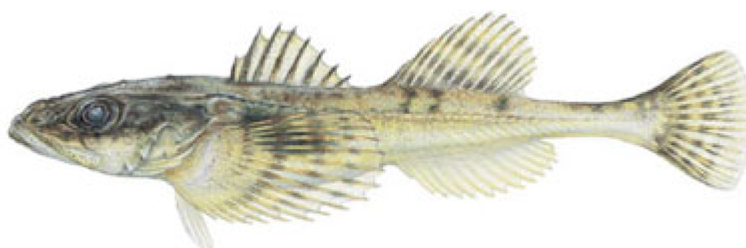
COSEWIC
Assessment and Status Report

on the

Deepwater Sculpin
Myoxocephalus thompsonii

Great Lakes-Upper St. Lawrence populations
Southern Hudson Bay-James Bay populations
Saskatchewan-Nelson River populations
Waterton Lake population
Western Hudson Bay populations
Western Arctic populations

in Canada



Great Lakes-Upper St. Lawrence populations - SPECIAL CONCERN
Southern Hudson Bay-James Bay populations - DATA DEFICIENT
Saskatchewan-Nelson River populations - NOT AT RISK
Waterton Lake population - SPECIAL CONCERN
Western Hudson Bay populations - NOT AT RISK
Western Arctic populations - NOT AT RISK
2017

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:

COSEWIC. 2017. COSEWIC assessment and status report on the Deepwater Sculpin *Myoxocephalus thompsonii*, Great Lakes-Upper St. Lawrence populations, Southern Hudson Bay-James Bay populations, Saskatchewan-Nelson River populations, Waterton Lake population, Western Hudson Bay populations and Western Arctic populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxxvii + 61 pp. (http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Previous report(s):

COSEWIC 2006. COSEWIC assessment and update status report on the deepwater sculpin *Myoxocephalus thompsonii* (Western and Great Lakes-Western St. Lawrence populations) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 39 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Parker, B. 1987. COSEWIC status report on the deepwater sculpin *Myoxocephalus thompsoni* (Great Lakes population) in Canada. Committee on the Status of Endangered Wildlife in Canada. 1-20 pp.

Production note:
COSEWIC would like to acknowledge Erik Szkokan-Emilson and Pete Cott for writing the status report on Deepwater Sculpin (*Myoxocephalus thompsonii*), Great Lakes-Upper St. Lawrence populations, Southern Hudson Bay-James Bay populations, Saskatchewan-Nelson River populations, Waterton Lake population, Western Hudson Bay populations, and Western Arctic populations in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Nicholas Mandrak, Co-chair of the COSEWIC Freshwater Fishes Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le Chabot de profondeur (*Myoxocephalus thompsonii*), populations des Grands Lacs et du haut Saint-Laurent, populations du sud de la baie d'Hudson et de la baie James, populations de la rivière Saskatchewan et du fleuve Nelson, population du lac Waterton, populations de l'ouest de la baie d'Hudson et populations de l'ouest de l'Arctique au Canada.

Cover illustration/photo:
Deepwater Sculpin — Cover illustration – J. R. Tomelleri.

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COSEWIC
Assessment Summary

Assessment Summary – April 2017

Common name
Deepwater Sculpin - Great Lakes-Upper St. Lawrence populations

Scientific name
Myoxocephalus thompsonii

Status
Special Concern

Reason for designation
This small-bodied fish occurs in the deeper parts of at least 11 coldwater lakes in Ontario and Quebec, including lakes Superior, Huron and Ontario. Previously, it was thought to be extirpated in Lake Ontario, but now appears to have re-established in that lake, with catches currently comparable to those in lakes Huron and Michigan. The population in one lake in Quebec may be extirpated due to eutrophication; the threat of invasive species is ongoing in the other lakes.

Occurrence
Ontario, Quebec

Status history
The "Great Lakes - Upper St. Lawrence populations" unit (which includes the former "Great Lakes populations" unit, designated Threatened in April 1987) was designated Special Concern in April 2006. Status re-examined and confirmed in April 2017.

Assessment Summary – April 2017

Common name
Deepwater Sculpin - Southern Hudson Bay – James Bay populations

Scientific name
Myoxocephalus thompsonii

Status
Data Deficient

Reason for designation
This small-bodied, glacial-relict fish is known from the deepest parts of three lakes in Ontario with no known threats. It may also exist in other lakes in Ontario and Manitoba. Quantitative data on population sizes, geographic range, and known threats are too limited to determine status. All populations outside of the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit, but are currently assessed by freshwater biogeographic zone.

Occurrence
Ontario

Status history
“Western populations” was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the 'Southern Hudson Bay – James Bay populations' unit was designated Data Deficient.

Assessment Summary – April 2017

Common name
Deepwater Sculpin - Saskatchewan – Nelson River populations

Scientific name
Myoxocephalus thompsonii

Status
Not at Risk

Reason for designation
This small-bodied, glacial-relict fish occurs in the deepest parts of at least 40 lakes in Ontario and Manitoba with no known threats. All populations outside of the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit, but are currently assessed separately by freshwater biogeographic zone. In this biogeographic zone, the Waterton Lake population was assessed separately as a result of its disjunction and genetic uniqueness.

Occurrence
Manitoba, Ontario

Status history
"Western populations" was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the 'Saskatchewan – Nelson River populations' unit was designated Not at Risk.

Assessment Summary – April 2017

Common name
Deepwater Sculpin - Waterton Lake population

Scientific name
Myoxocephalus thompsonii

Status
Special Concern

Reason for designation
This small-bodied glacial-relict fish is known from a single lake in southwestern Alberta. The population size is relatively small and a change in water quality or invasive species could put the population at risk. All populations outside of the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit. This population was assessed separately due to its genetic uniqueness and disjunction from other populations in the Saskatchewan-Nelson River biogeographic zone.

