

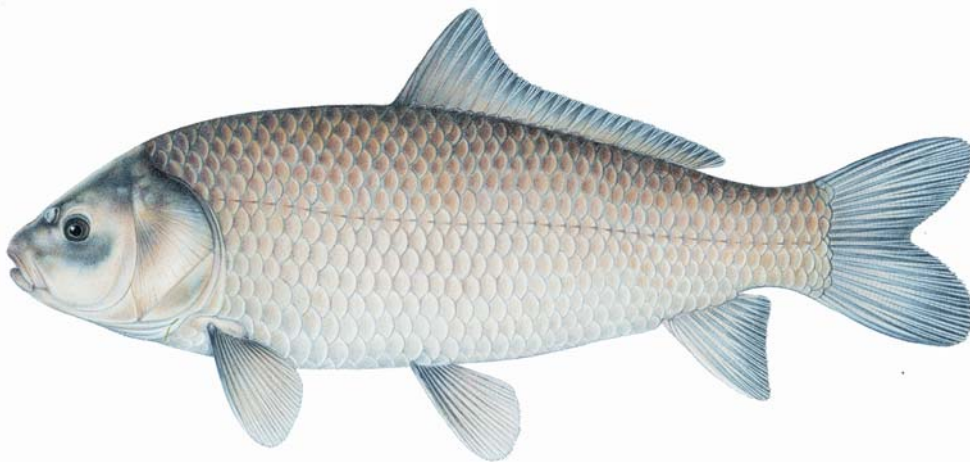
**COSEWIC**  
**Assessment and Update Status Report**

on the

**Bigmouth Buffalo**  
*Ictiobus cyprinellus*

Great Lakes - Upper St. Lawrence populations  
Saskatchewan - Nelson River populations

**in Canada**



**Great Lakes - Upper St. Lawrence populations - NOT AT RISK**  
**Saskatchewan - Nelson River populations - SPECIAL CONCERN**  
**2009**

**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:

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Bigmouth Buffalo — Illustration by Joseph Tomelleri. Used under licence to DFO.

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## COSEWIC Assessment Summary

### Assessment Summary – April 2009

**Common name**

Bigmouth Buffalo - Great Lakes - Upper St. Lawrence populations

**Scientific name**

*Ictiobus cyprinellus*

**Status**

Not at Risk

**Reason for designation**

Populations in Ontario appear to be doing well and there are no immediate threats to its continued survival; the area of occupancy appears to have increased and it has been found at 8 new locations since last assessed in 1989.

**Occurrence**

Ontario

**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 (Great Lakes – Upper St. Lawrence populations) was designated Not at Risk in April 2008. Last assessment based on an update status report.

### Assessment Summary – April 2009

**Common name**

Bigmouth Buffalo - Saskatchewan - Nelson River populations

**Scientific name**

*Ictiobus cyprinellus*

**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.

**Occurrence**

Saskatchewan, Manitoba

**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 based on an update status report.



**COSEWIC**  
**Executive Summary**

**Bigmouth Buffalo**  
*Ictiobus cyprinellus*

Great Lakes - Upper St. Lawrence populations  
Saskatchewan - Nelson River populations

**Species information**

The Bigmouth Buffalo is one of five species in the genus *Ictiobus*, and one of 18 sucker species and one of two, possibly three, *Ictiobus* species found in Canada. Buffaloes are superficially similar to the Common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*), but these species have stiff, serrated spines leading the dorsal and anal fins, and Common Carp also have barbels. Buffaloes can be distinguished from most other suckers of the family (Catostomidae) by their long, falcate (curved) dorsal fin.

A large freshwater fish, the Bigmouth Buffalo can attain a maximum length and weight of 914 mm and 36 kg respectively, and individuals can attain ages in excess of 20 years

**Distribution**

The Bigmouth Buffalo is widely distributed in the Mississippi drainages of eastern North America. In Canada, disjunct populations have been reported from the Lake Erie, Huron, Ontario, and St. Clair drainages of the Great Lakes basin. Disjunct populations are also found in the Assiniboine and Red river drainages of the Hudson Bay basin.

The Great Lakes populations are found within the Great Lakes-Upper St. Lawrence National Freshwater Biogeographic Zone, and the Manitoba and Saskatchewan populations are found in the Saskatchewan-Nelson River National Freshwater Biogeographic Zone. The population structure within each of these biogeographic zones is unknown.

**Habitat**

Bigmouth Buffalo are found in lakes and medium- to large-sized rivers in slower waters.

## **Biology**

In most areas, the maximum reported age for Bigmouth Buffalo has been less than 10 years; although the oldest previously reported Bigmouth Buffalo was 20 years, it is now known that they may live considerably longer. The maximum reported length and weight are 914 mm and 36 kg. Bigmouth Buffalo have a highly adapted and size-selective filtering mechanism, and feed almost exclusively on invertebrates. Bigmouth Buffalo can hybridize naturally with Smallmouth Buffalo (*Ictiobus bubalus*) and Black Buffalo (*Ictiobus niger*). Bigmouth Buffalo are not as impacted by turbidity as other freshwater fishes.

## **Population sizes and trends**

The Bigmouth Buffalo has not been collected in a standardized manner, nor have there been any specific studies on population sizes, in Canada. Therefore, it is difficult to assess population sizes and trends. However, some inferences on population trends can be made based on the collection of the species over time in Canada.

Populations in Ontario (Great Lakes-Upper St. Lawrence Biogeographic Zone) appear to be doing well and there are no immediate threats to their continued survival; the area of occupancy appears to have increased and it has been found at eight new locations since last assessed in 1989. Although there has been an increase in the extent of occurrence and area of occupancy in Manitoba (Saskatchewan-Nelson River Biogeographic Zone), 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.

## **Limiting factors and threats**

As successful reproduction appears to be associated with flooding of shoreline vegetation, loss of spawning habitat associated with regulated water levels is a threat to Bigmouth Buffalo. In the Great Lakes basin, the Bigmouth Buffalo has hybridized with introduced *Ictiobus* species.

## **Special significance of the species**

This species is considered a delicacy by some cultures in the United States and is harvested for this reason. There is limited demand for buffaloes in Canada, but they may be found in the live food fish market. A commercial fishery in Saskatchewan, dating from the 1940s, ended in 1983. This genus is of some scientific interest, in relation to its taxonomic and systematic considerations.

## **Existing protection or other status designations**

Bigmouth Buffalo was designated as Special Concern in 1989 by COSEWIC. The national rank in Canada for Bigmouth Buffalo is N4 (apparently secure), and the national general status ranking of Bigmouth Buffalo has not been assessed. In Saskatchewan, a provincial status of Endangered has been recommended, but formal listing is still pending. In Manitoba, a status of Not At Risk has been recommended. In Ontario, the provincial rank for Bigmouth Buffalo is SU (status undetermined).



## COSEWIC HISTORY

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 (2009)

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

**Update  
COSEWIC Status Report**

on the

**Bigmouth Buffalo**  
*Ictiobus cyprinellus*

Great Lakes - Upper St. Lawrence populations  
Saskatchewan - Nelson River populations

**in Canada**

2009



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## SPECIES INFORMATION

### Name and classification

Kingdom	Animalia
Phylum	Chordata
Class	Actinopterygii
Order	Cypriniformes
Family	Catostomidae
Species:	<i>Ictiobus cyprinellus</i> (Valenciennes, 1844)

### Common Names

English:	Bigmouth Buffalo (Nelson <i>et al.</i> 2004)
French:	<i>buffalo à grande bouche</i> (Coad 1995)

### Description

A large freshwater fish, the Bigmouth Buffalo can attain a maximum length and weight of 914 mm and 36 kg respectively, and individuals can attain ages in excess of 20 years (see **Biology** below). The Bigmouth Buffalo (Figure 1) is one of five species in the genus *Ictiobus*, which is in the family Catostomidae (Nelson *et al.* 2004). It is characterized by a robust, deep body (body deepest over pectoral fins) and is laterally compressed (Scott and Crossman 1998, Stewart and Watkinson 2004). The caudal peduncle is short and deep at 10.2-11.6% of total length. The mouth is very large, oblique and is more terminal than in any other sucker species (Trautman 1981). The lips are thin and only faintly striated, with the tip of the upper lip about on the level with the lower edge of the eye (Trautman 1981). Other characteristics from Trautman (1981) are: lateral lines scale of 35-43; dorsal fin ray count at 24-32; and subopercle broadest at its middle, with its posterior edge forming an even curve.

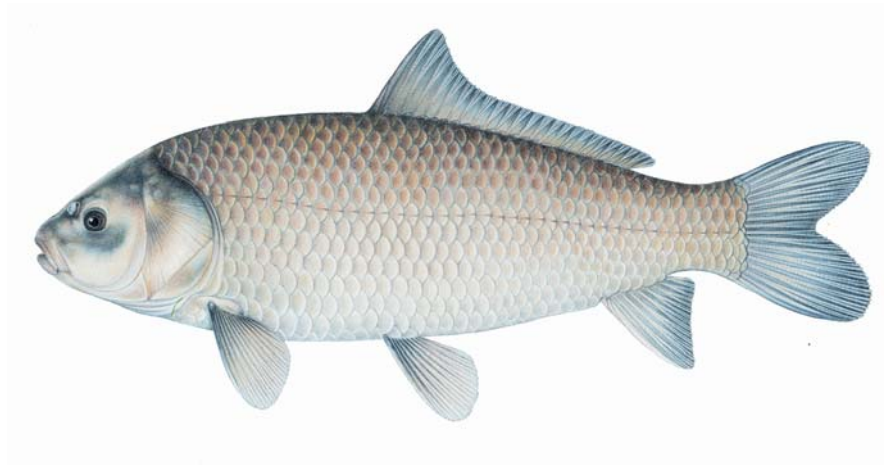


Figure 1. The Bigmouth Buffalo (*Ictiobus cyprinellus*). Illustration by Joe Tomelleri. Used under licence to DFO.

The Bigmouth Buffalo is slate or olive-bronze coloured on the dorsal surface, with the sides a lighter, more olive-yellow colour. The ventral colour is yellow and white with the fins uniformly light brownish-slate. Colouration can vary with turbidity, being very pale and yellowish in turbid waters to quite olive-blue in very clear waters (Trautman 1981).

