell (pers. comm.) may have interbred with Winnipeg River stocks. This is unlikely at present given the limitation to upstream availability because of the natural and manmade barriers near the mouth of the river, preventing upstream movement (see Designatable units and Figure 8). Only two lake sturgeon were captured during a study of fish movement at the City of Winnipeg floodway inlet control gates in 2005 (Graveline and MacDonnell 2005) and also is present in the Pigeon, Bloodvein, Poplar and Berens rivers that flow into the east side of Lake Winnipeg and is harvested by Aboriginal

communities. However, virtually no population data are available for these rivers. Based on mark-recapture studies, the sturgeon population in Round Lake on the Pigeon River is estimated to have between 800 to 1000 individuals with very few (< 100) spawning females (Dick 2004). Recent telemetry studies have been conducted on the population in the Ontario portion of the Berens River. There is no information on the status of the population, but it is believed to be depressed from commercial fishing that took place in the 1950s (M. Schillemore, Ontario Ministry of Natural Resources, Red Lake, ON, personal communication). It is currently not exploited.

In summary, very large populations of lake sturgeon must have once existed in Lake Winnipeg, but these populations were depleted by commercial exploitation in the first decades of the 1900s. Historic sizes of population components in rivers in the range of this DU are poorly known, but all are known to be depleted. There is no firm evidence of naturally reproducing populations in the major watersheds of the Assiniboine or Red Rivers in recent years, although there have been small angling catches each year. A number of smaller rivers draining into Lake Winnipeg do continue to support lake sturgeon, but the little evidence available suggests that numbers of spawning females are unlikely to exceed a hundred annually in any component. Stocking has been undertaken in the major rivers of this DU since 1996, but survival rates appear to be low, and it would be at least one or two more decades before lake sturgeon stocked in these rivers could establish reproducing populations if they were to survive.

Winnipeg River-English River (DU5)

Large commercial fisheries for lake sturgeon once existed on the Winnipeg River, and in the 1930s catches were in excess of 35,000 kg. By 1947 the annual catch was less than 2000 kg at which time the fishery became economically non-viable. After a hiatus of 9 years the fishery was reopened and the 1956 take was in the order of 12,000 kg with a slight increase in 1957 and then a decline to about 5000 kg in 1959 at which time the fishery was closed (Harris *et al.* 2000; Lysack, unpubl. data). Opened again in the 1960s, harvest continued to decline and the fishery was closed in 1970 due to mercury contamination (Harris *et al.* 2000). Since the 1970s only a few (~ 5 per year) have been taken as bycatch with other species (Harris *et al.* 2000). Today, they have essentially disappeared from a major historic lake sturgeon spawning and nursery area below the Seven Sisters Dam on the Winnipeg River (H. Letander, Sagkeeng First Nations Elder, personal communication), and from above Scott Rapids where few fish have been reported since the 1990s. Two fish were taken in 2 weeks of fishing above Scott Rapids (Lysack, unpubl. data), and 40 juvenile and sub-adults were taken in additional sampling in the late 1990s (Dick, unpubl. data). In June 2000, two overnight gill net sets below Seven Sisters Dam on the Winnipeg River caught a single juvenile sturgeon.

Mark-recapture studies provided a mean estimate of 2352 sturgeon in the Winnipeg River from Seven Sisters to Point de Bois in the late 1990s (Guimon and Coucherne vs. *The Queen* 2001; Lysack unpubl. data), with catch per unit effort

showing a downward trend (Figure 16). The mark-recapture study indicated that 72% of the fish caught and released were below the mean age of maturity, which was taken to be the same as that for fish in the Nelson River, i.e., 27 years (Lysack unpubl. data). This would produce an estimate of 660 mature fish, although according to lake sturgeon life history, only a portion of these would spawn annually. Moreover, the estimate of 2352 may be an overestimate since mark-recapture results were biased in some years (particularly the last 2 years of the study) by the removal of tagged and untagged fish by poachers. A third index demonstrating decline in this population is the CPUE determined for the Nutimik-Numano stock (Figure 16) that declined by 54.9% between 1983 and 1999.

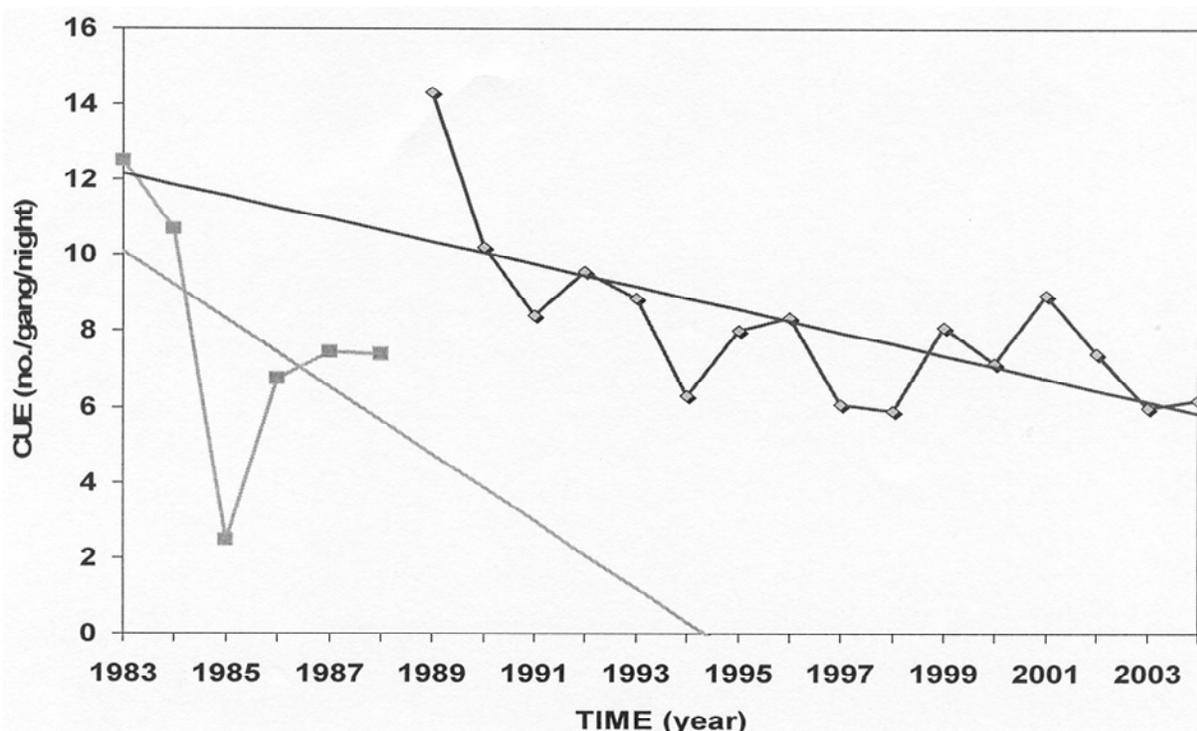


Figure 16. Temporal changes in Catch Per Unit Effort (CPUE) of the Nutimik-Numano stock. The upper line indicates CPUE from 1983-1988 and the lower line indicates CPUE from 1989-2004. CPUE changes provide a method of indexing temporal changes in stock size. The Nutimik-Numano stock is decreasing over time. From 1983 to 1988, 9 inch and 12 inch nets were set. A 5.5 inch mesh net was added to the 9 inch and 12 inch mesh nets in 1989. Since 1989, CPUE has decreased by 7.84 fish/net/night. This is a 54.9% decrease.

Lake sturgeon are not known to currently occur in the Black Sturgeon River (Harris *et al.* 2000).

Little is known about lake sturgeon in the English River, which like the Winnipeg River is fragmented by falls, rapids and dams. They have not been recorded from the upper reaches of the river by the Ontario Ministry of Natural Resources or by the local

Native people (Lesley Barnes, Ontario Ministry of Natural Resources, Red Lake, Ontario; personal communication). Apparently they are taken occasionally in lower sections by Aboriginal people, and possibly anglers and poachers, but are quite rare there (Bruce Ranta, Ontario Ministry of Natural Resources, Kenora, Ontario; personal communication). Index netting in 1998 and 1999 in the portion of the river between Ball and Separation lakes failed to catch any lake sturgeon (McAughey, personal communication).

In summary, populations were large enough to produce commercial catches of over 35,000 kg in the 1930s, but these catches were unsustainable and the populations were unable to support catches of less than a third that size by the 1950s. Although commercial fisheries have been closed since the 1970s, lake sturgeon are uncommon to rare at sites that historically were major spawning beds, and lake sturgeon rarely are taken in angling and subsistence catches. A single mark-recapture estimate is available for a major portion of the population in the DU, and it suggests it is unlikely that the mature population exceeds 660 fish, of which less than half are female, and only a portion of these would spawn each year.

Lake of the Woods-Rainy River (DU6)

In the late 1800s, Lake of the Woods was known as the “greatest sturgeon pond in the world”; however, the annual commercial catch had fallen from an annual average of 225,000 kg to 1000 kg by 1915 (Macins 1972:1). Some recovery of the Rainy River/Lake of the Woods population has been sustained since 1970, largely in response to water quality improvement. (Mosindy and Rusak 1991). The one remaining commercial licence held by a First Nation has remained closed by voluntary moratorium, following a government buyout of non-native licences in 1995. Current harvest by recreational and subsistence fisheries is estimated to be 5500 kg/year (T. Mosindy, Ontario Ministry of Natural Resources, Kenora ON; personal communication). Size of the population, comprised of adult and sub-adult fish >1 m in length, was estimated at 15,000 fish in 1990 (Mosindy and Rusak 1991) and over 50,000 fish in 2004 (Stewig 2005; Mosindy, pers comm.). At an average weight of 5 kg for fish in the 1-m length range, the harvest represents approximately 1100 fish or ~ 2% fishing mortality, which appears to be sustainable.

On Rainy Lake, research and stock assessment data are only available for the South Arm (a shared stock with Minnesota). The population is thought to be recovering (D. McLeod, OMNR, Fort Frances, ON, personal communication). Abundance may be increasing, but a full age structure has not been re-established (although estimates of age composition may be affected by the sampling gear), and recruitment is still variable. This population mixes with the lower Seine River population, and discreteness of the spawning components is unknown. The other two lake basins (North Arm and Redgut Bay) have not been assessed.

In the Seine River the population below Sturgeon Falls (Crilly) Dam is probably distinct from the population above the dam due to a migration barrier. Limited stock

assessment on the lower Seine River in 1993-95 suggested the population was depressed, with low abundance, low mean age, and few old fish (McLeod, 1999). This population is subject to subsistence harvest, but the exploitation rate is unknown. The population in the upper Seine River has not been assessed, but is likely also low in abundance.

There has been limited assessment of the lake sturgeon population component in the Namakan Reservoir (including Namakan Lake, Sand Point Lake, Little Vermilion Lake, Crane and Kabetogama lakes in Minnesota, and Loon River), although an active commercial fishery existed until 2001 (McLeod, personal communication). Adult fish are captured annually in fall walleye index netting. Commercial fishery observations indicate a healthier stock than Rainy Lake (good abundance and age structure, good recruitment of younger fish). The limited assessment effort has supported a conclusion that this population component is likely increasing, and still recovering. Lake sturgeon in the Namakan River (including Little Eva, Bill and Three Mile lakes) may be genetically similar to those in the Namakan Reservoir. Intermixing is likely occurring, but there may be discrete spawning stocks further upstream. Population status is not known, but limited sampling with nets conducted in the lower portion in fall 2005 found high catch rates of adults with no juveniles captured.

Lake sturgeon populations in Little Turtle Lake (including Big and Little Turtle rivers), Lac La Croix and Loon Lake have not been assessed and their status is unknown. In Quetico Provincial Park, lake sturgeon populations occur in Sturgeon Lake, Russell Lake, Tanner Lake and the Maligne River. The status of these populations is unknown, but lake sturgeon are regularly observed in these locations (B. Jackson, OMNR, Atikokan, ON personal communication).

In summary, lake sturgeon in this DU were reduced by commercial fishing in the 1800s, but there has been substantial rebuilding of many stock components, particularly in recent decades. A total population estimate is not available, but estimates of the Rainy River/Lake component of the Lake of the Woods component exceeds 50,000 lake sturgeon > 1 m, and exploitation rates appear sustainable. Some population components still have an age composition skewed towards younger fish, but in most components where estimates are available, the proportion of mature fish is either stable or increasing.

Southern Hudson Bay-James Bay (DU7)

This ecozone covers portions of northeastern Manitoba, northern Ontario and northern Quebec. Lake sturgeon occur at multiple locations in most of the major river systems in this area. Relatively unexploited sturgeon populations of unknown size occur in the Gods and Hayes rivers of northeastern Manitoba (Matowski, pers. comm.). The Hayes and Fox rivers had landings of 2800 kg in both 1939 and 1941 (Lysack, pers. comm.) Currently, the lake sturgeon population size and harvest, including the Aboriginal fishery, for the Gods/Hayes system is unknown, although 26 lake sturgeon were reported at the mouth of the Hayes River in 2005 (MacDonnell unpubl. data). A

gillnetting study conducted on a 20-km reach of the Fox River (a tributary of the Hayes) between Great Falls and Rainbow Falls in 2004 provided an estimate of 625 (\pm 375) adult lake sturgeon (MacDonnell, unpubl. data).

Data from lake sturgeon populations for rivers in northern Ontario indicate that several have been impacted by hydroelectric dams (Seyler *et al.* 1996, 1997a, b, c; S. McGovern, Ontario Ministry of Natural Resources, Timmins, ON; personal communication). Estimates of lake sturgeon numbers in the Little Long Generation Station head pond on the Mattagami and the Goundhog and Kapuskasing rivers varied from 8000 to 25,000 fish all ages in the late 1980s (Nowak and Jessop 1987; Sheenan and McKinley 1992). The Groundhog River sturgeon population, assessed in a study of adult sturgeon habitat by Seyler (1997a), appears to be quite healthy as there are good spawning runs and recruitment, and a broad age-class distribution. In the Moose River basin, the Kenogami River has populations consisting of predominantly younger-aged fish with a small proportion over 30 years of age (Ecologistics 1988). The Kwataboahagan, Cheepash, North French, Missinaibi and Onakawana rivers have relatively unimpacted, healthy populations (McGovern, pers. comm.). Lake sturgeon exist throughout the Abitibi River, but the population is substantially impacted in this system. Spawning habitat is marginal in areas impacted by dams, but some of the best lake sturgeon habitat in the system remains in the area downstream of Otter Rapids (McGovern, pers. comm), and the population in the Fredrickhouse River of the Abitibi drainage appears to be healthy (M. Gauthier, OMNR Cochrane, ON, personal communication).