Occurrence
Alberta

Status history
"Western populations" was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the 'Waterton Lake population' unit was designated Special Concern.

Assessment Summary – April 2017

Common name
Deepwater Sculpin - Western Hudson Bay populations

Scientific name
Myoxocephalus thompsonii

Status
Not at Risk

Reason for designation
This small-bodied, glacial-relict fish is known from the deepest part of six lakes in Saskatchewan with no known threats. It may also exist in other lakes. All populations outside of the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit, but are currently assessed separately by freshwater biogeographic zone.

Occurrence
Saskatchewan

Status history
"Western populations" was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the 'Western Hudson Bay populations' unit was designated Not at Risk.

Assessment Summary – April 2017

Common name
Deepwater Sculpin - Western Arctic populations

Scientific name
Myoxocephalus thompsonii

Status
Not at Risk

Reason for designation
This small-bodied, glacial-relict fish is known from the deepest parts of 23 lakes in Saskatchewan, Alberta, and Northwest Territories with no known threats. It may also exist in other lakes. All populations outside of the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit, but are currently assessed separately by freshwater biogeographic zone.

Occurrence
Northwest Territories, Alberta, Saskatchewan

Status history
"Western populations" was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the 'Western Arctic populations' unit was designated Not at Risk.

COSEWIC
Executive Summary

Deepwater Sculpin
Myoxocephalus thompsonii

Great Lakes-Upper St. Lawrence populations
Southern Hudson Bay-James Bay populations
Saskatchewan-Nelson River populations
Waterton Lake population
Western Hudson Bay populations
Western Arctic populations

Wildlife Species Description and Significance

Deepwater Sculpin (*Myoxocephalus thompsonii*) is a lake-dwelling sculpin that serves as an important prey item of coldwater piscivores of commercial, recreational, and Aboriginal (CRA) value, such as Lake Trout (*Salvelinus namaycush*) and Burbot (*Lota lota*). It is sometimes confused with the closely related Fourhorn Sculpin (*Myoxocephalus quadricornis*), which has both marine and freshwater forms. However, Deepwater Sculpin is morphologically distinct from the Fourhorn Sculpin by an elongate body and lack of scales. It can be separated from all other cottids based on the absence of cephalic horns, a gill membrane that is free from the isthmus, and distinct separation between the two dorsal fins. In Canada, there are six designatable units (DUs) for Deepwater Sculpin based on where it occurs in relation to the National Freshwater Biogeographical Zones.

Distribution

Outside the Laurentian Great Lakes, Deepwater Sculpin is almost entirely restricted to Canada with just a few populations occurring in the northern United States. The species is considered a glacial relict of its Arctic marine sister species, the Fourhorn Sculpin, and it occurs only in the Laurentian Great Lakes and formerly glaciated regions of southwestern Quebec, Ontario, Manitoba, Saskatchewan, and the Northwest Territories. An isolated population is known to exist in Waterton Lake in southwestern Alberta. Deepwater Sculpin distribution is patchy due to the path of glacial retreat and the distribution of lakes with suitable conditions, but information gaps also exist, in part due to the logistical challenges of sampling remote lakes and deepwater habitats.

Habitat

Deepwater Sculpin is found in cold, highly oxygenated lakes throughout its range. It often occupies deep habitats; however, its habitat expands to shallower depths in colder, northern lakes.

Biology

The Deepwater Sculpin has a maximum age of 9 has been reported with maturity at 3 years for females and 2 years for males. It is sympatric with glacial relict crustaceans *Diporeia* spp. and *Mysis diluviana*, which make up the majority of its diet. Deepwater Sculpin is an important component of the diet of coldwater piscivores, such as Lake Trout and Burbot. Dispersal between lakes may be limited to cases where larvae may drift via river flow, and this has been speculated to occur only from Lake Huron to Lake Erie through the St. Clair and Detroit rivers.

Population Sizes and Trends

Deepwater Sculpin is known to occur in 86 lakes throughout Canada, including four Laurentian Great Lakes (it is vagrant in Lake Erie), as well as Great Slave and Great Bear lakes. In the Laurentian Great Lakes, its populations are stable in Lake Superior and it is recovering in Lake Ontario, but trawl survey catches in Lake Huron and Lake Michigan are declining. This decline is thought to be a result of a shift to deeper waters (away from trawls) in response to Quagga Mussel (*Dreissena bugensis*) invasion and associated migration of prey into deeper waters rather than an actual population decline. Many inland lakes where Deepwater Sculpin has been found at some point have only been sampled sporadically and surveys are often limited to presence/absence data. Misidentification and a lack of focus on small-bodied and deep-dwelling fishes in conventional surveys could also be contributing to our limited knowledge of the inland distribution of this species.

Threats and Limiting Factors

The main threat to Deepwater Sculpin is eutrophication from urban and agricultural sources (primarily in the Great Lakes-Upper St. Lawrence DU). Quagga Mussel impacts are a possible threat to Deepwater Sculpin, in that it is forcing prey into deeper habitat. Increasing water temperatures are a threat to Deepwater Sculpin in all DUs. While the effect is yet unknown, we may expect greater impact in more southern and shallower lakes where coldwater habitat is more limited.

Deepwater Sculpin is limited by the availability of deep, cold, highly oxygenated water, constraining its dispersal between lakes with suitable habitat. Its present distribution indicates no secondary dispersal from its postglacial lake boundaries throughout Canada.