The Bigmouth Buffalo is one of 18 (19 if smallmouth buffalo is present in Canada; see Mandrak and Cudmore 2005) sucker species found in Canada (Scott and Crossman 1998), and one of 15 (16) sucker species found in the Canadian Great Lakes basin (Cudmore-Vokey and Crossman 2000). Buffaloes are superficially similar to the Common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*) but these species have stiff, serrated spines leading the dorsal and anal fins, and Common Carp also have barbels (Page and Burr 1991). Buffaloes can be distinguished from most other suckers (Catostomidae) by their long, falcate dorsal fin (Page and Burr 1991). They are most similar to the carpsuckers (genus *Carpionodes*), but are olive coloured and have a semicircular subopercle compared to the silver colour and subtriangular subopercle in the carpsuckers (Page and Burr 1991). The large, oblique, terminal mouth of the Bigmouth Buffalo readily separates it from the Black (*I. niger*) and Smallmouth (*I. bubalus*) buffaloes (Bailey *et al.* 2004). However, an ongoing genetic study of buffaloes revealed that even morphologically distinct Bigmouth Buffalo exhibited extensive introgression with Black and/or Smallmouth buffaloes in the Canadian Great Lakes basin (H. Bart, Tulane University, unpubl. data). This is consistent with the observation of such hybrids in Lake Erie soon after smallmouth buffalo were introduced into the basin between 1920 and 1930 (Trautman 1981). Bigmouth Buffalo from the Red and Assiniboine rivers showed no evidence of introgression, thought possibly to have occurred with smallmouth buffalo in the nearby Pembina River of North Dakota (H. Bart, Tulane University, unpubl. data).

### **Genetic description**

The genetic population structure of the Bigmouth Buffalo in Canada is unknown.

### **Designatable units**

Based on the Canadian Freshwater Biogeographic Zone classification adopted by COSEWIC, the Great Lakes populations are found within the Great Lakes-Upper St. Lawrence Biogeographic Zone, and the Manitoba (including Lake of the Woods) and Saskatchewan populations are found in the Saskatchewan-Nelson River Biogeographic Zone. The population structure within each of these zones is unknown. Thus, 2 DUs are apparent, based on the occurrence of discrete populations of the species in 2 separate Biogeographic Zones.

## Eligibility

The Bigmouth Buffalo is native to North America (Nelson *et al.* 2004), and native to the Saskatchewan-Nelson River drainage of Saskatchewan and Manitoba (Johnson 1963; Lee and Shute 1980; Scott and Crossman 1998; Stewart and Watkinson 2004). Stewart *et al.* (1985) suggested that it entered the Red River from the Mississippi drainage after 2000 BP, and thence into the Assiniboine-Qu'Appelle, and English-Winnipeg systems and became established (Crossman and McAllister 1986).

However, it is uncertain if it is native to the Great Lakes drainage, or was introduced from the Mississippi basin. Mandrak and Crossman (1992) listed it as “Introduced” based on the relatively recent first record (see **Distribution** below). Trautman (1981) indicated that it was first recorded in the Ohio waters of Lake Erie in 1854, and Hubbs (1930) indicated it was sporadically present as well, but was not recorded again until after the 1920s. During the early 1900s indiscriminate stocking of all three species of buffalos (Bigmouth Buffalo, Smallmouth Buffalo, and Black Buffalo) occurred in the Ohio waters of Lake Erie, North Carolina, and Massachusetts (Fuller 2008). However, the stockings did not differentiate by species, they were simply recorded as “buffalofish”, and it is impossible to determine which species were planted where. Lee and Shute (1980) include lakes Erie, St. Clair, and Michigan within the native range, Scott and Crossman (1998) stated that the species occurs in Lake Erie as possibly both a native and introduced species, and Cudmore-Vokey and Crossman (2000) show the species as established in lakes Michigan, St. Clair and Erie.

Given that the species was recorded in Lake Erie prior to any plantings from the Mississippi basin and it is not known which species was planted, the species is probably native to at least the American waters of the lake. Additionally, there were very few specific collection efforts in the early decades of the 20<sup>th</sup> century, and Bigmouth Buffalo have not been collected in any standardized manner. Thus, it should not be surprising that it was not recorded in the Canadian waters of Lake Erie prior to 1957 (Scott 1957). Its current presence in Canadian waters of the Great Lakes basin is probably a reflection of a northward range extension at some time in the past. It probably existed in the Canadian waters of Lake Erie for some time previous to its detection in 1957.

Attempts were made to obtain Aboriginal Traditional Knowledge (ATK) on the species, but to date have not resulted in any information being brought forward for this species.

## DISTRIBUTION

### Global range

The Bigmouth Buffalo is widely distributed in the Mississippi drainages of eastern North America (Figure 2) (Lee and Shute 1980, Page and Burr 1991). In the Mississippi drainage, including the Missouri and Ohio rivers, it is found from the Gulf of Mexico northward to Minnesota and North Dakota. In the Great Lakes basin, disjunct populations have been reported from the Lake Erie, Huron, Ontario, and St. Clair basins. Disjunct populations are also found in the Assiniboine and Red river drainages of the Hudson Bay basin.

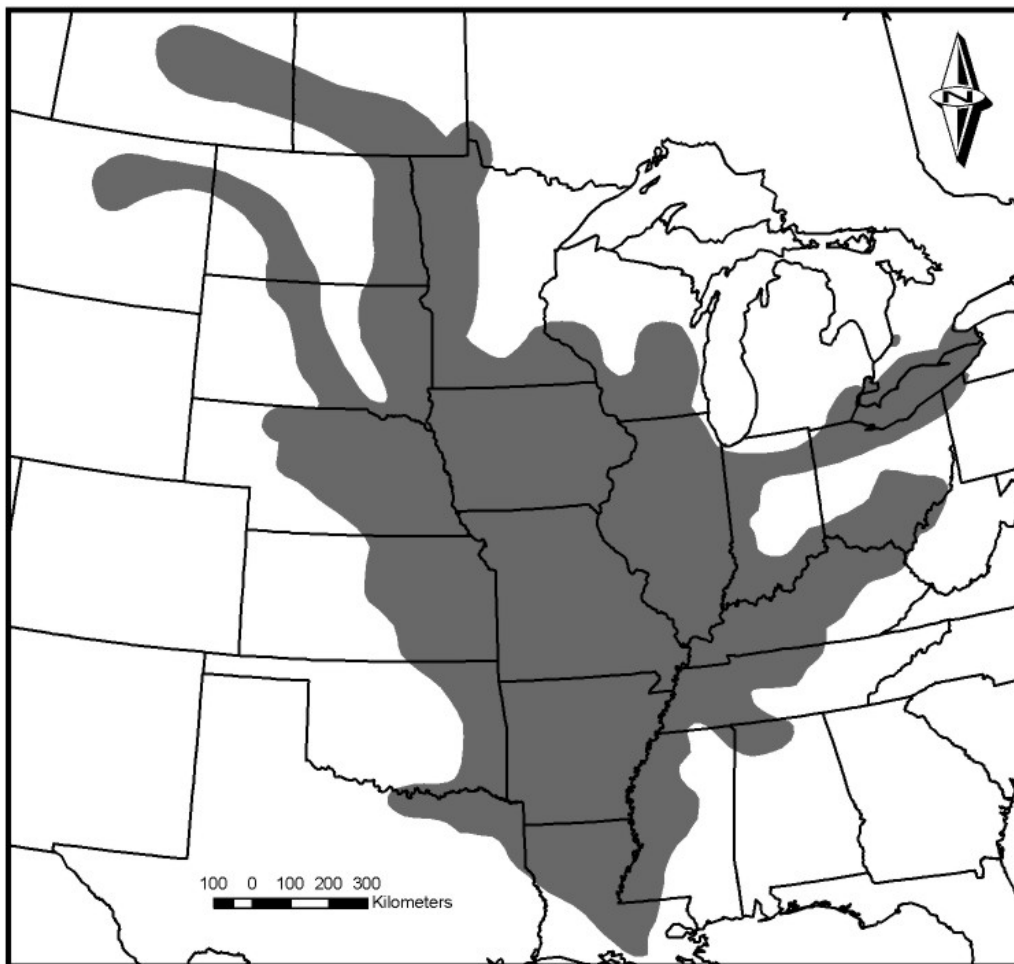


Figure 2. Global distribution of the Bigmouth Buffalo. Modified from Page and Burr (1991).

## Canadian range

The Bigmouth Buffalo exhibits disjunct eastern populations in the Great Lakes basin (Figure 3; see **also Population sizes and trends**), and western populations in the Lake of the Woods and Assiniboine and Red river drainages (Figure 4). In the Great Lakes basin, it was first caught in Lake Erie in 1957 (Scott 1957), and then in Lake St. Clair by 1972 (Goodchild 1990). Two records from the Bay of Quinte (Lake Ontario drainage) may represent an introduction related to the live food fish industry (Goodchild 1990). However, by the year 2000, Bigmouth Buffalo were found in several rivers (Grand, Sydenham, Thames and Welland rivers) and Hamilton Harbour (Lake Ontario). By the year 2005, it was found farther upstream in these rivers, coastal marshes (Rondeau Bay, Point Pelee, Big Creek, Essex Co.) in the western basin of Lake Erie, and the Ausable River, tributary to Lake Huron (DFO, ROM, Mandrak, unpubl. data). Therefore, it is more likely that the Bay of Quinte records are a natural range extension into Lake Ontario, and not the result of introductions from a live fish market in Toronto (see Goodchild 1990).

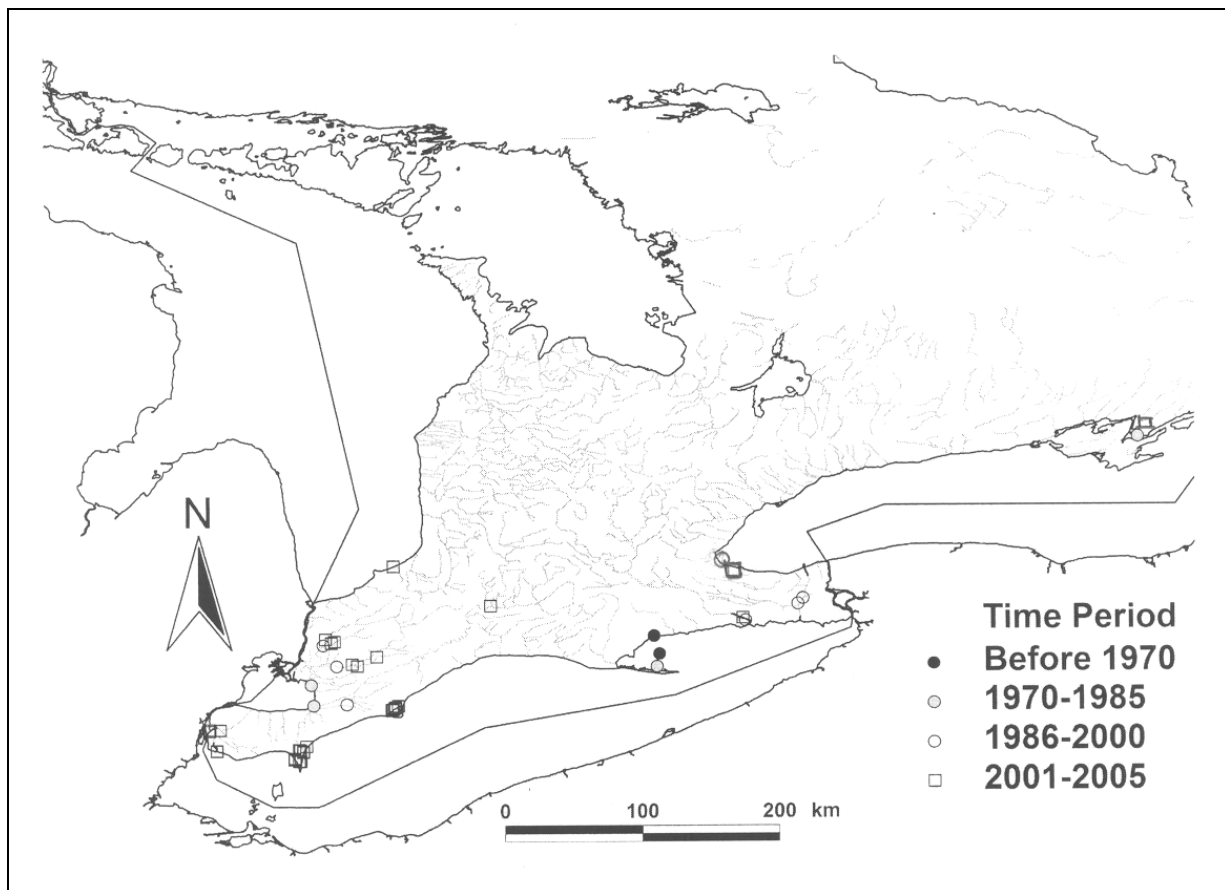


Figure 3. Ontario portion of the Canadian distribution of the Bigmouth Buffalo.