Hydro-Québec (2001) reports that lake sturgeon are distributed widely in northern Quebec where they are present and widespread in the James Bay watershed and the basins of the Harricana, Nottaway, Broadback, Opincaca, Rupert, Eastmain and La Grande rivers; however, no population data are available. Ferguson and Duckworth (1997) also indicate that lake sturgeon are common in the La Grande and Rupert rivers, and in the area of Lake Abitibi, and absent in most of the other smaller rivers and lakes of the southern Hudson Bay/James Bay drainage. However, they report that lake sturgeon is rare in other rivers draining into James Bay and southern Hudson Bay, such as the Harricana, Nottaway and Eastmain rivers. As elsewhere, new fisheries often have been initially successful, but rarely sustainable. Commercial fisheries have been sporadically conducted in various locations on an annual quota basis based on a 0.08 kg/ha of total waterbody area (Fortin *et al.* 1992; Ferguson and Duckworth 1997). In a major part of the lake sturgeon distribution area in Northern Quebec, according to the *James Bay and Northern Quebec Agreement* (INAC 1993), lake sturgeon fishing since 1973 has been limited to Native people. South of this territory, recommendations have been made to close most of the fisheries in the James Bay watershed. Commercial fishing is now allowed in only three sections of the Upper Nottaway system (the Bell, Megiscane Est and Megiscane Ouest networks) where quotas of 0.1 kg/ha are thought to be sustainable based on available habitat, which is less than the total waterbody area (Fortin *et al.* 1992, Ministère des Ressources naturelles et de la Faune, 2005).

Microsatellite DNA characterization studies of lake sturgeon from the Rupert and Eastmain-Opinaca watersheds (Bernatchez and Saint-Laurent 2004) indicate that lake sturgeon from the Rupert River are distinct from those of the Eastmain-Opinaca system, but no tests were made with lake sturgeon from any other waterbodies. Lake sturgeon from the Rupert River are structured into three genetically distinct populations, but there is no evidence for structuring within the Eastmain-Opinaca population. Hydro-Québec is in the process of further development of hydroelectric power generation facilities, in an area where lake sturgeon populations have already been fragmented by the construction of dams and impoundments for large-scale production of hydroelectric power (see, for example, Hydro-Québec 2004a). The proposed development would result in a partial diversion of the Rupert River, essentially joining the Rupert and Eastmain watersheds (Hydro-Québec 2004 a, b). The Eastmain River has already been connected to the La Grande River in the 1970s for hydroelectric production. All these modifications may have implications *vis à vis* future viability of either or both populations. Bernatchez and Saint-Laurent (2004) indicate that, in Quebec, lake sturgeon are likely a threatened or vulnerable species.

In summary, lake sturgeon population components in a number of watersheds through northeastern Manitoba, northern Ontario, and northwestern Quebec appear healthy, but generally are poorly quantified, and in a few watersheds, different reports of population status are inconsistent. Some components in Quebec and Ontario have been fragmented by hydroelectric dams, whereas hydroelectric developments have created the potential for connection between other watersheds supporting lake sturgeon. Many northern drainages have not been subjected to commercial fisheries, and where commercial fisheries have occurred, all but three small fisheries have been closed due to unsustainable harvesting in the past.

Great Lakes-Upper St. Lawrence (DU8)

Canadian waters of the Great Lakes were opened to commercial sturgeon fishing in 1879 (Prince 1905). Within a short time, populations of lake sturgeon throughout the Great Lakes, and in the surrounding waterbodies in Canada and the US, declined to less than 1% of their former strength (Hay-Chmielewski and Whelan 1997). Commercial catches for the Great Lakes are provided in Tables 4-6. Currently, lake sturgeon populations are extant at 63 sites in the Great Lakes and St. Lawrence basin; however, successful spawning is documented from only 20 sites (and is unknown for the rest). Spawning run size estimates are available for only 17 of these sites, and populations at only four of these sites are considered to have a spawning run greater than 500 adults (Holey *et al.* 2000). As many as 20 spawning populations in the Great Lakes may have been lost, but other populations are now showing signs of modest recovery (A. Dextrase, Ontario Ministry of Natural Resources, Peterborough, ON; personal communication).

Eight tributaries to Lake Superior in Ontario are documented to have extant, self-sustaining populations of lake sturgeon, but the species is extirpated from six other tributaries (Holey *et al.* 2000). In spring 1998, it was estimated that the Kaministiquia

River had 140 fish (15 adult fish/km of river). Population densities were estimated to be 1.2 fish/ha in the lower reaches and 5.0 fish/ha in the upper reaches (Stephenson, pers. comm.) A fall 2001 estimate for the Kaministiquia River was 188 adult fish for the 12 km of river netted during the survey (Friday and Chase 2006). In the spring of 2003 and 2004 it was estimated that the Black Sturgeon River had 96 (2003) and 103 (2004) adult spawning fish (Friday 2006). Spring assessment netting on the Goulais River was also conducted from 2000 to 2004. Low numbers were caught each year: 2000 (n=9), 2001 (n=11), 2003 (n=9) and 2004 (n=20) [Chase 2006]. During the spring of 2002 a survey of the Big Pic River and its tributaries was conducted. Very few fish were captured: Big Pic River (n=13), Kagiano River (n=3) and Black River (3) [H. Quinlan, USFWS, Ashland, WI; personal communication]. Kelso and Cullis (1996) reported that lake sturgeon are extirpated from Nipigon Bay of Lake Superior. Commercial harvest is prohibited in the waters of Lake Superior and its tributaries, but recreational and subsistence harvesting are still permitted.

Lake Nipigon was first opened to commercial fishing in 1917 and lake sturgeon were quickly over-fished. The peak harvest of 42,273 kg was reported in 1924, but the fishery collapsed by 1930 and has not recovered. Although the commercial fishery no longer targets lake sturgeon, a 770-kg commercial quota was established in the early 1980s to cover incidental catches of lake sturgeon associated with the lake whitefish, lake trout and walleye gillnet fishery. The reported commercial harvest of lake sturgeon has averaged less than 45 kg annually since the quota was set. Recreational and subsistence harvest of lake sturgeon is assumed to be minimal; however, no harvest statistics are available for Lake Nipigon. There have been no programs initiated to assess lake sturgeon populations in Lake Nipigon since the work conducted by Harkness in the 1920s (Harkness and Dymond 1961). Ontario Ministry of Natural Resources staff with the Lake Nipigon Fisheries Assessment Unit have occasionally captured and released juvenile lake sturgeon while conducting periodic Fall Walleye Index Netting projects since 1996 (R. Salmon. OMNR, Nipigon, ON; personal communication).

In the Canadian portion of Lake Huron, lake sturgeon were known from 21 sites, and still are extant at eight of these sites (Holey *et al.* 2000). All of the extant populations are considered small, with the exception of the St. Clair River/Southern Lake Huron population. Successful reproduction is known at four sites, and unknown for the rest, although spawning is suspected to occur in several other tributaries of Lake Huron. The size of spawning runs is unknown except for the Mississagi River, where an estimate of the spawning run is in the order of 150 fish (Holey *et al.* 2000; Mohr, pers. comm). A commercial harvest is still permitted in the Ontario waters of Lake Huron. Currently there are 41 licensees with a quota of 12,000 kg, but the annual harvest has averaged 2227 kg, approximately 325 fish. Recreational and subsistence fishing is also permitted, but no landing statistics are available.

Recently, Lake Huron populations have been assessed annually through a cooperative program with commercial fishers (Mohr 1996, 1997, 1998/99, 2000). A total of 648 fish were sampled in 2000, the largest number observed since the program

started in 1995. Mohr (1998/99) reported that some populations of lake sturgeon in the Lake Huron drainage are localized, while others move in and out of an area. Thirty-nine tagged fish were recaptured in Lake Huron in 2000 and, of these, five fish had been tagged in Lake St. Clair, 10 in Saginaw Bay, Michigan and the remainder in the Ontario waters of Lake Huron. Fish tagged in the Ontario waters of Lake Huron also were caught in the Detroit River, St. Clair River and Saginaw Bay. A number of age-two fish were observed in 2000 in the North Channel and southern Lake Huron, and age-three fish were common in southern Georgian Bay, indicating recruitment in all basins of Lake Huron (Mohr 2000). The age-class distribution and average size is similar through the late 1990s with the largest fish recorded in the Mississagi River spawning run (Mohr 2000). Although 60% of the fish sampled were of legal harvestable size (1.09 m), only 28% were harvested (Mohr 2000). McMurtry *et al.* (1997) reported that lake sturgeon are extirpated in Lake Simcoe, in the Lake Huron basin.

Historically lake sturgeon in the St. Clair system were abundant; however, over-exploitation and habitat loss impacted the populations. The Michigan Department of Natural Resources (unpublished data 2005) estimated that lake sturgeon in the St. Clair basin (including US waters) may be in the order of between 15,000 and 25,000 fish (all ages). However, Holey *et al.* (2000) report that the St. Clair and Detroit rivers have a small, extant population. Recent tag recapture data provide an estimate for the Lake St. Clair component of approximately 5000 individuals of all ages (B. Locke, Ontario Ministry of Natural Resources, Peterborough, unpublished data). Some of these may be migrants from the Detroit and/or St. Clair rivers or Lake Erie.

Commercial and recreational fisheries exist in the Ontario waters of Lake St. Clair. A substantial commercial sturgeon fishery existed on Lake St. Clair in the late 1800s but since 1920 only a small commercial fishery has continued. The annual quota of 1542 kg has not changed since 1986. Currently this fishery consists of two licences, one of which has been inactive recently, that annually take on average 772 kg of lake sturgeon using hook and line gear. Recent (1996) creel surveys for the Lake St. Clair basin indicated that the recreational harvest is between 30-50 fish/year in Ontario, primarily taken during spawning in the St. Clair River (Locke, unpubl. data). Ongoing aging studies from samples taken in the commercial fishery show that the age structure of the population has remained stable for the past 40 years (Locke, unpubl. data). This would indicate that there has been stable recruitment and mortality for at least the same period of time.

Historically, there were 4 population components known from Lake Erie, and three of the four are currently extant. The three lake sturgeon population components appear to be increasing in Lake Erie (L. Cargnelli, Ontario Ministry of Natural Resources, London, ON; personal communication), although no population contains more than 1000 individuals. The Lake Erie annual index-netting program catches some lake sturgeon, as does the commercial gill net fishery in the western basin; however, the origin of the individuals captured in the western basin may be Lake Huron or the St. Clair River system. Recent, increasingly frequent observations of juvenile sturgeon in Lake Erie (Locke, pers. comm.) indicate that there could be increased recruitment, or a strong year class present in the lake.

Historically, lake sturgeon were abundant in Lake Ontario, and provided a peak commercial harvest of over 225,000 kg in 1890. However, by 1900 the population component had declined such that the commercial catch was insignificant, and this fishery is often cited as a classic example of over-fishing (Christie 1973). Commercial harvest of lake sturgeon was banned in New York State in 1976, and in Ontario in 1978. Currently no commercial or recreational harvest is permitted in Lake Ontario waters. Although the role of habitat degradation in the decline is unclear, the damming and degradation of tributary spawning areas may have been a significant factor in the continued decline of these population components. In 1983, the species was listed as “threatened” in New York State (Carlson 1995).

Lake sturgeon populations in the Ontario waters of Lake Ontario appear to be showing some recovery (A. Mathers, Ontario Ministry of Natural Resources, Picton, ON; personal communication), although no population contains more than 1000 individuals. Prior to 1996, only two lake sturgeon were observed in the long-term surveys in eastern Lake Ontario and the Bay of Quinte. Since 1996, a total of 24 sub-adult lake sturgeon have been caught in survey gear. A few lake sturgeon were caught in 1997 in Lake Ontario index nettings, and commercial fishers report sturgeon in their nets as bycatch. Spawning fish have been noted in the Trent River below Dam 1, and in the Salmon River (Mathers, pers. comm.). Recently lake sturgeon have been documented to be reproducing at two of the five known historic spawning sites in Lake Ontario. Small populations of lake sturgeon are still found at two other historic sites but spawning has not been documented (Quinlan 2005), and status of the Amherst Island shoal population component is unknown (Holey *et al.* 2000).

Commercial fishermen have also reported the incidental capture of up to fifty juveniles annually in eastern Lake Ontario since 1996. This increase in lake sturgeon bycatch may be attributable to either increased natural reproduction within Lake Ontario and its tributaries, or movements of juvenile sturgeon stocked into waters adjacent to the eastern basin. Observations of adult lake sturgeon during the spawning period in the Black River (New York) and in the Trent River (Ontario) during the mid-1990s suggest that increased natural reproduction may be occurring. In studies of lake sturgeon on the lower Niagara River in 1998-1999, 33 sturgeon were collected, ranging from 0.3 to 1.3 m total length, indicating continuing recruitment to the population. In addition, increased incidental catches of lake sturgeon by recreational anglers and sightings by recreational SCUBA divers suggest that the lake sturgeon population in the lower Niagara River may be increasing. In the short-term it seems likely that lake sturgeon numbers will remain at low levels in Lake Ontario, but the increased catches of sub-adult sturgeon since 1996 are encouraging.