Protection, Status and Ranks

In 2006, COSEWIC designated the Deepwater Sculpin Great Lakes-Western St. Lawrence population as “Special Concern” and the Western populations as “Not at Risk”. The Great Lakes-Western St. Lawrence population (now known as Great Lakes-Upper St. Lawrence population) is listed as “Special Concern” under the federal *Species at Risk Act*. In April 2017, COSEWIC assessed the Great Lakes-Upper St. Lawrence population as Threatened, and the former ‘Western populations’ unit was divided into 5 new designatable units (see Technical summaries for information on status designation). The new *Fisheries Act* protects commercial, recreational or Aboriginal (CRA) fisheries. Although not subject to a CRA fishery, this species can support CRA fishery species and, thus, is afforded protection under the *Fisheries Act*. Specific populations found in Waterton Lakes National Park, Alberta are partially protected by the *National Parks Act*. For Deepwater Sculpin within Fathom Five National Marine Park and Lake Superior National Marine Conservation Area, fishes and habitat would be under the *Canada National Marine Conservation Areas Act*.

TECHNICAL SUMMARY – Great Lakes-Upper St. Lawrence populations

Myoxocephalus thompsonii

Deepwater Sculpin
Great Lakes-Upper St. Lawrence populations

Chabot de profondeur
Populations des Grands Lacs et du haut Saint-Laurent

Range of occurrence in Canada: Quebec, Ontario

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	4-5 yrs (possibly up to 9 yrs)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Increases observed in Lake Ontario, new inland lake records in Ontario, but have not been found in Lac Heney, Quebec, despite surveys in 2004, 2005, and 2016.	Unknown
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 a. clearly reversible and b. understood and c. ceased? At the moment, Deepwater Sculpin appears to be stable in Lake Superior, declining in Lake Huron, and increasing Lake Ontario. In Quebec, it was historically documented in Lac Heney, but was not captured during a 2004 survey. It occurs in Lac des Trente et Un Milles and Grand lac Rond (formerly Lake Roddick) in the Laurentide region.	a. Unknown b. No c. No
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence *Extent of Occurrence*: EOO: 281 846 km² (pre-2006 observations) EOO: 559 288 km² (all observations to present) *based on minimum convex polygon around lakes	474,027 km² (2006-2015)
Index of area of occupancy (IAO)	>2 000 km²
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate) QC (lakes n=2) Grand lac Rond (formerly Lake Roddick), lac des Trente et Un Milles, ON (lakes n= 9) Lake Superior, Lake Huron, Lake Ontario, High Lake, Fairbank Lake, Dog Lake, Lake Matinenda, Lake Manitou, and Lake Nipigon. Note: Possibly vagrant in Lake Erie Historical records in Cedar Lake, Notellum Lake, and Gloucester Pool ON, and Lac des Îles, Lac des Écorces, Lac Simoneau, and Lac Memphremagog QC are likely made in error. Historical records exist for Lac Heney but Deepwater Sculpin was not collected in targeted surveys in 2004, 2005, and 2016.	Found in at least 11
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy? Since 2006, Deepwater Sculpin is thought to be occupying deeper habitats in Lake Huron; however, nearshore waters of Lake Huron have been identified as important nursery habitats for this species. It is expanding its distribution in Lake Ontario.	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Is there an [observed, inferred, or projected] decline in number of "locations"*? Deepwater Sculpin was historically documented in Lac Heney, Quebec, but not captured in 2004, 2005, or 2016 surveys. It possible that this population has been extirpated due to eutrophication.	Observed in QC lakes
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? There are multiple stressors exerted on the Great Lakes and the net effect on Deepwater Sculpin is uncertain and difficult to predict. For example, Quagga Mussel is an invasive species in lakes Ontario and Huron, establishing in around 2005. In Lake Huron, it has been suggested that Deepwater Sculpin may have moved into deeper habitats as a result of Quagga Mussel and reductions of its native prey *Diporeia*. In contrast, Deepwater Sculpin in Lake Ontario appears to have expanded its distribution and abundance. Deepwater Sculpin was not collected in a 2004 survey in some inland lakes where it was historically recorded. It is possible that this lack of detection may be the result of a decline in habitat in some locations (e.g., Lac Heney, QC).	Yes, inferred
Are there extreme fluctuations in number of subpopulations?	Probably not
Are there extreme fluctuations in number of "locations"∗?	Probably not
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	Probably not

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
QC (lakes n=2) Grand lac Rond, Lac des Trente et Un Milles ON (lakes n= 9) Lake Superior, Lake Huron, Lake Ontario, High Lake, Fairbank Lake, Dog Lake, Lake Matinenda, Lake Manitou, and Lake Nipigon.	Unknown
Total	Unknown

[*] See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Unknown

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species?

Yes, on 21 June 2016. In attendance: Nick Mandrak (Freshwater Fishes SSC co-chair), Jennifer Heron (moderator and Arthropods SSC co-chair), Erik Szkokan (writer), Pete Cott (writer and FWF SSC member), Bill Tonn, Doug Watkinson and Tim Haxton (FWF SSC members), Scott Reid (Ontario jurisdictional member for COSEWIC), Jeff Keith (Saskatchewan), Blair Wasylenko (Ontario) and Angèle Cyr (Secretariat).