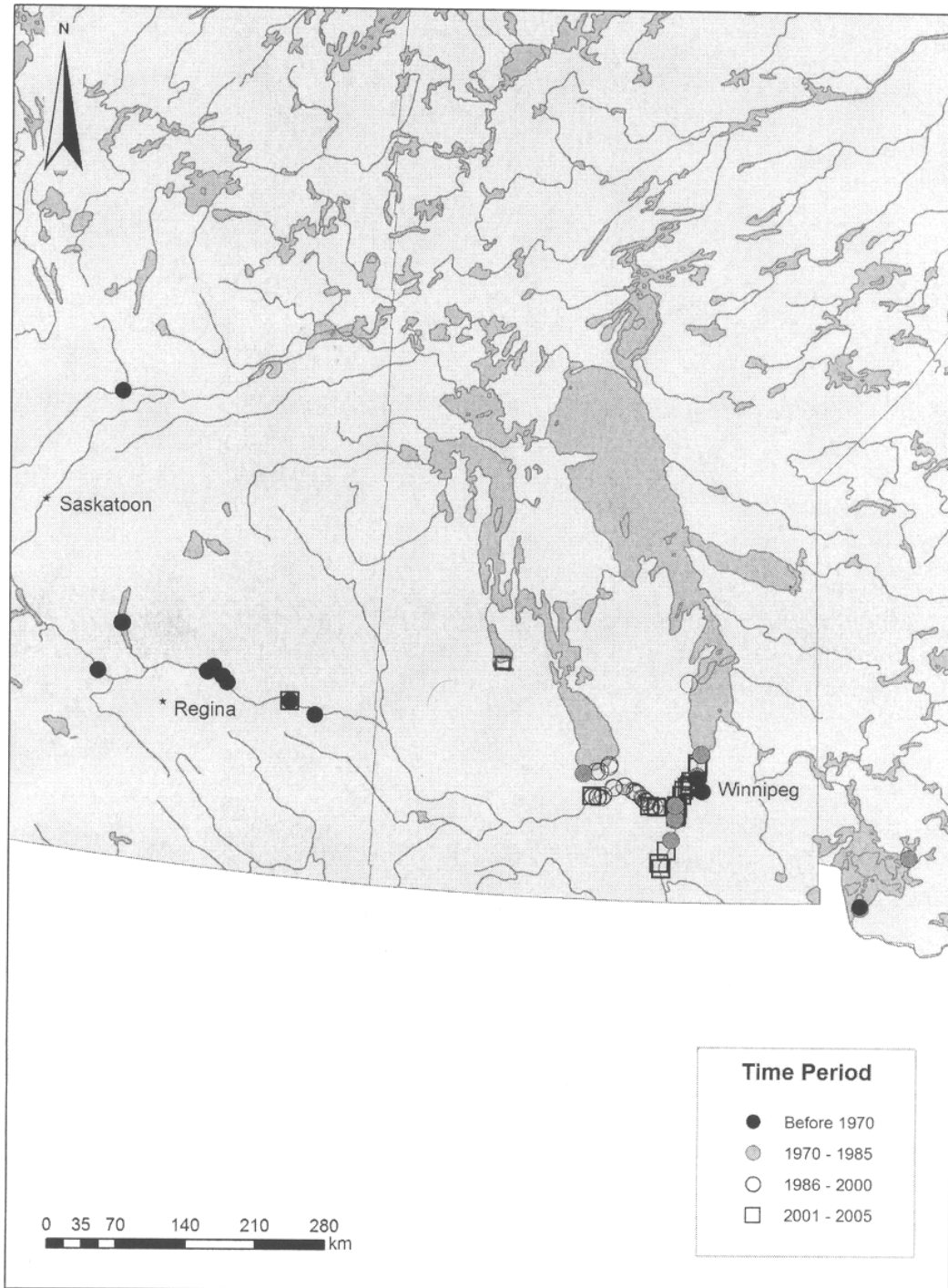


Figure 4. Manitoba and Saskatchewan portion of the Canadian distribution of the Bigmouth Buffalo.



The first (western) Canadian record may have been that of Gilchrist (1888) mistakenly listed under the name *I. bubalus* (there are no *bona fide* Canadian records of *I. bubalus*; see Scott and Crossman 1998). The first *bona fide* record is from 1907 when it was caught in Cook's Creek, a tributary to the Red River (Hinks 1943; Atton 1983). Since then, it has been collected in the Red River, and several tributaries, between the Canada-United States border and the south basin of Lake Winnipeg, into which it flows (Goodchild 1990; Stewart and Watkinson 2004), and there is an unconfirmed report from Lake Dauphin in 2002 (Stewart and Watkinson 2004). It has also been caught in Delta Marsh at the southern end of Lake Manitoba. Rawson (1949) described Bigmouth Buffalo as present in the Qu'Appelle River, and abundant in the Qu'Appelle Lakes (Buffalo Pound, Crooked, Echo, Katepwa, Last Mountain, Mission, Pasqua and Round lakes) (Figure 5). Rawson (1949) also indicated it as present in the North Saskatchewan River at Prince Albert; however, according to his field notes, Rawson was reluctant to do so because he had never examined the specimen (R. Hlasny, Saskatchewan Environment, pers. comm.). Extensive sampling at this site in 1957 and 1958 (30 net sets of large mesh gillnet), and in 1985 and 1986 (78 net sets of large mesh gillnet) failed to capture any Bigmouth Buffalo (R. Hlasny, Saskatchewan Environment, pers. comm.). Fishes in the North Saskatchewan River would have had to disperse through glacial Lake Agassiz or, more recently, Lake Winnipeg (Stewart and Watkinson 2004); however, the first record occurrence of Bigmouth Buffalo in Lake Winnipeg is much more recent than 1949. Therefore, the North Saskatchewan River record seems questionable and should be excluded from further consideration.

Bigmouth Buffalo were collected in the Lake of the Woods (Northwestern Ontario) in 1973 and 1976 (Goodchild 1990).

### Occurrences

Generally, occupied sites that are separated by a gap of 20 km or more of any aquatic habitat that is not known to be occupied, or part of possible spawning migrations, are taken to represent different occurrences (NatureServe 2007). However, Moen (1974) indicated that Bigmouth Buffalo move substantial distances (380 km) to find suitable spawning sites. Dams, waterfalls and upland habitat and major confluences may represent separation barriers (see NatureServe 2007). Locations are thus defined as occupied sites where dispersal between such sites is rare or impossible, and a single threatening event could rapidly affect all individuals (see **Limiting Factors and Threats**). On that basis, there are approximately 20 known (extant) occurrences in Canada constituting seven locations.



Figure 5. Qu'Appelle River basin and Qu'Appelle Lakes with existing dams and fish passageways identified.

The extent of occurrence (EO) in the Great Lakes-Upper St. Lawrence Biogeographic Zone is estimated to be less than 50,000 km<sup>2</sup> (Polygon Estimate; see COSEWIC 2007). The area of occupancy (AO) is difficult to determine as many of the locations are based on a single record; however the biological area of occupancy was estimated to be < 200 km<sup>2</sup> (based on occupied habitat, assuming average stream widths of 50 m, and in lacustrine habitat 20 km separation distances within 1 km of shorelines). An Index of Area of Occupancy (IAO), based on 1 x 1 and 2 X 2 km overlaid grids, was estimated to be 2210 and 3268 km<sup>2</sup> respectively.

The EO in the Saskatchewan-Nelson Biogeographic Zone was estimated (Polygon Estimate) at < 100,000 km<sup>2</sup>, the biological AO at < 500 km<sup>2</sup>, and the Index of AO from overlaid 1 X 1 and 2 km X 2 km grids at 1600 and 2,396 km<sup>2</sup> respectively (Table 1). There are at least three locations in this Biogeographic Zone (Table 2). The Lake of the Woods should be a considered separate location. Given the current unimpeded connections between them, the Lower Assiniboine River, Red River and Lake Winnipeg subpopulations should be considered to be a part of a single location. The Qu'Appelle River system may represent one or more locations as the result of fragmentation by a

series of 10 dams (Figure 5). Three of the dams have fish passage structures that may allow upstream movement of fishes; however, such movement is not possible at the seven other dams, and even downstream movement may be hindered at all 10 dams (Figure 5). In addition, Buffalo Pound Lake and Last Mountain Lake do not have known Bigmouth Buffalo populations above them in the watershed; therefore, there is no potential for recolonization unless fish can pass upstream through the existing fishways. However, in the absence of additional information on the potential movement of Bigmouth Buffalo within the Qu'Appelle system, it is recommended that it be considered a single location.