Lake sturgeon populations in the Ottawa River basin once were abundant (Small 1883; Dymond 1939) but have declined due to anthropogenic stresses (Toner 1943; Haxton 2002, 2006). In 1879, the commercial lake sturgeon fishery harvested fish from the Madawaska and Bonnechère rivers, and from lakes in Lanark and Renfrew counties, all of which are tributaries to the Ottawa River (Harkness and Dymond 1961). Today, lake sturgeon do not exist in these waterbodies; the chances of re-establishment

are remote due to fragmentation and barriers (Seyler 1997a, b). Commercial harvest on the Ottawa River peaked at 28,800 kg in 1898 and never again attained similar levels (T. Haxton, OMNR, Kemptville, ON, unpubl. data). Currently, commercial harvesters are licensed for the Quebec portion of the Ottawa River only, from Quyon to Fort William. Quotas have been established at 0.1 kg/ha/yr of Quebec waters since the early 1990s (OMNR and Gouvernement du Québec Faune et Parcs 1999), and an average of 1250 kg of lake sturgeon was harvested from the Ottawa River from 2000 to 2005 (Haxton, unpubl. data). Despite strict harvest controls, there is little evidence of recovery throughout the Ottawa River watershed. Abundance varies substantially among river reaches (Haxton 2002). A study on the contribution of waterpower management, commercial harvest and contaminants to lake sturgeon population dynamics in the Ottawa River suggests that waterpower management has the greatest influence (Haxton, unpubl. data) although the results are not definitive.

Spawning has been documented in all Ottawa River reaches, but recruitment appears to be a limiting factor in several reaches (Haxton, unpublished data). In 1949, over 400 lake sturgeon were sampled on the spawning shallows below the Fitzroy Dam on the Ottawa River; only eight lake sturgeon were found in a repeat survey in 2001 (Haxton 2002), 58 were caught in 2003 (including 7 recaptures from 2001), and 17 in 2004 (including 3 recaptures from 2003). Based on the small number of recoveries Haxton (2006) estimated a spawning population of 202 (93-378; 95% C.I.). However because only males were observed in spawning condition and very few juveniles were found in this study (Haxton 2006), especially in comparison to the historical study and concurrent studies on other spawning shoals in the Ottawa River, the productivity of this component may be very low. Only limited recruitment appears to be occurring, and many of the fish observed may have been born before 1932, when the dam was completed. The influence of downstream migration or drift, and barriers impeding upstream migration are unknown for this population component.

There is a small commercial fishery on the Quebec portion of the Ottawa River between Quyon and Fort William (Haxton 2002). There are also commercial fisheries in Lake Timiskaming (286 fish/year) where the population is considered stable (Fortin *et al.* 1992; Nadeau, pers. comm.). There was a spring fishery of 25 to 30 fish for caviar in the Timiskaming-Abitibi district for 50 years, but this was discontinued in 2000 and fishing for lake sturgeon is restricted to June 15 through July 16, and to September 15 through October 31 (Nadeau, pers. comm.). There also is some subsistence fishing for lake sturgeon in the Timiskaming-Abitibi area.

In the St. Lawrence River, all 14 known Canadian population components are extant; 12 are considered small, two are large (Holey *et al.* 2000). Spawning is known to occur at six sites, probably not occurring at two sites, and unknown at six sites (Holey *et al.* 2000). Of the known spawning populations, four have spawning runs of <1,000 individuals, the spawning runs in the St. Maurice population has ~1,250 individuals, and the Des Prairies population has ~7,000 individuals (Holey *et al.* 2000; Fortin *et al.* 2002). The growth characteristics of the upper St. Lawrence sturgeon populations (collected in 1993 and 1994) below the Robert Moses Dam near Massena, New York were examined by Johnson *et al.* (1998) and found to be similar to growth of lake sturgeon 25 years ago.

Catches in the St. Lawrence River remained fairly consistent from 1920 to 1984 (Figure 15; Dumont *et al.* 2000, 2006), a phenomenon not observed in fisheries elsewhere. This may be related to a number of factors. The St. Lawrence River sturgeon fishery started much later, and the major fishery is located on a large river/lake system (which makes it more difficult to remove all spawning fish as spawning occurs at several sites along the river). The annual harvest is also much lower than historically found elsewhere (e.g. Lake Erie, Lake of the Woods; Tables 5, 6). In addition, the fishery focused on sub-adult and smaller adults, rather than only on large individuals (Fortin *et al.* 1992). Dumont *et al.* (1987) also attributed the ability of this stock component to sustain harvest for 80 years without a collapse to the relatively high productivity of the system, the restriction of intensive commercial fishing to specific zones, leaving some sectors unexploited to act as reservoirs, and the high selectivity of the historically used commercial gill nets (19 to 20 cm stretched mesh).

However, by 1987 the St. Lawrence population component was considered overexploited. Dumont *et al.* (1987), and La Haye *et al.* (1992) reported trends in age structure, year-class strength (based on the age distribution of the 2- to 8-years-old segment), and abundance of mature females (over age 25), all indicating that overexploitation probably began in the mid-1970s, and was continuing. In addition the reported commercial catch remained very high after 1986 (mean 202,000 kg, range 152,000-259,000 kg), greatly surpassing the landings reported before 1983 (maximum ca 65,000 kg, but reporting was considered incomplete). In 1987, the St. Lawrence population component was considered overexploited due to high annual natural and fishing mortality rates of the exploited segment (ages 15 to 30), unbalanced age structure, low reproductive potential and excessive annual harvest (Dumont *et al.* 1987). The utilized spawning grounds were found to be reduced to primarily the upstream part of the system. Many previously used sites were no longer accessible or utilized because of various human interventions (Dumont *et al.* 1987; La Haye *et al.* 1992).

Between 1987 and 1991 a new management plan was gradually implemented to reduce the catch, provide more protection to spawners and strengthen enforcement (Dumont *et al.* 2000b, 2006). The fishing season and the number of fishing licences were reduced, long-lines and seines were banned, gillnet stretched mesh was restricted to 20 cm, and recreational fishing regulations were tightened. In the 1990s, research was undertaken to increase the knowledge of the characteristics of spawning grounds and juvenile habitats, and to develop an index of year-class strength in order to adjust harvests to expected changes to the age 15- to 25-year-old portion of the population component, which constitutes the majority of the harvest (Fortin *et al.* 1993; Nilo *et al.* 1997; Fortin *et al.* 2002).

The commercial harvest was sampled again in four fishing sectors in 1994 and further data were collected in 1998 (see Dumont *et al.* 2000b). The 1994 samples indicated that, from the early 1980s to the mid-1990s, length-at-age remained about the same, but the 1994 weights at given length were 7 to 15% lower. The observed decrease of somatic condition may have been related to changes in the trophic condition of the St. Lawrence River, possibly causing a decrease in the potential

production of the lake sturgeon population component. Catch curves based on commercial catches showed that annual mortality rates were high throughout this period and the apparent age of recruitment to the fishery shifted substantially to older fish in Lac Saint-Louis (from age 16 to 23) and Lac Saint-Pierre (from age 14 to 20). Between 1994 and 1998, CPUE from the 20-cm gillnet fishery declined 7% in Lac Saint-Louis and 25% in Lac Saint-Pierre. The annual rate of decrease was similar (1.75%) but only the second decrease was statistically significant. Juvenile surveys indicated continuous production of cohorts between 1980 and 2001, but the index of year-class strengths decreased by 58% from 1984 to 1992 ($r_s = -0.7$; $P = 0.02$) (Dumont *et al.* 2000b). Two comparatively strong year classes were produced in 1993 and 1994, but subsequent ones were average and in one case weak. From 1995 to 1999, mark-recapture estimates of the number of mature females on the Des Prairies River spawning ground declined by 61%, from 1231 to 500 fish (Fortin *et al.* 2002). At the same time exports of lake sturgeon declined by 36%, and there also was a notable decrease (10%) in the weight of lake sturgeon of comparable size from the 1980s to 1994.

Taken together the evidence led to the conclusion that the 1987 management plan had failed to reverse the decline in stock status (Dumont *et al.* 2000b). A 200-tonne commercial catch quota was implemented in 1999, coupled with the obligation to tag and register each sturgeon carcass. The quota was decreased by 20% in 2000, 2001 and 2002 and has been maintained at 80 tonnes (which corresponds to about 11,000 sturgeon) thereafter. Since 2003, the fishing season has been shortened by two months (June 14 to July 31 and September 14 to October 15) [Ministère des Ressources naturelles et de la Faune du Québec 2005].

Concurrently, habitat conservation and improvement measures were implemented. The quality and area of two spawning grounds were successfully increased in the Des Prairies and Saint-Maurice rivers (Fortin *et al.* 2002; GDG Conseil 2001). In the Des Prairies River, the most important spawning ground of the system, egg-to-larvae survival has increased from an average of 0.8% before the improvement (1995-1996) to 5.4, 3.7 and 2.4% in 1997, 1998 and 1999, respectively (Fortin *et al.* 2002). Larval production was also increased from 3.9 million (1.2 to 8.6 million) between 1994 and 1996 to 7 million (2 to 12.8 million) between 1997 and 2003 (Fortin *et al.* 2002; Garceau and Bilodeau 2004). Three other spawning grounds were artificially created: in 1999 downstream of Beauharnois Generating Station, in 2001 in the Saint-François River, and in the fall of 2005 in the lower part of the Chaudière River (Trenca and Collin 2006). The first trial has not been successful (Environnement Illimité 2002), but the spawning bed created in the Saint-François River has been utilized for reproduction (Faucher and Abbott 2001; Alliance Environnement *et al.* 2002). Monitoring of the third trial has been planned for spring 2007; however, during the spring of 2006, following the completion of an industrial waste water treatment plan, many lake sturgeon were observed or caught in the Chaudière River for the first time since the 1950s (Guy Trenca, Regional Biologist (Chaudière-Appalaches Ministère des Ressources naturelles et de la Faune du Québec, Charny, QC; personal communication).

Dredging projects along the navigation channels and in harbour works were also analyzed and modified in order to protect juvenile habitats. Improvements in water flow management, erosion protection, and construction of sewage treatment facilities in the l'Assomption watershed have also improved two lake sturgeon spawning beds, resulting in a 10-fold increase in larval production. The project also raised enthusiasm among authorities and organizations where the species has become a regional symbol. The watershed management corporation has recognized the spawning areas as key sites for biodiversity and developed plans for their conservation and restoration (Dumas *et al.* 2003).

In the 1980s, new operating and discharge criteria were tested and applied to ensure access to a spawning ground used before the construction in 1960 of the Pointe-des-Cascades Dam at the confluence of the St. Lawrence River in Lac Saint-Louis. A new fishway was opened in 2001 (Paradis and Malo 2003), at the Saint-Ours dam, on the Richelieu River, but only a few large lake sturgeon have used it each year (Fleury and Desrochers 2004).

A multidisciplinary study was initiated in 2001 in order to quantify the impacts of water discharge variation on the St. Lawrence River fish community. A two-dimensional spatially explicit fish habitat model covered a large part of the lake sturgeon distribution area in the Quebec section of the St. Lawrence River. Surfaces of suitable lake sturgeon habitat increased with discharge. Recommendations concerning fish habitat protection in the fluvial St. Lawrence were presented to the International Joint Commission under the in-process evaluation of the regulation criteria of the Lake Ontario – St. Lawrence River system (Mingelbier *et al.* 2004, 2005ab).

In 2006, a hydroelectric project in the Courant Sainte-Marie, Montréal, was withdrawn in order to protect one of the rare remaining rapid sectors of the St. Lawrence River and to maintain free movements of migratory species (lake sturgeon, American shad, *Alosa sapidissima*, American eel, *Anguilla rostrata*, copper redhorse, *Moxostoma hubbsi*, etc.) [Dumont *et al.* 2005]. In the mid-1980s a similar project was rejected for similar environmental concerns at another site, the Lachine Rapids, located about 15 km upstream.

In summary, a variety of trends are seen in lake sturgeon population components in this large DU. Throughout the Great Lakes, lake sturgeon abundances are certainly much lower than they were historically, but self-sustaining population units are present in all the Great Lakes and many tributaries. The major declines were usually in late 1800 or early 1900s, following opening of commercial fisheries, which tended to follow patterns of “boom–and–bust”. Most commercial fisheries in the Great Lakes have been closed or greatly reduced for many decades, and usually recreational catches are tightly restricted as well. Many spawning components remain in the Great Lakes and their tributaries, and some monitoring programs suggest that abundances are increasing. However, age composition of essentially all population components tend to lack older fish, numbers of spawners are often low each year, and many traditional spawning sites are not used.

In the St. Lawrence River and its tributaries, commercial fisheries collapsed in only a few areas, such as the Ottawa River drainage basins. Commercial harvests showed no overall trend in much of the Quebec portion of the St. Lawrence basin, but assessments in the 1980s and again in 1990 both found the population components supporting the fisheries to be harvested unsustainably. Harvests have been reduced from over 200,000 kg to quotas of 80,000 kg. Enforcement has been improved, and there are preliminary indications that these catches may be sustainable. There have also been many initiatives to improve habitat quality, particularly in spawning and nursery areas, and to improve water flow regimes. There are indications that recruitment is improving in some portions of the range of this DU in Quebec, as a result of these habitat initiatives.

Population trends in native and subsistence fisheries

The above statistics do not include any subsistence fishing data that ranges from 50 to at least 200 fish/year in some communities in western Canada. Historically, lake sturgeon were an important aspect of the diet where available, particularly in the Battleford and Cumberland House areas (Smith 2003). Sturgeon were at one time abundant in the lower Saskatchewan River (see Population sizes and trends - DU2 above), especially from the area of Cumberland House to Lake Winnipeg at Grand Rapids (Kew 1962). Since the time of earliest settlement in the area, fish for local use as food for humans and dogs has been a way of life for the Native peoples in the area of Cumberland, Suggi, Namew, and Windy lakes (Kew 1962).

The Native fishermen (both First Nations and Metis) of the area formed the Cumberland House Fishermen's Cooperative in 1950 (incorporated 1951) and have undertaken management of the commercial fishery, which had existed since at least the 1920s (Skaptason 1926). A quota of 4000 kg of sturgeon was established, but never met (Kew 1962) despite the fact that in the 1920s, that quota had been 30,000 kg. Commercial harvests in the Cumberland Lake area had peaked at 19,000 kg in 1935 with a subsequent decline to little more than 2000 kg in 1939, followed by a recovery to about 8000 kg in the early 1950s (Wallace 1991). Wallace (1991) estimated that a quota of 3200 kg was sustainable for the fishery prior to construction of the E.B. Campbell dam. Construction of the dam led to considerable loss and disruption of critical habitat and has resulted in a population decline in excess of 80% as well as decreased reproductive success in the remaining fish (see DU2 above). Although the Cooperative still holds an annual quota of 3200 kg, Native fishermen have voluntarily ceased commercial operations as a conservation measure (Wallace 1991; pers. comm.). A limited number of fish may still be caught for subsistence and cultural use.