Overall threat impact: High-medium

i. Natural System Modifications (High-medium): Invasive non-native Quagga mussels occurring in deep water forcing prey of Deepwater Sculpin into deeper habitat.
ii. Pollution (Medium): Eutrophication, particularly in inland lakes from cottage development, potentially from livestock ranching, farming, and forestry.
iii. All other threat categories were low, negligible, or unknown.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. Deepwater Sculpin has a global NatureServe conservation rank of G5 (Secure), and a rank of N5 (secure) in the US and N4N5 (secure to apparently secure) in Canada. This species has a rank of S3 (vulnerable) in Ontario, and S1S2 (imperilled to critically imperilled) in Quebec. Outside of Canada, it is ranked S1S2 (imperilled to critically imperilled) in Indiana, S5 (secure) in Michigan and Wisconsin, S1 (critically imperilled) in New York, and SX (extirpated) in Pennsylvania. It is not ranked in Minnesota or Ohio. The Great Lakes populations have not been ranked by this system either, but Lake Michigan and the American sides of lakes Huron and Superior all have large or increasing Deepwater Sculpin populations. Deepwater Sculpin ranks third in terms of biomass in Lake Superior. Lake Michigan may have the largest densities of this species in the Laurentian Great Lakes. Lake Ontario may have been re-colonized from Lake Huron via Lake Erie. Deepwater Sculpin is now common in the catches of survey trawls in both the Canadian and American sides of Lake Ontario. Other than within the Laurentian Great Lakes, immigration from outside Canada is not possible.	

Is immigration known or possible? Larval drift from Lake Huron (via Lake Erie) is proposed as one of the potential mechanisms for the re-colonization of Lake Ontario. Immigration is very unlikely for inland lakes.	Yes (lake dependent)
Would immigrants be adapted to survive in Canada? Deepwater Sculpin is a glacial relict and adapted to cold, deep waters such as the Canadian side of the Laurentian Great Lakes and many lakes throughout Canada. However, the scale of local adaptation to a given isolated lake is unknown for this species.	Unknown (in isolated lakes other than the Laurentian Great Lakes).
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?+ Deepwater Sculpin was historically documented in Lac Heney, Quebec, but not captured in 2004, 2005, or 2016 surveys. It possible that this population has been extirpated due to eutrophication. Quagga Mussel has invaded Lake Huron and is increasing water clarity and forcing the primary food source of the Deepwater Sculpin, *Mysis*, into deeper, darker water, and it is thought that the sculpin is shifting to deeper habitat accordingly. The impact of this ecosystem-level change on the Deepwater Sculpin is unknown.	Yes, in some lakes
Are conditions for the source population deteriorating?+ The ecosystem changes caused by the invasive Quagga Mussel described above are also occurring in Lake Michigan and the American side of Lake Huron.	Yes
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely? Rescue from Lake Huron, via larval drift though Lake Erie, is one hypothesis proposed for the recolonization of Deepwater Sculpin in Lake Ontario. *Except for populations within isolated (inland) lakes.	Yes*

Data Sensitive Species

Is this a data sensitive species? No

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status History

COSEWIC: The "Great Lakes-Upper St. Lawrence populations" unit (which includes the former "Great Lakes populations" unit, designated Threatened in April 1987) was designated Special Concern in April 2006. Status re-examined and confirmed in April 2017.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not Applicable
Reasons for designation: This small-bodied fish occurs in the deeper parts of at least 11 coldwater lakes in Ontario and Quebec, including lakes Superior, Huron, and Ontario. Previously, it was thought to be extirpated in Lake Ontario, but now appears to have re-established in that lake, with catches currently comparable to those in lakes Huron and Michigan. The population in one lake in Quebec may be extirpated due to eutrophication; the threat of invasive species is ongoing in the other lakes.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Data are insufficient to determine across the range.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Exceeds EOO, IAO, and location thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds thresholds.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

TECHNICAL SUMMARY - Southern Hudson Bay-James Bay populations

Myoxocephalus thompsonii

Deepwater Sculpin Southern Hudson Bay-James Bay populations	Chabot de profondeur Populations du sud de la baie d'Hudson et de la baie James

Range of occurrence in Canada: Ontario

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	4-5 yrs (possibly up to 9 yrs)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
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 a. clearly reversible and b. understood and c. ceased?	a. Unknown b. Unknown c. Unknown
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence *Extent of Occurrence*: EOO: N/A (pre-2006 observations) EOO: 10 100 km² (all observations to present) *based on minimum convex polygon around lakes	10 100 km² (2006-2015)
Index of area of occupancy (IAO) Continuous IAO (2 km x 2 km): Greater than 2 000 km² *based on grids over entire lakes	300 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate) ON (lakes n= 3) Echoing Lake, Sparkling Lake, and McCrea Lake.	At least 3
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Unknown
Are there extreme fluctuations in number of subpopulations?	Unknown
Are there extreme fluctuations in number of "locations"∗?	Unknown
Are there extreme fluctuations in extent of occurrence?	Unknown
Are there extreme fluctuations in index of area of occupancy?	Unknown

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Found in at least 3 lakes; Echoing Lake, Sparkling Lake, and McCrea Lake.	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].	Unknown, but unlikely to exceed thresholds

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, on 27 September 2016. In attendance: Nick Mandrak (Freshwater Fishes SSC co-chair), Dave Fraser (moderator), Erik Szkokan (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (Québec MRRF), Angèle Cyr (Secretariat). Overall threat rank was none. All threats identified were either negligible or unknown in consequence.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. This DU is endemic to Canada; therefore, there are no outside populations to provide immigrants to Canada.	
Is immigration known or possible? Immigration is not possible for inland lakes.	No
Would immigrants be adapted to survive in Canada? Deepwater Sculpin is a glacial relict and adapted to cold, deep waters throughout Canada; however, the scale of local adaptation to a given isolated lake is unknown for this species.	Unknown
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	Unknown
Are conditions for the source population deteriorating?[+] There is no source population for this DU.	n/a
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely? This DU is endemic to Canada; therefore, rescue is not possible.	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: “Western populations” was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the ‘Southern Hudson Bay-James Bay populations’ unit was designated Data Deficient.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status and Reasons for Designation:

Status: Data Deficient	**Alpha-numeric codes:** Not Applicable
Reasons for designation: This small-bodied, glacial-relict fish is known from the deepest parts of three lakes in Ontario with no known threats. It may also exist in other lakes in Ontario and Manitoba. Quantitative data on population sizes, geographic range, and known threats are too limited to determine status. All populations outside the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit, but are currently assessed by freshwater biogeographic zone.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although the EOO and IAO are below the thresholds for Threatened, and the number of locations below the threshold for Endangered, search effort has been extremely limited and it is likely that the species is present in many more lakes.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion D (Very Small or Restricted Population): Not applicable. Although comes close to qualifying for Threatened, D2, because the population exists only at three locations, the species would not, however, qualify for critically endangered in a very short period of time because the threats are minimal.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

TECHNICAL SUMMARY – Saskatchewan-Nelson River populations

Myoxocephalus thompsonii

Deepwater Sculpin
Saskatchewan-Nelson River populations

Chabot de profondeur
Populations de la rivière Saskatchewan et du fleuve Nelson

Range of occurrence in Canada: Northwestern Ontario, Manitoba

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	4-5 yrs (possibly up to 9 yrs)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
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 a. clearly reversible and b. understood and c. ceased?	a. Unknown b. Unknown c. Unknown
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence *Extent of Occurrence*: EOO: 126 898 km² (pre-2006 observations) EOO: 163 618 km² (all observations to present) *based on minimum convex polygon around lakes	163 618 km²
Index of area of occupancy (IAO) Continuous IAO (2 km x 2 km): Greater than 2 000 km² *based on grids over entire lakes	>2 000 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate) ON (lakes n= 32) Raven Lake, Sturgeon Lake, Lake 259 (ELA), Teggau Lake (ELA), Lake 310 (ELA), William Lake, Horseshoe Lake, Dicker Lake, Passover Lake, Burton Lake, Trout Lake, Eagle Lake, Burchell Lake, Saganaga Lake, Squeers Lake, Huston Lake, Cliff Lake, Agnes Lake, Kakagi Lake, Otukamamoan Lake, Pipestone Lake, Poohbah Lake, Sarah Lake, Sawbill Lake, Sheridan Lake, This Man Lake, Sparkling Lake, Titmarsh Lake, Victoria Lake, Mameigwess Lake, Red Lake, Sandybeach Lake, and Indian Lake. MB (lakes n= 7) Lake of the Woods, Lake Athapapuskow, Second Cranberry Lake, Westhawk Lake, George Lake, Mirond Lake, and Clearwater Lake. Note: Upper Waterton Lake is also in the Saskatchewan – Nelson River Freshwater Biogeographic Zone but due disjunction from the other lakes within this zone it is treated as its own DU.	At least 40
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Unknown
Are there extreme fluctuations in number of subpopulations?	Probably not

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Are there extreme fluctuations in number of “locations”∗? Recently, Deepwater Sculpin were discovered in new lakes throughout their range. It is likely that the species is more widely distributed in inland lakes than previously thought.	Probably not
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Found in at least 39 lakes: ON (lakes n= 32) Raven Lake, Sturgeon Lake, Lake 259 (ELA), Teggau Lake (ELA), Lake 310 (ELA), High Lake, William Lake, Horseshoe Lake, Dicker Lake, Passover Lake, Burton Lake, Trout Lake, Eagle Lake, Burchell Lake, Saganaga Lake, Squeers Lake, Huston Lake, Cliff Lake, Agnes Lake, Kakagi Lake, Otukamamoan Lake, Pipestone Lake, Poohbah Lake, Sarah Lake, Sawbill Lake, Sheridan Lake, This Man Lake, Sparkling Lake, Titmarsh Lake, Victoria Lake, Mameigwess Lake, Red Lake, Sandybeach Lake, and Indian Lake. MB (lakes n= 7) Lake of the Woods, Lake Athapapuskow, Second Cranberry Lake, Westhawk Lake, George Lake, Mirond Lake, and Clearwater Lake.	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].	Unknown, but unlikely to exceed thresholds

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, on 27 September 2016. In attendance: Nick Mandrak (Freshwater Fishes SSC co-chair), Dave Fraser (moderator), Erik Szkokan (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (Québec MRRF), Angèle Cyr (Secretariat). Overall threat rank is low-low. All threat categories are low, negligible, or unknown. i. Pollution (low): Eutrophication, particularly in inland lakes from cottage development, potentially from livestock ranching, farming, and forestry. ii. Energy production and mining (low): Hard rock mining under or adjacent to lakes has the potential to impact overall habitat quality.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. This DU is endemic to Canada; therefore, there are no outside populations to provide immigrants to Canada.	
Is immigration known or possible? Immigration is very unlikely for inland lakes.	No
Would immigrants be adapted to survive in Canada? Deepwater Sculpin is a glacial relict and adapted to cold, deep waters throughout Canada; however, the scale of local adaptation to a given isolated lake is unknown for this species.	Unknown
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	Unknown
Are conditions for the source population deteriorating?[+] There is no source population for this DU.	n/a
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely? This DU is endemic to Canada; therefore, rescue is not possible.	No

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: “Western populations” was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the 'Saskatchewan-Nelson River populations' unit was designated Not at Risk.

