

Management Plan for the Bigmouth Buffalo (*Ictiobus cyprinellus*) in Canada (Saskatchewan-Nelson River populations)

Bigmouth Buffalo



2019

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(populations des rivières Saskatchewan et Nelson) (proposition)

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Preface

Under the Species at Risk Act (S.C. 2002, c.29; Government of Canada 2002) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years. The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada.

The Minister of Fisheries and Oceans is the competent minister under SARA for the Bigmouth Buffalo and has prepared this management plan as per section 65 of SARA. It has been prepared in cooperation with the governments of Saskatchewan and Manitoba, in cooperation and consultation with many individuals, organizations, and government agencies, as per section 66(1) of SARA.

Success in the management of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Bigmouth Buffalo and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgments

This management plan was prepared by Melanie VanGerwen-Toyne (DFO), Pooi-Leng Wong (DFO), and Calum Bonnington (contractor). Fisheries and Oceans Canada would like to thank the following organizations for their support in the development of this management plan: Manitoba Sustainable Development, Saskatchewan Water Security Agency, Saskatchewan Ministry of Environment, and the University of Saskatchewan.

Executive summary

The Bigmouth Buffalo (*Ictiobus cyprinellus*) is a large, deep-bodied fish of the sucker family Catostomidae. The Saskatchewan – Nelson River populations of Bigmouth Buffalo was listed as a species of special concern under the federal Species at Risk Act (SARA) in 2011. In Canada, this designated unit is found in three disjunct areas: the Lake of the Woods, Ontario; the Lower Assiniboine, Red, La Salle and Seine rivers, Delta Marsh, southern Lake Manitoba, and southern Lake Winnipeg, Manitoba; and the Qu'Appelle River system, Saskatchewan (COSEWIC 2009).

Although regular fisheries assessments have occurred in Ontario waters, no Bigmouth Buffalo have been reported from the Lake of the Woods since 1976 (Dextrase IN COSEWIC 2009). Bigmouth Buffalo populations in Manitoba are considered to be secure. The populations in Saskatchewan are thought to have declined (COSEWIC 2009). COSEWIC (2009) identified the primary anthropogenic threat to Bigmouth Buffalo populations in the Qu'Appelle River system, Saskatchewan, as the loss or degradation of spawning habitat due to water management practices.

The long-term objective of this management plan is to maintain existing Bigmouth Buffalo (Saskatchewan – Nelson River populations) population levels and distribution, and protect habitat within watersheds in which the species is found. Management should be directed towards maintaining sufficient quality and quantity of habitats to support known populations.

The following short-term objectives (over the next 10 years) have been identified to assist in meeting the long-term objective:

- i. improve our knowledge of the species' biology and population characteristics
- ii. determine species distribution, movement, and habitat requirements
- iii. increase public awareness and stewardship
- iv. identify and mitigate threats to the species

Broad strategies to reach the objectives listed above have been organized thematically into the following four categories, each of which is associated with key conservation measures:

Surveys and monitoring:

- assess the distribution of Bigmouth Buffalo in Manitoba and document species biological information

Research:

- study the Bigmouth Buffalo population in the Lake Winnipeg drainage, Manitoba to increase understanding of its distribution, movements, and habitat use

- determine if there is mixing of Bigmouth Buffalo populations in the lower Qu'Appelle River, Saskatchewan and the Assiniboine River, Manitoba
- identify additional spawning areas for Bigmouth Buffalo in Manitoba and Saskatchewan
- investigate the impact of the Common Carp (*Cyprinus carpio*) on the spawning success of Bigmouth Buffalo in Delta Marsh, Manitoba
- determine summer, fall, and winter distribution and habitat use of adults in the upper Qu'Appelle River system, Saskatchewan
- analyze the age demographics of spawning Bigmouth Buffalo in the Qu'Appelle River system, Saskatchewan

Stewardship, outreach and communication:

- develop educational signs about Bigmouth Buffalo and install in strategic locations in Manitoba and Saskatchewan
- present information to interested parties in Manitoba and Saskatchewan on how they can participate in the conservation of the Bigmouth Buffalo
- present information to rough fish¹ fishers on the potential of Bigmouth Buffalo as a bycatch in Manitoba

Management, coordination and threat mitigation:

- breach dykes at Last Mountain Lake, Saskatchewan to allow Bigmouth Buffalo access to additional wetlands/spawning areas

¹ Rough fish, species considered undesirable as food/sport

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This management plan will benefit the environment by promoting the conservation of the Bigmouth Buffalo. The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan will have a positive effect on the environment and will not entail any significant adverse effects.....	21

1. COSEWIC² species assessment information

Date of assessment: April 2009

Common name: Bigmouth Buffalo - Saskatchewan-Nelson River populations

Scientific name: *Ictiobus cyprinellus*

COSEWIC status: Special concern

Reason for designation: Although there has been an increase in the extent of occurrence (EO) and area of occupancy (AO) in Manitoba, the species is apparently not abundant there. Dramatic declines in the Qu'Appelle River basin appear to be related to changes in water management practices that have led to elimination and/or degradation of spawning habitat and subsequent reduction in reproductive potential. Increasing demands for water for agricultural purposes may also be limiting for other population components in this Biogeographic Zone.