**Table 1. Index of Area of Occupancy calculated using 2 km x 2 km grids for the Saskatchewan-Nelson River Biogeographic Zone.**

Location	Subpopulation	Status	IAO 2x2 Grids
Qu'Appelle Lakes	Qu'Appelle River	unknown	124
Qu'Appelle Lakes	Craven Lake	possibly extirpated	
Qu'Appelle Lakes	Round Lake	probably extirpated	11
Qu'Appelle Lakes	Last Mountain Lake	probably extirpated	129
Qu'Appelle Lakes	Katepwa	probably extirpated	12
Qu'Appelle Lakes	Mission Lake	possibly extirpated	7
Qu'Appelle Lakes	Echo Lake	possibly extirpated	9
Qu'Appelle Lakes	Crooked Lake	extant	14
Qu'Appelle Lakes	Buffalo Pound Lake	extant	37
Qu'Appelle Lakes	Pasqua Lake	extant	19
Lower Assiniboine River / Red River / Lake Winnipeg	Delta Marsh	extant	38
Lower Assiniboine River / Red River / Lake Winnipeg	Assiniboine River	extant	81
Lower Assiniboine River / Red River / Lake Winnipeg	Red River	extant	116
Lower Assiniboine River / Red River / Lake Winnipeg	Lake Manitoba - Lunar Beach	unknown	1
Lower Assiniboine River / Red River / Lake Winnipeg	Lake Winnipeg - Icelandic River	unknown	1
Total			599 (2,396 km <sup>2</sup> )

**Table 2. Saskatchewan-Nelson sampling effort.**

Location	Subpopulation	Years Collected (No. Captured)	Collection Summary	Current Status	Threats
<b>1. Qu'Appelle Lakes</b>	Qu'Appelle River			Declining	Water management for even flow regime causing low flows and loss of habitat during spawning. Until 1983, commercial exploitation increased turbidity
<i>May have been a single continuous population in Assiniboine and Qu'Appelle rivers until fragmented by dams.</i>	Round Lake	1949 (abundant) 1999 (0) 2004 (0)			
	Last Mountain Lake	1949 (abundant) 1996 (~20 adults) 1997 (1 YOY)			
	Katepwa Lake	1949 (abundant) 1999 (0)			
	Mission Lake	1949 (abundant)			
	Craven Lake	1949 (abundant) 1996 (~20)			
	Echo Lake	1949 (abundant)			
	Crooked Lake	1949 (abundant) 2004 (428 YOY)			
	Buffalo Pound Lake	1949 (abundant) 1999 (4 adults)			
	Pasqua Lake	1949 (abundant) 1951-1983 (commercial catch recorded annually) 1999 (7 adults, 1 YOY) 2000 (1024)			
	<b>2. Lower Assiniboine River/Red River/Lake Winnipeg</b>	Assiniboine River	1995-2002 (61)		Expanding?
<i>May have been a single continuous population in Assiniboine and Qu'Appelle rivers until fragmented by dams. Possible that Delta Marsh, Lake Manitoba and Dauphin populations originated from dispersal of individuals from Assiniboine River after floodway opened in 1974.</i>	Delta Marsh	1998 (64) 1999 (23)			
	Lake Manitoba Lundar Beach	2005 (1)			
	Dauphin Lake	2002 (unconfirmed report)			
	Red River				
	Cook's Creek	1907 (>0)			
	East Selkirk	1978 (>0)			
	St. Norbert	1998 (>0)			
	Mainstem	2001-3 (31)			
	Seine River	2005 (3)			
	Mainstem La Salle	2005 (1) 2005 (8)			
Lake Winnipeg	2002 (2 YOY)				
<b>3. Lake of the Woods</b>		1973 1976	<i>Regular fisheries assessments in Ontario waters have failed to capture any additional specimens since 1976.</i>	Extirpated?	Unknown

## HABITAT

### Habitat requirements

Bigmouth Buffalo are found in medium- to large-sized rivers in slower waters; frequenting oxbows and flood plain lakes, sloughs, bayous, and shallow lakes (Becker 1983). Although generally considered a 'big-water' fish, in the southern portion of the state of Wisconsin, they are occasionally found in streams only 6-12 m wide, and most frequently found in waters greater than 1.5 m in depth over substrates of mud, silt, sand, gravel, clay and rubble (Becker 1983). Johnson (1963) suggested that the Bigmouth Buffalo was not found in the Frenchman and Souris rivers of Saskatchewan because of their steep gradients and intermittency, and not found in the Assiniboine River probably because of another ecological factor, such as lack of lakes.

Bigmouth Buffalo usually are found in the deeper pools of larger streams, shallow overflow ponds, lowland lakes and human-made impoundments where they usually occur in schools at midwater or near the bottom (Pfleiger 1975; Trautman 1981). They prefer waters of low gradient and moderate to slow current, and do not penetrate waters of steep gradient. In Saskatchewan, Bigmouth Buffalo prefer water shallower than 5 m (Johnson 1963). Becker (1983) reports that in Wisconsin they are usually found in water more than 1.5 m in depth over substrates of mud, silt, sand, gravel, clay, and rubble.

They appear to have a tolerance for high turbidity (Trautman 1981; Becker 1983), and are usually most abundant in more turbid areas of rivers. Bigmouth Buffalo also appear to be able to endure low oxygen tensions (Gould and Irvin 1962), mild salinity, and high (up to 30° C) water temperatures (Minckley *et al.* 1970). In fact, the species exhibits a preference for warm, highly eutrophic waters (Johnson 1963; Staroska and Applegate 1970; Stang and Hubert 1984; Goodchild 1990). Goodchild (1990) speculated that its gradual movement into Canadian waters might be the result of overall climatic warming.

Shallow bays, small tributary streams and shallow ditches, marshy areas and backwaters are utilized for spawning (Johnson 1963; Eddy and Underhill 1974; Trautman 1981). Spawning is apparently dependent on spring flooding to provide access to spawning areas and the introduction of floodwater is necessary to activate spawning activity (Johnson 1963). Hlasny (2003) observed Bigmouth Buffalo spawning in Last Mountain Lake and at the Craven Dam in Saskatchewan in 1996. At both locations Bigmouth Buffalo were observed in moving water (temperature at both locations 14.5° C) depositing eggs and milt into thick vegetation. The eggs were attached to grass at the edge of the channel, no deeper than 10 cm in the water column.

In the habitat suitability model for Bigmouth Buffalo populations in the United States, Edwards (1983) described ideal habitat conditions for both riverine and lacustrine populations. These are presented below.

## Riverine

Populations of Bigmouth Buffalo are found in riverine habitats with 50-75% pools, backwaters and marsh areas. Current velocities in these areas are less than 30 cm/s and have 25-75% vegetative cover.

## Lacustrine

Lacustrine populations of Bigmouth Buffalo are found in habitats with 25-75% littoral areas and protected embayments during the summer months. In these areas, the minimum total dissolved solids during the growing season were greater than 200 ppm and there was 25-75% vegetated cover.

## Riverine and lacustrine

Preferred habitat characteristics for both riverine and lacustrine populations consisted of less than 50 JTU (Jackson Turbidity Units) maximum turbidity during average flow or summer stratification, pH of 6.5-8.5, 30-34°C adult temperature ranges in summer (15-18°C nursery temperatures), 5-10 mg/L minimum dissolved oxygen during spring and summer, and maximum salinity during spring and summer of less than 4.5 ppt.

## **Trends**

Many of the rivers in southern Ontario are highly turbid as a result of flowing over clay substrates and through highly agricultural lands. These streams have likely always been turbid to some degree, but turbidity has likely increased as a result of the clearing of forests and use of tile drains for agricultural purposes (Taylor *et al.* 2004). Conversely, the water clarity in lakes Huron, St. Clair and Erie and their connecting channels, the Detroit and St. Clair rivers, has increased as a result of the invasion and impact of dreissenid mussels (Wittman 1999). Given the preference for moderate turbidity by Bigmouth Buffalo (Nelson 2003, Cudmore *et al.* 2004), some areas of the Great Lakes may become too clear, and their tributaries may become too turbid.

In Saskatchewan, Hlasny (2003) noted that large-scale changes in water management in the Qu'Appelle River basin occurred in the 1980s. A total of 58 km of the river channel was deepened and 19 of 32 km of meanders were removed. This increased the flow downstream of the Craven Dam from 4.13 m<sup>3</sup>sec<sup>-1</sup> to 12.25 m<sup>3</sup>sec<sup>-1</sup>. These alterations reduced the frequency of the channel flooding its banks and the length of time the banks are flooded thereby reducing spawning habitat and opportunity (see **Limiting Factors**).

## **Protection/ownership**

In Canada, the Bigmouth Buffalo occurs in publicly owned waters, and all fish habitat within these waters is protected by the federal *Fisheries Act*. In Ontario, it is present in the Big Creek NWA, Long Point NWA, St. Clair NWA, Point Pelee National Park, and Rondeau Provincial Park. Therefore, its habitat may receive additional protection afforded to national wildlife areas, and national and provincial parks through the *National Parks Act* and *Provincial Parks Act*.

## **BIOLOGY**

### **General**

Johnson's (1963) study of the biology of the species in Canada has been the basis for biological information on the species in Canada and the United States (Scott and Crossman 1998). More recently, Hlasny (2003) provided additional information on populations in Saskatchewan.

### **Reproduction**

Spawning occurs in late April and May in Wisconsin (Becker 1983). A sudden rise in water temperature triggers movement to spawning areas (Becker 1983, Edwards 1983). According to Edwards (1983), ideal spawning habitat is inundated terrestrial, or submergent or emergent vegetation. Johnson (1963) also indicated the importance of spring flooding to provide access to spawning areas and as a trigger for spawning activity.

Goodchild (1990) provided spawning information using Johnson (1963). Hlasny (2003) updated the Johnson (1963) report by providing spawning observations within the Qu'Appelle River basin, Saskatchewan, starting from early June and going to August in water temperature from 13.1-25.5°C. No nest site preparation occurs (Becker 1983). Spawning occurs in 0.3-0.9 m of moving water over abundant vegetation, especially thick mats about 15-30 cm thick (Hlasny 2003). The eggs average 1.5 mm in diameter and become attached to the vegetation or any object they contact (Becker 1983), and hatch in about 2 weeks. The number of eggs contained by mature females varies with size and age; Johnson (1963) estimated that there were approximately 750,000 eggs in an 8 kg, 665 mm female from Saskatchewan, whereas Harlan and Speaker (1956) estimated that a 4.5 kg, 520 mm female from Iowa contained over 400,000 eggs.

In Illinois, spawning was observed in a reservoir at depths of 0.5-0.75 m over a bottom of hard-packed clay and some gravel, with decomposing vegetation (Burr and Heidinger 1983). In the Missouri River, Bigmouth Buffalo were observed spawning in water so shallow that their backs were exposed (Pfleiger 1975).

Young of the year (YOY) Bigmouth Buffalo appear by the end of June in the Qu'Appelle River (Johnson 1963), and in the Red River in early to mid-July (Stewart and Watkinson 2004).

## Growth

Growth is fairly rapid, but slower in more northern areas than in the south. In Saskatchewan the young are about 18 mm long by late June and 64 mm by late August (Scott and Crossman 1998), attaining an average length of 71 mm by the end of the first summer (Johnson 1963). In Ohio, young-of-the-year ranged from 43 to 102 mm and 127 to 178 mm by the end of their first year (Trautman 1981). Bigmouth Buffalo from Minnesota and Tennessee were consistently larger than those from Saskatchewan at each age group (Carlander 1969). Fish at 9 years of age from Pasqua Lake are only as large as 3-year-old fish in Tennessee (Scott and Crossman 1998). The fry of pond reared fish from the lower Mississippi valley are 6.5 to 133 mm in length and fingerlings are 100 mm long by the end of the first season, but may reach 175 to 200 mm as young-of-the-year densities are reduced (Kleinholz 2000). By the end of their second year pond-reared fish may range from 1 to 2.5 kg in weight and over 400 mm in length (Kleinholz 2000). Growth is somewhat density dependent; the dominance of particular year classes may result in 10-30% or greater reductions in growth rate depending on the strength of the year class (Eddy and Underhill 1974), and in pond cultures high density stocking may significantly retard growth (Kleinholz 2000).