Status and Reasons for Designation:

Status: Not at Risk	**Alpha-numeric codes:** Not Applicable
Reasons for designation: This small-bodied, glacial-relict fish occurs in the deepest parts of at least 40 lakes in Ontario and Manitoba with no known threats. All populations outside of the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit, but are currently assessed separately by freshwater biogeographic zone. In this biogeographic zone, the Waterton Lake population was assessed separately as a result of its disjunction and genetic uniqueness.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Exceeds EOO, IAO, and location thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds thresholds.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

TECHNICAL SUMMARY – Waterton Lake population

Myoxocephalus thompsonii

Deepwater Sculpin — Chabot de profondeur
Waterton Lake population — Population du lac Waterton

Range of occurrence in Canada: Upper Waterton Lake, southwest Alberta

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	4-5 yrs (possibly up to 9 yrs)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
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 a. clearly reversible and b. understood and c. ceased?	a. Unknown b. Unknown c. Unknown
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence *Extent of Occurrence*: EOO: 24 km² (pre-2006 observations) EOO: 24 km² (all observations to present) *based on minimum convex polygon around lakes	24 km²
Index of area of occupancy (IAO) Continuous IAO (2 km x 2 km): 24 km² *based on grids over entire lake	24 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate) Upper Waterton Lake, Alberta	1
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No
Are there extreme fluctuations in number of subpopulations?	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

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Upper Waterton Lake	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].	Unknown

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, on 27 September 2016. In attendance: Nick Mandrak (Freshwater Fishes SSC co-chair), Dave Fraser (moderator), Erik Szkokan (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (Québec MRRF), Angèle Cyr (Secretariat). Overall threat rank was high-medium. i. Pollution (High-medium): Eutrophication, particularly from septic beds and other urban sources.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. Deepwater Sculpin has a global NatureServe conservation rank of G5 (Secure), and a rank of N5 (secure) in the US and N4N5 (secure to apparently secure) in Canada. It is listed as SU (unrankable) in Alberta. Outside of Canada, it is ranked S3 (imperiled-imperiled-vulnerable) in Montana.	
Is immigration known or possible? Immigration is very unlikely for inland lakes.	No
Would immigrants be adapted to survive in Canada? Deepwater Sculpin is a glacial relict and adapted to cold, deep waters throughout Canada; however, the scale of local adaptation to a given isolated lake is unknown for this species.	Unknown
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?+	No
Are conditions for the source population deteriorating?+ There is no source population for this DU.	n/a
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely? Deepwater Sculpin has not been recorded in the Montana portion of Upper Waterton Lake.	No

Data Sensitive Species

Is this a data sensitive species? No

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status History

COSEWIC: “Western populations” was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the ‘Waterton Lake population’ unit was designated Special Concern.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not Applicable
Reasons for designation: This small-bodied glacial-relict fish is known from a single lake in southwestern Alberta. The population size is relatively small and a change in water quality or invasive species could put the population at risk. All populations outside the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit. This population was assessed separately due to its genetic uniqueness and disjunction from other populations in the Saskatchewan-Nelson River biogeographic zone.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although comes close to qualifying for Endangered because the EOO and IAO (both 24 km^2) are below thresholds and population exists at a single location, no other sub-criteria are met.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion D (Very Small or Restricted Population): Not applicable. Although comes close to qualifying for Threatened, D2, because the population exists at a single location, the species would not, however, qualify for critically endangered in a very short period of time.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

TECHNICAL SUMMARY – Western Hudson Bay populations

Myoxocephalus thompsonii

Deepwater Sculpin
Western Hudson Bay populations

Chabot de profondeur
Populations de l'ouest de la baie d'Hudson

Range of occurrence in Canada: Saskatchewan

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	4-5 yrs (possibly up to 9 yrs)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
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 a. clearly reversible and b. understood and c. ceased?	a. Unknown b. Unknown c. Unknown
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence *Extent of Occurrence*: EOO: 18 772 km² (pre-2006 observations) EOO: 67 865 km² (all observations to present) *based on minimum convex polygon around lakes	67 865 km²
Index of area of occupancy (IAO) Continuous IAO (2 km x 2 km): Greater than 2 000 km² *based on grids over entire lakes	>2 000 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate) SK (lakes n=5) Lac la Ronge, Reindeer Lake, Laonil Lake, Canoe Lake, and Lac la Plonge. Note: Historical records in East Lake SK is likely made in error.	At least 5
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Unknown
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"∗? Recently, Deepwater Sculpin was discovered in new lakes throughout its range. It is likely that the species is more widely distributed in inland lakes than previously thought.	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
At least 5 lakes in Saskatchewan; Lac la Ronge, Reindeer Lake, Laonil Lake, Canoe Lake, and Lac la Plonge.	Unknown

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

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].	Unknown

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, on 27 September 2016. In attendance: Nick Mandrak (Freshwater Fishes SSC co-chair), Dave Fraser (moderator), Erik Szkokan (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (Québec MRRF), Angèle Cyr (Secretariat). Overall threat rank was none. All threats identified were either negligible or unknown in consequence.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. This DU is endemic to Canada; therefore, there are no outside populations to provide immigrants to Canada.	n/a
Is immigration known or possible? Immigration is very unlikely between inland lakes.	No
Would immigrants be adapted to survive in Canada? Deepwater Sculpin is a glacial relict and adapted to cold, deep waters throughout Canada; however, the scale of local adaptation to a given isolated lake is unknown for this species.	Unknown
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	Unknown
Are conditions for the source population deteriorating?[+] There is no source population for this DU.	n/a
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely? This DU is endemic to Canada; therefore, rescue is not possible.	No

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: “Western populations” was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the ‘Western Hudson Bay populations’ unit was designated Not at Risk.