Canadian occurrence: Saskatchewan, Manitoba

COSEWIC status history: The species was considered a single unit and designated special concern in April 1989. Split into two populations in April 2008 to allow a separate designation of the Bigmouth Buffalo (Great Lakes - Upper St. Lawrence populations). The Bigmouth Buffalo (Saskatchewan–Nelson River populations) was not assessed in April 2008; it retained the special concern designation of the original Bigmouth Buffalo. The population was designated special concern in April 2009. Last assessment was based on an updated status report.

2. Species status information

Global status: In the United States, the Bigmouth Buffalo is listed as G5 (NatureServe 2017).

Canadian status: NatureServe (2019) ranked the Saskatchewan-Nelson River populations of Bigmouth Buffalo as G5TNR, meaning globally “secure” (common, widespread, and abundant) at the species level, but “not ranked” at the subspecies level. The Bigmouth Buffalo (Saskatchewan-Nelson River populations) was designated as special concern by COSEWIC in 2009 (COSEWIC 2009) and was listed as special concern under the federal Species at Risk Act in 2011. The Canadian Endangered Species Conservation Council (CESCC) provided a national general status ranking of Bigmouth Buffalo as secure (4) (CESCC 2006). A provincially administered list of Species at Risk in Saskatchewan lists Bigmouth Buffalo as S3 (Vulnerable/Rare to uncommon: moderate risk of extinction or extirpation) (Saskatchewan Conservation

² COSEWIC – Committee on the Status of Endangered Wildlife in Canada

Data Centre 2019), and in Manitoba as S5 (widespread, abundant, and secure throughout the province) (Manitoba Conservation Data Centre 2019) (table 1).

Table 1. Summary of existing protection or other status designations assigned to the Bigmouth Buffalo (Saskatchewan-Nelson River populations).

Jurisdiction	Authority/organization	Year(s) assessed and/or listed	Status/designation	Designation level
Canada	CESCC	2006	Secure (4)	Population
Canada	COSEWIC	2009	Special concern	Population
Canada	Species at Risk	2011	Special concern	Population
Province	Saskatchewan Wild Species at Risk Regulations of the province's The Wildlife Act (Government of Saskatchewan 1998)	2019	Vulnerable/rare to uncommon (S3)	Population
Province	Manitoba	2019	Widespread, abundant, and secure (S5)	Population
International	NatureServe	2019	Globally secure and subspecies/varieties unranked (G5TNR)	Population

3. Species information

3.1. Species description

Bigmouth Buffalo is one of a few *Ictiobus* species found in Canada. It is characterized by a robust, deep and laterally compressed body (figure 1). Studies of Bigmouth Buffalo in Saskatchewan have recorded fish typically measuring 25 to 50 cm in length and weighing between 2 to 5 kg, but some fish in excess of 80 cm and 15 kg (20+ years old) have been caught (Johnson 1963, Hlasny 2000, Sereda and Pollock pers. comm., Hlasny and Bryshun pers. comm.). A study conducted in 2016 and 2017 in Manitoba captured Bigmouth Buffalo as large as 80 cm and 13.5 kg (Watkinson pers. comm.).

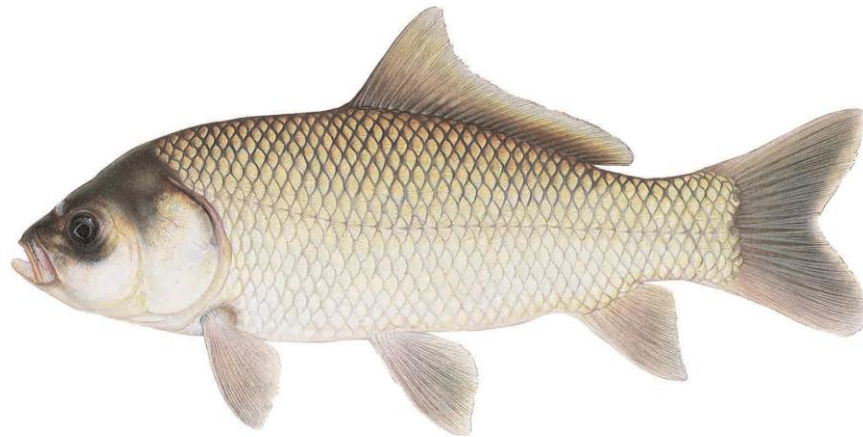


Figure 1. Bigmouth Buffalo. © Tomelleri

3.2. Population and distribution

Global range: In the United States, Bigmouth Buffalo are widely distributed throughout the Mississippi drainages in eastern North America, from the Gulf of Mexico northward to Minnesota and North Dakota (figure 2).