Johnson (1963) reported that males in Saskatchewan reach sexual maturity at smaller sizes than females, some maturing by the time they reach 305 mm (0.5 kg - age 4) and most by 381 mm (1.7 kg - age 5). Some females were found to be immature at 475 mm (1.8 kg-age 7 to 8), but most over 508 mm (2 kg-age 11) were mature. There is no sexual dimorphism as regard to weight at age (Johnson 1963, Hlasny 2003). Females apparently do not spawn every year in Saskatchewan (Johnson 1963). Some southern fish (both sexes) may be sexually mature by the end of their first year, and most reach sexual maturity by the end of their second year (Becker 1983, Kleinholz 2000).

In most areas, the maximum reported age for Bigmouth Buffalo has been less than 10 years (Carlander 1969; Hesse *et al.* 1978); although the oldest previously reported Bigmouth Buffalo was 20 years at 696 mm TL from Saskatchewan (Johnson 1963). Johnson (1963) reported that the bulk (over 80%) of the fish sampled (n = 275, age range 6-11 yr) in Pasqua Lake in 1955 were aged 7 years, and in 1956, aged 8 years, indicating a strong year class from 1948, which was predominant in the other Qu'Appelle Lakes as well, and was a year noted for high spring runoff and flooding. Hlasny (2003), in his 2000 study of Bigmouth Buffalo on Paqua Lake, caught fish (n = 499) ranging in age from 2 to 24 years, with the largest group (30% of fish sampled) aged 5 years. Since females mature between ages 8 to 11 years, and males at 5 to 15 years, the generation time, or average age of parents in the population, would be more in the neighbourhood of 14 to 15 years in unexploited populations. No information on ages and sexual maturity are available for Bigmouth Buffalo in the Great Lakes



drainage, but age at maturity would probably be closer to 1 to 2 years as given by Becker (1983) for Bigmouth Buffalo in Wisconsin, and the generation time might be closer to the 10-year average age reported by Calander (1969).

Paukert and Long (1999) felt that due to the maximum length and weight of 914 mm and 36 kg respectively, individuals older than 20 years are likely. Using otoliths, Paukert and Long (1999) aged six fish (ranging in size from 856 to 950 mm) from the Keystone Reservoir in Oklahoma in a range of 19 to 26 years. The findings indicate that Bigmouth Buffalo can attain ages greater than 20 years, and may exceed it by a considerable margin. Based on the scale aging of 499 individuals caught in Pasqua Lake, SK in 2000, Hlasny (2003) found a 24-year-old fish. A comparison of growth rates in Pasqua Lake calculated from measurements of 1831 specimens caught in 1955/6 (Johnson 1963), and 1024 specimens caught in 2000 (Hlasny 2003), indicated that rates had not changed between the 1955/56 samples and those of 2000. However, growth rates in Pasqua Lake were slightly slower in larger individuals (>500 mm) than in a more southern population in Indiana (Hlasny 2003).

## **Diet**

Bigmouth Buffalo have a highly adapted and size-selective filtering mechanism, and are able to feed mid-water and on the bottom (Nelson 2003; Stewart and Watkinson 2004). Bigmouth Buffalo are microphagous feeders primarily consuming invertebrates such as cladocerans, copepods, chironomids and ostracods, and also ingest detritus and fine sediments (Johnson 1963; Tafaelli *et al.* 1970; Nelson 2003). Seasonal variation in diet items consumed was apparent in a diet study of Bigmouth Buffalo in Oklahoma reservoirs, with cladoceran consumption peaking in early spring, while ostracod consumption peaked in the fall (Tafaelli *et al.* 1970).

A diet study in Indiana found that the dominant items (over 80% in volume and frequency) in the stomachs of Bigmouth Buffalo were sand and silt particles with dead plant and animal material, algae and other microflora and microfauna (Whitaker 1974).

Bigmouth Buffalo occupy a food niche encompassing benthic and planktonic feeding and diet probably influenced by availability of foods rather than active selection (Johnson 1963).

## **Movements/dispersal**

Spring migrations into flooded streams, marshes, etc., do occur, and individuals may move long distances to find suitable areas (Eddy and Underhill 1974; Cooper 1983). The results of a mark-recapture study in a South Dakotan reservoir indicate that the movement of Bigmouth Buffalo may be extensive with females showing a stronger tendency to move downstream than males (Moen 1974). Maximum distance travelled was 380 km and maximum rate of travel was 6.4 km per day (Moen 1974). They readily move into marshes and backwaters during periods of spring flooding (Johnson 1963).

## Interspecific interactions

Bigmouth Buffalo can hybridize naturally with Smallmouth Buffalo and Black Buffalo (Carlander 1969, Trautman 1981, Nelson 2003).

In the Qu'Appelle Lakes, Yellow Perch (*Perca flavescens*), White Sucker (*Catostomus catostomus*) and Spottail Shiner (*Notropis hudsonius*) were most often associated with Bigmouth Buffalo (Johnson 1963). Other predaceous fishes such as Northern Pike (*Esox lucius*), Black Bullhead (*Ameiurus melas*), Burbot (*Lota lota*), Yellow Perch and Walleye (*Sander vitreus*) may be found in the same waters, but the gibbous body of Bigmouth Buffalo is hard to engulf and large adults are relatively free of predation (Scott and Crossman 1998).

The only parasites listed for the species in Canada are the ectoparasitic copepod *Argulus spendiculosus*, and infestations of *Myxosporidia* sp. (Margolis and Arthur 1979). Infestations of myxosporidian spores encysted on the gills of young fish in Saskatchewan were found to be detrimental to young fish as they interfere with the feeding mechanism (Johnson 1963). Hoffman (1967) listed two (species of) trematodes, five cestodes, two nematodes, three anancephalons, one leech and two crustacean parasites of Bigmouth Buffalo in North America. Bigmouth Buffalo retained in holding tanks or in pond cultures appear to be susceptible to parasitic infestations (Becker 1983; Kleinholz 2000).

## Physiology

Bigmouth Buffalo are physiologically adapted for life in warm, turbid, eutrophic bodies of water (Johnson 1963; see also **Habitat requirements** above). Although adults are able to tolerate high turbidity (Pfleiger 1975), eggs may be adversely affected (see **Anthropogenic factors**). They can withstand low oxygen tensions (< 0.9 mg/L- Gould and Irvin 1962), high water temperatures (up to 31.7° C – Proffitt and Benda 1971), and moderate salinity (< 4.5 ppt-Edwards 1983).

## Adaptability/behaviour

Bigmouth Buffalo can hybridize naturally with Smallmouth Buffalo and Black Buffalo (Carlander 1969; Trautman 1981; Nelson 2003). The distribution of Bigmouth Buffalo in Canada is restricted and localized. They are apparently tolerant of changes in habitat associated with turbidity and eutrophication (Johnson 1963; Stang and Hubert 1984) and easily adapt to a variety of conditions including reservoirs and ponds (Staroska and Applegate 1970; Minckley *et al.* 1970; Goodchild 1990).

Johnson (1963) noted a pronounced tendency to school during the summer, often in the upper 0.6 m of water. The dorsal fin may project above the surface and commercial fishers take advantage of this behaviour in setting their nets. Bigmouth Buffalo also have a particular “bouncing” feeding movement, swimming at an angle of about 55° to the bottom and “bouncing” or “skipping” along as they suck up food particles (Johnson 1963; Minkley *et al.* 1970).

Bigmouth Buffalo are group spawners and there is no nest preparation or parental care of the eggs. Burr and Heidinger (1983) observed spawning behaviour in Crab Orchard Lake, Illinois. Groups of three or more individuals, usually two males alongside one female, would rush along the water surface and then sink to the bottom, sometimes assuming a vertical position to broadcast eggs and sperm over decaying vegetation. Pfeiffer (1975) observed similar behaviour in fish of the Missouri River.

## **POPULATION SIZES AND TRENDS**

The Bigmouth Buffalo has not been collected in a standardized manner, nor have there been any specific studies on population sizes, in Canada. Therefore, it is difficult to assess population sizes and trends. However, some inferences on population trends can be made based on the collection of the species over time in Canada.

### **Great Lakes-Upper St. Lawrence Biogeographic Zone**

The Bigmouth Buffalo was first caught in Lake Erie in 1957, and subsequently both in the lake, and some of its wetlands and tributaries. It was first collected in Long Point Bay of Lake Erie in 1957, but not since 1972, despite extensive sampling (DFO, ROM, unpubl. data). In 2004, 30 sites in the Inner Bay were intensively sampled by boat electrofishing (>1000 sec/500m site) (N.E. Mandrak, unpubl. data). Sampling was also undertaken by DFO in 2005 along the tip of Long Point (N.E. Mandrak, unpubl. data). However, many nearshore areas with suitable habitat in Long Point Bay have not been sampled.

Bigmouth Buffalo has only been collected in Point Pelee and Rondeau Bay since 2000 despite prior intensive sampling. Since 1913, fish surveys were conducted at Point Pelee by the Canadian Museum of Nature (CMN), Royal Ontario Museum (ROM), Park staff and others (H. Surette, University of Guelph, unpubl. data). At Point Pelee, most historical sampling was done by seining. Due to soft organic substrates, extensive emergent macrophytes and water depths generally greater than 1m, seining can only be undertaken in very small portions of the ponds (H. Surette, University of Guelph, pers. comm.). These seinable portions are typically narrow (<2m) nearshore areas with sandy substrates and limited aquatic macrophytes along the eastern shores of the ponds bounded by the eastern beach. Rondeau Bay was sampled in 14 different years since 1921 by the CMN and ROM (Royal Ontario Museum, unpubl. data), and in 10 different years since 1963 (DFO, ROM, unpubl. data). Recent sampling included boat electrofishing (>1000 sec/500m site) and fine-mesh hoopnetting (2 nets set

overnight) around Rondeau Bay in 2002 (10 sites, electrofishing only) and 2004 (16 sites), and sampling the inner marshes of Rondeau Provincial Park by seining and fine-mesh hoopnetting in 2005 (N.E. Mandrak, unpubl. data).

It was collected at the mouth of the Grand River in 1999 and 2002 (Tom MacDougall, OMNR, pers. comm.), and Big Creek (Essex Co.) in 2003 (L. Bouvier, University of Guelph, unpubl. data), but these areas have not been well surveyed with appropriate gear prior to these first records. It was only recently (2003, 2004) collected in the Detroit River during a boat electrofishing survey of Area of Concern sites (DFO, unpubl. data) despite a similar survey using the same methods and effort conducted in 1989 and 1990 (MacLennan 1992).

