

COSEWIC Assessment and Status Report

on the

Chestnut Lamprey *Ichthyomyzon castaneus*

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

in Canada



DATA DEFICIENT
2010

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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Production note:

COSEWIC acknowledges Claude Renaud for writing the provisional status report on the Chestnut Lamprey, *Ichthyomyzon castaneus*. The contractor's involvement with the writing of the status report ended with the acceptance of the provisional report. Any modifications to the status report during the subsequent preparation of the 6-month interim status report were overseen by Dr. John Post, Co-chair of the COSEWIC Freshwater Fishes Specialist Subcommittee.

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Chestnut Lamprey — Adult Chestnut Lamprey in lateral view. Photographed by Douglas A. Watkinson, Freshwater Institute, Fisheries and Oceans Canada, Winnipeg.

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COSEWIC Assessment Summary

Assessment Summary – November 2010

Common name

Chestnut Lamprey - Great Lakes - Upper St. Lawrence populations

Scientific name

Ichthyomyzon castaneus

Status

Data Deficient

Reason for designation

Insufficient information exists for assessment purposes. The occurrence of this species in the Great Lakes – Upper St. Lawrence basin has been confirmed with recent collections of 2 adults and correction to the identification of 4 adults from museum collections. No further information on distribution, abundance or habitat is available for this species.

Occurrence

Ontario, Quebec

Status history

The species was considered a single unit and designated Special Concern in April 1991. Split into two populations in November 2010. The “Great Lakes - Upper St. Lawrence populations” unit was considered in November 2010 and placed in the Data Deficient category.

Assessment Summary – November 2010

Common name

Chestnut Lamprey - Saskatchewan - Nelson River populations

Scientific name

Ichthyomyzon castaneus

Status

Data Deficient

Reason for designation

Insufficient information exists for assessment purposes. This species' Saskatchewan - Nelson River populations unit is broadly distributed but has not been abundant where surveyed. It has been observed at 20 sites in total in this region. No information is available on population size or trends. Although prairie rivers are generally subject to agriculturally derived sedimentation, herbicides, pesticides and eutrophication, no information is available on specific threats to this species.

Occurrence

Saskatchewan, Manitoba, Ontario

Status history

The species was considered a single unit and designated Special Concern in April 1991. Split into two populations in November 2010. The “Saskatchewan - Nelson River populations” unit was considered in November 2010 and placed in the Data Deficient category.



COSEWIC
Executive Summary

Chestnut Lamprey
Ichthyomyzon castaneus

Species information

The Chestnut Lamprey is a parasitic species that attains a maximum size of 363 mm in total length as an adult and 165 mm as a larva. It has a single indented dorsal fin. Larger larvae (greater than approximately 95 mm) can be distinguished from all other Canadian lampreys by the presence of darkly pigmented lateral line organs. Adults can be distinguished from the two other Canadian lamprey species that have a single dorsal fin, Silver Lamprey and Northern Brook Lamprey, by possessing usually a total of six bicuspid inner lateral teeth, compared to usually none. There are two designatable units: a Saskatchewan-Nelson River DU and a Great Lakes-Upper St. Lawrence DU. This parasitic lamprey species is found in Canada (Saskatchewan, Manitoba, Ontario, and Québec) and the United States (19 contiguous states from North Dakota to Texas), but its closest relative, the Southern Brook Lamprey, a nonparasitic species, is only found in the United States.

Distribution

The Chestnut Lamprey is only found in North America, being distributed in Canada and the United States. In Canada, it is found in Saskatchewan, Manitoba, Ontario and Québec, occurring in two biogeographic zones: the Saskatchewan-Nelson River zone and the Great Lakes-Upper St. Lawrence zone.

Habitat

The Chestnut Lamprey spends its entire life in fresh waters. It is found in lakes and rivers of various sizes.

Biology

The Chestnut Lamprey lives an undetermined number of years (presumed to be 5-7) as a filter-feeding larva mostly spent buried or partially buried in the bottom of streams. It begins transformation in the fall, acquiring an oral disc with teeth. It lives about 18 months as an adult, feeding on the blood and other body fluids of a variety of fishes. It reproduces in the spring and dies shortly after.

Population sizes and trends

Twenty-seven extant populations are known across its Canadian range. Most collections consist of a single specimen. The population sizes are unknown, but the largest grouping of this species observed in Canada (about 50 individuals) occurred during a spawning event. No trend can be inferred as collections have been made very intermittently and, with one exception, the Assiniboine River, Manitoba, the collection effort has not been quantified.

Limiting factors and threats

Two of seven populations in the Great Lakes Basin are or were subjected to chemical applications to control the invasive Sea Lamprey.

Existing protection

The federal *Fisheries Act* prohibits the destruction of fish habitat. The Chestnut Lamprey was assessed as Vulnerable (= Special Concern) by the COSEWIC in April 1991 and is listed as Special Concern on Schedule 3 of SARA. This assessment, however, applied only to the provinces of Saskatchewan and Manitoba, because the populations in Ontario and Québec were only discovered after 1991. Both the Saskatchewan-Nelson River populations and the Great Lakes Upper-St-Laurence populations were presented as two separate units and designated Data Deficient by COSEWIC in November 2010.

TECHNICAL SUMMARY – DU1

Genus species Ichthyomyzon castaneus
Chestnut Lamprey
Great Lakes-Upper St. Lawrence populations

Lamproie brune
Populations des Grands Lacs et du haut Saint-Laurent

Range of occurrence in Canada: Ontario, Québec

Demographic Information

Generation time (usually average age of parents in the population)	8 yrs
Is there an observed continuing decline in number of mature individuals?	Unknown
Estimated percent of continuing decline in total number of mature individuals within 2 generations.	Unknown; only three specimens collected within the last two generations (16 yrs)
Observed percent reduction in total number of mature individuals over the last 3 generations.	Unknown; only three specimens collected over the last three generations (24 yrs)
Projected or suspected percent reduction in total number of mature individuals over the next 3 generations.	Unknown
Suspected percent reduction in total number of mature individuals over any 3 generations period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (Based on Table 1)	301,013 km ²
Area of Occupancy (AO) Index of area of occupancy (IAO) (Based on Table 1) 2 X 2 km grid	1,528 km ²
Is the total population severely fragmented?	Yes
Number of "locations*"	6
Is there an observed, inferred, or projected continuing decline in extent of occurrence?	No
Is there an observed, inferred, or projected continuing decline in index of area of occupancy?	No
Is there an observed, inferred, or projected continuing decline in number of populations?	No. although perhaps the Chippewa River (ON) population is extirpated
Is there an observed, inferred, or projected continuing decline in number of locations?	No, although perhaps the Chippewa River (ON) population is extirpated
Is there an observed, inferred, or projected continuing decline in area, extent and/or quality of habitat?	No
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No

* See definition of location in COSEWIC O&P Manual.

Are there extreme fluctuations in index of area of occupancy?	No
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Number of Mature Individuals (in each population)

Population	N Mature Individuals
Brewery (Brasserie) Creek (QC)	Unknown
Chippewa River (ON)	Unknown
Mad River (ON)	Unknown
St. Lawrence River (Cornwall area) (ON)	Unknown
St. Lawrence River (Montréal area) (QC)	Unknown
St. Lawrence River (Québec City area) (QC)	Unknown
Detroit River (ON)	Unknown
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done
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Threats (actual or imminent, to populations or habitats)

The Chestnut Lamprey is or has been negatively affected by control measures directed towards the Sea Lamprey in two rivers (Chippewa and Mad) in the Laurentian Great Lakes Basin. Although the Mad River has not been treated since 1976, the mainstem Nottawasaga River into which the Mad River empties continues to be treated; the Chestnut Lamprey may be extirpated from the Chippewa River.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? USA: Wisconsin and Michigan (S4: apparently secure) [NatureServe 2009]	
Is immigration known or possible?	Unlikely
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Unlikely

Current Status

COSEWIC: Data Deficient (2010)

Status and Reasons for Designation

Status: Data Deficient	Alpha-numeric code: Not Applicable
Reasons for designation: Insufficient information exists for assessment purposes. The occurrence of this species in the Great Lakes - Upper St. Lawrence basin has been confirmed with recent collections of 2 adults and correction to the identification of 4 adults from museum collections. No further information on distribution, abundance or habitat is available for this species.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Insufficient data to determine
Criterion B (Small Distribution Range and Decline or Fluctuation): Insufficient data to determine
Criterion C (Small and Declining Number of Mature Individuals): Insufficient data to determine
Criterion D (Very Small or Restricted Total Population): Insufficient data to determine
Criterion E (Quantitative Analysis): Insufficient data to determine

TECHNICAL SUMMARY – DU2

Genus species Ichthyomyzon castaneus

Chestnut Lamprey

Saskatchewan-Nelson River populations

Lamproie brune

Populations des rivières Saskatchewan et Nelson

Range of occurrence in Canada: Saskatchewan, Manitoba, Ontario

Demographic Information

Generation time (usually average age of parents in the population)	8 yrs
Is there an observed, inferred, or projected continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Not applicable
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over the last 10 years, or 3 generations.	Unknown
Projected or suspected percent reduction or increase in total number of mature individuals over the next 10 years, or 3 generations.	Unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over any 10 years, or 3 generations period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	Not applicable
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (Based on appendices 1 and 2)	124,915 km ²
Area of Occupancy (AO)	
Index of area of occupancy (IAO) (Based on appendices 1 and 2) 2 X 2 km grid	6,356 km ²
Is the total population severely fragmented?	No
Number of "locations*"	12
Is there an observed, inferred, or projected continuing decline in extent of occurrence?	No
Is there an observed, inferred, or projected continuing decline in index of area of occupancy?	No
Is there an observed, inferred, or projected continuing decline in number of populations?	No
Is there an observed, inferred, or projected continuing decline in number of locations?	No
Is there an observed, inferred, or projected continuing decline in [area, extent and/or quality] of habitat?	No
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

* See definition of location in the COSEWIC O&P Manual.