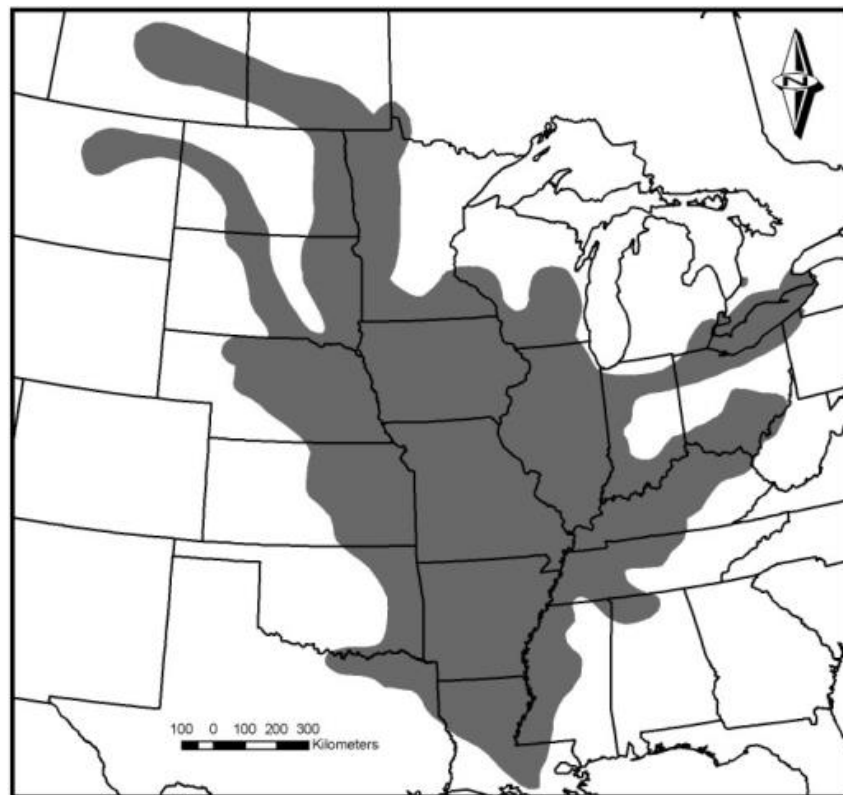


Figure 2. Global distribution of Bigmouth Buffalo. COSEWIC 2009 (Modified from Page and Burr 1991).

Canadian range: The Bigmouth Buffalo are found in two biogeographic zones. The Great Lakes-Upper St. Lawrence populations have been reported from the Lake Erie, Huron, Ontario and St. Clair basins. This designated unit was assessed as Not-at-Risk by COSEWIC (2009). The Saskatchewan – Nelson River populations have been found in three disjunct areas: the Lake of the Woods, Ontario; the Lower Assiniboine, Red, La Salle and Seine rivers, Delta Marsh, southern Lake Manitoba, and southern Lake Winnipeg, Manitoba; and the Qu'Appelle River system, Saskatchewan (COSEWIC 2009) (figure 3). However, although regular fisheries assessments have occurred in Ontario waters, no Bigmouth Buffalo have been reported from the Lake of the Woods since 1976 (Dextrase IN COSEWIC 2009). Also, Bigmouth Buffalo are a relatively recent introduction to the Lake Manitoba system; they are thought to have arrived in the early 1970s following the construction and operation of the Portage Diversion (also known as Assiniboine River Floodway) (Stewart et al. 1985).