The Bigmouth Buffalo was first captured in Lake St. Clair in Mitchell's Bay in 1972. Between 1977 and 2006, fall index trap netting in St. Luke's and Mitchell's bays of Lake St. Clair has captured several specimens almost every year (Ontario Ministry of Natural Resources (OMNR) Lake Erie Management Unit, unpubl. data). Specimens have been caught in a tributary to Lake St. Clair, the Thames River, and its tributaries since 1980. Bigmouth Buffalo were caught in Jeanettes Creek in 1980 and 2004 (186 individuals), and a tributary to Jeanettes Creek in 1989. Since 2003, specimens have been caught in the Thames River itself between the mouth and Springbank Dam in London, Ontario, ca. 300 km upstream. Specimens have been caught in the North Sydenham and East Sydenham rivers, tributary to Lake St. Clair, since 1997. Specimens were not caught in the Sydenham River watershed prior to 1997, and the Thames River watershed prior to 1980, despite widespread sampling (ROM, unpubl. data).

The Bigmouth Buffalo has not been collected in the St. Clair River despite boat electrofishing surveys of ten 500 m transects along the river in 1989, 2003, 2004 and 2007 (DFO, unpubl. data).

The only voucher-confirmed specimens of Bigmouth Buffalo collected from the Canadian portion of the Lake Huron drainage were caught at the mouth of the Ausable River by boat electrofishing in 2003 and 2007 (DFO, unpubl. data). However, limited sampling has taken place before and after the collection of these specimens (ROM, DFO, unpubl. data). Sightings, not substantiated with a voucher, have been reported by OMNR staff in southern Lake Huron in 1983, and in Lake Huron off Southampton in 2005.

Several specimens have been collected in the Lake Ontario basin since 1981. Two specimens have been collected in the Bay of Quinte, one in 1981 and one in 2005. However, specimens were not caught during annual boat electrofishing surveys conducted between 1989 and 2004 (GLLFAS 2005). These specimens may represent a small, established population, or were introduced as suggested by Goodchild (1990), or have dispersed eastward from populations in western Lake Ontario. Several specimens were collected in the Welland River in 1997; however, limited sampling has taken place before and after the collection of these specimens (ROM, DFO, unpubl. data). Twenty-one specimens have been caught in the Cootes Paradise Fishway at the western end of

Hamilton Harbour between 1997 and 2005 (1997 (1 specimen); 1999 (2); 2000 (6); 2002 (6); 2003 (3); 2005 (3); T. Theysmeyer, Royal Botanical Gardens, pers. comm.), and likely originated as the result of dispersal westward from the Welland River.

Bigmouth Buffalo are known from the the Ohio waters of Lake Erie, as well as the American waters of Lake St. Clair (Goodchild 1990; Lee and Shute 1980; Smith 1979; Trautman 1981; Becker 1983; Cooper 1983). Thus, there is a base for moderate rescue effect from populations in nearby U.S. waters; however, populations in Ohio have not been ranked, while those of Pennsylvania are considered critically imperiled, and those of Michigan are vulnerable (NatureServe 2007).

### **Saskatchewan-Nelson River Biogeographic Zone**

The history of known sampling for this Biogeographic Zone is provided in Table 2. Where known, the effort used for this sampling is summarized below.

#### Manitoba

Bigmouth Buffalo were reported from the Red River of the North by Eigenmann (1895), but were first collected in 1907 in Cook's Creek, a tributary to the Red River (Hinks 1943). Hinks (1943) reported only one specimen of 12.7 kg from southern Manitoba and Scott and Crossman (1998) considered it rare to absent in the Red and Assiniboine rivers. However, the opening of the Assiniboine River Floodway in 1974 (which diverts floodwater from the river into Lake Manitoba near Delta Marsh) permitted the dispersal of a number of species (including Bigmouth Buffalo) into Lake Manitoba. In 1982 and 1983, Bigmouth Buffalo were collected in Delta Marsh at the south end of Lake Manitoba (Stewart *et al.* 1985), indicating that they had probably arrived from the Assiniboine River via the floodway. Crossman and McAllister (1986) substantiated its presence in the Assiniboine River. Collections from the Red River near East Selkirk in 1978, and Lower Devil Lake in the Lake Winnipeg drainage in 1981 (Goodchild 1990), provided further evidence of a more extensive distribution in Manitoba.

Since then, it has been collected in the Red River, and several tributaries (e.g. Buffalo Creek (2005), Second Creek (2003), Truro Creek (2002); M. Erickson, Manitoba Water Stewardship, pers. comm.), between the Canada-United States border and the south basin of Lake Winnipeg, into which it flows. Stewart and Watkinson (2004) reported that it is known from the Red River and the lowermost portions of its tributaries. It has recently been caught in the Red River Back Bay at St. Norbert floodgates (1998), in the Seine River Diversion (2004), in the south basin of Lake Winnipeg during beam trawl surveys (2002) (Nelson 2003), and 30 specimens were collected in the Red River during electrofishing surveys in 2002 and 2003 (D. Watkinson, unpubl. data). The estimated size range of fish captured in the Red River in 2002 represented fish ranging in age from 1+ to >15+ years, indicating an established population (Nelson 2003). There is also an unconfirmed report from Lake Dauphin in 2002 (Stewart and Watkinson (2004).

In 1998, 64 Bigmouth Buffalo were collected in Delta Marsh in the south end of Lake Manitoba in 20 gillnet sets over the summer, and 23 were netted in 1999 using the same methods. In 2005, a mature individual was caught at Lunder Beach, 60 kilometres north of Delta Marsh (Nelson 2003). The presence of Bigmouth Buffalo in fish surveys below Portage la Prairie Dam on the Assiniboine River and its tributaries since 1995 appears to have increased (Nelson 2003). It has not been collected in the Assiniboine River above Portage la Prairie Dam despite recent sampling by boat electrofishing (Nelson 2003).

The new records in Manitoba are probably more a reflection of increased search effort in the last two decades than of a range expansion.

### Ontario

Bigmouth Buffalo were reported from Lake of the Woods in 1973 and 1976 (Goodchild 1990), headwaters of the Winnipeg River that drains into the south basin of Lake Winnipeg. The current status of the Lake of the Woods population is unknown; however, regular fisheries assessments in the Ontario waters have failed to capture any additional specimens since 1976 (A. Dextrase, OMNR, pers. comm.). Their occurrence may have been the result of a failed, undocumented introduction, or the long-distance dispersal of individuals from populations in Manitoba or Minnesota.

### Saskatchewan

Rawson (1949) described Bigmouth Buffalo as abundant in the Qu'Appelle Lakes (Buffalo Pound, Crooked, Echo, Katepwa, Last Mountain, Mission, Pasqua and Round lakes), and as present in the North Saskatchewan River at Prince Albert. As indicated above, the North Saskatchewan record is questionable and should not be considered further. Johnson (1963) also reported the species as abundant in the Qu'Appelle Lakes.

Bigmouth Buffalo were last seen spawning at the Craven Dam and Last Mountain lakes ( $\approx$  20 adults at each location) in 1996. However, in 1997, 304 seine hauls in Last Mountain Lake yielded only a single Bigmouth Buffalo YOY (R. Hlasny, Saskatchewan Environment, pers. comm.). In 1999, Bigmouth Buffalo were collected using 6 hoop net sets, 6 Beamish trap sets and 51 seine hauls in each of Buffalo Pound (4 adults), and Pasqua (7 adults, 1 YOY) but not in Katepwa and Round lakes using the same gear and effort (R. Hlasny, Saskatchewan Environment, pers. comm.). In 2000, 1024 Bigmouth Buffalo were caught during a mark-recapture study in Pasqua Lake in 124 down hauls between June 1 and August 31 (Hlasny 2003). The mark-recapture study estimated a population size between 8535 and 12,326 individuals using both Schnabel and Schumacher methods (Hlasny 2003). Bigmouth Buffalo were the third most abundant species caught using Beamish traps (418 YOY) and seines (10 YOY) in Crooked Lake in 2004, but similar sampling in Round Lake failed to capture any buffalo (B. Howard and A. Schweitzer, DFO, pers. comm.). Based on the scale aging of 499 individuals caught in Pasqua Lake in 2000, Hlasny (2003) noted five missing year classes (1977, 1987-1990). Hlasny (2003) attributed limited recruitment in those years to low runoff,

intermittent flows and, consequently, low lake levels leading to reduced amount of habitat and time for spawning. Hlasny (2003) also calculated that, based on a mean population estimate of 8700 fish, there would be 2865 fish, weighing 19,390 kg, within the size range of the commercial fishery. This is less than 24% of the average catch during the commercial fishery between 1950 and 1983 (Hlasny 2003; Figure 6) despite the fact that the fishery ended in 1983. However, based on the fishable biomass available in 1983 compared to 2000, there has been a loss of 76% during the 17-year period (Hlasny 2003).

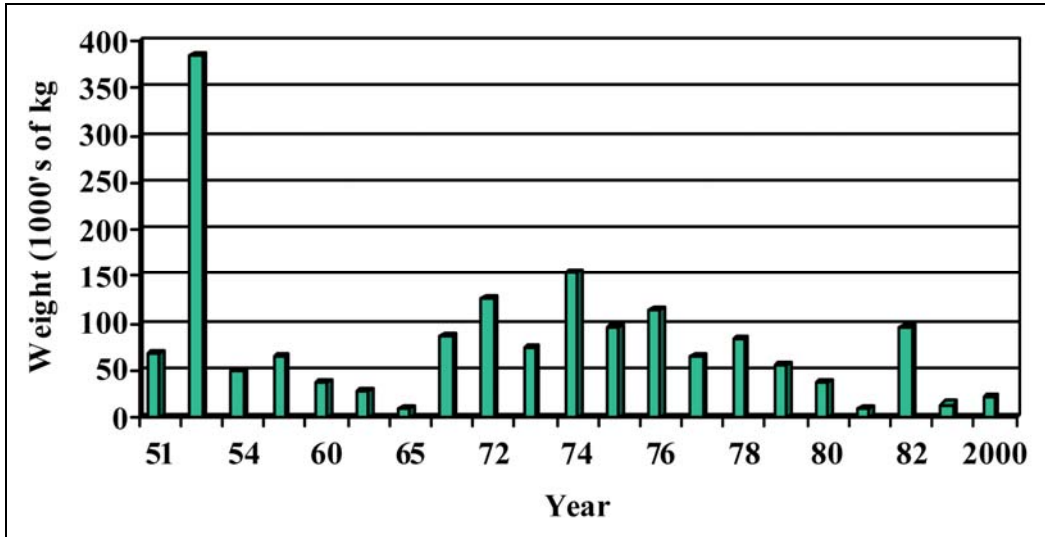


Figure 6. Commercial catch of Bigmouth Buffalo taken from Pasqua Lake between 1950 and 1983, with the available 2000 catch in kg shown (adopted from Hlasny 2003).