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Assiniboine River (MB)	Unknown
Brokenhead River (MB)	Unknown
Devils Creek (MB)	Unknown
Hazel Creek (MB)	Unknown
La Salle River (MB)	Unknown
Lake Minnedosa (MB)	Unknown
Lake of the Woods (ON)	Unknown
Lake Wahtopanah (MB)	Unknown
Lake Winnipeg (MB)	Unknown
Oak Creek (MB)	Unknown
Qu'Appelle River (SK)	Unknown
Rat River (MB)	Unknown
Red River (MB)	Unknown
Roseau River (MB)	Unknown
Round Lake (SK)	Unknown
Seine River (MB)	Unknown
Shell River (MB)	Unknown
Whitemouth River (MB)	Unknown
Whitesand River (SK)	Unknown
Winnipeg River (MB)	Unknown
Lake Manitoba (MB) is considered historical as there have been no records for over 100 yrs (since 1904).	Unknown
Total	

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done
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Threats (actual or imminent, to populations or habitats)

No threats have been identified.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? USA: North Dakota and Minnesota (SNR: not ranked) [NatureServe 2009]	
Is immigration known or possible?	Unlikely
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Unlikely

Current Status

COSEWIC: Data Deficient (2010)

Status and Reasons for Designation

Status: Data Deficient	Alpha-numeric code: Not Applicable
Reasons for designation: Insufficient information exists for assessment purposes. This species' Saskatchewan - Nelson River populations unit is broadly distributed but has not been abundant where surveyed. It has been observed at 20 sites in total in this region. No information is available on population size or trends. Although prairie rivers are generally subject to agriculturally derived sedimentation, herbicides, pesticides and eutrophication, no information is available on specific threats to this species.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Insufficient data to determine
Criterion B (Small Distribution Range and Decline or Fluctuation): Insufficient data to determine
Criterion C (Small and Declining Number of Mature Individuals): Insufficient data to determine
Criterion D (Very Small or Restricted Total Population): Insufficient data to determine
Criterion E (Quantitative Analysis): Insufficient data to determine

PREFACE

A considerable amount of new information has been obtained since the original COSEWIC status report on the Chestnut Lamprey (Lanteigne 1991). The Canadian distribution now includes Ontario and Québec (Renaud *et al.* 1996; Renaud and de Ville 2000). Records from Lake Manitoba, dating from 1894 and 1904, were reported by Hubbs and Trautman (1937), but overlooked in the original COSEWIC report. These two records are historical because the species has not been collected there since. Two designatable units (DU) are now recognized: Saskatchewan-Nelson River and Great Lakes-Upper St. Lawrence. The Chestnut Lamprey has been collected as recently as 2009 in both the Saskatchewan-Nelson River Biogeographic Zone and Great Lakes-Upper St. Lawrence Biogeographic Zone. Based on an extensive mark-recapture study conducted in Michigan (Hall 1963), the home range of the Chestnut Lamprey over the course of its adult life has been estimated to be a stream length of 50 km, and hence this is the criterion used to establish the minimum boundaries between populations in a given waterbody. All of the previous Canadian records of Chestnut Lamprey were based on adult individuals. The presence of larval Chestnut Lamprey has now also been confirmed in Canada (Rat River, Manitoba). A second Canadian spawning locality, besides the Rat River (Case 1970), is now confirmed in the lower reaches of the Whitemouth River, Manitoba, based on an event observed in 1990 (Manitoba Fisheries Branch, pers. comm. 2010). While Lanteigne (1991) identified a number of potential threats to the Saskatchewan-Nelson River DU, no direct limiting factors or threats to this DU are identified in this update status report. However, two of the seven populations in the Great Lakes-Upper St. Lawrence DU are or were likely negatively impacted by lampricide treatments targeting the Sea Lamprey (*Petromyzon marinus*) in the Great Lakes.



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 (2010)

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.

COSEWIC Status Report

on the

Chestnut Lamprey *Ichthyomyzon castaneus*

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

in Canada

2010

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WILDLIFE SPECIES INFORMATION

Name and classification

Class:	Petromyzontida
Order:	Petromyzontiformes
Family:	Petromyzontidae
Genus:	<i>Ichthyomyzon</i>
Species:	<i>Ichthyomyzon castaneus</i> Girard, 1858
English Common Name:	Chestnut Lamprey
French Common Name:	lamproie brune

Morphological description

The Chestnut Lamprey (Figure 1) attains a maximum adult total length of 363 mm (Moore and Kernodle 1965) and a maximum larval total length of 165 mm (Lanteigne 1981). It has the characteristic elongate body and seven gill pores on each side of the branchial region common to all lampreys. The larval stage has a horseshoe-shaped oral hood without teeth and the adult stage has an oral disc with teeth made of keratin. While the common name refers to the brownish body colouration in adults, they may also be dark grey to olive (Hall and Moore 1954; Cross 1967), to light green (Cochran 1986a) and spent (i.e., spawned out) individuals are blue-black (Hubbs and Trautman 1937). It belongs to the genus *Ichthyomyzon*, distinctive among lampreys by possessing a single indented dorsal fin; all other genera possess two distinct dorsal fins. This genus is endemic to North America and comprises six species; three, including the Chestnut Lamprey, that are parasitic as adults and three that do not feed as adults (i.e., nonparasitic). Two of its congeners also occur in Canada; the parasitic Silver Lamprey, *I. unicuspis* and the nonparasitic Northern Brook Lamprey, *I. fossor*. Both are broadly sympatric with the Chestnut Lamprey from Manitoba to Québec. In the adult stage, they are distinguished from the Chestnut Lamprey by the usual absence in their oral disc of bicuspid inner lateral teeth (Range: 0-2; strong mode of 0) compared to typically 6-8 bicuspid inner lateral teeth (Range: 1-8; mode of 6) in the Chestnut Lamprey. Hubbs and Trautman (1937) showed that 98% of all Silver Lamprey had 0 bicuspid inner lateral teeth and 77% of all Chestnut Lamprey had 6-8 bicuspid inner lateral teeth. In Renaud *et al.* (1996), 81% of Silver Lampreys from Ontario had 0 bicuspid inner lateral teeth (the rest had 1 or 2 bicuspid inner lateral teeth); four of the five Ontario Chestnut Lamprey specimens possessed 4 or 5 bicuspid inner lateral teeth; the fifth possessed 3 or 4 (the number of cusps on one inner lateral tooth could not be determined because it was missing). However, Hall and Moore (1954) report two specimens of *I. castaneus* without any bicuspid inner lateral teeth; one from Oklahoma and the other from Texas, where neither *I. unicuspis* nor *I. fossor* have ever been reported. These are taken as extremely rare cases.



Figure 1. Adult Chestnut Lamprey in lateral view. Photographed by Douglas A. Watkinson, Freshwater Institute, Fisheries and Oceans Canada, Winnipeg.

These three species are more difficult to distinguish as larvae (called ammocoetes), although larger larvae can be distinguished based on presence or absence of pigmentation of the lateral line organs. According to Vladykov and Kott (1980) and Lanteigne (1981, 1988), larvae of Silver Lamprey and Northern Brook Lamprey possess unpigmented lateral line organs, whereas the ammocoetes of Chestnut Lamprey possess darkly pigmented lateral line organs. However, Neave *et al.* (2007), using mitochondrial DNA assays to unambiguously distinguish Chestnut from Silver Lamprey and Northern Brook Lamprey ammocoetes (see **Spatial population structure and variability** below), found that the lateral line organs were not pigmented in any Chestnut Lamprey <80 mm in total length but were darkly pigmented in 24% of those ≥ 80 mm; all individuals ≥ 105 mm in length had pigmented lateral line organs (Docker, pers. comm. 2010). Renaud (in press) states that pigmentation of the lateral line organs can be used to recognize Chestnut Lamprey ammocoetes at least after they have attained a total length of 94 mm. The lateral line organs remain darkly pigmented once the larvae transform into adults in the Chestnut Lamprey; they become darkly pigmented in adults of Silver Lamprey but remain unpigmented in those of Northern Brook Lamprey (Hubbs and Trautman 1937).

According to Hubbs and Trautman (1937), the Chestnut Lamprey is most closely related to the nonparasitic Southern Brook Lamprey, *I. gagei*, which occurs only in the United States. Together, the Chestnut Lamprey and Southern Brook Lamprey constitute what has been termed a species pair (Zanandrea 1959), in which the two members of the pair are virtually indistinguishable morphologically, except for characters related to feeding at the adult stage.

Spatial population structure and variability

No genetic study has been conducted on Canadian individuals of Chestnut Lamprey. Chestnut Lamprey is genetically distinguishable from both Silver Lamprey and Northern Brook Lamprey. Mandrak *et al.* (2004) sequenced 4,363 base pairs (bp) from a number of genes, or portions thereof, in the mitochondrial genome and found 7.2% sequence divergence between Chestnut Lamprey (n = 1 individual) from the Manistee River, Michigan (Lake Michigan Basin) and Silver Lamprey (n = 1-3) and Northern Brook Lamprey (n = 2-6) from Canadian and US localities in the Great Lakes Basin. Based on some of these differences, Mandrak *et al.* (2004), Neave (2004) and Neave *et al.* (2007) used restriction fragment length polymorphism of a portion of the mitochondrial *ND5* gene to rapidly distinguish between 62 Chestnut Lamprey larvae from three US populations in the Lake Michigan Basin (Manistee, Big Sable and Betsie rivers, Michigan) and a combined total of 143 larvae of Silver Lamprey and Northern Brook Lamprey from various Canadian and US localities in the Great Lakes Basin (Huron, Michigan and Superior basins).

Designatable units

The Chestnut Lamprey is a recognized, native Canadian species (Nelson *et al.* 2004). It is a year-round resident in Canadian waters, having been collected regularly in January-February and April to November (Appendices 1 and 2). It has a wide distribution and is divided into 27 populations (Table 1; see rationale for the recognition of populations under **Canadian range** below) from Saskatchewan to Québec; one population (in Lake Manitoba is considered extirpated). Its presence in Canada has been known since 1884 (Thompson 1898).