According to Houston (1987), subsistence catches amount to approximately 2300 fish/year in northern Quebec [this value was considered to be about the same in 2002 (Nadeau, pers. comm.)]. Although most people contacted (see "Authorities Consulted" section) indicated that there was some subsistence fishing in their administrative regions, the numbers harvested generally are unknown. The subsistence fisheries are

an important component of the current situation but there are few records on fish taken in traditional subsistence sturgeon fisheries.

Ojibway subsistence fisheries of the mid-19th century provide the only numerical estimate of the historical Aboriginal lake sturgeon harvest (Holzkamm and McCarthy 1988). During this time, fresh and dried sturgeon meat, as well as isinglass, a gelatinous material procured from the dried inner membrane of the sturgeon swim bladders, became important commercial by-products of the subsistence fisheries that were traded to the Hudson's Bay Company (HBC) (Holzkamm and McCarthy 1988). The HBC isinglass trade records have been used to estimate the traditional harvest of lake sturgeon by the Ojibway in the Lac la Pluie district (Holzkamm and McCarthy 1988). Between 1823 and 1885, records estimate an average yield of nearly 141,210 kg of fish/year. The harvest was estimated to be between 74 and 319 fish in 2002 (Bretecher and MacDonnell 2001). Holzkamm and McCarthy (1988) suggest that these records probably are low as the labour-intensive process of isinglass production may have resulted in the frequent discarding of the swim bladders of small catches, and of small fish, and any sturgeon retained by the Ojibway for personal use would not be accounted for in the HBC records (Holzkamm and Wilson 1988). Hopper and Power (1991) discussed a multi-species subsistence fishery, including lake sturgeon, in the Winisk River in northern Ontario. Forty lake sturgeon, averaging 8.7 kg, were harvested from October 1987 to September 1988 for a total of about 350 kg.

Traditional knowledge indicates that lake sturgeon have been a preferred species in the domestic fisheries of the Cree- and Ojibway-speaking people of the Nishnawbe-Aski Nation in northern Ontario for generations (Michalenko *et al.* 1991). Historically, families would gather in the spring at spawning sites in the Severn River and its tributaries, especially the Windigo River to capture spawning fish for food. The annual harvest was estimated to be 250 fish. A non-native commercial fishery established at Muskrat Dam in 1951 fished the population to the extent that the enterprise was no longer commercially viable within five or six years (Michalenko *et al.* 1991). A second non-native commercial operation managed by the Hudson Bay Company at Bearskin Lake from 1953 to the early 1970s suffered a similar fate. Since 1965, residents of Muskrat Dam have maintained a domestic food fishery for sturgeon, the annual harvest ranging from 200 to 400 fish, depending on need (Michalenko *et al.* 1991), and in some years very few fish are taken. Local (Native) fishermen report a decline in numbers in the Windigo and Severn rivers, which they attribute to the commercial fisheries of the 1950s, and the community has chosen not to continue commercial fishing, even though they have licences for a quota of 500 kg (Michalenko *et al.* 1991).

Lake sturgeon at one time were known in the Grand River as far upstream as Brantford, Ontario, and until at the least the 1920s, were taken by the local Mohawks for food (Jamieson 2005). Lake sturgeon are not known in the Grand River today, and there is now a dam near the mouth of the river (Mandrak, personal observation).

Historical use of lake sturgeon by First Nations people has been well documented in Quebec. For example, in the archaeological site of Pointe-du-Buisson, at the

confluence of the St. Lawrence River in Lac Saint-Louis, bones of lake sturgeon, channel catfish and catostomids dominate the remnants of meals identified and associated to the Late Woodland period circa 920-940 A.D. (Courtemanche 2003). Mohawk people of Kahnawake are still practising subsistence fishery in Lachine Rapids, at the outlet of Lac Saint-Louis.

The Cree of northern Quebec have a time honoured association with the land and its resources that is foundational to their culture, social-economic base, way-of-life, and lake sturgeon has always been a highly valued species. The rights of the Native inhabitants in respect of the lands and their resources were recognized in Canada's first modern land claim settlement, The James Bay Northern Quebec Agreement of 1975 [(JBNQA) *see, for example*, INAC 1993]. The rights of Native peoples to the exclusive use of the wildlife resources of the area, including sturgeon, are set out in sub-sections of Section 24 of the Agreement.

Guaranteed harvest rights and limits were established and adopted in 1982 based on historic patterns of harvest as determined by a massive Native Harvesting Research (NHR) project carried out between 1972 to 1979 (James Bay and Northern Quebec Native Harvesting Research Committee 1982). The project did not undertake any background or baseline studies *vis à vis* estimates of population sizes and trends, etc., but did provide an indication of annual harvest levels by community over the period of the study and allowed for input of elders and the harvesters regarding insights on the state of the resource. Lake sturgeon harvests were reported regularly by fishermen in all communities (Table 7) and the results indicate that the average harvest was in the area of 2000 fish per year. Results varied from year to year, and community to community, reflecting local need and availability of fish; the total average for the region was 2311 fish. Age and size were not reported, but the fishing methods and pattern of harvest, as well as comments supplied by the fishermen indicated that usually only larger, mature fish are taken.

Table 7. Means of estimated annual harvest of sturgeon by communities in northern Quebec, 1974 – 1979 (James Bay and Northern Quebec Native Harvesting Research Committee 1982).

| | |
|--------------|------|
| Great Whale | 0 |
| Fort George | 615 |
| Paint Hills | 155 |
| Eastmain | 94 |
| Rupert House | 229 |
| Nemaska | 63 |
| Mistassini | 366 |
| Wasapini | 789 |
| Total | 2311 |

The report (James Bay and Northern Quebec Native Harvesting Research Committee 1982) also indicates that the La Grande River system is the northern limit of the range as stated by Scott and Crossman (1998), and that sturgeon are not equally abundant in the river systems of the area as subsequently confirmed by Fortin *et al.* (1992) and Ferguson and Duckworth (1997). Despite the massive hydroelectric power development that has already been carried out in the region, and plans for further development, no other surveys of subsistence use have been conducted, nor have there been any studies to establish baseline data on status and abundance that would permit an evaluation of population sizes and trends (Hydro-Québec 2004 a, b). It is thought that subsistence use of sturgeon remains at the levels of the late 1970s and early 80s as reported in the Wealth of the Land report (INAC 1993), and these values have been used as a baseline for subsistence use in the mandated environmental impact assessments carried out by Hydro-Québec in support of hydroelectric power development projects (Environnement Illimité 2003; Hydro-Québec 2004 a, b). However, the historic values (INAC 1993) were reflected as guaranteed harvest levels in the JBNQA and not as quotas. Actual harvest levels in some areas (Rupert, Eastmain and Nottaway rivers) may in fact be in excess of those levels (Environnement Illimité 2003). Since the time of the NHR survey some 10,000 km of access roads have been developed in support of hydroelectric development (Hydro-Québec 2004a,b) and these roads have increased access to sturgeon habitat and facilitated harvests that were not possible at the time of the NHR survey.

Since the 1920s several attempts have been made to establish commercial fisheries in the James Bay territory; the largest of which was initiated with the backing of the Department of Indian Affairs and Northern Development in the late 1960s, and involved lakes Sakami, Evans, Némiscau and Mesgouez and a network of lakes near Matagami. The fishery was terminated in the 1970s when mercury contamination became an issue (A.F. Penn, Science Advisor, Grand Council of the Crees, Montréal, QC; personal communication). Another fishery on the Nottaway and Rupert rivers, initiated in 1989 was terminated in 1994, when, as elsewhere (Lake Timiskaming, Harricana River, and the above fishery), reductions in CPUE, as well as size and age structure, suggested that these fisheries were not sustainable. Although the results of an evaluation of the Nottaway/Rupert fishery were not available for use in the Fortin *et al.* (1992) report, they recommended that sustainable quotas where such fisheries existed should be based on the yield in kg/ha of suitable habitat, not total waterbody, and should be implemented for commercial and subsistence fisheries, and that no quota should exceed 0.1 kg/ha (Environnement Illimité 2003).

LIMITING FACTORS AND THREATS

Limiting factors for lake sturgeon are related to climate, hydrology, and water temperature and chemistry. Climate, and resulting hydrological conditions, may be determinants of year-class strength. Low flows and low water temperatures during spawning have been shown to have a negative influence on fecundity of Russian sturgeon (*Acipenser gueldenstaedtii*) in the Volga River (Khoroshko 1972), and on white

sturgeon in the Sacramento, San Joaquin and Columbia rivers (Kolhorst *et al.* 1991). In the St. Lawrence River, year-class strength appears to be determined in the first few months of life. Climatic and hydrological conditions in June, during which larvae drift from spawning grounds and exogenous feeding begins, were identified as critical determinants of year-class strength in this river (Nilo *et al.* 1997). Conversely, high water temperatures may be lethal in the early embryonic development of lake sturgeon. Successful incubation seems to be possible within a temperature range of 10-18°C, but highest survival and uniform hatching appear within a narrower range of 14-16°C in white sturgeon and lake sturgeon. Temperatures of 18-20°C lead to substantial deformities and mortality and temperatures above 20°C are lethal (Wang *et al.* 1985).

Threats to the lake sturgeon include overexploitation, dams, habitat degradation, contaminants, and introduced species. Undoubtedly, commercial fishing was the most significant factor that caused the historical decline of lake sturgeon populations. All lake sturgeon populations that have been impacted by exploitation have declined, many to very low levels (Brousseau 1987; Houston 1987; NatureServe 2004). As this is a slow growing, late maturing, intermittently spawning species, depleted populations, even when protected, may take many years to recover, if at all. As local commercial fishing operations have ceased across the range of the species, the decline has slowed or stopped in many populations, but none have recovered to historic abundance, and some have become extirpated (NatureServe 2004). Where commercial fishing still exists, it typically is based on small quotas. For example, a commercial fishery currently exists in the Canadian waters of Lake St. Clair. Fish are caught using baited set-lines, and the annual commercial harvest ranges from 500 to 800 kg (Locke pers. comm.).

The high value of sturgeon roe and smoked meat encourages poaching, even from depleted stocks. While the impact of poaching is difficult to determine, it is estimated that several thousand lake sturgeon are illegally sold each year. It has been reported that black market prices for white sturgeon steaks are as high as \$15-25/kg (Ptolemy and Vennesland 2003). An organized poaching ring, operating in the Pacific Northwest, provided large quantities of white sturgeon caviar to retailers, much of it marketed to the public as beluga (*Huso huso*) caviar (Waldman 1995). There are reported to be black markets in Alberta where lake sturgeon flesh brings similar prices and processed roe may fetch in excess of \$100/kg (J. Stock, Saskatchewan Parks and Renewable Resources, Maple Creek, SK; personal communication). Dumont *et al.* (1987) indicated that in the 1980s illegal fisheries in the St. Lawrence River system were extensive and well organized, targeting large spawning fish.

Dams have direct and indirect effects on lake sturgeon. Dams may directly impact lake sturgeon by acting as barriers to movement at certain times of the year, especially during spawning. Unless these dams are redesigned to allow fishes to move freely, impacts on migrations will continue to be substantial (Thuemler 1985; Ferguson and Duckworth 1997). In Lac Saint François, the combined effects of the gradual construction of dams at both extremities of the lake between 1912 and 1958 and of the overfishing of the residual stock likely caused the collapse of lake sturgeon there. Since the beginning of the 1960s, sturgeon movement between the St. Lawrence River and

the Ottawa River has been almost completely blocked by the Carillon hydroelectric dam at the head of Lac des Deux Montagnes, contributing to the collapse of lake sturgeon in the Ottawa River reach between Carillon and Gatineau (Dumont *et al.* 1987). Many other historic spawning tributaries in the St. Lawrence River may also be inaccessible due to the construction of dams and barriers.

Dams may directly impact lake sturgeon by entrainment, seasonal disruptions in habitat, and disrupting spawning triggers and timing. McKinley *et al.* (1998) showed that loss due to entrainment at the Little Long Generating Station in the Mattagami River system of northern Ontario is highest during the spring freshet when the plant is under continuous operation. During the operation of hydroelectric dams, flow rates change based on demand and these changes may be unpredictable. Such fluctuating flow rates are detrimental to sturgeon movements. Findlay *et al.* (1997) concluded that lake sturgeon populations in the South Saskatchewan and Saskatchewan rivers had experienced significant declines and stress associated with overexploitation prior to the construction of any dams. They further concluded that modification of the hydrological regime following the construction of three major dams (E.B. Campbell, Gardiner and Grand Rapids), in concert with increased water consumption for residential and agricultural purposes, resulted in major loss and degradation of sturgeon habitat, resulting in reduced recruitment in already stressed populations. The physical barriers also further fragmented the populations and reduced any chance of recruitment by immigration, as well as increasing mortality rates from wounding and death caused by entrainment in the turbines. The Moose River basin is one of the most fragmented river systems in Canada, but the impact of dams on lake sturgeon is largely unknown (Seyler 1997a).

Dams undoubtedly cause habitat fragmentation resulting in the separation/exclusion of particular life stages (adults upstream and yearling/juvenile downstream), as well as stranding downstream after peaking plant flows (McGovern, pers. comm.). Auer (1996b) found that 74% more lake sturgeon of greater weight and increased reproductive readiness spawned below the Pickett hydroelectric facility on the Sturgeon River, Michigan when flows were returned to near natural levels. Sixty-eight percent more females were found in these years and spawning sturgeon of both sexes spent less time on the spawning grounds (Auer 1996b).