Bigmouth Buffalo may have originally dispersed into Manitoba from the Mississippi River via the Red River (Stewart *et al.* 1985), and from there, upstream into the English-Winnipeg system and/or the Assiniboine-Qu’Appelle system (Crossman and McAllister 1986). There may be a modest rescue potential for the Canadian populations of this DU as the species is still present in the Mississippi drainage of North Dakota and Minnesota, but its current status there has not been ranked (NatureServe 2007).

## LIMITING FACTORS AND THREATS

### Natural factors

Although Bigmouth Buffalo share an environment with many large predaceous fishes, there is little evidence of predation on the young. Large adults are probably free from predation because of their shape and size (Johnson 1963; Scott and Crossman 1998). Bigmouth Buffalo may have a selective advantage in occupying a food niche that overlaps both benthic and limnetic feeding (Goodchild 1990).

Bigmouth Buffalo can hybridize naturally with smallmouth buffalo and black buffalo (Carlander 1969; Trautman 1981; Nelson 2003), and are thought to have done so in Canadian Great Lakes waters (H. Bart, Tulane University, pers. comm.). Such hybridization may threaten the genetic integrity and fitness of populations sympatric with other buffalo species.

Heavy parasitic infestations, particularly by Myxosporidian spores, which are enclosed in cysts on the gills, may severely debilitate populations due to interference with feeding mechanisms. The gill rakers of Bigmouth Buffalo are specialized for plankton feeding (Johnson 1963; Starostka and Applegate 1970).

The success of Bigmouth Buffalo populations, at least in the Saskatchewan-Nelson Biogeographic Zone (Johnson 1963), may be density dependent, as has been noted in cultured populations (Kleinholz 2000). Females are fecund, bearing about 250,000 eggs/kg of body weight (Kleinholz 2000), although it may be more like 100,000/kg in northern fish (Johnson 1963). Northern fishes mature later than their southern counterparts (8 to 11 yr versus 1 to 3 yr), and may not spawn every year. There is no information available on natural mortality, but given that there are no known predators of the young, and that predation and disease do not appear to be significant limiting factors, an extremely successful reproductive rate may be self-limiting. Overabundance may result in a high level of intraspecific competition, leading to poor growth and condition, and late maturity of individuals. Subsequent year-class strength may be extremely low or non-existent. In his studies of lake populations in Saskatchewan, Johnson (1963) suggested that the highly successful 1948 year-class was partly responsible for a distorted growth rate and misleading appraisal of size and age of sexual maturation. Strong and weak year-classes are very apparent in this species (Scott and Crossman 1979), and can be related to environmental conditions at the time of spawning, particularly spring water levels and flooding. Kleinholz (2000) noted a similar response to density in pond cultures.

Successful reproduction appears to be associated with spring waters levels, and is dependent on spring flooding to provide access to spawning areas, to activate spawning activity (Johnson 1963), and maintain shoreline vegetation (Moen 1974; Hlasny 2003). In drought years, or years with low spring runoff, reproduction may be limited or non-existent. Hlasny (2003) indicated that prior to the implementation of water regulation in the 1980s, annual precipitation played a key role in determining lake levels and the availability of shoreline vegetation for spawning Bigmouth Buffalo. In drought years lake elevations receded and shoreline vegetation became inaccessible for spawning, but during years with normal spring precipitation shoreline vegetation would become flooded and successful reproduction would occur. Drought in the southern prairies is not uncommon (Pollard 2003), and may be more common given predicted changes in aquatic ecosystems, especially in the prairies, associated with global climate change (Poff *et al.* 2002; Schindler and Donahue 2006).



## **Anthropogenic factors**

In Saskatchewan, changes in water management within the Qu'Appelle River were undertaken in the 1980s to ensure an even flow regime based on flow requirements for walleye and northern pike (Dunn and Hjertaas 1981). Changes such as channelization, removal of meander loops, and setting of lake levels, have negatively impacted Bigmouth Buffalo by eliminating spawning habitats through reduction of vegetated side channels and meander loops, and increasing bank full flow capacity (Hlasny 2003), and resulted in low flows during the critical Bigmouth Buffalo spawning and incubation period. This reduces the number of years during which successful spawning can take place in the river and the time frame that the vegetated areas available for spawning stay flooded between Pasqua Lake and the Craven Dam site (Hlasny 2003). Hlasny (2003) noted at least five missing year classes (1977, 1987-1990) attributed to limited recruitment in those years because of low runoff, intermittent flows and, consequently, low lake levels leading to reduced amount of habitat and time for spawning.

Commercial exploitation coupled with the changes in flow regime and prolonged periods of drought may have also negatively impacted populations in the Qu'Appelle watershed.

Turbidity as the result of the degradation of littoral habitat in reservoirs caused by fluctuating water levels may further impact Bigmouth Buffalo populations (Edwards 1983). Egg hatching is adversely affected by turbidities in excess of 100 ppm or by marked fluctuations in the water level (Becker 1983). The average age of Bigmouth Buffalo sampled in Pasqua Lake, Saskatchewan in 2007 was 6 years (Figure 7). Given that females do not reach sexual maturity until 8 years of age, or older, the fishable biomass of 19,390 kg reported by Hlasny (2003) for 2000, if exploited, would result in removal of individuals before any contribution to recruitment could be made. This further exacerbates the problem resulting from missing age classes due to failed recruitment in years of low flow. The missing year classes and age structure of this population indicate that overall recruitment is low, and that the population is under severe stress.

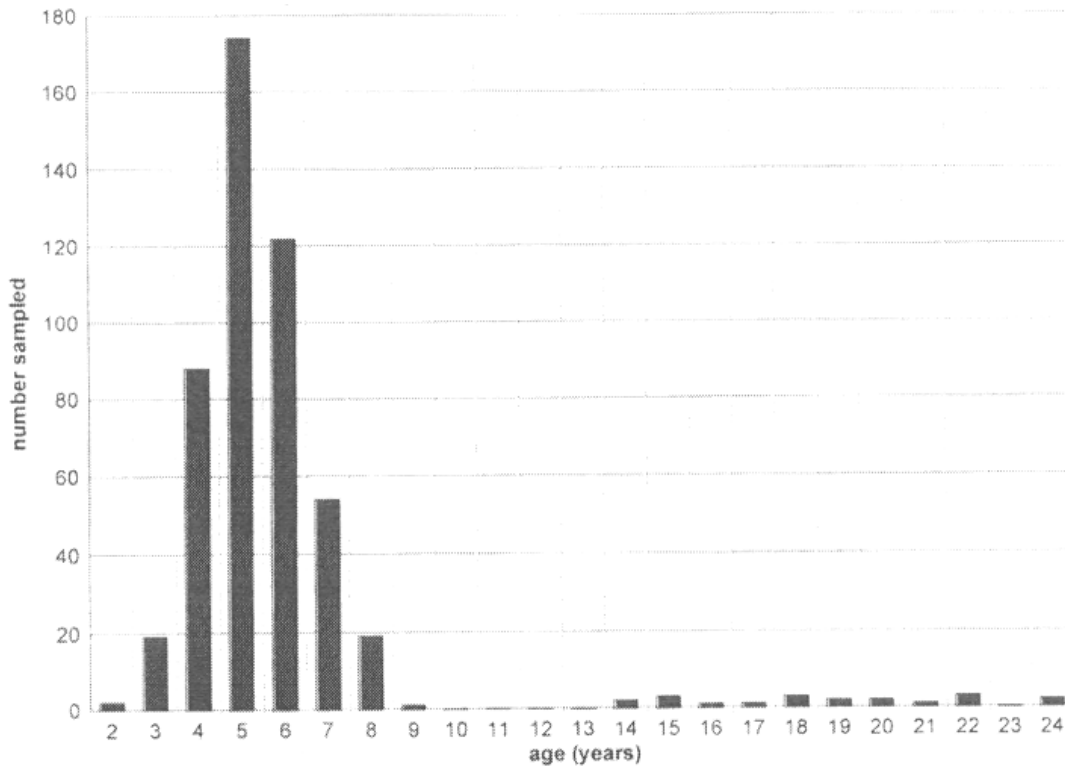


Figure 7. Age distribution of Bigmouth Buffalo caught in 2000 in Pasqua Lake, Saskatchewan (Hlasny 2003)

Stewart and Watkinson (2004) felt Bigmouth Buffalo would be vulnerable to Bighead Carp (*Hypophthalmichthys nobilis*) and Silver Carp (*H. molitrix*), should either species be introduced to Canadian waters. In the Illinois River basin, a marked decline has been noticed in Bigmouth Buffalo captures as the introduced Bighead and Silver Carp abundance increases (M. Pegg, Illinois Natural History Survey, pers. comm.). Mandrak and Cudmore (2004) suggest that these Asian carp species would compete for food resources with Bigmouth Buffalo.

### **SPECIAL SIGNIFICANCE OF THE SPECIES**

Bigmouth Buffalo are not usually considered a sport fish and will seldom take a hook (Jordan and Evermann 1923). However, the meat is nutritious and excellent when smoked (Becker 1983). Bigmouth Buffalo is considered a delicacy by some cultures in the United States and is harvested for this reason. There may be some limited demand for buffaloes in Canada, and they have been found live in fish markets in the Toronto area (Goodchild 1990; N. Mandrak, pers. obs.). A commercial fishery in Saskatchewan, going back to the 1940s, ended in 1983 (Hlasny 2003). There is a significant commercial fishery in the U.S. and the species contributes a major portion of the commercial catch of the Mississippi River with catches in excess of 672 kg.ha<sup>-1</sup> not uncommon (Goodchild 1990).

Pond culture is profitable and Bigmouth Buffalo have been reared in ponds in the southern U.S. since the early 1900s. Yields of 287 kg.ha<sup>-1</sup> without fertilization or feeding have been reported (Cross 1967), but managed aquaculture can result in yields in excess of 1000 kg.ha<sup>-1</sup>, with a net profit of about \$1111/ha in 2000 dollars (Kleinholz 2000).

Given the taxonomic and systematic problems, this genus is of some scientific interest.

## EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The global, national (United States and Canada), and subnational (state and provincial) ranks for Bigmouth Buffalo are given in the Technical Summary.

The Bigmouth Buffalo was designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1989 (NatureServe 2007) and is listed on Schedule 3 of the *Species at Risk Act* ([www.sararegistry.ca](http://www.sararegistry.ca)). National rank in Canada for Bigmouth Buffalo is N4 (apparently secure) (NatureServe 2005). The national general status ranking of Bigmouth Buffalo is secure (4) (CESCC 2006). It has been given provincial general status ranks of 1 (At Risk) in Saskatchewan, 4 (Secure) for Manitoba, and 3 (Sensitive) for Ontario (CESCC 2006).