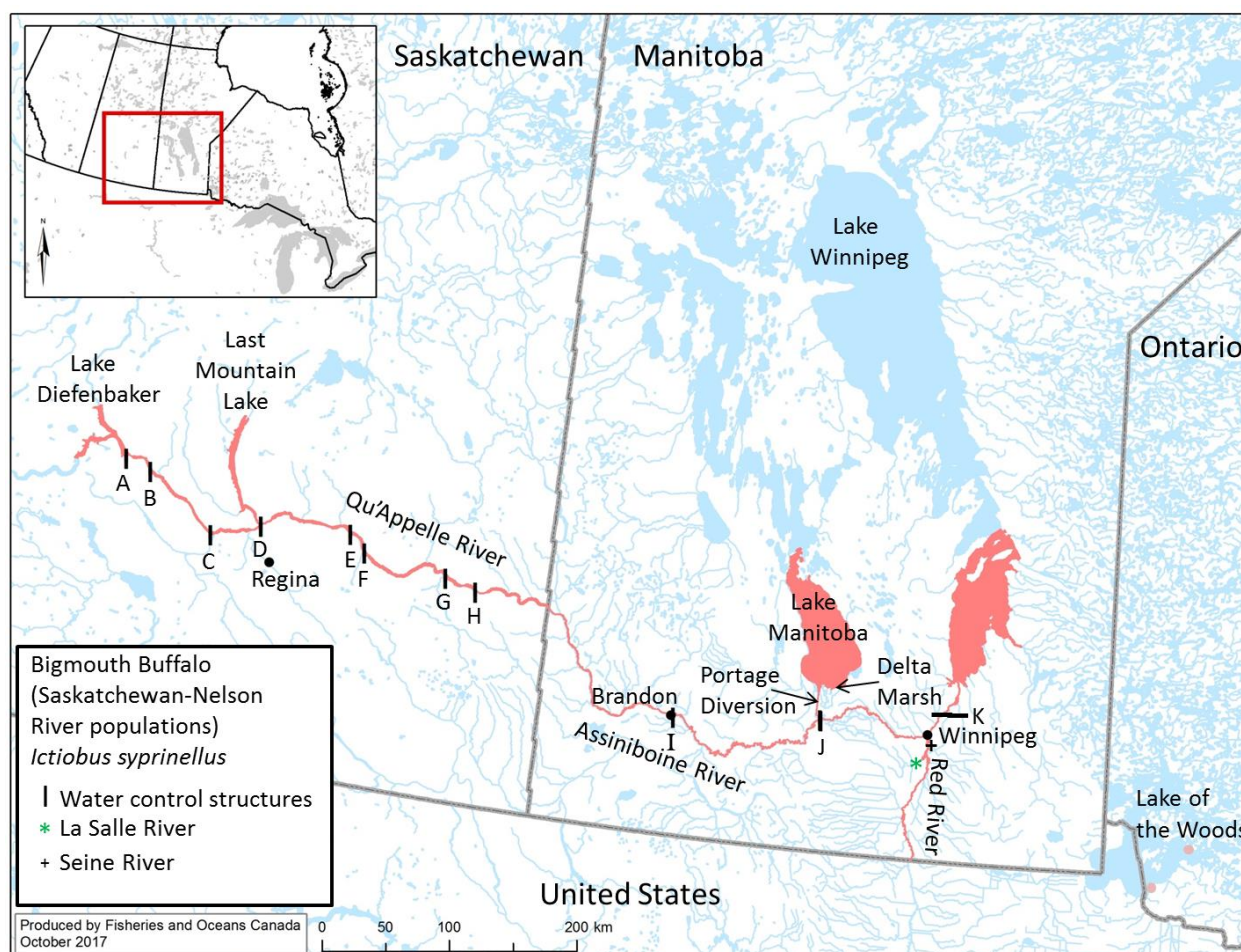


Figure 3. Distribution of the Bigmouth Buffalo (Saskatchewan – Nelson River populations). (Alphabets on map: A=Qu'Appelle dam, B=Eyebrow dam, C=Buffalo Pound dam, D=Craven dam, E=Echo dam, F=Katepwa dam, G=Crooked dam, H=Round dam, I=Brandon rock ramp, and J=Portage Diversion River Control Structure, K=St. Andrews Lock and Dam).

3.3. Needs of the Bigmouth Buffalo

Spawning: Bigmouth Buffalo exhibit broadcast spawning in the spring, and may move long distances to find suitable habitat (Cooper 1983). Movement to spawning areas can be triggered by a sudden rise in water temperature (Becker 1983, Edwards 1983) or with the onset of spring flooding (Johnson 1963). Spring floods also provide access to the preferred spawning habitat of inundated terrestrial or submerged vegetation in marshes and backwaters (Johnson 1963, Trautman 1981, Edwards 1983, Hlasny 2000, Sereda and Pollock 2014). In Manitoba, spring floods provide several kilometers of suitable spawning habitat for the Bigmouth Buffalo in the [Seine](#) and [La Salle](#) rivers, tributaries of the Red River (Watkinson pers. comm.), as well as in similar tributaries of the lower Assiniboine River (Long pers. comm.). In the [Qu'Appelle](#) River system, Saskatchewan, spawning has been identified in several marshes and lakes and generally occurs in May when water temperatures reach 17 to 18°C (Sereda and Pollock 2014). Hlasny (2000) reported an apparent delay in spawning which started in early June in water temperature from 13.1 to 25.5°C and occurred in 0.3 to 0.9 m of moving water over abundant vegetation, especially mats approximately 15 to 30 cm thick. In the west end of Buffalo Pound Lake, Saskatchewan spawning occurs in shallow (1 to 2 m) water with dense sago pondweed (*Stuckenia pectinata*), cattail (*Typha spp.*) and northern water milfoil (*Myriophyllum sibiricum*) (Sereda et al. 2014). In Illinois, spawning was observed in a reservoir at depths of 0.5 to 0.75 m over a bottom of hard-packed clay and some gravel, with decomposing vegetation (Burr and Heidinger 1983). In the Missouri River, the species was observed spawning in water so shallow that their backs were exposed (Pfleiger 1975).

Young of the year: The emergence of young of the year (YOY) is variable, but generally occurs by late spring or early summer. Johnson (1963) reported that YOY appeared by the end of June in the [Qu'Appelle](#) River. Sereda and Pollock (2014) reported that in Buffalo Pound Lake (within the [Qu'Appelle](#) River system), when the water temperature reached 17 to 19°C the first YOY (sac fry 7 to 10 days post spawn) appeared on May 21 with all eggs hatched by May 24. In the Red River, YOY appeared in early to mid-July (Stewart and Watkinson 2004). YOY fish are >25 mm in length (Sereda pers. comm.).