Status and Reasons for Designation:

Status: Not at Risk	**Alpha-numeric codes:** Not Applicable
Reasons for designation: This small-bodied, glacial-relict fish is known from the deepest part of six lakes in Saskatchewan with no known threats. It may also exist in other lakes. All populations outside the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit, but are currently assessed separately by freshwater biogeographic zone.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Data are insufficient to determine across the range.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Exceeds EOO and IAO thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds thresholds.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

TECHNICAL SUMMARY – Western Arctic populations

Myoxocephalus thompsonii

Deepwater Sculpin
Western Arctic populations

Chabot de profondeur
Populations de l'ouest de l'Arctique

Range of occurrence in Canada: Saskatchewan, Alberta, Northwest Territories

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	4-5 yrs (possibly up to 9 yrs)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
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 a. clearly reversible and b. understood and c. ceased?	a. Unknown b. Unknown c. Unknown
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence *Extent of Occurrence*: EOO: 561 783 (pre-2006 observations) EOO: 561 783 km² (all observations to present) *based on minimum convex polygon around lakes	561 783 km²
Index of area of occupancy (IAO) Continuous IAO (2 km x 2 km): Greater than 2 000 km² *based on grids over entire lakes	>2 000 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate) SK (lakes n=12) Lake Athabasca, Black Lake, Riou Lake, Beaverlodge Lake, and South McMahon Lake (formally C1), Wollaston Lake, Hatchet Lake, Milliken Lake, Waterbury Lake, Yalowega Lake, McKay Lake, McLennan Lake. AB (lakes n=2) Lake Athabasca, Colin Lake NT (lakes n=10) Great Slave Lake, Great Bear Lake, Lac la Marte, Keller Lake, Prosperous Lake, Alexie Lake, Chitty Lake, Drygeese Lake, Baptiste Lake, and the Husky Lakes chain, which is connected to the Beaufort Sea	Found in at least 23 lakes
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Unknown
Are there extreme fluctuations in number of subpopulations?	Unknown
Are there extreme fluctuations in number of "locations"*? Recently, Deepwater Sculpin were discovered in new lakes throughout their range. It is likely that the species is more widely distributed in inland lakes than previously thought.	No
Are there extreme fluctuations in extent of occurrence?	No

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Found in at least 23 lakes	Unknown
SK (lakes n=12) Lake Athabasca, Black Lake, Riou Lake, Beaverlodge Lake, and South McMahon Lake (formally C1), Wollaston Lake, Hatchet Lake, Milliken Lake, Waterbury Lake, Yalowega Lake, McKay Lake, McLennan Lake. AB (lakes n=2) Lake Athabasca, Colin Lake NT (lakes n=10) Great Slave Lake, Great Bear Lake, Lac la Marte, Keller Lake, Prosperous Lake, Alexie Lake, Chitty Lake, Drygeese Lake, Baptiste Lake, and the Husky Lakes chain, which is connected to the Beaufort Sea	
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].	Unknown, but unlikely to exceed thresholds

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, on 27 September 2016. In attendance: Nick Mandrak (Freshwater Fishes SSC co-chair), Dave Fraser (moderator), Erik Szkokan (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (Québec MRRF), Angèle Cyr (Secretariat). i. Pollution (low): Eutrophication from urban development

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. This DU is endemic to Canada; therefore, there are no outside populations to provide immigrants to Canada.	
Is immigration known or possible? Immigration is very unlikely for inland lakes.	No
Would immigrants be adapted to survive in Canada? Deepwater Sculpin is a glacial relict and adapted to cold, deep waters throughout Canada; however, the scale of local adaptation to a given isolated lake is unknown for this species.	Unknown

Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?+	Unknown
Are conditions for the source population deteriorating?+ There is no source population for this DU.	Not applicable
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely? This DU is endemic to Canada; therefore, rescue is not possible.	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: "Western populations" was considered a single unit and designated Not at Risk in April 2006. When the species was split into five separate units in April 2017, the 'Western Arctic populations' unit was designated Not at Risk.

Status and Reasons for Designation:

Status: Not at Risk	**42. Alpha-numeric codes:** Not Applicable
Reasons for designation: This small-bodied, glacial-relict fish is known from the deepest parts of 23 lakes in Saskatchewan, Alberta, and Northwest Territories with no known threats. It may also exist in other lakes. All populations outside the Great Lakes – Upper St. Lawrence Freshwater Biogeographic Zone were previously assessed as a single unit, but are currently assessed separately by freshwater biogeographic zone.	

Applicability of Criteria
Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Data are insufficient to determine across the range.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Exceeds EOO, IAO, and location thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Data are insufficient to determine.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds thresholds.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect)

PREFACE

This report identifies 29 populations of Deepwater Sculpin not in the 2006 status report. There is evidence that existing Deepwater Sculpin populations are stable or have possibly increased since the 2006 report, and there is also new information (new populations) to suggest that its area of occupancy is larger than previously thought. Its populations are stable in Lake Superior and there are vagrant individuals in Lake Erie. Trawl-survey catches in Lake Huron and Lake Michigan are declining; however, this seems to be a result of a shift to deeper waters (away from trawls) in response to Quagga Mussel (*Dreissena bugensis*) invasion and associated migration of *Mysis* (prey) rather than actual population declines. Most notably though, the Lake Ontario population has shown remarkable recovery. Once thought to be extirpated, survey catches have steadily increased since 2006 to a point where it is now a common catch. It is thought by some that there was a relict population but too small and too deep to be detected in previous routine surveys, or that it recolonized through larval drift from the upper Great Lakes, through Lake Erie. Either way, the Deepwater Sculpin population in Lake Ontario is increasing. Existing inland lake populations seem relatively stable across its range and several new populations have been identified since the 2006 report because of significant increases in monitoring. The use of deep-set small-mesh gillnets in standard broad-scale monitoring of lakes in Ontario has led to the catches of Deepwater Sculpin in 22 additional lakes in that province alone, with more likely to come, as well as new populations found in Alberta (1), and NWT (5). It is unlikely that these newly found populations represent an actual increase in the area of occupancy, as connectivity between suitable habitats is minimal across the range and mobility is further hindered by the species' general reliance on deep, cold water habitats. Instead this represents a more accurate delineation of the area.