Table 1. Records of Chestnut Lamprey in Canada¹

Population	River/Lake Basin	Year (no. and stage of development)
Saskatchewan		
Whitesand River	Assiniboine River	1962 (1 adult), 2005 (1 adult; sighting only)
Qu'Appelle River	Qu'Appelle River	1977 (1 adult), 2001 (1 adult; sighting only)
Round Lake	Qu'Appelle River	1965 (1 adult), 1980 (1 adult)
Manitoba		
Lake Manitoba	Lake Manitoba	1894 (1 adult), 1904 (1 adult)
Lake Winnipeg	Lake Winnipeg	1952 (1 adult), 1963 (10 adults)
Lake Wahtopanah	Little Saskatchewan River	2001 (3 adults), 2003 (1 adult), 2005 (3 adults)
Lake Minnedosa	Little Saskatchewan River	2004 (5 adults)
Whitemouth River	Winnipeg River	1990 (≥ 2 adults)
Shell River	Assiniboine River	1981 (≥ 1 adult), 1991 (1 adult)
Winnipeg River	Winnipeg River	pre-1943 (> 1 adult), 1991 (1 adult)
Devils Creek	Red River	1983 (1 adult)
Brokenhead River	Lake Winnipeg	2002 (2 adults), 2008 (23 adults)
Hazel Creek	Lake Winnipeg	2002 (4 adults)
Red River	Red River	1951 (1 adult), 1957 (4 adults), 1973 (1 adult), 1974 (10 adults), 1978 (1 adult), 1989 (1 adult), 1991 (1 adult), 1992 (1 adult), 1993 (1 adult), 2002 (3 adults)
Assiniboine River	Assiniboine River	1884 (1 adult), 1933 (≥ 1 adult), 1977 (≥ 1 adult), 1979 (≥ 1 adult), 1982 (≥ 2 adults), 1983 (≥ 1 adult), 1984 (1 adult), 1990 (1 adult), 1995 (4 adults), 1996 (4 adults), 2001 (3 adults), 2002 (4 adults), 2003 (4 adults)
Oak Creek	Assiniboine River	2004 (1 adult)
Rat River	Red River	1960 (2 ammocoetes), 1968 (c. 50 adults), 1970 (2 ammocoetes), 1976 (1 ammocoete)
Roseau River	Red River	1991 (24 adults)
Seine River	Seine River	1974 (4 adults)
La Salle River	Lake Winnipeg	2009 (2 adults)
Ontario		
Lake of the Woods	Lake of the Woods	1970 (2 adults)
Chippewa River	Lake Superior	1966 (1 adult)
Mad River	Lake Huron	1958 (date uncertain, but before 1986) (1 adult)
Detroit River	Lake Erie	2004 (1 adult)
St. Lawrence River (Cornwall area)	St. Lawrence River	1994 (1 adult)
Québec		
St. Lawrence River (Montréal area)	St. Lawrence River	1941 (1 adult), 2009 (1 adult)
St. Lawrence River (Québec City area)	St. Lawrence River	1964 (1 adult)
Brewery (Brasserie) Creek	Ottawa River	1976 (1 adult)

¹ These records were taken from the following sources: Atton and Merkowsky (1983), Barnucz (pers. comm.), Canadian Museum of Nature Fish Collection, Case (1970), Docker (pers. comm. 2009), Firlotte (pers. comm. 2009), Fonger and McMaster (2005), Hlasny (pers. comm.), Hinks (1943), Holm (pers. comm. 2008, 2009), Hubbs and Trautman (1937), Jensen (1980), Keleher (1952), Lanteigne (1981, 1988), Lowden (2008), Manitoba Fisheries Branch (pers. comm. 2010), Massé (pers. comm. 2010), McMaster (pers. comm. 2009), Mooi (pers. comm. 2008), Renaud *et al.* (1996), Renaud and de Ville (2000), Thompson (1898), Watkinson (pers. comm. 2009).

The Chestnut Lamprey in Canada constitutes two designatable units based on its occurrence in two distinct freshwater biogeographic zones, the Saskatchewan-Nelson River zone and the Great Lakes-Upper St. Lawrence zone.

Special significance

The parasitic Chestnut Lamprey and the genus to which it belongs are endemic to Canada and the United States. Its closest relative, the nonparasitic Southern Brook Lamprey, does not occur in Canada. This is of scientific interest because another closely related parasitic-nonparasitic species pair in the genus, Silver Lamprey and Northern Brook Lamprey, occurs sympatrically in Canada, and the recognition of each member of the pair as distinct species has been the subject of recent debate (Renaud *et al.* 2009a). Further inquiry into the reason why one species pair occurs in Canada, while the other does not, may help determine whether each constituent of these pairs are distinct species or ecomorphotypes of a single species. The species-ecomorphotype conundrum is a significant knowledge gap and its solution has eluded lamprey systematists for over a century (Renaud *et al.* 2009a). Additionally, parasitic lamprey species are not generally viewed favourably by the public, and this puts the Chestnut Lamprey inherently at risk.

DISTRIBUTION

Global range

The Chestnut Lamprey is endemic to North America. It is found in Canada and the United States (Figure 2). It occurs in four contiguous Canadian provinces from Saskatchewan to Québec (Figure 3). South of the Canadian border, its range continues, with a few discontinuities, across 19 contiguous US states from the northern states of North Dakota, Minnesota, Wisconsin, and Michigan to the southern states of Texas, Louisiana, Mississippi, Alabama, and Georgia.

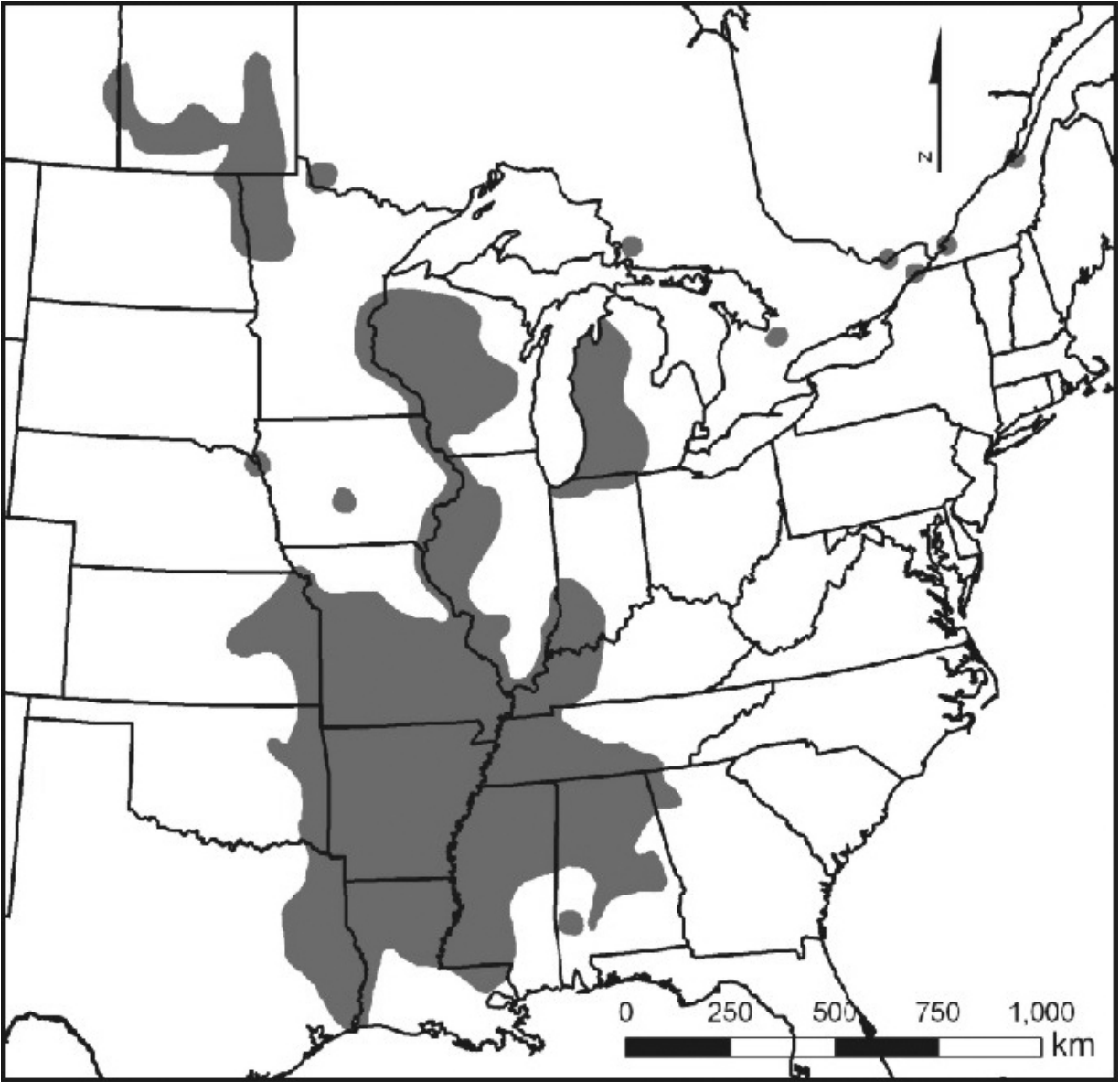


Figure 2. North American distribution of the Chestnut Lamprey (Copyright American Fisheries Society; used with permission; from Renaud *et al.* 2009a).