Natural flow, in combination with temperature, may represent an important CPUE that stimulates spawning in lake sturgeon. While waiting for these CPUEs in areas of perturbed flow, spawning may be delayed and the energy needed for reproduction may be diverted to other body functions (Khoroshko 1972; Auer 1996b). Auer (1996b) reported that in years of unnatural, dramatically fluctuating and interrupted water flow, lake sturgeon remained in the spawning area below Pickett Dam for 4 to 6 weeks longer than during years of natural flow. In these years, little evidence of spawning was recorded and few fish were in reproductive condition although water temperatures were within the normal range for spawning (Auer 1996b). Khoroshko (1972) reported that the condition of female Russian sturgeon was negatively affected when fish were forced to expend energy during their pre-spawn period in areas of unnaturally high flow

associated with hydroelectric dams. A reduction in the quality and quantity of eggs resulted (Khoroshko 1972). Lake sturgeon may be affected in a similar manner (Auer 1996b). For example, increased flows at critical spawning times could carry eggs to suboptimal habitat for food and protection from predators, and lowered water levels could expose eggs to desiccation as the sticky egg surface ensures they can attach to rocky substrates immediately after fertilization. McKinley *et al.* (1993) reported that lower concentrations of plasma nonesterified fatty acids may be attributed to altered nutritional status due to varying flow regime located downstream of hydroelectric stations.

The construction of fishways might help alleviate the problem of habitat fragmentation, but would not remedy the loss and degradation of habitat resulting from the modification of flow regimes. However, the swimming ability of sturgeon is different than that of species for current fishway designs, and their large size further complicates design of adequate safe passages (Peake *et al.* 1997). Each year since 2001, only a few large lake sturgeon are among the thousands of fish, belonging to more than 35 species, which use the Vianney-Legendre fishway on the Richelieu River (Fleury and Desrochers 2004).

Habitat degradation associated with other human activities also has been identified as a threat. For example, in the past, the lower reaches of the Assiniboine River were an important area for lake sturgeon because of a rich macroinvertebrate food source [i.e. mayfly larvae (Choudhury and Dick 1993)]. Today this reach of the river suffers from deterioration in overall water quality due to erosion, suspended sediments and the addition of sewage effluents.

Contaminants often have been suggested as a cause for decline in lake sturgeon (Harkness and Dymond 1961; Mongeau *et al.* 1982; Rousseaux *et al.* 1995). In an attempt to evaluate the effects of contaminants on lake sturgeon, bioindicators were measured in a sample of lake sturgeon from two sites: Des Prairies River, confluent with the St. Lawrence River (Montréal), and a reference site in the upper reach of the Ottawa River in the La Verendrye Park. Negative effects of organics contaminants were suspected, fish taken from the Des Prairies River having moderate to severe hepatic pathology (Rousseaux *et al.* 1995). Among larvae raised in an artificial stream, prevalence of fin deformities was highly significantly greater in the progeny of lake sturgeon sampled in Des Prairies River (6.3%) compared with the progeny of lake sturgeon from the reference site (1.7%) [Doyon *et al.* 1999]. Concentrations of liver and intestine retinoids were also found to be significantly lower (as much as 40 times lower) in the Des Prairies River sample (Doyon *et al.* 1998, 1999; Ndayibagira *et al.* 1995).

Wood fibre and chemical effluent from pulp and paper mills, along with agricultural runoff and siltation, have been found to degrade known lake sturgeon spawning areas (Mosindy 1987). An accidental discharge of toxic effluent caused a large die-off of lake sturgeon along the St. Lawrence River in 1984 (Dumont *et al.* 1987). Levels of mercury and polychlorinated biphenyls (PCBs) in lake sturgeon have been much higher than acceptable (Hart 1987) and the Lake St. Clair lake sturgeon fishery was closed in 1970

due to mercury contamination (Baldwin *et al.* 1978), but re-opened in 1991. As the lake sturgeon is a benthic species, fish often are exposed to high contaminant loads. Individuals exposed to systems with high contaminant loads compared to non-contaminated systems had lower retinoids than fish in non-contaminated systems (Ndayibagira *et al.* 1995).

Contamination of habitat resulting from agricultural practices has had an adverse impact on many populations, especially in the Prairies (Graham 1981; Pflieger 1975; Mosindy 1987; NatureServe 2004). Farmers use 35 times as much fertilizer as they did a half-century ago with phosphorus and nitrogen, in particular, significantly adding to the nutrient loading of many lakes and streams. Domestic livestock production also poses problems where manure and waste products can enter the water from feedlots located near streams, manure spread on fields or over ice in winter (DFO 1992). Channelization, ditching, tilling and land clearing also have led to increased sedimentation and loss of cover; thereby leading to habitat loss and degradation in the tributaries to Lake Erie and throughout much of the mid-west in the United States (NatureServe 2004), the Prairies (DFO 1992) and the Rainy River in northern Ontario (Mosindy 1987).

Sediment disposal operations can affect sturgeon directly by causing direct mortality of different life history stages by burial and gill clogging, or indirectly by habitat degradation (Hatin *et al.* in press). Dredging and dumping operations conducted for the construction of the navigation channel and the St. Lawrence Seaway in the 1950s and 1960s caused major manmade habitat changes. Channel and harbour maintenance is now an annual occurrence (Dumont *et al.* 1987, Robitaille *et al.* 1988) and there is a need to learn more about the relationship between habitat characteristics, feeding and distribution of lake sturgeon in the river (Nilo *et al.* 2006). In a large-scale study on sediment disposal in the Upper Estuary, Hatin *et al.* (in press) observed site avoidance and a negative impact of sediment disposal operations for Atlantic sturgeon but not for lake sturgeon, likely because the lake sturgeon diet is more diversified.

Lake sturgeon from swim-up size to about 120 mm have been shown to be very sensitive to the lampricide TFM used to control sea lamprey (*Petromyzon marinus*) in the Great Lakes basin (Johnson *et al.* 1999, Boogaard *et al.* 2003). As a result of the high degree of overlap between the historic distribution of lake sturgeon and sea lamprey distribution in the Great Lakes basin, TFM may pose a significant threat to lake sturgeon (Auer 1999). Sea lamprey control programs in the Great Lakes basin have developed treatment protocols to minimize impacts on lake sturgeon (Holey *et al.* 2000); however, these protocols are now being relaxed as sea lamprey numbers are increasing.

Other threats may include the introduction of non-native species such as zebra mussel (*Dreissena polymorpha*), rainbow smelt (*Osmerus mordax*), and round goby (*Neogobius melanostomus*), that may compete for food and habitat, prey on eggs and fish, and cause habitat disturbances (DFO 1992, Scott and Crossman 1998). The introduction of non-native plants, such as Eurasian water milfoil (*Myriophyllum*

spicatum) and purple loosestrife (*Lithrum salicaria*), also could lead to habitat disruption and reduction in diversity (DFO 1992).

SPECIAL SIGNIFICANCE

The lake sturgeon is a fascinating species. It, like all sturgeons, is a living fossil, and retains the cartilaginous skeleton and shark-like caudal fin of its ancestors of the Devonian period (Harkness and Dymond 1961). It is the largest freshwater fish species in Canada (Scott and Crossman 1998). Sturgeons have been utilized by humans throughout history and were gourmet items in ancient Rome and medieval Europe (Ono *et al.* 1983). In North America, lake sturgeon were scorned by the early settlers as a nuisance species, but commercial markets for smoked, dried, and fresh fish quickly developed after 1860. As a result, intensive fisheries commenced and peaked in 1900 when over 1 million kg were harvested from the Great Lakes. This, in turn, led to drastic declines from which most populations have never recovered (Houston 1987). In addition to their value as food, including caviar, lake sturgeon were a source of oil, leather and isinglass (Harkness and Dymond 1961). Even today, the quality of Canadian lake sturgeon caviar is judged by many to be second only to Caspian Sea caviar derived from beluga, and retails at over \$200/kg, while the flesh retails at about \$40/kg.

Lake sturgeon always have been of special significance to Native peoples. The historic relationship of sturgeon to Aboriginal communities includes local or indigenous knowledge such as rare phenotypes, ecological and genetic uniqueness of sub-populations, and declines in abundance. Lake sturgeon have been important to Aboriginal groups since at least 500 BC, if not before, and are still important to many First Nations communities today (Prince 1905; Holzkamm and Wilson 1988; Kelly 1998; Dick and Macbeth 2003). Elders report that sturgeon were a primary food source and were used in their entirety (Kelly 1998). Five kinds of meat were obtained as well as other important products such as containers made from skins, glue from swim bladders, paint binding agents (Prince 1905; Tough 1996), scrapers from scutes, and arrowheads from tail bones (Harkness and Dymond 1961). Sturgeon also were closely connected to Aboriginal spirituality (Holzkamm and Wilson 1988; Dick and Macbeth 2003). Kelly (1998) remembered that the sturgeon was a sacred animal to be given offerings and acknowledged in special ceremonies. In Ojibway mythology, the great sturgeon, *Numae*, was associated with the spiritual power controlling fishes and fisheries (Holzkamm and Wilson 1988; Kelly 1998). *Numae* also was the guardian of the Sturgeon Clan, a distinguished Ojibway family (Tough 1996; Kelly 1998). To the Aboriginal groups of the eastern forests, the nutritional, material and spiritual significance of the sturgeon was analogous to the relationship between bison and tribes of the western plains (Ono *et al.* 1983; Tough 1996).

In some parts of its distribution lake sturgeon is still of high economic importance. Along the Quebec part of the St. Lawrence River, the income of more than 70 commercial fishermen fully or partly depends on lake sturgeon harvest. For many, this

is a family business that has been handed on from one generation to the other for more than 100 years.

The lake sturgeon also has special significance relating to watershed health. It is long-lived and has strong site fidelity for spawning and additional habitat requirements, such as specific food items at particular stages of the life history.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The management of lake sturgeon and its habitat in Canada is through regulations pursuant to the *Fisheries Act*. While the Federal Department of Fisheries and Oceans regulates habitat aspects of the Act, the provinces have been delegated responsibility for regulation of harvest. These regulations are administered and enforced by each province in which the species occurs. Throughout its range in Canada, the lake sturgeon commercial, recreational and Aboriginal fisheries have been subject to special regulation.

In Alberta, lake sturgeon was declared a Threatened species in 2003 (S. Cotterill, Alberta Sustainable Resource Development, Edmonton, AB; personal communication) and there has been zero legal harvest since 2004. The Saskatchewan recreational fishery was closed in 1999. Although a quota of 3200 kg still remains for the commercial fishery at Cumberland House; this quota has not been achieved since the 1980s (Wallace 1991; Findlay *et al.* 1997) and the fishery is under a negotiated moratorium through the efforts of the Saskatchewan River Sturgeon Management Board. In Manitoba, all fisheries are closed for conservation reasons in much of the current range. Following a Canada Supreme Court decision (*Regina vs. Sparrow 1990*), Manitoba Natural Resources changed its policies and removed all restrictions, including season and mesh size, from the Treaty Indian domestic sturgeon fishery (Macdonald 1998). This led to an intensive subsistence fishery in the Nelson River off the mouth of the Landing River during 1991 and, due to the amount harvested, was followed by closure of the fishery and the establishment of the Nelson River Sturgeon Co-management Board.

In Ontario, there is limited commercial fishing, and sport fishing is prohibited in some waters (e.g., Lake Ontario, St. Lawrence River). The province is currently considering options for further limiting the sport harvest. A management plan for the Lake of the Woods and Rainy River involving Ontario, Minnesota and Rainy River First Nations included an expanded closed season to better protect spawning fish. There is an annual possession limit of one fish per angler and a harvestable slot of 100 - 140 cm total length to protect spawners, especially females. A government buyout of all non-native commercial fishing licences occurred in 1995. The only remaining commercial sturgeon licence is held by Rainy River First Nations who have chosen not to fish in order to contribute to population recovery. In Lake Nipigon, there is an annual quota of 772 kg but only 32 kg were harvested in 1998 (Van Ogtrop and Salmon 1998). Recently, there have been efforts to develop more restrictive, lake-wide angling

regulations on the Canadian side of Lake Superior (M. Friday, Ontario Ministry of Natural Resources, Thunder Bay, ON; personal communication). When the Lake St. Clair fishery was re-opened in 1991 most of the fisheries were bought out with the exception of a couple that remain as assessment tools. One of these has a quota of 15 to 30 sturgeon per year, but the licence will not be renewed when the current permit expires (Locke, pers. comm.).

In Quebec, habitat is also protected by “Loi sur la qualité de l’environnement” (Environmental Quality Act). Fish habitat is also protected by “Loi sur la conservation et la mise en valeur de la faune “ (Act respecting the conservation and development of wildlife) which, under articles 128.1 to 121.18 controls activities that could modify biological, physical or chemical component peculiar to fish habitat. Sportfishing is regulated by a closed season (November 1 to June 14) and a daily bag and possession limit of one fish per angler. Commercial fishing is allowed to a limited number of fishermen from June 14 to July 16 and September 15 to October 31 in three sections of the St. Lawrence River between Lac Saint-Louis and the limits of fresh water near Orleans Island, in four reaches of the Ottawa River and in three sections of the Nottaway River. Quotas were, respectively, 80 t, 2.6 t and 2.4 t in 2005.

In the Quebec part of the St. Lawrence River, sustained management effort has been invested over the past 25 years to prevent additional fragmentation of this 350 km stretch of fluvial habitat, intensify the efforts to reduce water pollution in the Great Lakes–St. Lawrence River system, preserve, and in some cases, improve the quality of the known spawning grounds, and improve the knowledge of the biology and habitat of this population. The lake sturgeon fishery has been subjected to conservative restrictions, measures of control, law enforcement and periodic monitoring. The other fisheries are also monitored, but only by controlling quotas. Lake sturgeon is a key species in the evaluation of the impacts of hydroelectric development in the James Bay watershed. Dam construction, watershed diversion and development of a wide network of access roads in support of hydroelectric development and forest exploitation certainly represent new threats to the protection of this longlived migratory fish.