The decline of Bigmouth Buffalo in Saskatchewan led to a formal review of its status by Saskatchewan's dual advisory boards in 1998 (Hlasny 2003, K. Murphy, pers. comm.). A status of Endangered under the *Wild Species at Risk Regulations* of the province's *The Wildlife Act, 1988* has been recommended, but formal listing is still pending (K. Murphy, pers. comm.).

A provincial status report on Bigmouth Buffalo (Nelson 2003) was reviewed by Manitoba's Endangered Species Advisory Committee, which recommended a status of Not At Risk (S. Matkowski, Manitoba Natural Resources, pers. comm.).

In Ontario, the provincial rank for Bigmouth Buffalo is SU, meaning that the status of this species is currently undetermined (NatureServe 2007). It is listed as special concern on the Species at Risk in Ontario List (OMNR 2005).

In the United States, the Bigmouth Buffalo is considered nationally (N5) secure. Its subnational rank ranges from S1 to S5 throughout its distribution in the United States (see Technical Summaries for specific state ranks).

## TECHNICAL SUMMARY – DU 1

### *Ictiobus cyprinellus*

Bigmouth Buffalo

Great Lakes-Upper St. Lawrence Populations

Buffalo à grande bouche

### Demographic Information

Generation time (average age of parents in the population)	10 yr
Observed percent reduction or increase in total number of mature individuals over the last 45 years (3 generations).	Unknown, but increasing
Projected or suspected percent reduction or increase in total number of mature individuals over the next 30 years (3 generations)	Not Applicable
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over any 30 year (3 generation) period, over a time period including both the past and the future.	Not Applicable
Are the causes of the decline clearly reversible?	Not Applicable
Are the causes of the decline understood?	Not Applicable
Have the causes of the decline ceased?	Not Applicable
Observed, inferred, or projected trend in number of populations	Increasing
Are there extreme fluctuations in number of mature individuals?	Unknown
Are there extreme fluctuations in number of populations?	Unknown

### Extent and Area Information

Estimated extent of occurrence (Polygon method – see Distribution)	< 50,000 km <sup>2</sup>
Observed, inferred, or projected trend in extent of occurrence	Increasing
Are there extreme fluctuations in extent of occurrence?	No
Area of Occupancy (AO) Difficult to determine as many populations based on single record – estimated by average stream length X width	< 200 km <sup>2</sup>
Index of area of occupancy (IAO)	
1 X 1 km overlaid grid	2210 km <sup>2</sup>
2 X 2 km overlaid grid	3268 km <sup>2</sup>
Observed, inferred, or projected trend in area of occupancy	Increasing
Are there extreme fluctuations in area of occupancy?	No
Is the total population severely fragmented?	No
Number of current locations	4
Trend in number of locations	Increasing
Are there extreme fluctuations in number of locations?	No
Trend in area and/or quality of habitat	Great Lakes proper declining – wetlands increasing.

**Number of mature individuals in each population**

<b>Population</b>	<b>N Mature Individuals</b>
Number of mature individuals unknown for all populations.	
Ausable River	
Lake St. Clair	
North Sydenham & Sydenham rivers	
Thames River	
Detroit River	
Big Creek wetland (Essex Co.)	
Point Pelee	
Grand River	
Welland River	
Hamilton Harbour	
Bay of Quinte	
Total	Unknown
Number of extant populations	11

**Quantitative Analysis**

	Not Applicable
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**Threats (actual or imminent threats to populations or habitats)**

- decreasing turbidity in lakes Huron, St. Clair, Erie and Ontario; hybridization with other <i>Ictiobus</i> species introduced into the Great Lakes basin.
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**Rescue Effect (immigration from an outside source)**

Moderate

• does species exist elsewhere (in Canada or outside)?	Yes
• status of the outside population(s)?	MI – S3; OH – SNR; PA – S1; NY – not ranked
• is immigration known or possible?	Yes
• would immigrants be adapted to survive here?	Yes
• is there sufficient habitat for immigrants here?	Yes

**Current Status (Species)**

<p><b>Nature Conservancy Ranks</b> (NaturServe 2007)</p> <p><b>Global – G5</b></p> <p><b>National</b></p> <p>    US – N5</p> <p>    Canada N4</p> <p><b>Regional</b></p> <p>    US – AL (S2S3), AZ (SNA), AK (S4), IL (S3S4), IN (S4), IA (S5), KS (S5), KY (S4S5), LA (S5), MI (S3), MN (SNR), MS (S4), MO (SNR), MT (S4), NE (S4), NC (SNA), ND (SNR), OH (SNR), OK (S4), PA (S1), SD (S5), TN (S5), TX (S4), WV (S1), WI (S4)</p> <p>    Canada – ON – SU</p> <p><b>Wild Species 2005</b> (Canadian Endangered Species Council 2006)</p> <p>    Canada – 4</p> <p>    Saskatchewan –1, Manitoba – 4, Ontario – 3</p> <p><b>SARA</b></p> <p>    SC – Schedule 3</p> <p><b>COSEWIC</b> Great Lakes Upper St. Lawrence Populations: Not At Risk (November 2008)</p>
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### Status and Reasons for Designation

<b>Status:</b> Not At Risk	<b>Alpha-numeric code:</b> Not Applicable
<b>Reasons for Designation:</b> Populations in Ontario appear to be doing well and there are no immediate threats to its continued survival; the area of occupancy appears to have increased and it has been found at 8 new locations since last assessed in 1989.	

### Applicability of Criteria

<b>Criterion A</b> (Declining Total Population): Not Applicable – No evidence of decline.
<b>Criterion B</b> (Small Distribution, and Decline or Fluctuation): Not Applicable – The AO calculated from an overlaid 2 X 2 km grid is > 3000 km <sup>2</sup> , and there is no evidence of overall decline.
<b>Criterion C</b> (Small Total Population Size and Decline): Not Applicable – The number of mature individuals is unknown, and the AO and number of populations is increasing.
<b>Criterion D</b> (Very Small Population or Restricted Distribution): Not Applicable – Number of mature individuals is not known; and distribution is wide (AO exceeds 20 km <sup>2</sup> ).
<b>Criterion E</b> (Quantitative Analysis): Not Applicable – No data.

## TECHNICAL SUMMARY - DU 2

### ***Ictiobus cyprinellus***

Bigmouth Buffalo

Saskatchewan-Nelson River Populations

Buffalo à grande bouche

### **Demographic Information**

Generation time (average age of parents in the population)	14-15 yr
Observed percent reduction in total number of mature individuals over the last 45 years (3 generations).	Unknown, but in the Qu'Appelle Lakes may be in the order of 78% and the lake of the Woods population has been extirpated.
Projected or suspected percent reduction or increase in total number of mature individuals over the next 30 years (3 generations)	Unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over any 30 year (3 generation) period, over a time period including both the past and the future.	Not Applicable
Are the causes of the decline clearly reversible?	Unknown
Are the causes of the decline understood?	Not in all populations
Have the causes of the decline ceased?	No
Observed, inferred, or projected trend in number of populations	Declining
Are there extreme fluctuations in number of mature individuals?	Yes
Are there extreme fluctuations in number of populations?	Unknown

### **Extent and Area Information**

Estimated extent of occurrence	<100,000 km <sup>2</sup>
Observed, trend in extent of occurrence	Decreasing
Are there extreme fluctuations in extent of occurrence?	No
Area of Occupancy (AO) Difficult to determine as many populations based on single record – estimated by average stream length X width	< 500 km <sup>2</sup>
Index of area of occupancy (IAO)	
1 x 1 km overlaid grid	1600 km <sup>2</sup>
2 X 2 km overlaid grid	2396 km <sup>2</sup>
Observed trend in area of occupancy	Unknown
Are there extreme fluctuations in area of occupancy?	No
Is the total population severely fragmented?	Yes
Number of current locations	3
Trend in number of locations	Decline
Are there extreme fluctuations in number of locations?	Unknown
Trend in area and/or quality of habitat	Declining
Are there extreme fluctuations in number of populations (>1 order of magnitude)?	No

**Number of mature individuals in each population**

Population	N Mature Individuals
Number of mature individuals unknown for all populations.	
Lake of the Woods - probably extirpated	
Red River - unknown	
Lake Winnipeg - unknown	
Assiniboine River - unknown	
Lake Manitoba - unknown	
Lake Dauphin - unknown (unconfirmed)	
Qu'Appelle River - unknown	
Round Lake - probably extirpated	
Last Mountain Lake - probably extirpated	
Katepwa - probably extirpated	
Mission Lake - may be extirpated	
Echo Lake - may be extirpated	
Crooked Lake - very few	
Buffalo Pound Lake - very few	
Pasqua Lake 9-12000 (individuals - not necessarily mature)	
Total	Unknown
Number of extant populations	12

**Quantitative Analysis**

	Not Applicable
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**Threats (actual or imminent threats to populations or habitats)**

<p><b>Immediate:</b></p> <ul style="list-style-type: none"> <li>- Channelization, removal of meander loops and regulation of lake levels, increasing turbidity resulting from water management practices</li> <li>- Global warming</li> </ul> <p><b>Potential:</b></p> <ul style="list-style-type: none"> <li>- Introduction of exotics such as bighead and sliver carp</li> <li>- hybridization with other buffalo species</li> <li>- exploitation</li> </ul>
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**Current Status (Species)****Nature Conservancy Ranks** (NaturServe 2007)**Global – G5****National**

US – N5

Canada N4

**Regional**

US – AL (S2S3), AZ (SNA), AK (S4), IL (S3S4), IN (S4), IA (S5), KS (S5), KY (S4S5), LA (S5), MI (S3), MN (SNR), MS (S4), MO (SNR), MT (S4), NE (S4), NC (SNA), ND (SNR), OH (SNR), OK (S4), PA (S1), SD (S5), TN (S5), TX (S4), WV (S1), WI (S4)  
 Canada – ON – SU

**Wild Species 2005** (Canadian Endangered Species Council 2006)

Canada – 4

Saskatchewan –1, Manitoba – 4, Ontario – 3

**SARA**

SC – Schedule 3

**COSEWIC** Saskatchewan – Nelson Rivers Populations: Special Concern (April 2009)**Status and Reasons for Designation**

<b>Status:</b> Special Concern	<b>Alpha-numeric code:</b> Not Applicable
<b>Reasons for Designation:</b> 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.	

**Applicability of Criteria**

<b>Criterion A</b> (Declining Total Population): Not Applicable – Total population and overall rate of decline unknown.
<b>Criterion B</b> (Small Distribution, and Decline or Fluctuation): Not Applicable - The Index of Area of Occupancy exceeds the threshold.
<b>Criterion C</b> (Small Total Population Size and Decline): Not Applicable – The number of mature individuals is unknown, as is rate of decline.
<b>Criterion D</b> (Very Small Population or Restricted Distribution): Not Applicable – Number of mature individuals is not known, and the Index of Area of Occupancy exceeds 20 km <sup>2</sup> .
<b>Criterion E</b> (Quantitative Analysis): Not Applicable – No data.

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## **COLLECTIONS EXAMINED**

None.