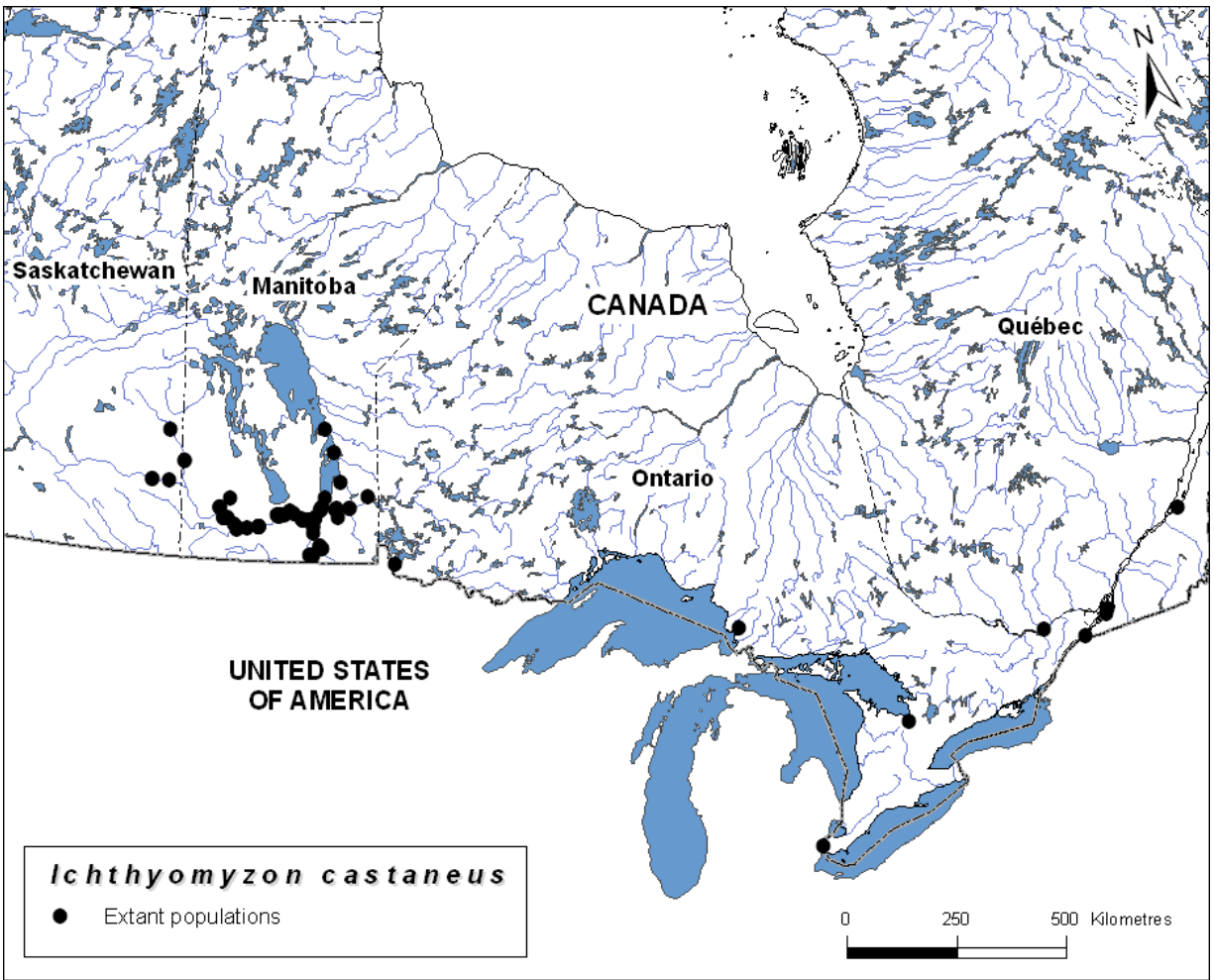


Figure 3. Canadian distribution of the Chestnut Lamprey.

Canadian range

When first assessed by the COSEWIC (Lanteigne 1991, 1992), the Chestnut Lamprey was known only from the provinces of Saskatchewan and Manitoba. Its presence has since also been confirmed in Ontario and Québec (Renaud *et al.* 1996, Renaud and de Ville 2000). In his *The Lampreys of Eastern Canada*, Huntsman (1917) identifies as *Ichthyomyzon bdellium* a 175 mm long lamprey having a single indented dorsal fin and four bicuspid inner lateral teeth, the others being unicuspid. This specimen, for which the precise locality could not be determined, can only refer to a Chestnut Lamprey, as *I. bdellium*, the Ohio Lamprey is only known from the United States (Nelson *et al.* 2004). Additionally, two historical records, dated 15 May 1894 and 2 Jan. 1904, from Lake Manitoba, and reported in Hubbs and Trautman (1937), were overlooked in the original status report (Lanteigne 1991, 1992), and also by Stewart and Watkinson (2004) in their *The Freshwater Fishes of Manitoba*.

The Chestnut Lamprey occurs in the Saskatchewan-Nelson River and Great Lakes-Upper St. Lawrence biogeographic zones (Table 1). While the distribution in the former zone is fairly continuous, in the latter zone, it is disjunct. The Canadian range equals about 10% of the global distribution (Figure 2). Twenty-seven extant Canadian populations are recognized (Table 1), based on their presence in a given waterbody (river or lake) coupled with the fact that this species is not highly mobile, engaging as an adult in a limited migration downstream of perhaps tens of kilometres, for feeding purposes, and an equivalent upstream migration for reproduction. Fifty kilometres is the estimated home range of the Chestnut Lamprey over the course of its adult life (see **Dispersal/Migration**). This is why in the St. Lawrence River, for example, three populations are recognized, based on the distances well in excess of 50 km separating the populations near Québec City, Montréal and Cornwall, respectively (Figure 3). On the basis of the distance separating the various populations, connectivity of the basins, and consideration of the impact of a potential threat, the 20 extant populations in the Saskatchewan-Nelson designatable unit (DU) are estimated to represent 12 locations and the seven populations in the Great Lakes-Upper St. Lawrence DU represent six locations.

Collection data are not organized in terms of historical versus either new locations or new populations, and cannot be, because the information is unknown. With one exception (see **Search effort**), these data simply document that the Chestnut Lamprey was collected at a certain time and place, not when it was searched for, but not collected. Within the last three Chestnut Lamprey generations (24 yrs), individuals from 14 of 20 populations in the Saskatchewan-Nelson biogeographic zone were collected/sighted only 26 times in total between 1989 and 2009 (Qu'Appelle and Whitesand rivers, Saskatchewan; Hazel and Oak creeks, Assiniboine, Brokenhead, La Salle, Red, Roseau, Shell, Whitemouth, and Winnipeg rivers, and lakes Minnedosa and Wahtopanah, Manitoba), and six of these, the Brokenhead, Hazel, La Salle, Minnedosa, Oak, and Wahtopanah populations, have been collected only since 2001. During the same 24 yr period, individuals from only three of seven populations in the Great Lakes-Upper St. Lawrence biogeographic zone were collected; once in 1994 (St. Lawrence River, Ontario), once in 2004 (Detroit river, ON) and once in 2009 (St. Lawrence River at Montréal, Québec).

The EO for the Saskatchewan-Nelson designatable unit is 124,915 km². Its IAO is 6,356 km² using a 4 km² grid and 4,870 km² using a 1 km² grid. The EO for the Great Lakes-Upper St. Lawrence designatable unit is 301,013 km². Its IAO is 1,528 km² using a 4 km² grid and 1,082 km² using a 1 km² grid.

HABITAT

Habitat requirements

The Chestnut Lamprey spends its entire life cycle in fresh water. In Michigan, the larvae live buried preferentially in streams with moderate current (about 30-60 cm/s), in a substrate of firm sand and silt and a little growth of the macroalga *Chara*, but may also be found in areas with consolidated black mud and silt, supported by a rather dense stand of *Chara* or other vegetation (Hall 1960). Recently metamorphosed adults are likewise found in burrows (Hall 1963).

The habitat characteristics of a 72 km stretch of the upper Manistee River, Michigan, may be regarded as optimal conditions. According to Hall (1963), this is where the densest population of Chestnut Lamprey occurs anywhere across its wide range. The upper Manistee River is characterized by a stable flow, as measured by the ratio of maximum to minimum flow 11:3.4 over an 18 year period. The gradient is about 1 m/1.6 km. Conductivity was about 290 $\mu\text{S}/\text{cm}$ at 18 °C. The stream is pollutant-free. Much of the substrate is made of unstable banks of sand, except for a 1 km stretch that contains considerable amounts of gravel and less sand. Additionally, overhanging banks in this short stretch provide more cover than in the other areas.

In Canada, adults have been collected in small to large lakes and in creeks to large rivers (Table 1). Nineteen collections from the Assiniboine River, Manitoba, for which there are precise data (Watkinson, pers. comm. 2009), were made between May and September, at depths (it is not specified whether depth of water or depth of capture) varying from 0.35 to 3.92 m (Mean = 1.17; SD = 0.86), water velocity from 1 to 110 cm/s (Mean = 0.52; SD = 0.34), and over substrates of sand (n = 8), clay (n = 1), or the following mixtures: sand-gravel (n = 3), gravel-cobble (n = 3), silt-sand (n = 1), clay-gravel (n = 1), limestone-cobble (n = 1), or clay-silt-cobble (n = 1). Renaud *et al.* (1996) reported that adults were found in open, clear, and brown-tinged waters, over a stony substrate, at a maximum depth of 20 m in Lake of the Woods, Ontario and in swift, clear water, over a rocky and vegetated substrate in the St. Lawrence River, Ontario. In the Detroit River, Ontario, one adult Chestnut Lamprey was collected in slow current, at 2 m depth over sand, rubble and gravel (Barnucz pers. comm. 2010).

During most of its 18 month adult life chestnut lamprey requires host fishes on which to feed, and for this it uses various species (see **Interspecific interactions**). When unattached to hosts, a study in Wisconsin found adults in very swift current to occur in crevices between boulders, at depths of less than 1 m (Cochran 1984, 1987).

A study in the Rat River, Manitoba, showed that the Chestnut Lamprey requires small, shallow, fast-flowing streams (9.5 m wide, 38 cm deep, about 1 m/s water velocity), with coarse gravel (3.5-5.0 cm in diameter), for nest construction and spawning (Case 1970). In Michigan, spawning was observed in streams 6.5-43.0 m wide and 40-90 cm deep (Morman 1979).

Over the course of its life, Chestnut Lamprey requires a wide range of water velocities; from 30-60 cm/s as a larva (Hall 1960), 1-110 cm/s as a feeding adult (Watkinson, pers. comm. 2009), and about 1 m/s as a spawning adult (Case 1970).