The conservation rankings of all freshwater fishes have been determined by the Association of Biodiversity Information at the national, provincial and state levels and can be found on the Nature Conservancy web site (see NatureServe 2004). In the United States, the lake sturgeon is presumed extirpated in Alabama, North Carolina, North Dakota and West Virginia; and possibly extirpated in Georgia and Kansas. It is ranked as (S1) in Arkansas, Indiana, Iowa, Kentucky, Missouri, Nebraska, New York, Pennsylvania, Tennessee and Vermont; (S2) in Illinois, Michigan and Ohio; and (S3) in Minnesota and Wisconsin. In Canada, it is ranked as (S2/S3) in Alberta and Manitoba; (S2) in Saskatchewan; (S3) in Ontario; and (S4) in Quebec.

All 24 species of sturgeon in the world, including lake sturgeon, are currently listed on Appendix II of the Convention for International Trade in Endangered Species of Wild Fauna and Flora (CITES). In the United States, the federal status is Potentially Endangered (Kempinger 1988) and lake sturgeon are protected in all 18 states where

the species historically occurred (Johnson 1987). Birstein *et al.* (1997) considered the lake sturgeon to be threatened and vulnerable in the United States and Canada. The lake sturgeon has been assessed as Least Concern by the IUCN (IUCN 2004).

EXISTING STATUS

Nature Conservancy Ranks (NatureServe 2004)

Global – G3,

U.S., National – N3,

Regional: AL – SX, AR – S1, GA – SH, IL – S2, IN – S1, IA – S1,
KY – S1, MI – S2, MN – S3, MO – S1, NE – S1, NY – S1S2, NC – SX,
ND – SX, OH – S2S3, PA – S1, TN – S1, VT – S1, WV – SX, WI – S3

Canada, National – N4,

Regional: AB – S2S3, SK – S2, MB – S2S3, ON – S3, QC – S4

IUCN – Least Concern

CITES – Appendix II

AFS – Threatened

Wild Species 2005 (Canadian Endangered Species Council 2006)

National – 3

Regional – AB – 1, SK – 1, MB – 1, ON – 3, QC – 3

COSEWIC

NAR 1986 (COSEWIC 2004);

Western populations Endangered 2005;

Lake of the Woods-Rainy River populations Special Concern May 2005;

Southern Hudson Bay-James Bay populations Special Concern 2005;

Great Lakes-Upper St Lawrence populations Special Concern 2005.

TECHNICAL SUMMARY (DU1)

Acipenser fulvescens

Lake sturgeon

Western Hudson Bay populations

SK, MB

Esturgeon jaune

| | |
|--|---|
| Extent and Area information | |
| • extent of occurrence (EO)(km ²) | ~300,000 |
| • specify trend (decline, stable, increasing, Unknown) | Unknown |
| • are there extreme fluctuations in EO (>1 order of magnitude)? | No |
| • area of occupancy (AO) (km ²) | <300,000 |
| • specify trend (decline, stable, increasing, Unknown) | Decline |
| • are there extreme fluctuations in AO (>1 order magnitude)? | No |
| • number of extant locations | 3? |
| • specify trend in # locations (decline, stable, increasing, Unknown) | Unknown |
| • are there extreme fluctuations in # locations (>1 order of magnitude)? | No |
| • habitat trend: specify declining, stable, increasing or Unknown trend in area, extent or quality of habitat | Unknown |
| Population information | |
| • generation time (average age of parents in the population) (indicate years, months, days, etc.) | 35-54 years |
| • number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values) | Unknown, probably low 1000s |
| • total population trend: specify declining, stable, increasing or Unknown trend in number of mature individuals | Declining Poorly known |
| • if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period) | >98% between 1920s and 1939 |
| • are there extreme fluctuations in number of mature individuals (>1 order of magnitude)? | No |
| • is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤1 successful migrant/year)? | Probably |
| • list each population and the number of mature individuals in each The 1800 may be an overestimate; the lower end of the C.I. is 1304. The length weight info indicates that immature sturgeon may have been included in the estimate, and there were no sturgeon caught that were much beyond the age of sexual maturity. | Churchill Mainstem low 100s, Little Churchill – <1800 Other tributaries – unknown |
| • specify trend in number of populations (decline, stable, increasing, Unknown) | Unknown |
| • are there extreme fluctuations in number of populations (>1 order of magnitude)? | No |
| Threats | |
| - exploitation and dams | |

| | |
|---|------------------------|
| Rescue Effect (immigration from an outside source) | Unlikely |
| • <i>does species exist elsewhere (in Canada or outside)?</i> | Yes |
| • <i>status of the outside population(s)?</i> | DUs 2-3 – Endangered |
| • <i>is immigration known or possible?</i> | Possible, but unlikely |
| • <i>would immigrants be adapted to survive here?</i> | Yes |
| • <i>is there sufficient habitat for immigrants here?</i> | Yes? |
| Quantitative Analysis | Not Applicable |

Status and Reasons for Designation (DU1)

| | |
|--|--|
| Status: Endangered | Alpha Numeric Code: A2ad; C1 + 2a(ii) |
| <p>Reasons for Designation: A precipitous > 98% decline from 1929-1939, has been followed by a slow, steady decline in the Churchill River to the point that records of mature individuals are almost non-existent in the past five years. Historically, overexploitation probably was the primary threat; more recently dams are probably the most important threat.</p> | |
| <p>Applicability of Criteria</p> | |
| <p>Criterion A: (Declining Total Population): Population declined by more than 98% from 1929-1939 in the Churchill River, followed a slow, steady decline thereafter to the present. A remnant population exhibiting characteristics of stress from overfishing remains in the Little Churchill River.</p> | |
| <p>Criterion B: (Small Distribution and Decline or Fluctuation): Not Applicable – EO and AO exceed threshold limits.</p> | |
| <p>Criterion C: (Small Total Population Size and Decline): Population has crashed to less than 30% of levels in the early 20th century; remnant population size although not known is likely numbered in the low 1000s or possibly 100s. (Churchill River mainstem population)</p> | |
| <p>Criterion D: (Very Small Population or Restricted Distribution): Not Applicable - EO and AO exceed threshold values. Number of mature individuals is thought to be low.</p> | |
| <p>Criterion E: (Quantitative Analysis): Not Applicable – no data.</p> | |

TECHNICAL SUMMARY (DU2)

Acipenser fulvescens

Lake sturgeon

Saskatchewan River populations

AB, SK, MB

Esturgeon jaune

| | |
|---|----------------------------|
| Extent and Area information | |
| • extent of occurrence (EO)(km ²) | >400,000 |
| • specify trend (decline, stable, increasing, Unknown) | Unknown |
| • are there extreme fluctuations in EO (>1 order of magnitude)? | No |
| • area of occupancy (AO) (km ²) | <400,000 |
| • specify trend (decline, stable, increasing, Unknown) | Unknown |
| • are there extreme fluctuations in AO (>1 order magnitude)? | No |
| • number of extant locations | 4 |
| • specify trend in # locations (decline, stable, increasing, Unknown) | Decline |
| • are there extreme fluctuations in # locations (>1 order of magnitude)? | No |
| • habitat trend: specify declining, stable, increasing or Unknown trend in area, extent or quality of habitat | Decline (dam construction) |
| Population information | |
| • generation time (average age of parents in the population) (indicate years, months, days, etc.) | 35-54 years |
| • number of mature individuals (capable of reproduction) in the Canadian population: Assuming a 2:1 (♀♀:♂) sex ratio and 2 yr spawning cycle for ♂♂, and 4 for ♀♀ then the effective population would be < 670 in AB&SK and < 450 in MB | ~3300 |
| • total population trend: specify declining, stable, increasing or Unknown trend in number of mature individuals | Decline |
| • if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period) | >50% SK and AB, > 80% MB |
| • are there extreme fluctuations in number of mature individuals (>1 order of magnitude)? | No |
| • is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤1 successful migrant / year)? | Yes |
| • list each population and the number of mature individuals in each : Saskatchewan River AB – 700 North Saskatchewan River SK - ? South Saskatchewan River SK - ? Lower Saskatchewan River (EB Campbell Dam to Brand Rapids MB) - 1300 | ~ 2000 (AB+SK) + 1300 MB |
| • specify trend in number of populations (decline, stable, increasing, Unknown) | Unknown |
| • are there extreme fluctuations in number of populations (>1 order of magnitude)? | No |
| Threats | |
| Existing: overexploitation, dams, habitat degradation, and poaching | |

| | |
|---|--|
| Rescue Effect (immigration from an outside source) | Unlikely |
| • <i>does species exist elsewhere (in Canada or outside)?</i> | Yes |
| • <i>status of the outside population(s)?</i> | DU1 – Endangered DU3 – Endangered DU4 – virtually extirpated |
| • <i>is immigration known or possible?</i> | Limited by dams, falls |
| • <i>would immigrants be adapted to survive here?</i> | Yes? |
| • <i>is there sufficient habitat for immigrants here?</i> | Yes? |
| Quantitative Analysis | |

Status and Reasons for Designation (DU2)

| | |
|---|--------------------------------|
| Status: Endangered | Alpha Numeric Code: A2b |
| <p>Reasons for Designation: Seventy-six of 111 historic sites in Saskatchewan and Alberta have been lost and there has been an 80% decline reported in the Cumberland House area from 1960-2001. A 50% decline from 1988 to 2003 has also been reported in the lower Saskatchewan River from Cumberland House to The Pas in Manitoba.</p> | |
| <p>Applicability of Criteria</p> | |
| <p>Criterion A: (Declining Total Population): Populations in SK and AB have demonstrated recent declines of over 50% (1998-2003) and that of SK/MB over 80% (1960-2001).</p> | |
| <p>Criterion B: (Small Distribution and Decline or Fluctuation): Not Applicable: EO and AO exceed threshold limits.</p> | |
| <p>Criterion C: (Small Total Population Size and Decline): Meets the criteria for threatened (1), decline in excess of 50% over three generations and a total population of < 3300 mature individuals.</p> | |
| <p>Criterion D: (Very Small Population or Restricted Distribution): Not applicable – threshold limits are exceeded.</p> | |
| <p>Criterion E: (Quantitative Analysis): Not applicable – no data.</p> | |

TECHNICAL SUMMARY (DU3)

Acipenser fulvescens

Lake sturgeon

Nelson River populations

MB

Esturgeon jaune

| | |
|---|---|
| Extent and Area information | |
| • extent of occurrence (EO)(km ²) | ~40,000 |
| • specify trend (decline, stable, increasing, Unknown) | Unknown |
| • are there extreme fluctuations in EO? | No |
| • area of occupancy (AO) (km ²) | <40,000 |
| • specify trend (decline, stable, increasing, Unknown) | Unknown |
| • are there extreme fluctuations in AO? | No |
| • number of extant locations | <5? |
| • specify trend in # of locations | Unknown |
| • are there extreme fluctuations in # locations? | No |
| • habitat trend: specify declining, stable, increasing or Unknown trend in area, extent or quality of habitat | Declining (dam construction) |
| Population information | |
| • generation time (average age of parents in the population) (indicate years, months, days, etc.) | 35-54 years |
| • number of mature individuals (capable of reproduction) in the Canadian population: Assuming a 1:1 (♀♀:♂♂)sex ratio and 2 yr spawning cycle for ♂♂, and 4 for ♀♀ then the effective population would be < 1000 | <3000 |
| • total population trend | Declining |
| • if decline, % decline over the last/next 10 years or 3 generations, whichever is greater | 89-90% in Sipiwesk Lake and Landing River |
| • are there extreme fluctuations in number of mature individuals (>1 order of magnitude)? | No |
| • is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤1 successful migrant / year)? | Yes |
| • list each population and the number of mature individuals in each: Effective populations – Sipiswesk lake 150, Limestone Dam 64, Others low 10s | Sipiswesk Lake ~1200 Below Limestone Dam – 500 Landing River – low 10s Gull Lake < 500 Cross and Playgreen – extirpated Other populations – low 100s |
| • specify trend in number of populations | Unknown |
| • are there extreme fluctuations in number of populations? | No |
| Threats | |
| Existing: overexploitation, dams. Potential: poaching | |
| Rescue Effect (immigration from an outside source) | |
| • does species exist elsewhere (in Canada or outside)? | Unlikely |
| • status of the outside population(s)? | Yes |
| | DU1 Endangered DU2 Endangered DU4 – virtually extirpated DU6 Special Concern |

| | |
|---|--|
| <ul style="list-style-type: none"> • <i>is immigration known or possible?</i> | Possible, some fish from the Hayes River may spawn in the lower Nelson, but fate of progeny is unknown |
| <ul style="list-style-type: none"> • <i>would immigrants be adapted to survive here?</i> | Yes |
| <ul style="list-style-type: none"> • <i>is there sufficient habitat for immigrants here?</i> | Yes |
| Quantitative Analysis | |

Status and Reasons for Designation (DU3)

| | |
|--|--------------------------------|
| Status: Endangered | Alpha Numeric Code: A2b |
| <p>Reasons for Designation: Portions of this designatable unit sustained large commercial fisheries from the early to mid-1900s, during which time there were dramatic declines in landings. More recently, a fishery at Sipiwesk Lake exhibited an 80-90% decline in landings from 1987-2000; and groups of 5-6 spawning fish were observed in the Landing River in 1990 compared to 100s observed several decades ago. Historically, overexploitation probably was the primary threat; more recently dams probably are the most important threat.</p> | |
| <p>Applicability of Criteria</p> | |
| <p>Criterion A: (Declining Total Population): Based on direct observation and an index of abundance, several of the populations have shown recent dramatic declines: Sipiwesk Lake - 80-90% decline in landings from 1987-2000, Landing River – groups of 5-6 spawning fishes in 2000 vs. 100s several decades ago.</p> <p>Criterion B: (Small Distribution and Decline or Fluctuation): Not Applicable: EO and AO exceed threshold limits.</p> <p>Criterion C: (Small Total Population Size and Decline): Meets T C1; total number of mature individuals is probably less than 10,000, and populations have declined by more than 10% in the last three generations.</p> <p>Criterion D: (Very Small Population or Restricted Distribution): Not applicable – Threshold limits exceeded.</p> <p>Criterion E: (Quantitative Analysis): Not Applicable – no data.</p> | |

TECHNICAL SUMMARY (DU4)