Adult: Bigmouth Buffalo are predominantly found in the slower moving water of medium to larger-sized rivers. Off-channel habitat with moderate to slow current such as side-channels, oxbows, sloughs, bayous or shallow lakes are preferred (Johnson 1963, Trautman 1981, Becker 1983). Adults are adapted to warm, turbid and often eutrophic bodies of water (Johnson 1963, Trautman 1981, Becker 1983, Nelson 2003, Cudmore et al. 2004) and high water temperatures (up to 30°C) (Minckley et al. 1970). They are tolerant of low levels of dissolved oxygen (Gould and Irvin 1962), and readily adapt to new conditions such as reservoirs and ponds (Goodchild 1990). Outside of spawning periods, they are more likely to be found mid-water or near the bottom in the deeper sections of long runs or pools, and most likely to be found in waters >1.5 m in depth over substrates of mud, silt, sand, gravel, clay and rubble (Trautman 1981, Becker

1983). Johnson (1963) reported that in Saskatchewan, Bigmouth Buffalo prefer water shallower than 5 m.

Limiting factors: Natural factors that may limit the distribution of the Bigmouth Buffalo include hybridization, heavy parasitic infestations, and drought.

Bigmouth Buffalo can hybridize naturally with Smallmouth Buffalo (*Ictiobus bubalus*) and Black Buffalo (*Ictiobus niger*) (Carlander 1969, Trautman 1981, Nelson 2003); however, these species are not known to be present within the Saskatchewan-Nelson River designated unit (Atton and Merkowsky 1983, Stewart and Watkinson 2004).

Heavy parasitic infestations, particularly by Myxosporidian spores, may debilitate populations due to interference with feeding mechanisms (COSEWIC 2009).

Successful reproduction is dependent on spring flooding to provide access to spawning areas and to initiate spawning activity (Johnson 1963). In drought years, lake elevations recede and shoreline vegetation become inaccessible for spawning. Drought in the southern prairies is not uncommon and may become more common given the predicted changes in aquatic ecosystems associated with global climate change (Poff et al. 2002; Schindler and Donahue 2006). The impact of drought on flows in the Qu'Appelle River system can be mitigated to some extent by water released from Lake Diefenbaker through the Qu'Appelle Dam (Pollock pers. comm.) or other mitigation measures.

4. Threats

4.1. Threat assessment

Threats to the Bigmouth Buffalo have been organized into the following categories:

Threat category I: habitat loss/access/fragmentation

Threat category II: harvesting

Threat category III: invasive species

Table 2. Summary of threats to the Bigmouth Buffalo (Saskatchewan-Nelson River populations).

#	Threat	Level of concern ³	Extent	Occurrence	Frequency	Severity ⁴	Causal certainty ⁵
I-1	Loss of / access to spawning habitat	Medium	Local	Current	Seasonal	Moderate	Medium
I-2	Loss of / access to rearing habitat	Medium	Local	Current	Seasonal	Moderate	Medium
I-3	Habitat fragmentation	Medium	Local	Current	Seasonal	Moderate	Medium
II-1	Commerical fishery (rough fish or bycatch)	Low	Widespread	Unknown	Unknown	Unknown	Low
II-2	Recreational fishing	Low	Widespread	Unknown	Unknown	Unknown	Low
III-1	Common Carp	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

³ Level of concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table).

⁴ Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).

⁵ Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability for example expert opinion; Low: the threat is assumed or plausible).

4.2. Description of threats

Threat category I: habitat loss/access/fragmentation

#I-1. COSEWIC (2009) reported that declines in Bigmouth Buffalo in the Qu'Appelle River basin appear to be related to changes in water management practices that led to elimination and/or degradation of spawning habitat. In the 1980s, changes were made to the channel morphology and flow regime within the Qu'Appelle River drainage to reduce variation in flow to control flooding. Habitats that were created benefited Walleye (*Sanders vitreus*) and Northern Pike (*Esox lucius*), two important recreational fish species (Dunn and Hjertaas 1981). Changes such as channelization, removal of meander loops, and setting of lake levels, may have negatively impacted Bigmouth Buffalo by eliminating/degrading spawning habitats through reduction of available inundated or submerged vegetation. However, recent analysis has indicated that water management practices have resulted in periodic increased flow down the Qu'Appelle valley, potentially creating more areas with inundated or submergent vegetation (Sereda et al. 2014) compared to natural flows. In recent years, there have also been concerns over the ability of fish to access spawning grounds in the Qu'Appelle River system due to insufficient water levels or physical barriers.

#I-2. During high flow years (from water control management or annual precipitation) vegetated habitat may be flooded, providing spawning habitat for Bigmouth Buffalo, but waters may recede too quickly in some areas resulting in loss of rearing habitat, stranding of adult fish, or mortality of fish eggs or fry. Efforts are currently being made to mitigate these issues (see section 6).

#I-3. The distribution of Bigmouth Buffalo contains numerous water control structures (figure 3) which may block fish movement and result in habitat fragmentation. In Saskatchewan, the Qu'Appelle River system contains a series of eight water control structures. In Manitoba, two water control structures exist in the Assiniboine River and one in the upper Red River. Some of these may block fish movement entirely or unidirectionally and it is unknown if there is any movement of fish between Saskatchewan and Manitoba.