The only published case of spawning in Canada was in the open (Case 1970), and this is also the usual behaviour in Michigan (Morman 1979) and Missouri (Pflieger 1997). However, there is a reported case, in Michigan, of a spawning aggregation of 8-10 individuals, under a log, in about 60 cm of water (Hall 1963), and also in a crevice between boulders, in Wisconsin (Cochran and Gripenotrog 1992).

Habitat trends

Saskatchewan-Nelson River DU

Many of the Chestnut Lamprey records are associated with water regulation structures, which restrict, or at least impede, movement. The collections of interest were made at the dam on the Whitesand River, Saskatchewan (Jensen 1980), at a control structure on Round Lake, Saskatchewan (Jensen 1980), at Kamsack Weir on the Assiniboine River, Saskatchewan (Fonger and McMaster 2005), on the Red River, Manitoba, at the lower end of the St. Andrews Dam fishway, at the floodway opening north of St. Andrews Dam, between Selkirk and St. Andrews locks and at the Selkirk Hydro Station (Keleher 1952; Docker, pers. comm. 2009), at Minnedosa Dam, Lake Minnedosa, Manitoba (Manitoba Fisheries Branch, pers. comm. 2010), at a small dam on the Brokenhead River, Manitoba (Lowden 2008), at a Hydro weir on the Assiniboine River, Manitoba (Firlotte, pers. comm. 2009), near the tailrace of a dam on the Rat River, Manitoba (Case 1970), and finally, on the Roseau River, Manitoba, 19 adults on their spawning migration were collected off the wall of the Dominion City Dam and five were collected at the bottom of this dam (Docker, pers. comm. 2009). This implies that these structures impede Chestnut Lamprey movement, but the above structures have been in operation for over three Chestnut Lamprey generations (24 yrs).

Water quality and riparian assessments conducted in the Assiniboine River watershed, Saskatchewan, in 2005, indicate generally healthy habitat conditions for Chestnut Lamprey (Fonger and McMaster 2005).

Great Lakes-Upper St. Lawrence DU

Two of the six populations, Chippewa River, Lake Superior Basin and Mad River, Lake Huron Basin, are or have been treated with lampricide to control the Sea Lamprey, *Petromyzon marinus* (see **Limiting Factors and Threats**). The Mad River, a tributary of the Nottawasaga River, has not been treated since 1976 (i.e., within the past three Chestnut Lamprey generations) but the mainstem Nottawasaga River continues to be treated with lampricide.

Habitat protection/ownership

Chestnut Lamprey is not known to occur on any lands protected by the Parks Canada Agency (Nantel, pers. comm. 2009). The federal *Fisheries Act* prohibits the destruction of fish habitat.

Saskatchewan-Nelson River DU

No specific information was available to the author.

Great Lakes-Upper St. Lawrence DU

Roughly an 8 km long section out of 30 km, where Sea Lamprey Control Centre personnel have conducted surveys along the Mad River, goes through the northwestern section of Canadian Forces Base Borden (Department of National Defence land). Land uses in the remaining section include poultry farming, orchards and urban areas (towns of Glen Huron, Creemore, Avening and Glencairn).

BIOLOGY

Information presented below on the biology of the Chestnut Lamprey uses a variety of sources and is based, as much as possible, on Canadian populations. Where the information is based on US populations, this is specified. Certain aspects of the behaviour of the Chestnut Lamprey are discussed here because they may be useful for future, if any, recovery attempts.

Observations made in the Manistee River, Michigan, by Hall (1963), and on captive stock from the Namekagon River, Wisconsin, by Cochran (1984, 1986a), indicated that adult Chestnut Lamprey fed predominantly at night. During daytime snorkel surveys conducted in the latter river, in May and September 1982 and September 1983, Cochran (1984, 1986a) further observed that 35 of the more than 38 adults encountered were hidden under cover objects. Cochran (1984, 1986a) hypothesized that this diel behaviour is an adaptation to reduce predation pressure from aquatic or aerial predators as the light green colour of Chestnut Lamprey adults contrasts starkly with the dark background, both when viewed laterally and from above.

Cochran (1984, 1985) demonstrated in laboratory experiments that Chestnut Lamprey collected from Wisconsin showed statistically significant preference for host fish (Northern Hog Sucker, *Hypentelium nigricans*) with larger surface areas. Cochran (1984, 1986b) showed in laboratory studies, corroborated by field observations, that adult Chestnut Lamprey of all sizes actively seek and preferentially attach to the dorsal surface of the trunk region, as well as to the dorsal aspect of the pectoral and pelvic fins, of a variety of hosts (White Sucker, *Catostomus commersonii*, Northern Hog Sucker and Shorthead Redhorse, *Moxostoma macrolepidotum*). He hypothesized that dorsal attachment to a host is an adaptation to foraging on fishes that live in shallow

waters with rough substrate, in order to prevent abrasion and detachment. The author further suggested that a consequence of dorsal attachments may be a reduced impact on host populations through prolonged attachments to individual hosts and reduced attack rates. As adults approach sexual maturity, the frequency of attacks on hosts declines (Cochran 1984, 1986a).

Life cycle and reproduction

The life cycle comprises three stages: a larval stage lasting several years (presumed by Scott and Crossman (1973) to be 5-7 yrs); a metamorphosis stage, which begins in August and is complete by January (i.e., which lasts approximately 5-6 months); followed by an adult stage that lasts about 18 months (Hall 1963). Generation time is, therefore, estimated to be 7-9 years.

Ammocoetes reach a maximum total length of 165 mm (Lanteigne 1981). The diet of the filter-feeding larva of this species has not been studied, but the ammocoetes of other lampreys for which the diet is known feed on detritus, algae, and bacteria (Sutton and Bowen 1994). Metamorphosing ammocoetes have total lengths of 94-165 mm (Renaud, in press) and do not feed. Adults range from 85 to 363 mm in total length (Renaud, in press). During their feeding phase, adults are external parasites that feed predominantly on the blood and other body fluids of fish hosts. Their intestinal contents tested positive for blood using an assay designed to detect blood in stools (Renaud *et al.* 2009b).

Lampreys are semelparous (i.e., they die after spawning). Adults cease feeding and undergo a short upstream spawning migration, in the spring, to streams with gravel substrate, with which they construct their nest. Case (1970) described the spawning behaviour of the Chestnut Lamprey in the Rat River, a tributary to the Red River, Manitoba. These activities occurred on 11-12 June 1968. Nest construction began in early afternoon (13:00). Lampreys attached to stones (3.5-5.0 cm in diameter) with their oral discs and moved these stones to create a nest. The stones so moved constituted the perimeter of the nest. In 3 hours, about 50 lampreys had excavated a communal nest 60 cm long, 100 cm wide and about 5 cm deep. Such a large aggregation of spawning individuals is exceptional. The number of individuals per nest, in 11 nests surveyed in Michigan, varied from one to 10 (Hall 1963; Morman 1979). Within an hour of nest completion, the females attached to the stones at the upstream end of the nest, individual males attached to the head of a female, and each male wrapped his tail around the anterior part of the female's body. The male's tail portion then moved down towards the female's tail, and both bodies quivered rapidly. Those individuals not engaged in mating picked up stones from the upstream portion of the nest and placed them inside the nest, covering the recently fertilized eggs, and further expanded the nest upstream. Eggs were elliptical and measured on average 0.64 mm by 0.56 mm. Spawning activity and upstream excavation continued throughout the night and were essentially terminated by 10:30, having lasted over 20 hours.

A female with free eggs in its body cavity was collected on 7 June 2004 from Oak Creek, Manitoba (Mooi, pers. comm. 2008), 19 adults on their spawning migration were collected in the Roseau River, Manitoba, on 25 May 1991 (Docker, pers. comm. 2009), a spent female was collected in the Chippewa River, Ontario, on 6 July 1966 (Renaud *et al.* 1996) and a male in spawning condition was collected in the Mad River, Ontario, on 18 May, year unknown (Renaud *et al.* 1996). These records, as well as the spawning event recorded in the Rat River, Manitoba, by Case (1970), indicate a June, and perhaps late May, spawning period for Chestnut Lamprey in Canada. Stewart and Watkinson (2004) state that mature adult Chestnut Lamprey were collected in the Roseau River at the Dominion City Dam, Manitoba, in mid- to late June, but the collection deposited in the University of Manitoba is dated 25 May 1991 (Docker, pers. comm. 2009).

In Michigan, spawning also occurs between 28 May and 25 June, with peak spawning in early June (Hall 1963; Morman 1979). However, in Wisconsin, spawning is suggested to occur in April and May, where a large concentration of Chestnut Lamprey in mid-April, consisting of hundreds of individuals attached to vegetation, was interpreted as a spawning aggregation (Becker 1983). In Tennessee, spawning is probably in early May, based on the collection of a spent individual on 23 May (Etnier and Starnes 1993). In Missouri, spawning occurs in the first three weeks of May (Pflieger 1997).

Fecundity was estimated gravimetrically (i.e., eggs were counted in an ovarian sample of a given weight and extrapolated to the total weight of the ovaries) to be 42,000 eggs in a 284 mm mature female from Oklahoma (Hall and Moore 1954). However, the fecundity of a 255 mm mature female from Wisconsin was estimated to be 13,400 eggs (Becker 1983). Absolute fecundity (i.e., the total count of eggs per female) was recorded for eight adult females of undetermined lengths from the Muskegon River, Michigan. The mean was 13,677 eggs and the range 10,144-18,563 (Beamish and Thomas 1983).

Predation

According to Case (1970), the eggs are probably eaten by many small fishes, chiefly the Common Shiner, *Luxilus cornutus*. Cochran *et al.* (1992) attributed the death of two adult lampreys, in Wisconsin, measuring 149-210 mm long, to birds, possibly heron. While these two lampreys were not consumed, it is likely that some are.

Physiology

The physiological requirements and tolerances have not been experimentally determined for the species, but one can get a general idea of these based on the environmental parameters recorded during the collection of specimens (Appendices 1 and 2). Additionally, the recording by Case (1970) of the water temperature during spawning (16.5 °C) provides valuable information.

Larvae measuring 94-152 mm in total length were collected in an 8 km stretch of the Rat River, Manitoba, in the months of February, May and August (Table 1), indicating that the ammocoete probably leads a fairly sedentary life style. Otherwise, one would not expect to find them in the same general area over a 6 month period. However, mark-recapture or telemetry studies would need to be conducted to confirm this.