Acipenser fulvescens

Lake sturgeon
Red-Assiniboine Rivers-Lake Winnipeg populations
SK, MB, ON

Esturgeon jaune

| | |
|--|---|
| Extent and Area information | |
| • extent of occurrence (EO)(km ²) | ~250,000 |
| • specify trend | Decline |
| • are there extreme fluctuations in EO? | No |
| • area of occupancy (AO) (km ²) | <250,000 |
| • specify trend | Decline |
| • are there extreme fluctuations in AO | No |
| • number of extant locations | <5 |
| • specify trend in # locations | Decline |
| • are there extreme fluctuations in # | No |
| • habitat trend: | Decline |
| Population information | |
| • generation time (average age of parents in the population) | 35-54 years |
| • number of mature individuals (capable of reproduction) in the Canadian population | Very few |
| • total population trend: | Decline |
| • if decline, % decline over the last/next 10 years or 3 generations, whichever is greater | Close to 100% |
| • are there extreme fluctuations in number of mature individuals? | No |
| • is the total population severely fragmented | Yes |
| • list each population and the number of mature individuals in each | Lake Winnipeg – 3 in last 28 years Assiniboine – none (excluding stocked fish) Red River – unknown, but probably very few Pigeon River – low 10s East tributaries to L Winnipeg – unknown |
| • specify trend in number of populations | Decline |
| • are there extreme fluctuations in number of populations (>1 order of magnitude)? | No |
| Threats | |
| Existing: overexploitation, dams, and habitat degradation and contamination, Potential: poaching and genetic contamination through stocking of fish from non-native populations. | |
| Rescue Effect (immigration from an outside source) | |
| • does species exist elsewhere (in Canada or outside)? | Unlikely |
| • status of the outside population(s)? | Yes |
| • is immigration known or possible? | DU2 – Endangered DU3 – Endangered, DU5 – Endangered North Dakota – Extirpated |
| • would immigrants be adapted to survive here? | Limited by dams |
| • is there sufficient habitat for immigrants here? | Yes |
| Quantitative Analysis | |

Status and Reasons for Designation (DU4)

| | |
|---|---|
| Status: Endangered | Alpha Numeric Code: A2bc; C2a(i) |
| Reasons for Designation: A very large commercial fishery existed between the late 1800s and early 1900s. Since then (i.e. in the last 3-5 generations), the lake sturgeon has virtually disappeared from the Red-Assiniboine River and Lake Winnipeg. This was primarily the result of overfishing, although dams probably also affect remnant populations. | |
| Applicability of Criteria | |
| Criterion A: (Declining Total Population): Based on an index of abundance, several of the populations have shown recent dramatic declines: Lake Winnipeg – only 3 fish caught in last 28 years of index netting program. Red-Assiniboine River – no fish caught in recent standardized sampling. The loss of populations in these areas has also led to a substantial decline in the area of occupancy and extent of occurrence. | |
| Criterion B: (Small Distribution and Decline or Fluctuation): Not applicable – EO and AO exceed threshold limits. | |
| Criterion C: (Small Total Population Size and Decline): Total number of mature individuals <2500, continuing decline and no population with more than 250 mature individuals. | |
| Criterion D: (Very Small Population or Restricted Distribution): May qualify as Threatened as the number of mature individuals is probably less than 1000. | |
| Criterion E: (Quantitative Analysis): Not applicable – No data. | |

TECHNICAL SUMMARY (DU5)

Acipenser fulvescens

Lake sturgeon

Winnipeg River-English River populations

MB, ON

Esturgeon jaune

| | |
|--|--|
| Extent and Area information | |
| • extent of occurrence (EO)(km ²) | ~ 15,000 |
| • specify trend | Unknown |
| • are there extreme fluctuations in EO? | No |
| • area of occupancy (AO) (km ²) | <1,000 |
| • specify trend | Unknown |
| • are there extreme fluctuations in AO? | No |
| • number of extant locations | 8? |
| • specify trend in # locations | Decline |
| • are there extreme fluctuations in # locations? | No |
| • habitat trend | Declining |
| Population information | |
| • generation time (average age of parents in the population) | 35-54 |
| • number of mature individuals (capable of reproduction) in the Canadian population | Unknown |
| • total population trend: | Unknown |
| • if decline, % decline over the last/next 10 years or 3 generations, whichever is greater | 54.9 |
| • are there extreme fluctuations in number of mature individuals? | No |
| • is the total population severely fragmented? | Yes |
| • list each population and the number of mature individuals in each | Below Seven Sisters Dam – <10, probably extirpated Seven Sisters Dam to Slave Falls – unknown Slave Falls to Scott Rapids – <650 Scott Rapids to Eaglenest – <10, probably extirpated English, Wabigoon, Black Sturgeon rivers – Unknown, but probably <500 mature individuals |
| • specify trend in number of populations | decline |
| • are there extreme fluctuations in number of populations ? | No |
| Threats | |
| Existing: overexploitation, dams. Potential: poaching, genetic contamination if stocked with non-native population, or accidental release at Rainy River hatchery. | |
| Rescue Effect (immigration from an outside source) | Unlikely |
| • does species exist elsewhere (in Canada or outside)? | Yes |
| • status of the outside population(s)? | DU4 – Endangered DU6 – Special Concern DU7 – Special Concern DU8 – Threatened North Dakota – Extirpated Minnesota – Vulnerable |

| | |
|---|--|
| <ul style="list-style-type: none"> • <i>is immigration known or possible?</i> | Upstream movement not possible due to falls and dams |
| <ul style="list-style-type: none"> • <i>would immigrants be adapted to survive here?</i> | Yes |
| <ul style="list-style-type: none"> • <i>is there sufficient habitat for immigrants here?</i> | Yes? |
| Quantitative Analysis | |

Status and Reasons for Designation (DU5)

| | |
|--|----------------------------------|
| Status: Endangered | Alpha Numeric Code: A2bcd |
| <p>Reasons for Designation:</p> <p>Historically, the lake sturgeon populations in this designatable unit supported a large commercial fishery. However, there are limited historical and recent data. The limited recent data available show that populations are declining in the Winnipeg River above Seven Sisters Dam, and essentially have disappeared below the dam. Historically, overexploitation probably was the primary threat; now dams and poaching probably are the most important threats.</p> | |
| <p>Applicability of Criteria</p> | |
| <p>Criterion A: (Declining Total Population): EN A2bcd. The loss of two populations in the area has also led to a substantial decline in the area of occupancy and extent of occurrence. The overall population is declining and has demonstrated a decline of over 50% in the last three generations.</p> <p>Criterion B: (Small Distribution and Decline or Fluctuation): TH 2ab(i, ii, iii, iv, v). The species occurs at 8 locations with an area of occupancy of < 2000 km².</p> <p>Criterion C: (Small Total Population Size and Decline): TH 2a(i). The overall population has declined by 55% in the last two generations, and this decline appears to be continuing. The remaining populations are fragmented by natural barriers and dams: two populations of 8 have probably been lost, and no population contains more than 1000 mature individuals.</p> <p>Criterion D: (Very Small Population or Restricted Distribution): Population and distribution data exceed threshold limits.</p> <p>Criterion E: (Quantitative Analysis): Not Applicable – no data.</p> | |

TECHNICAL SUMMARY (DU6)

Acipenser fulvescens

Lake sturgeon

Lake of the Woods-Rainy River populations

ON

Esturgeon jaune

| | |
|--|--|
| Extent and Area information | |
| • extent of occurrence (EO)(km ²) | ~100,000 |
| • specify trend | Unknown |
| • are there extreme fluctuations in EO? | No |
| • area of occupancy (AO) (km ²) | <100,000 |
| • specify trend | Unknown |
| • are there extreme fluctuations in AO? | No |
| • number of extant locations | 2+ |
| • specify trend in # locations | Stable |
| • are there extreme fluctuations in # locations? | No |
| • habitat trend: | Increasing, following a decline |
| Population information | |
| • generation time (average age of parents in the population) | 35-54 years |
| • number of mature individuals (capable of reproduction) in the Canadian population | 50,000 fish >1m (adults and sub-adults) in Lake of the Woods/Rainy River – increasing. Unknown, for other populations |
| • total population trend: | Increase |
| • if decline, % decline over the last/next 10 years or 3 generations, whichever is greater | Unknown |
| • are there extreme fluctuations in number of mature individuals? | No |
| • is the total population severely fragmented? | No |
| • list each population and the number of mature individuals in each | Lake of the Woods/Rainy River 50,000 fish >1m (adults and sub-adults) Rainy Lake, Seine River, Namakan Reservoir, Little Turtle Lake, Sturgeon Lake, Russell Lake, Tanner Lake, Maligne River – unknown, but depressed and in low abundance |
| • specify trend in number of populations | Stable |
| • are there extreme fluctuations in number of populations? | No |
| Threats | |
| Existing: overexploitation, dams. Potential: poaching, genetic contamination if stocked with non-native population, or accidental release at Rainy River hatchery, and further impoundments. | |
| Rescue Effect (immigration from an outside source) | |
| • does species exist elsewhere (in Canada or outside)? | Unlikely Yes |
| • status of the outside population(s)? | DU5 – Endangered DU7 – Special Concern DU8 – Threatened Minnesota – Extirpated |
| • is immigration known or possible? | Unlikely due to natural barriers and dams |
| • would immigrants be adapted to survive here? | Yes |
| • is there sufficient habitat for immigrants here? | Yes? |
| Quantitative Analysis | |

Status and Reasons for Designation (DU6)

| | |
|--|---|
| Status: Special Concern | Alpha Numeric Code: Not Applicable |
| Reasons for Designation: Historically, populations in this designatable unit supported a substantial commercial fishery. Although this led to a severe decline, recovery has been sustained since 1970. Dams have not impeded access to important stretches of suitable habitat, but do restrict immigration from the adjacent Winnipeg River. | |
| Applicability of Criteria | |
| Criterion A: (Declining Total Population): Not Applicable – populations have declined in the past, but have shown recovery since the 1970s. | |
| Criterion B: (Small Distribution and Decline or Fluctuation): Not Applicable – EO and AO exceed threshold limits. | |
| Criterion C: (Small Total Population Size and Decline): Not Applicable – population and decline information unknown. | |
| Criterion D: (Very Small Population or Restricted Distribution): Population and distribution data exceed threshold limits. | |
| Criterion E: (Quantitative Analysis): Not Applicable – no data. | |

TECHNICAL SUMMARY (DU7)

Acipenser fulvescens

Lake sturgeon

Southern Hudson Bay-James Bay populations

MB, ON, QC

Esturgeon jaune

| | |
|---|---|
| Extent and Area information | |
| • <i>extent of occurrence (EO)(km²)</i> | ~1,000,000 |
| • <i>specify trend</i> | Stable |
| • <i>are there extreme fluctuations in EO?</i> | No |
| • <i>area of occupancy (AO) (km²)</i> | <1,000,000 |
| • <i>specify trend</i> | Stable? |
| • <i>are there extreme fluctuations in AO?</i> | No |
| • <i>number of extant locations</i> | >10 |
| • <i>specify trend in # locations</i> | Stable? |
| • <i>are there extreme fluctuations in # ?</i> | No |
| • <i>habitat trend</i> | Decline? |
| Population information | |
| • <i>generation time (average age of parents in the population)</i> | 35-54 years |
| • <i>number of mature individuals (capable of reproduction) in the Canadian population</i> | Unknown |
| • <i>total population trend</i> | Unknown |
| • <i>if decline, % decline over the last/next 10 years or 3 generations, whichever is greater</i> | |
| • <i>are there extreme fluctuations in number of mature individuals?</i> | No |
| • <i>is the total population severely fragmented?</i> | Yes |
| • <i>list each population and the number of mature individuals in each</i> | Unknown |
| • <i>specify trend in number of populations</i> | Unknown |
| • <i>are there extreme fluctuations in number of populations ?</i> | No |
| Threats | |
| Existing: dams, poaching Potential: overexploitation via new commercial harvest and increasing road access. | |
| Rescue Effect (immigration from an outside source) | Unlikely |
| • <i>does species exist elsewhere (in Canada or outside)?</i> | Yes |
| • <i>status of the outside population(s)?</i> | DUs 1-5 – Endangered DU6 – Special Concern DU8 – Threatened |
| • <i>is immigration known or possible?</i> | Possible, but unlikely |
| • <i>would immigrants be adapted to survive here?</i> | Yes |
| • <i>is there sufficient habitat for immigrants here?</i> | Unknown |
| Quantitative Analysis | |

Status and Reasons for Designation (DU7)

| | |
|--|---|
| Status: Special Concern | Alpha Numeric Code: Not applicable |
| Reasons for Designation: There are limited population data available for populations in this designatable unit and there have been declines in habitat and possibly abundance for some population components related to exploitation and the multitude of dams. The increased access to relatively unimpacted populations and the likelihood of increased hydroelectric development in some areas are causes for concern for this designatable unit. | |
| Applicability of Criteria | |
| Criterion A: (Declining Total Population): Not Applicable – there have been declines in habitat, and possibly populations, but no trend data is available. | |
| Criterion B: (Small Distribution and Decline or Fluctuation): Not Applicable – EO and AO exceed threshold limits. | |
| Criterion C: (Small Total Population Size and Decline): Not applicable – No information available on population sizes and decline. | |
| Criterion D: (Very Small Population or Restricted Distribution): EO, AO and population size exceed threshold limits. | |
| Criterion E: (Quantitative Analysis): Not Applicable – No data. | |

TECHNICAL SUMMARY (DU8)