Threat category II: harvesting

#II-1. A commercial fishery for Bigmouth Buffalo in Canada was established in Saskatchewan in the 1940s and ended in 1983 due to reduced catches (Hlasny 2000; Hlasny pers. comm.). Although there are no known Bigmouth Buffalo commercial fisheries in any Canadian waters currently, there have been discussions about initiating a commercial fishery for Common Carp (*Cyprinus carpio*) in the Qu'Appelle system (Tyree pers. comm.), and in expanding rough fish fisheries in Manitoba; Common Carp (*Cyprinus carpio*) in particular (Long pers. comm.). Bigmouth Buffalo are often misidentified as carp (Stewart and Watkinson 2004) and may therefore be at an increased risk of capture through misidentification or bycatch.

#II-2. Bigmouth Buffalo are also captured incidentally by recreational fishers (anglers or bow fishers); however, this harvest is thought to be low and poses a low threat to the species (Sereda pers. comm.).

Threat category III: invasive species

#III-1. Bigmouth Buffalo are currently facing potential resource competition (food and habitat) from Common Carp (Pollock pers. comm.). In addition, Zebra Mussel (*Dreissena polymorpha*) are known to occur in much of the Bigmouth Buffalo range including several locations within Manitoba⁶. Although impacts to Bigmouth Buffalo from Zebra Mussel may not be direct, potential changes to the food-web and/or water quality should be considered.

⁶ [Government of Manitoba Aquatic Invasive Species](#)

5. Management objective

5.1 Long-term objective

The long-term objective of this management plan is to maintain existing Bigmouth Buffalo (Saskatchewan – Nelson River populations) population levels and distribution, and protect habitat within watersheds in which the species is found. Management should be directed towards maintaining sufficient quality and quantity of habitats to support known populations.

5.2. Objectives

The following short-term objectives (over the next 10 years) have been identified to assist in meeting the long-term objective:

- i. improve our knowledge of the species' biology and population characteristics
- ii. determine species distribution, movement, and habitat requirements
- iii. identify and mitigate threats to the species
- iv. increase public awareness and stewardship

6. Broad strategies and conservation measures

6.1. Actions already completed

The Saskatchewan Water Security Agency and the Saskatchewan Ministry of Environment have completed studies on the biology and habitat of Bigmouth Buffalo in the [Qu'Appelle](#) River system (Hlasny 2000; Sereda et al. 2014; Sereda and Pollock 2014) which have provided information that has helped identify some of the current needs of, and threats to, the population.

The Saskatchewan Water Security Agency has also developed a fishway operating plan for the [Qu'Appelle](#) River system to ensure the timing and duration of fishway operation is adequate for Bigmouth Buffalo (and other species) (Sereda et al. 2014). Further, the Saskatchewan Water Security Agency has also installed riffles and breached berms in strategic areas of the upper [Qu'Appelle](#) River to permanently backwater adjacent wetlands and vegetated side channels, which has created and provided access to spawning habitat for Bigmouth Buffalo independent of water control structure operations.

These studies have been used to identify current and proposed conservation measures that will further our understanding of Bigmouth Buffalo biology and habitat needs, and take actions to mitigate threats to the population.

6.2. Conservation measures

Success in the conservation of this species is not solely dependent on the actions of any single jurisdiction; rather it requires the commitment and cooperation of many different constituencies that will be involved in implementing the directions and measures set out in this management plan.

The purpose of this management plan is to outline what is required to achieve the management objective for the Bigmouth Buffalo to guide not only activities to be undertaken by Fisheries and Oceans Canada, but those for which other jurisdictions, organizations and individuals have a role to play. Fisheries and Oceans Canada strongly encourages all Canadians to participate in the conservation of Bigmouth Buffalo through undertaking priority conservation measures outlined in this management plan. Fisheries and Oceans Canada recognizes the important role of the management team for Bigmouth Buffalo and its member organizations and agencies in the implementation of conservation measures for this species.

Proposed conservation measures that will further our understanding of Bigmouth Buffalo biology and habitat needs, and take actions to mitigate threats to the population have been numbered and organized according to the following broad strategies:

Broad strategy 1: surveys and monitoring

Broad strategy 2: research

Broad strategy 3: stewardship, outreach and communication

Broad strategy 4: management, coordination and threat mitigation

Table 3 identifies the conservation measures to be undertaken by Fisheries and Oceans Canada in collaboration with other organizations/jurisdictions to support the conservation of Bigmouth Buffalo. Conservation of Bigmouth Buffalo will be dependent on this overall collaborative approach, in which Fisheries and Oceans Canada is a partner in conservation efforts.

As all Canadians are invited to join in supporting and implementing this management plan for the benefit of the Bigmouth Buffalo and Canadian society as a whole, table 4 identifies measures that would support the conservation of Bigmouth Buffalo that could be undertaken voluntarily by other jurisdictions, groups and individuals interested in participating in the conservation of this species. If your organization is interested in participating in one of these measures, please contact the Central and Arctic Region Species at Risk Program at 1-866-538-1609.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

1

Table 3. Collaborative conservation measures for Bigmouth Buffalo to be implemented by Fisheries and Oceans Canada and its partners.