While Chestnut Lamprey in Michigan is thought to feed as an adult primarily between May through October (Hall 1963), Canadian adults attached to hosts (Table 1) were collected during most months of the year (January, April-November), indicating that active feeding probably occurs throughout the year. Four adults were collected in Manitoba, during the month of January, specifically, in lakes Manitoba and Winnipeg, in Devils Creek, and in the Red River; the last two taken off Northern Pike, *Esox lucius*. There are additional cases of attachments to fishes, presumably for feeding but perhaps for transport, during winter: in February to Northern Pike in the Namekagon River, Wisconsin (Cochran *et al.* 2003), in January to Common Carp, *Cyprinus carpio*, in the Northeastern Outing Club Lake, an oxbow of the Illinois River, Oklahoma (Moore and Kernodle 1965) and in December to Common Carp in the Missouri River, Kansas (Cross and Metcalf 1963). Additionally, Chestnut Lamprey adults have been seen swimming up to a hole cut in the ice in the Namekagon River (Cochran *et al.* 2003). The above examples of winter activity refute the statement by Hall (1963) that the adult Chestnut Lamprey is inactive in winter.

Some adults on their spawning migration were collected off the wall of a dam, to which they were attached by their oral disc (Docker, pers. comm. 2009), indicating an ability to live outside water for a period of time.

In the Rat River, Manitoba, the water temperature at spawning was 16.5 °C (Case 1970). In Michigan, water temperature at spawning varied from 15.6 to 22.2 °C, with a mean of 18.3 °C (Morman 1979).

Dispersal/migration

Chestnut Lamprey larvae are fairly sedentary and undergo passive dispersal downstream from the spawning area. As an adult, it attaches to fishes for feeding purposes or for transport. Dispersal, when attached, depends on the size of the host and its mobility. When the Chestnut Lamprey approaches sexual maturity, it ascends small streams where it congregates to spawn in the late spring, early summer.

Adult movements were assessed in a mark-recapture study of Chestnut Lamprey collected in traps, set along a 67 km stretch of the Manistee River, Michigan (Hall 1963). A total of 1,911 Chestnut Lamprey adults were marked and 1,015 of those were recaptured at least once. The mean distance travelled was over 3.2 km. Two individuals were recaptured 38 km from where they were marked, the maximum linear distance recorded. The 20 individuals most frequently recaptured (Mean = 9.4 times, SD = 3.2, Range: 6-15) travelled a mean total distance of 12.8 km (SD = 5.6, Range: 2.8-24.0)

over a mean period of 61.9 days (SD = 33.6, Range = 19-134). However, the mean net distance travelled from the point of marking, either upstream or downstream, was only 3.8 km (SD = 4.4, Range = 0.0-12.0), because the lampreys changed direction a mean of 3.9 times (SD = 2.3, Range = 1-9). Therefore, the home range is estimated to be about 50 km.

Interspecific interactions

In Canada, the only fish hosts that have been documented for the adult Chestnut Lamprey are the Northern Pike (Thompson 1898; Keleher 1952), the White Sucker (Renaud and de Ville 2000; Lowden 2008; Watkinson, pers. comm. 2010), the Silver Redhorse, *Moxostoma anisurum* (Watkinson, pers. comm. 2010), the Shorthead Redhorse (Watkinson, pers. comm. 2010), and the Lake Sturgeon, *Acipenser fulvescens* (Massé, pers. comm. 2010). Stewart and Watkinson (2004) further listed the Walleye, *Sander vitreus*, and Sauger, *S. canadensis*. However, it is not clear whether these are based on reports for Manitoba or elsewhere.

In the United States, fish hosts other than the ones reported in Canada include the introduced Common Carp, Rainbow Trout, *Oncorhynchus mykiss*, and Brown Trout, *Salmo trutta*, both hatchery-reared and native Brook Trout, *Salvelinus fontinalis*, and native Paddlefish, *Polyodon spathula*, Longnose Gar, *Lepisosteus osseus*, Goldeye, *Hiodon alosoides*, Creek Chub, *Semotilus atromaculatus*, Western Blacknose Dace, *Rhinichthys obtusus* (as *R. atratulus*), Northern Hog Sucker, Smallmouth Buffalo, *Ictiobus bubalus*, Spotted Sucker, *Minytrema melanops*, River Redhorse, *Moxostoma carinatum*, Golden Redhorse, *M. erythrurum*, Pealip Redhorse, *M. pisolabrum* (as *M. aureolum*), Blacktail Redhorse, *M. poecilurum*, Blue Catfish, *Ictalurus furcatus*, Channel Catfish, *I. punctatus*, Chain Pickerel, *Esox niger*, Burbot, *Lota lota*, Ozark Bass, *Ambloplites constellatus*, Largemouth Bass, *Micropterus salmoides*, Smallmouth Bass, *M. dolomieu*, Green Sunfish, *Lepomis cyanellus* and Bluegill, *L. macrochirus* (Gudger 1930; Hubbs and Trautman 1937; Knapp 1951; Hall and Moore 1954; Hall 1960, 1963; Cross and Metcalf 1963; Moore and Kernodle 1965; Becker 1983; Mayden *et al.* 1989; Pflieger 1997; Cochran and Jenkins 1994). Hall (1963) estimated that the Chestnut Lamprey was responsible for the mortality of one third of the stocked legal-sized trout (18 cm in length) in the Manistee River, Michigan. In aquarium experiments, Hall (1960) determined that duration of lamprey attachment to hatchery trout, either Rainbow Trout or Brook Trout, varied from 0.6 to 18.3 days, and 61% of these attachments (11 of 18) resulted in the death of the host. The 39% of attachments in which the trout survived lasted between 0.6 and 18.2 days. Cochran and Kitchell (1986) reported hosts (species unspecified) surviving attachments, also under laboratory conditions, that exceeded 35 days. They concluded that the Chestnut Lamprey exhibits a wide range in its feeding rate.

Hubbs and Trautman (1937) suggested that an adult specimen from Green Bay, Lake Michigan Basin, Michigan, may have been a hybrid between *I. castaneus* and *I. unicuspis* and Starrett *et al.* (1960) suggested that an adult specimen from the Mississippi River, in Illinois, might also have been a hybrid between these two species. However, it is possible that these individuals represent Silver and Chestnut lampreys with atypical dentition (i.e., Silver Lamprey with one or more bicuspid inner lateral teeth or Chestnut Lamprey with fewer than three bicuspid inner lateral teeth; see **Morphological description** above) and Hubbs and Trautman (1937: 14) stated: “It is improbable that any regular intergradation occurs between *castaneus* and *unicuspis*, for these forms remain essentially typical over their wide ranges ...”. While they used the words intergradation and forms, they clearly intended introgressive hybridization and species. In hybridization experiments, Piavis *et al.* (1970) showed that 45.9-82.9% of *I. castaneus* female X *I. castaneus* male hybrid offspring survived to the burrowing stage (developmental stage 17; the last stage before the experiments were terminated), while crosses between Chestnut and Silver lampreys were less successful: 20.8% *I. unicuspis* female X *I. castaneus* male survived to the same stage and 0% survival occurred in the *I. castaneus* female X *I. unicuspis* male experiments. Nevertheless, attention should be given to the possibility that hybrids may be encountered in the wild. Stewart and Watkinson (2004) reported finding dead, spent Chestnut Lamprey and Silver Lamprey in the Rat River at St. Malo, Manitoba, in early July. This means that at this location their spawning periods coincided and, therefore, could lead to some hybridization. Given the many diagnostic differences detected in the mitochondrial DNA of Chestnut and Silver lampreys (see **Spatial population structure and variability**) and the newly developed *Ichthyomyzon*-specific microsatellite markers (McFarlane and Docker 2009), it should be possible to detect hybrids between Chestnut and Silver lampreys using genetic methods.

Regarding the possibility of hybridization with other lamprey species, Chestnut Lamprey and Northern Brook Lamprey have been observed in the same nest in Missouri (Pflieger 1997) and Piavis *et al.* (1970) found 59.2% *I. fossor* female X *I. castaneus* male hybrid offspring survived to the burrowing stage (although 0% survival occurred in the *I. castaneus* female X *I. fossor* male crosses). In Michigan, cases of communal spawning likewise have been documented between Chestnut Lamprey and Sea Lamprey, and also, between Chestnut Lamprey, Sea Lamprey, and American Brook Lamprey, *Lampetra appendix* (Morman 1979). However, Piavis *et al.* (1970) found 0% survival in these intergeneric crosses.

The Silver Lamprey is almost completely allopatric to Chestnut Lamprey in Michigan's Lower Peninsula (Bailey *et al.* 2004). The lack of competition may explain, in part, the high density of Chestnut Lamprey in the upper Manistee River, Michigan, where it is the only parasitic species present. In contrast, Silver Lamprey and Chestnut Lamprey are broadly sympatric in Canada from Manitoba to Québec (Renaud *et al.* 1996; Renaud and de Ville 2000), and the Chestnut Lamprey appears to be doing much better in the western part of Canada, where it outnumbers Silver Lamprey, and much more poorly in eastern Canada, where the reverse is true (see **Abundance**).

Furunculosis, a bacterial disease due to *Aeromonas salmonicida*, caused the death of many individuals of Chestnut Lamprey and their hosts held in aquaria for feeding experiments (Hall 1963). While the identity of the hosts that died was not specified, the ones used in the experiments were hatchery-raised Rainbow Trout and Brook Trout, and native Brook Trout and White Sucker.

Adaptability

In Canada, the Chestnut Lamprey is found in a wide range of aquatic habitats from creeks to large rivers and small to large lakes (Table 1). Adults across its North American range feed on a wide variety of native host fishes, both large (e.g. Paddlefish) and small (e.g. Western Blacknose Dace), and from thick scaled (e.g. Longnose Gar) to naked (e.g. Channel Catfish). It also uses as hosts the introduced Brown Trout, Rainbow Trout and Common Carp, none with which it co-evolved. Cochran and Jenkins (1994) have pointed to the use of small hosts by the Chestnut Lamprey as evidence of its flexibility.