Acipenser fulvescens

Lake sturgeon

Great Lakes-Upper St. Lawrence populations

ON, QC

Esturgeon jaune

| | |
|---|--|
| Extent and Area information | |
| • <i>extent of occurrence (EO)(km²)</i> | ~600,000 |
| • <i>specify trend (decline, stable, increasing, Unknown)</i> | Decline |
| • <i>are there extreme fluctuations in EO?</i> | No |
| • <i>area of occupancy (AO) (km²)</i> | <600,000 |
| • <i>specify trend</i> | Decline |
| • <i>are there extreme fluctuations in AO?</i> | No |
| • <i>number of extant locations</i> | <70 |
| • <i>specify trend in #</i> | Decline |
| • <i>are there extreme fluctuations in # locations?</i> | No |
| • <i>habitat trend</i> | Decline |
| Population information | |
| • <i>generation time (average age of parents in the population)</i> | 35-54 years |
| • <i>number of mature individuals (capable of reproduction) in the Canadian population</i> | Unknown |
| • <i>total population trend:</i> | Dramatic decline 2-3 generations in the past, in last generation some populations in decline, some stable and some increasing |
| • <i>if decline, % decline over the last/next 10 years or 3 generations, whichever is greater</i> | 99% in the Great Lakes |
| • <i>are there extreme fluctuations in number of mature individuals?</i> | Unknown |
| • <i>is the total population severely fragmented</i> | Yes |
| <p><i>list each population and the number of mature individuals in each</i></p> <p><i>N.B. Population data are combined by major drainage basin, there are 63 known extant populations in this DU</i></p> | <p>For basin and tributaries:</p> <p>Lake Superior – 6 populations remain of 14, <1000 in each</p> <p>Lake Huron – 8 remain of 21, < 1000 in each;</p> <p>Lake Nipissing – unknown; Lake Simcoe – 0;</p> <p>Lake St. Clair – 5,000 (not aged), may include migrants from Detroit and St. Clair rivers as well as lakes Huron and Erie; Lake Erie – 3 populations remain of 4, <1000 in each Lake Ontario – 3, populations remain of 5, spawning in 2, <1000 in each</p> <p>Ottawa River – tributaries extirpated, mainstem very few Lake Timiskaming – likely 1 population, severely depleted, low 100s</p> <p>Upper St. Lawrence River – 14 of 14 populations remaining, previous decline due to contaminants and exploitation, populations had recovered, but are now showing signs of overexploitation; only 3 populations may be >1000 mature individuals</p> |

| | |
|---|--|
| <ul style="list-style-type: none"> • <i>specify trend in number of populations</i> | For basin and tributaries Lake Superior – decline Lake Huron – unknown Lake Nipissing – unknown Lake Simcoe – decline Lake St. Clair – increase Lake Erie – slight increase Lake Ontario – slight increase Lake Temiskaming – decline Upper St. Lawrence – decline, showing signs of overexploitation Ottawa River – decline |
| <ul style="list-style-type: none"> • <i>are there extreme fluctuations in number of populations?</i> | No |
| Threats | |
| Existing: overexploitation, dams, poaching, habitat degradation and contamination | |
| Rescue Effect (immigration from an outside source) | Unlikely |
| <ul style="list-style-type: none"> • <i>does species exist elsewhere (in Canada or outside)?</i> | Yes |
| <ul style="list-style-type: none"> • <i>status of the outside population(s)?</i> | DU6 – Special Concern DU7 – Special Concern Minnesota and Wisconsin – Vulnerable Michigan and Illinois – Imperiled Indiana, Pennsylvania, New York, Vermont – Critically Imperiled |
| <ul style="list-style-type: none"> • <i>is immigration known or possible?</i> | Possible, but unlikely |
| <ul style="list-style-type: none"> • <i>would immigrants be adapted to survive here?</i> | Yes |
| <ul style="list-style-type: none"> • <i>is there sufficient habitat for immigrants here?</i> | Yes? |
| Quantitative Analysis | |

Status and Reasons for Designation (DU8)

| | |
|--|--|
| Status: Threatened | Alpha Numeric Code: Meets criteria for Endangered A2abcd, but designated Threatened A2abcd because although a quarter of the populations have been lost, more than half of the remaining populations are either stable or recovering. |
| Reasons for Designation: <p>A very large commercial fishery existed in the Great Lakes between the mid-1800s and early 1900s (i.e. 2-3 generations ago) during which time populations of this species were reduced to a small fraction of their original size, and appear to be still at very low levels. Populations appear to be declining in parts of the Ottawa River, and disappearing from many of its tributaries due to dams. There has been a recent decline in the population in the St. Lawrence River probably due to overexploitation despite recovery efforts. The direct and indirect effects of dams, chemical control of sea lamprey, contaminants and invasive species currently threaten populations.</p> | |

Applicability of Criteria

Criterion A: (Declining Total Population): Meets A2abcd – The majority of populations (all in the Great Lakes portion) in this Designatable Unit exhibited close to a 100% decline in population size between the mid-1800s to early 1900s. Since that time, most lake Sturgeon populations have failed to increase in size, and 21 of the 63 known Canadian populations in this Designatable Unit now are considered extirpated.

Criterion B: (Small Distribution and Decline or Fluctuation): Not applicable – Wide distribution.

Criterion C: (Small Total Population Size and Decline): Not Applicable – Population sizes exceed thresholds.

Criterion D: (Very Small Population or Restricted Distribution): Not Applicable – Wide distribution.

Criterion E: (Quantitative Analysis): Not applicable – No data.

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BIOGRAPHICAL SUMMARIES OF REPORT WRITERS

T.A. Dick has a Bachelor of Science in Forestry (silviculture and wildlife management) and an M.Sc. in parasite ecology from the University of New Brunswick and a Ph.D. (immunology and cell biology) from the University of Toronto. He is currently a professor in the Department of Zoology, University of Manitoba and a recent recipient of an NSERC Northern Research Chair. Research over the years has included taxonomy, systematics, biogeography, ecology, immunology, cell and molecular biology. Over the past 15 years, he has been especially interested in food webs and trophic feeding patterns of freshwater fishes, and more recently his interests have become more interdisciplinary dealing with issues relating to aquatic biota, fish habitat, indices of biotic integrity in perturbed and unperturbed environments and conservation biology. He is also interested in marine environments and historical and contemporary ecological associations in aquatic systems. Research on the Acipenseriformes includes paddlefish (*Polyodon spathula*), shovelnose sturgeon (*Scaphirhynchus platorhynchus*) and lake sturgeon. Studies on lake sturgeon include use of traditional and local knowledge in lake sturgeon management, aquaculture and enhancement, and developing tools to describe sturgeon habitat using sonar technology to measure substrate and current and incorporating data into GIS. In addition, sturgeon behaviour is studied using radio and sonar tags.

R. Campbell is co-chair of the COSEWIC Freshwater Fishes SSC, and formerly CITES Management Authority for Canada, and Senior Policy Program Advisor Northern and Inland Fisheries, Department of Fisheries and Oceans. Bob has authored and co-authored several COSEWIC reports and currently works as a freelance consultant on environmental and fishery-related issues mainly dealing with species at risk.

Nicholas E. Mandrak is a Research Scientist with Fisheries and Oceans Canada in Burlington, Ontario. His research interests are the biodiversity, biogeography and conservation of Canadian freshwater fishes. Nick has co-authored 12 COSEWIC reports. He is a member of the COSEWIC Freshwater Fish Species Specialist Subcommittee.

Becky Cudmore is a Research Biologist with Fisheries and Oceans Canada in Burlington, Ontario. Her research interests involve the biodiversity of freshwater fishes, including the protection and recovery of species at risk and invasive species. Becky has co-authored four COSEWIC reports.

James D. Reist is a research scientist with Fisheries and Oceans Canada where he has investigated the biodiversity, ecology and anthropogenic impacts for northern and arctic fishes for the past 22 years. He holds graduate degrees specializing in evolution, systematics and taxonomy of northern fishes from the universities of Alberta and Toronto. His current work includes research on SARA-listed species such as shortjaw cisco, diversity and ecology of Arctic char and related species, development of a field guide for Canadian Arctic marine fishes, general status assessment and advice regarding arctic freshwater and marine fishes, and assessment of impacts from northern development and climate change upon freshwater fishes and their ecosystems. He is also presently a member of the COSEWIC Freshwater Fish Species Specialist Subcommittee.

Jake Rice is Director of Assessments and Scientific Advice for the Canadian Science Advisory Secretariat, Department of Fisheries and Oceans. Prior to taking on his position with CSAS in DFO Headquarters in 1996, he held positions as a Research Scientist with DFO, and served as Division Head of Groundfish in Newfoundland Region (St. John's) and Marine Fish in Pacific Region (Nanaimo). He has also held faculty positions in Biology, Environmental Studies, and Mathematics and Statistics at Memorial University, Arizona State University, and University of Copenhagen (as Guest Professor of the Royal Danish Academy). He received his B.Sc. in Conservation from Cornell University in 1970, and his Ph.D. in Zoology (Ornithology) from University of Toronto in 1974. He has over 150 primary scientific publications on community ecology of passerines in Canadian forests and US deserts, seabirds on the Newfoundland Coast, single-species and multi-species fisheries assessment methods, marine ecosystem indicators, and ecosystem approaches to management. He has been a jurisdictional member of COSEWIC since 1996, a member of the Science Advisory Board of NOAA, and has chaired a number of Expert Groups for the International Council for Exploration of the Seas, including a term as Chief Scientist of ICES.

Paul Bentzen is a professor and holds the Department of Fisheries Ocean Chair in Resource Conservation Genetics in the Department of Biology at Dalhousie University. He has been a member of the Marine Fishes Specialist Subcommittee of COSEWIC since 2005, and co-chair of that subcommittee since 2006.

Pierre Dumont is a fisheries biologist, working in Québec freshwater ecosystems since the beginning of the 1970s, where he has been involved in the impact studies of the James Bay hydropower development. He has worked for the Quebec government since 1978, first as a regional biologist in the Outaouais region and, since 1982, in the St. Lawrence River lowlands, in the most urbanized part of the province. He is mainly involved in scientific studies on the status and the exploitation of lake sturgeon, yellow perch and American eel, on the long-term monitoring of fish communities along the St. Lawrence River, on fish habitat improvement and on the restoration of the copper redhorse, a rare and endangered species, endemic to southwestern Québec. He has also been involved in the restoration program of the European sturgeon since 1998, when he had the chance to work at the Cemagref (Bordeaux France) for one year. He acts as co-director of graduate students in four Quebec universities. He received his doctoral degree in environmental sciences from the Université du Québec à Montréal in 1996. He has co-authored four COSEWIC reports.

AUTHORITIES CONSULTED

Lesley Barnes
Ontario Ministry of Natural Resources
Red Lake, Ontario

Alan Dextrase
Ontario Ministry of Natural Resources
Peterborough, ON

Marcel Bernard
Ministère des Ressources naturelles et
de la Faune du Québec
Secteur Faune, Québec, QC

John Durbin
Saskatchewan Environment
Regina, SK

R. Bruch
Wisconsin Department of Natural
Resources Oshkosh, WI

Martin Erickson
Fish Habitat Specialist
Manitoba Water Stewardship
Fisheries Branch
Winnipeg, MB

K. Campbell
Manitoba Conservation
Gimli, MB

W. Franzin
Department of Fisheries and Oceans
Freshwater Institute
Winnipeg, MB

L. Cargnelli
Management Biologist/Team Leader
Lake Erie Management Unit
London, ON

Ron Hempel
Department of Fisheries and Oceans
Freshwater Institute
501 University Crescent,
Winnipeg, MB

S. Cotterill
Acting Provincial Species at
Risk Specialist, Edmonton, AB

H. Letander
Elder, Sagkeeng First Nation
Pine Falls, MB

B. Locke
Ontario Ministry of Natural Resources
Peterborough, ON

W. Lysack
Manitoba Conservation
Winnipeg, MB

M. Friday
Ontario Ministry of Natural Resources
Thunder Bay, ON

M. Gauthier
Ontario Ministry of Natural Resources
Cochrane, ON

Daniel Hatin
Ministère des Ressources naturelles et
de la Faune du Québec
Québec, QC

T. Haxton
Ontario Ministry of Natural Resources
Kemptville, ON

B. Jackson
Ontario Ministry of Natural Resources
Atikokan, ON

Don MacDonnll
North/South Consultants Inc.
Winnipeg, Manitoba.

D. Macdonald
Manitoba Conservation
Thompson, MB

H. Mackay
Elder, Berens River, MB

Y. Mailhot
Regional Biologist
Ministère des Ressources naturelles et
de la Faune du Québec
Trois-Rivières, QC

A. Mathers
Management Biologist
Lake Ontario Management Unit
Picton, ON

S. Matkowski
Manitoba Conservation
Winnipeg, MB

Scott McAughey
Ontario Ministry of Natural Resources
Kenora, Ontario

D. MacDonnell
North/South Consultants Inc.
Winnipeg, MB

S. McGovern
Biologist, Ontario Ministry of Natural
Resources, Timmins, ON

D. McLeod
Ontario Ministry of Natural Resources
Fort Frances, ON

L. Mohr
Ontario Ministry of Natural Resources
Owen Sound, ON

T. Mosindy
Assessment Biologist
Lake of the Woods Fisheries
Assessment Unit, Kenora, ON

D. Nadeau
Regional Biologist (Abitibi-
Témiscamingue)
Ministère des Ressources naturelles et
de la Faune du Québec
Rouyn-Noranda, QC.

J. Nelson
Department of Zoology
University of Alberta
Edmonton, AB

A. F. Penn
Science Advisor
Grand Council of the Crees
Montral, QC

H. Quinlan
US Fish and Wildlife Service
Ashland, WI

Bruce Ranta
Ontario Ministry of Natural Resources
Kenora, Ontario

M. Robinson
Department of Zoology, University of
Guelph, Guelph, ON

R. Salmon
Ontario Ministry of Natural Resources
Nipigon, ON

S. Schillemore,
Ontario Ministry of Natural Resources
Red Lake, ON

C. Smith
Saskatchewan Environment, Fish and
Wildlife Branch, Regina, SK

S. Stephenson
Environmental Science Biologist
Freshwater Institute, 501 University
Crescent, Winnipeg, MB

J. Stock
Saskatchewan Parks and Renewable
Resources
Maple Creek, SK

Guy Trenchia
Regional Biologist (Chaudière-
Appalaches)
Ministère des Ressources naturelles et
de la Faune du Québec
Charny, QC.

R. Wallace
Saskatchewan Environment
Saskatoon, SK

Douglas Watkinson
Department of Fisheries and Oceans
501 University Crescent
Winnipeg, MB

COLLECTIONS EXAMINED

Not applicable.