#	Conservation measures	Priority ⁷	Threats or objectives addressed	Timeline	Potential partners
1-1	Survey areas of Manitoba to better understand the estimated extent of occupancy of the Bigmouth Buffalo and document species biological information	High	Determine species distribution Improve knowledge of species biology and population characteristics	1 to 5 years	Manitoba Sustainable Development
2-1	Determine Bigmouth Buffalo distribution, movement, and habitat preference in Lake Winnipeg drainage, Manitoba via acoustic telemetry	High	Determine species distribution, movement and habitat requirements	1 to 6 years	Manitoba Sustainable Development
2-2	Determine potential movement of Bigmouth Buffalo between the Qu'Appelle River in Saskatchewan and the Assiniboine River in Manitoba via acoustic and/or radio telemetry	High	Determine species distribution and movement	1 to 4 years	Manitoba Sustainable Development, University of Saskatchewan

⁷ "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the recovery objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the recovery population and distribution objectives, but are still important for recovery of the population. Low priority recovery measures will likely have an indirect or gradual influence on reaching the recovery objectives, but are considered important contributions to the knowledge base and/or public involvement and acceptance of species.

#	Conservation measures	Priority ⁷	Threats or objectives addressed	Timeline	Potential partners
2-3	Identify additional spawning areas for Bigmouth Buffalo in Manitoba and Saskatchewan	High	Determine species habitat requirements	1 to 5 years	Ducks Unlimited, Manitoba Sustainable Development, Saskatchewan Water Security Agency, Saskatchewan Ministry of Environment, University of Saskatchewan
2-4	Investigate the impacts of Common Carp on the spawning habitat (submersed aquatic vegetation) of Bigmouth Buffalo in Delta Marsh, Manitoba	Medium	Identify threats to the species	1 to 10 years	Ducks Unlimited, Manitoba Sustainable Development
3-1	Develop educational signs about Bigmouth Buffalo and install in strategic locations in Manitoba and Saskatchewan	Medium	Increase public awareness and stewardship	1 to 3 years	Manitoba Sustainable Development, Saskatchewan Water Security Agency, Saskatchewan Ministry of Environment, University of Saskatchewan

Table 4. Conservation measures that could be taken voluntarily by other agencies, organizations or individuals, who wish to contribute to the recovery of Bigmouth Buffalo.

#	Conservation measures	Priority ⁸	Threats or objectives addressed	Potential participants
2-5	Identify summer, fall and winter distribution and habitat use for adult Bigmouth Buffalo in the upper Qu'Appelle River, Saskatchewan	High	Determine species distribution and habitat requirements	University of Saskatchewan
2-6	Determine age demographics of spawning Bigmouth Buffalo in the Qu'Appelle River system, Saskatchewan	High	Improve knowledge of species biology and population characteristics	University of Saskatchewan
3-2	Presentations to interested parties (cabin owners, land owners, Indigenous groups, resource users) on how they can participate in the conservation of the Bigmouth Buffalo	Medium	Increase public awareness and stewardship	Environmental non-governmental organizations
3-3	Presentation to rough fish fishers on the Bigmouth Buffalo as a bycatch in Manitoba	Medium	Increase public awareness and stewardship	Manitoba Sustainable Development
4-1	Breach dykes at Last Mountain Lake to allow Bigmouth Buffalo access to additional wetlands/ spawning habitats	High	Identify threats to the species	Saskatchewan Water Security Agency

⁸ "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the recovery objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the recovery population and distribution objectives, but are still important for recovery of the population. Low priority recovery measures will likely have an indirect or gradual influence on reaching the recovery objectives, but are considered important contributions to the knowledge base and/or public involvement and acceptance of species.

6.3 Narrative to support implementation schedule

Broad strategy 1: surveys and monitoring

#1-1. In Manitoba, more information on the distribution of Bigmouth Buffalo is needed to understand the full extent of this species. This is relevant throughout the province, but one example is to investigate the species range expansion into Lake Manitoba via the Portage Diversion. These surveys will identify potentially new areas of Bigmouth Buffalo presence.

Broad strategy 2: research

#2-1. An acoustic telemetry study in the Lake Winnipeg Basin was initiated in 2016 and tagged 20 Bigmouth Buffalo in both the [La Salle](#) and [Seine](#) rivers. These fish have already moved considerable distances, with an average movement of >150 river km in four months. Additional fish will be tagged in the Red River downstream of the St. Andrews Lock and Dam to understand seasonal river versus lake use. Information on seasonal habitat use, mortality, river and population connectivity will be studied.

#2-2. It is unclear if there is mixing of the Bigmouth Buffalo populations in Saskatchewan and Manitoba. The Portage la Prairie Water Control Structure blocks upstream fish movement, but there is potential for fish to move downstream through the Portage Diversion channel and, in high flows, over the Assiniboine River control structure at Portage la Prairie. However, low level passage would likely result in fish mortality due to high turbulence and contact with the energy dissipating device immediately below the control structure. Expansion of current radio/acoustic telemetry studies into the lower [Qu'Appelle](#) River and upper Assiniboine River will help determine Bigmouth Buffalo usage of the rivers and the level of interaction between the populations in Saskatchewan and Manitoba.