POPULATION SIZES AND TRENDS

Search effort

The Chestnut Lamprey has not been the object of a targeted and standardized sampling program across its range. For the most part, collection of Chestnut Lamprey has occurred serendipitously. Canadian records, if the method of collection was mentioned at all, were collected using an assortment of sampling gear (backpack and boat electrofishing, gillnet, seine, trapnet, trawl, detached by hand from the wall of a dam, detached from host caught by angling).

The amount of time spent collecting (i.e., catch-per-unit-effort), as well as negative evidence (i.e., where the species was searched for but not collected), was seldom recorded. The few exceptions are noted below.

Saskatchewan-Nelson River DU

From 1995 to 2003, approximately one Chestnut Lamprey generation, Fisheries and Oceans Canada conducted fieldwork, during May to September, in the Assiniboine River, Manitoba, using a boat electrofisher (Watkinson, pers. comm. 2009). The number of adult Chestnut Lamprey collected per year was consistently low (3-4), and relative abundance estimates should be interpreted cautiously. These data showed catch-per-unit effort to be higher in 2003 (approximately 0.54 Chestnut Lampreys per hour of boat electrofishing) than in previous years (approximately 0.13-0.33 lampreys per hour in 1995-2002; Figure 4), but there was no consistent trend.

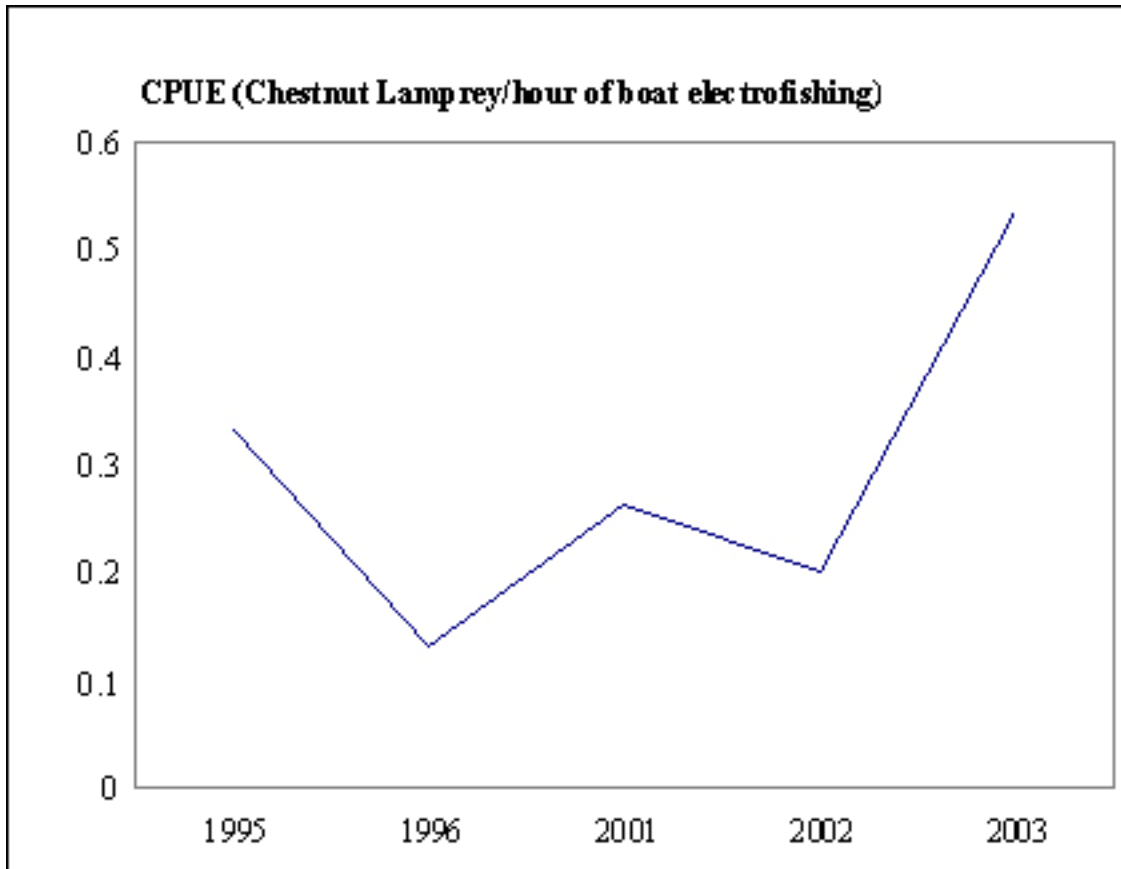


Figure 4. Catch-per-unit effort for Chestnut Lamprey in the Assiniboine River, Manitoba for the period 1995-2003. Data provided by Douglas A. Watkinson, Freshwater Institute, Fisheries and Oceans Canada, Winnipeg.

From June to mid-August 2005, nine sites predicted to be larval lamprey habitat in the Assiniboine River Basin, Saskatchewan, were electrofished, but no ammocoetes were collected (Fonger and McMaster 2005). Additionally, pot trapping for adult lamprey was conducted from mid-May to the end of July 2005 at 11 sites, where adult lamprey might congregate while migrating to spawning areas in the Assiniboine River Basin, Saskatchewan, but none were collected (Fonger and McMaster 2005). However, a probable observation of an adult Chestnut Lamprey attached to a Shorthead Redhorse on the Whitesand River, downstream of Fedoric Crossing, Saskatchewan, and another to an unidentified fish in the Assiniboine River at Kamsack Weir, Saskatchewan, were recorded in 2005 (Fonger and McMaster 2005; McMaster, pers. comm. 2009). Four additional sightings of lamprey in Saskatchewan have also been reported by anglers in unspecified years on the Assiniboine River at the Kamsack Weir, and downstream of Fort Pelly Weir, and on the Whitesand River downstream of Fedoric Crossing and in the Qu'Appelle River at the confluence with Cutarm Creek (Fonger and McMaster 2005; McMaster, pers. comm. 2009; Hlasny, pers. comm.. 2010). Chestnut Lamprey is the only lamprey recorded from Saskatchewan. Therefore, these probable observations are taken as evidence of the species continued presence in the province.

Great Lakes-Upper St. Lawrence DU

Seven veteran biologists of Sea Lamprey Control Centre, Fisheries and Oceans Canada (Rod McDonald, Fraser B. Neave, Barry Scotland, Mike Steeves, Brian Stephens, W. Paul Sullivan, and Andy Treble), with a combined 167 field seasons of experience dating back to the early 1970s, have examined hundreds of thousands of larval, parasitic-phase, and spawning-phase lampreys throughout the Great Lakes, and not one of them has ever observed a Chestnut Lamprey in Canadian waters (Sullivan, pers. comm. 2009). It is worth reiterating, however, that it is difficult to distinguish small Chestnut Lamprey ammocoetes from Silver and Northern Brook lamprey ammocoetes based on morphological characters (see **Morphological description** above). If a large percentage of those hundreds of thousands of lampreys observed were small ammocoetes, Chestnut Lamprey would go undetected, even by veteran biologists. Nevertheless, in their opinion, the few specimens reported in Renaud *et al.* (1996) constitute extremely rare anomalies (Sullivan, pers. comm. 2009).

Abundance

A total of 97 collections/observations comprising about 231 specimens (the number of individuals was not always accurately recorded) have been made in Canada between 1884 and 2009 (Appendices 1 and 2; Huntsman 1917; Fonger and McMaster 2005; McMaster, pers. comm. 2009; Barnucz, pers. comm. 2010; Hlasny, pers. comm. 2010). The vast majority of these (about 219 specimens) were made in the Saskatchewan-Nelson River biogeographic zone and only eight specimens were from the Great Lakes-Upper St. Lawrence biogeographic zone. Virtually all collections/observations are of adults. Only two ammocoetes were collected in 1960, two in 1970 and one in 1976 in the Rat River, Manitoba (Table 1), indicating recruitment at that locality. While ammocoetes have not been recorded from the Great Lakes-Upper St. Lawrence biogeographic zone, *Ichthyomyzon* larvae are generally not identified to species by Sea Lamprey Control Centre personnel and Chestnut Lamprey larvae have not been searched for in museum collections.

Since this species is semelparous (i.e., spawns only once) and there were about 50 individuals observed spawning in the Rat River, Manitoba (Case 1970), one could estimate a Canadian population to consist of roughly 50 individuals. In comparison, population estimates for the upper Manistee River, Michigan, reported to be the largest among Chestnut Lamprey populations, were made using the DeLury method. Hall (1963) obtained values between 141 and 1,460 for feeding adults, with the higher value at the beginning of the season (4-18 June) and the lower value at the end of the season (26 Sept.-17 Oct.). Since feeding adults are not sexually mature, these numbers overestimate population size because an undetermined number of feeding adults will die before reaching maturity the following spring. Given the reported high productivity of the Manistee River and the overestimate of its population size by using feeding rather than spawning adults, the population size estimate of 50 mature adults assumed for each Canadian population would not be unreasonable. However, the 50 individuals observed in the Rat River were recorded only over a 27 hour period

(Case 1970). It is thus premature to use this number as an estimate of population size for this or other Canadian populations until further investigations are carried out.

Saskatchewan-Nelson River DU

There are 20 extant populations in this zone (Devils Creek, Hazel Creek, Oak Creek, Assiniboine River, Brokenhead River, La Salle River, Qu'Appelle River, Rat River, Red River, Roseau River, Seine River, Shell River, Whitemouth River, Whites and River, Winnipeg River, Round Lake, Lake Minnedosa, Lake of the Woods, Lake Wahtopanah, Lake Winnipeg). The Lake Manitoba population is historical, there having not been any collections since 1904. Hinks (1943) stated that the Chestnut Lamprey was particularly abundant in the Winnipeg River, Manitoba. It is the most commonly collected of Manitoba's three lamprey species (Stewart and Watkinson 2004). The other two species are the Silver Lamprey and the Northern Brook Lamprey. Stewart and Watkinson (2004) further stated that even though the Chestnut Lamprey is the most common of the three Manitoba lampreys, it is not effectively sampled by any collecting gear and it may be more common and widespread than their data suggest. In a distributional study comparing the fishes of the Hatchie River System of Tennessee and Mississippi in 1972 versus 2001-2003, Keck and Etnier (2005) also suggested a similar interpretation. The presence of the Chestnut Lamprey was detected only during the latter period at two of the 130 localities surveyed and the authors suggested that this may be due to an increased sampling effort in the latter period. However, the increased sampling effort in the latter period only resulted in the collection of one specimen each from two localities.

Great Lakes-Upper St. Lawrence DU

There are seven populations in this zone (Brewery or Brasserie Creek, Chippewa River, Mad River, Detroit River, and three populations in the St. Lawrence River).

As there is no direct monitoring of Chestnut Lamprey populations, one can only evaluate the abundance of this species in relative terms. As one proceeds eastward in Canada, the abundance of the Chestnut Lamprey relative to Silver Lamprey shifts dramatically and progressively towards the latter. From being the most abundant lamprey species in Manitoba (Stewart and Watkinson 2004), it is found in a ratio of 1:47 in Ontario (Renaud *et al.* 1996: based on the examination of 242 adults of both species at the Canadian Museum of Nature, Ottawa and Royal Ontario Museum, Toronto) and 1:57 in Québec (Renaud and de Ville 2000: based on the examination of 175 adults of both species at the Canadian Museum of Nature).

Fluctuations and trends

The original COSEWIC report (Lanteigne 1991, 1992) listed 13 collection records of Chestnut Lamprey from Canada, restricted to Saskatchewan and Manitoba. This report adds another 84 records for a total of 97 (Appendices 1 and 2; Hunstman 1917; Fonger and McMaster 2005; McMaster, pers. comm. 2009; Barnucz, pers.

comm. 2010; Hlasny, pers. comm. 2010) and includes Ontario and Québec. These additional records are either new ones made since the last report or based on overlooked historical (Lake Manitoba) or re-identified museum material. Because the re-examination of museum-held material previously identified as *Ichthyomyzon unicuspis* at four Canadian institutions (University of Manitoba, Canadian Museum of Nature, Manitoba Museum and Royal Ontario Museum) and the search of old literature have been quite thorough, the finding of further additional museum-held material (at least adult specimens) is not expected.

Saskatchewan-Nelson River DU

Although search effort was not standardized, a comparison was made between the numbers of specimens collected/observed in the latest Chestnut Lamprey three generation period (1986-2009) with the previous period (1962-1985). In some cases, there is no record of the precise number of Chestnut Lamprey from each collection, but approximately 101 and 93 were collected/observed in each of these two periods (Table 1).

Great Lakes-Upper St. Lawrence DU

Likewise, although search effort was not standardized, a comparison was made between the numbers of specimens collected/observed in the latest Chestnut Lamprey three generation period (1986-2009) with the previous period (1962-1985). Three specimens were collected in the period 1986-2009 and three in the period 1960-1984 (Table 1).

The increase in extent of occurrence and area of occupancy since the last COSEWIC report (Lanteigne 1991, 1992) is not due to a recent expansion of the range but, except for two collections made in Ontario in 1994 and 2004 and one in Québec made in 2009, almost entirely to the discovery of misidentified records either in the literature (Huntsman 1917) or held in collections (Renaud *et al.* 1996; Renaud and de Ville 2000).

Rescue effect

The Chestnut Lamprey is reported from four states bordering Canada: North Dakota, Minnesota, Wisconsin and Michigan.

Saskatchewan-Nelson River DU

The NatureServe (2009) rankings for North Dakota and Minnesota are SNR (not ranked). The distribution of Chestnut Lamprey by watershed (map created June 2003) on the website shows that the records for North Dakota and Minnesota are 100 km south of Saskatchewan, Manitoba, and Ontario (NatureServe 2009). Rescue from North Dakota or Minnesota is considered unlikely (Renaud *et al.*, 2009a).

Great Lakes-Upper St. Lawrence DU

The NatureServe (2009) rankings for Wisconsin and Michigan are S4 (apparently secure). However, the distribution of Chestnut Lamprey by watershed (map created June 2003) on the website shows that the Wisconsin records nearest to Lake Superior are historical and there are no records on the Upper Peninsula of Michigan, while those of the Lower Michigan Peninsula are restricted to its western portion only. However, Bailey *et al.* (2004) mention a sample of 24 Silver Lamprey from the Lake Superior drainage of Michigan (i.e., Upper Peninsula) with 0-6 bicuspid circumoral (roughly equivalent to inner lateral) teeth. The specimens with 3-6 bicuspid teeth are probably Chestnut Lamprey. The Chestnut Lamprey is not reported from the states of Ohio eastward to Maine. Notwithstanding the probable presence of some Chestnut Lamprey on the Upper Peninsula of Michigan, the rescue effect for the Great Lakes-Upper St. Lawrence zone is considered unlikely (Renaud *et al.*, 2009a).

LIMITING FACTORS AND THREATS

Saskatchewan-Nelson River DU

Lanteigne (1991) listed a number of potential threats: destruction of spawning habitat through soil erosion and concomitant siltation; eutrophication through runoff of fertilizers; and pesticide and herbicide pollution affecting both Chestnut Lamprey and its hosts. However, no direct limiting factors or threats were identified in the Saskatchewan-Nelson River zone. There are many recent collections of the Chestnut Lamprey at a number of localities, including a well documented presence in the Assiniboine River spanning over 100 years. The loss of the Lake Manitoba population, for which the last reported collection was 1904, is difficult to explain other than as extirpation for reasons unknown.

Great Lakes-Upper St. Lawrence DU

In toxicological assays, Davis (1970) showed that *Ichthyomyzon* larvae, and this presumably would apply to those of Chestnut Lamprey, were less susceptible to the lampricide TFM (3-trifluoromethyl-4-nitrophenol) than those of Sea Lamprey, but were considerably more susceptible than those of American Brook Lamprey. The lethal dose at which 50% of test animals die (LD₅₀) for *Ichthyomyzon* was 1.83 parts per million (ppm), while it was 1.42 ppm for Sea Lamprey and 2.64 ppm for American Brook Lamprey. Notwithstanding these differences, the Chestnut Lamprey is negatively affected by control measures directed towards the Sea Lamprey in the Laurentian Great Lakes. These impact two of the seven populations of the Great Lakes-Upper St. Lawrence zone, namely, those of the Chippewa River, Lake Superior Basin and Mad River, Lake Huron Basin. In these two rivers, Chestnut Lamprey adults, in spawning condition or already spent, were collected together with Sea Lamprey, respectively, in 1966 and 1958 (this date uncertain, but before 1986), by Sea Lamprey Control Centre (SLCC) personnel. SLCC has treated the Chippewa River with

lampricide 17 times between 1961 and 2004 (Sullivan, pers. comm. 2009), and the river was still producing Sea Lamprey in the 2008 survey (Neave, pers. comm. 2009). The number of *Ichthyomyzon* larvae (all species combined; not identified to species) collected in the treated sections of the Chippewa River went from a high of 229 individuals in 1962 to none in the years 1977, 1984, 1985, 1990, 1998, and a single one collected in 2004 (Sullivan, pers. comm. 2009). The Mad River, a tributary to the Nottawasaga River, was treated with lampricide only four times, between 1961 and 1976 (Sullivan, pers. comm. 2009), although the main stem Nottawasaga River and the Pine River, another tributary to the Nottawasaga, were treated a further seven times between 1977 and 2009 (Neave, pers. comm. 2009). The Mad River has not been recolonized by Sea Lamprey since receiving its last lampricide treatment in 1976, and it continues to produce *Ichthyomyzon* larvae (Neave, pers. comm. 2009).

ABORIGINAL TRADITIONAL KNOWLEDGE AND COMMUNITY KNOWLEDGE

When requested, no Aboriginal Traditional Knowledge (Goulet, pers. comm. 2009) or Community Knowledge (Timm, pers. comm. 2009) on the Chestnut Lamprey was forthcoming.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The federal *Fisheries Act* contains provisions that can be applied to regulate flow needs for fish, fish passage, killing of fish by means other than fishing, the pollution of fish-bearing waters, and harm to fish habitat. The Chestnut Lamprey was assessed as Special Concern by the COSEWIC in April 1991 (Species at Risk Public Registry 2008) and is listed as Special Concern in Schedule 3 of SARA. However, this designation applied only to part of the Saskatchewan-Nelson River designatable unit, since the species was then known only from the provinces of Saskatchewan and Manitoba. Both the Saskatchewan-Nelson River population and the Great Lakes Upper-St-Laurence population were presented as two separate units and designated Data Deficient by COSEWIC in November 2010. The species is protected from harvest under the Saskatchewan *Fisheries Act* through lack of harvest limits (i.e., none may be caught). NatureServe (2009) gives a global status of G4 (Apparently Secure). The NatureServe (2009) status for individual jurisdictions (provinces and states) is given in Table 2. No jurisdiction across its wide range lists the species as Secure (S5). While the provincial rankings for Saskatchewan and Manitoba are S3S4 (Vulnerable/Apparently Secure), those for Ontario and Québec are virtually at either ends of the spectrum, with the former being S1? (Critically Imperiled?) and the latter being S4S5 (Apparently Secure/Secure).

Table 2. Conservation status of Chestnut Lamprey according to jurisdiction. Data from NatureServe (2009).

Conservation Status	State or Province
Possibly Extirpated (SH)	Kansas
Critically Imperiled (S1)	Nebraska
Critically Imperiled? (S1?)	Ontario
Imperiled (S2)	Alabama, Iowa, Kentucky
Vulnerable (S3)	Georgia, Illinois, Mississippi, Texas
Vulnerable/Apparently Secure (S3S4)	Manitoba, Saskatchewan
Apparently Secure (S4)	Arkansas, Indiana, Louisiana, Michigan, Oklahoma, Tennessee, Wisconsin
Apparently Secure/Secure (S4S5)	Québec
Not Ranked (SNR)	Minnesota, Missouri, North Dakota

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