#2-3. Areas utilized by Bigmouth Buffalo for spawning have been identified in Manitoba and Saskatchewan. In Manitoba, the east unit of Delta Marsh, a 19,000 hectare wetland along the southern shore of Lake Manitoba, is a known spawning site for the Bigmouth Buffalo (Wrubleski pers. comm.). However, Watchorn et al. (2012) has identified 425 km² of additional coastal wetlands around Lake Manitoba, which could also provide suitable spawning habitat for the species. In the [Seine](#) and [La Salle](#) rivers (tributaries of the Red River) spring floods provide several kilometers of suitable spawning habitat for the Bigmouth Buffalo (Watkinson pers. comm.), as do some tributaries of the lower Assiniboine River (Long pers. comm.). In the [Qu'Appelle](#) River system, Saskatchewan, Bigmouth Buffalo have been observed spawning in Rankin, Valeport and Fairy Hill marshes, Pasqua Lake, and Buffalo Pound Lake. Additional areas containing potential spawning habitat suitable for Bigmouth Buffalo have been identified, but have not been confirmed. Further investigation to confirm additional spawning areas is important to determine applicable conservation measures needed to protect this population.

#2-4. Common Carp use Delta Marsh to spawn and are believed to be responsible for reduction of submerged aquatic vegetation in the wetland; habitat required for successful Bigmouth Buffalo spawning. The impact of the Common Carp on the spawning success of Bigmouth Buffalo in the marsh is unknown. Knowledge gained from this investigation will increase knowledge on the health of the Bigmouth Buffalo population and inform conservation measures needed to protect spawning habitat.

#2-5. Details on the habitat use of adult Bigmouth Buffalo in the upper Qu'Appelle River system are limited. For instance, some information is available for certain areas such as Pasqua Lake (Hlasny 2000), but the summer, fall and winter staging sites of adults in the other areas are largely unknown. It is important to locate these areas where adults spend the majority of their time outside the spawning window so potential threats may be identified and mitigated.

#2-6. Rankin, Valeport and Fairy Hill marshes, and other areas in the Qu'Appelle River system contain spawning sites for the Bigmouth Buffalo. Understanding the age demographics of spawning adults would allow a better understanding of recruitment.

Broad strategy 3: stewardship, outreach and communication

#3-1. Development and installation of educational signs about Bigmouth Buffalo at sites important to the conservation of the species will help to inform and educate the public on the species. The goals of the signs are to mitigate potentially negative activities and aid in the conservation of Bigmouth Buffalo.

#3-2. Public participation in the conservation process for the Bigmouth Buffalo is essential in the commercial and recreational fisheries sectors because they can help with data collection and reduce potential bycatch. Furthermore, an informed citizenry is more likely to help with the conservation of species at risk, such as the Bigmouth Buffalo.

#3-3. There has been an increase of interest in expanding the rough fish fisheries in Manitoba that could potentially impact Bigmouth Buffalo as a bycatch. Communication in the form of presentations and factsheets on this subject could help mitigate impacts on Bigmouth Buffalo in the province.

Broad strategy 4: management, coordination and threat mitigation

#4-1. Dykes at Valeport Marsh (lower end of Last Mountain Lake) block water access to the backside marsh. Breaching of these dykes will allow fish to enter the wetlands and provide access to spawning habitat for Bigmouth Buffalo.

7. Measuring progress

To measure the progress toward meeting the long term objectives of this management plan, the following performance indicators have been identified:

- knowledge of the species biology and population characteristics have improved to facilitate management of the species and achieve the population and distribution objectives
- sufficient quality and quantity of habitat have been secured to maintain existing population levels and distribution
- some threats to the populations have been identified and mitigated

Detailed reporting on implementation of this management plan under s.72 of SARA will be done by assessing progress towards implementing the broad strategies and conservation measures. The implementation of this management plan will be monitored within five years after the plan has been posted to the SARA Registry.

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Appendix A: effects on the environment and other species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's (FSDS) goals and targets.

This management plan will contribute to the FSDS goal and key priority (healthy wildlife populations) that ensures all species have healthy and viable populations. Work under this goal will support progress towards the 2020 Biodiversity Goals and Targets for Canada and the global conservation objectives of the United Nations Convention on Biological Diversity, in particular, by ensuring that needed management plans are in place. This management plan will contribute to meeting the short term milestones in the FSDS, specifically that species at risk are exhibiting stabilizing or improved trends since their listing. The four broad strategies: surveys and monitoring; research; management, coordination and threat mitigation; and stewardship, outreach and communication, proposed to achieve the population and distribution objectives help to fulfill contributing actions in the FSDS.

Management planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the plan itself, but are also summarized below.

This management plan will benefit the environment by promoting the conservation of the Bigmouth Buffalo. The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan will have a positive effect on the environment and will not entail any significant adverse effects.