In the 2006 report, Deepwater Sculpin was divided into Great Lakes-Western St. Lawrence and western designatable units. In the current report, it is divided into six designatable units based on its occurrence in five freshwater biogeographic zones. Populations in the Saskatchewan-Nelson freshwater biogeographic zone were further subdivided into two designatable units, Upper Waterton Lake and lakes in the northern part of the zone, based on the large geographic disjunction of unsuitable habitat between Upper Waterton Lake and the other 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
(2017)

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.

Environment and Climate Change Canada
Canadian Wildlife Service
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Canada

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

COSEWIC Status Report

on the

Deepwater Sculpin
Myoxocephalus thompsonii

Great Lakes-Upper St. Lawrence populations
Southern Hudson Bay – James Bay populations
Saskatchewan – Nelson River populations
Waterton Lake population
Western Hudson Bay populations
Western Arctic populations

in Canada

2017

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Scorpaeniformes
Family: Cottidae
Genus and Species: *Myoxocephalus thompsonii* (Girard 1852)
English Common Name: Deepwater Sculpin (Page *et al*. 2013)
French Common Name: Chabot de profondeur (Page *et al*. 2013)
Other Common Names: *kanayok* (Inuktitut; McAllister *et al*. 1987)

Morphological Description

Deepwater Sculpin is an elongate, dorsoventrally flattened fish with length typically ranging from 51 to 76 mm total length (TL); maximum recorded length is 235 mm TL (Scott and Crossman 1973). Its body width is greatest at the uppermost preopercular spine and decreases posteriorly, with equal body depth and width at the first dorsal fin and a slender caudal peduncle (Scott and Crossman 1973). The eyes are small relative to its head size and are positioned on top of the head, which is characteristic of bottom-dwelling fishes. It also has a relatively large mouth, and small teeth on the jaws, palatines, vomer, and tongue (McPhail and Lindsey 1970; Scott and Crossman 1973). Its opercular isthmus is under the chin. It lacks preoperculomandibular (chin) pores, but it has four preopercular spines: two large upper spines that point posteriorly and upward, and two reduced lower spines that point downward (Scott and Crossman 1973). Frontal and parietal spines are absent in Deepwater Sculpin, which, along with the elongate body and lack of spines, differentiates it from the Fourhorn Sculpin (*Myoxocephalus quadricornis*). It has two completely separated dorsal fins, the first being reduced and with 7 to 10 spines, and the second larger with 11 to 16 soft rays (Scott and Crossman 1973). The pectoral fins have 15 to 18 soft rays, the pelvic fins one spine and three (sometimes four) rays, and the anal fin 11 to 16 rays. The caudal fin is square or truncated, and it has disk-like tubercles along its upper body. The Deepwater Sculpin is dark grey to brown in colouration, gradually lightening along the sides and towards the belly and with dark saddles on the back and mild speckling on the sides. There are three dark bands on the pectoral fins, light spotting on the pelvic fins, and faint blotches on the dorsal and anal fins (McPhail and Lindsey 1970; Scott and Crossman 1973) (Figure 1). It can be separated from all other sculpin species based on the absence of cephalic horns, a gill membrane that is free from the isthmus, and distinct separation between the two dorsal fins (Scott and Crossman 1973).

Figure 1. Slimy Sculpin (top), Spoonhead Sculpin (middle), and Deepwater Sculpin (bottom). Photo credits: Doug Watkinson, Fisheries and Oceans Canada (from Arciszewski *et al*. 2015).

Population Spatial Structure and Variability

Deepwater Sculpin has a somewhat disjunct distribution and, with few exceptions, appears to belong to a single mtDNA lineage (Sheldon 2006). Although the population is disjunct, advancements in broad-scale lake monitoring in Ontario are revealing a larger area of occupancy than previously thought (discussed below). Genetic information is limited, but most populations share a single haplotype, the Upper Waterton Lake (southwest Alberta) population sharing this and another unique haplotype, and the Fairbank Lake (near Sudbury, Ontario) population having a unique haplotype (Sheldon 2006).

Designatable Units

Canadian populations are known to occur in five of the 14 COSEWIC National Freshwater Biogeographic Zones (NFBZ)(Figure 2). NFBZ 10 – Great Lakes-Upper St. Lawrence for populations in Quebec and eastern Ontario; NFBZ 4 – Saskatchewan-Nelson River for populations in northwestern Ontario, Manitoba, central Saskatchewan, and southwestern Alberta; NFBZ 5 – Western Hudson Bay for populations in northeastern Saskatchewan; NFBZ 3 – Southern Hudson Bay – James Bay for populations in Ontario; and NFBZ 13 – Western Arctic for populations in northern Saskatchewan, northeastern Alberta, and the NWT. Each of these NFBZ has been defined based on independent drainages. The ichthyofauna within these distinct drainages have been isolated for several thousand years post-glaciation (Scott and Crossman 1973), and Deepwater Sculpin in each of these NFBZ are likely biologically unique.

The populations in each of these five NFBZ are considered separate designatable units (DU; COSEWIC 2004) based on the discrete and significance criteria, with an additional DU for the Waterton Lake population. Although Upper Waterton Lake is within the Saskatchewan-Nelson River NFBZ, the Waterton Lake population is isolated by an 800 km expanse of unsuitable habitat on the Canadian prairies and is a different habitat type (a subalpine lake vs. boreal lakes) from the other populations in this NFBZ; therefore, the Waterton Lake population warrants its own DU. Note that Wollaston Lake SK drains into both the Western Hudson Bay and Western Arctic NFBZ and, for the purposes of this report, is placed in the Western Hudson Bay designatable unit.

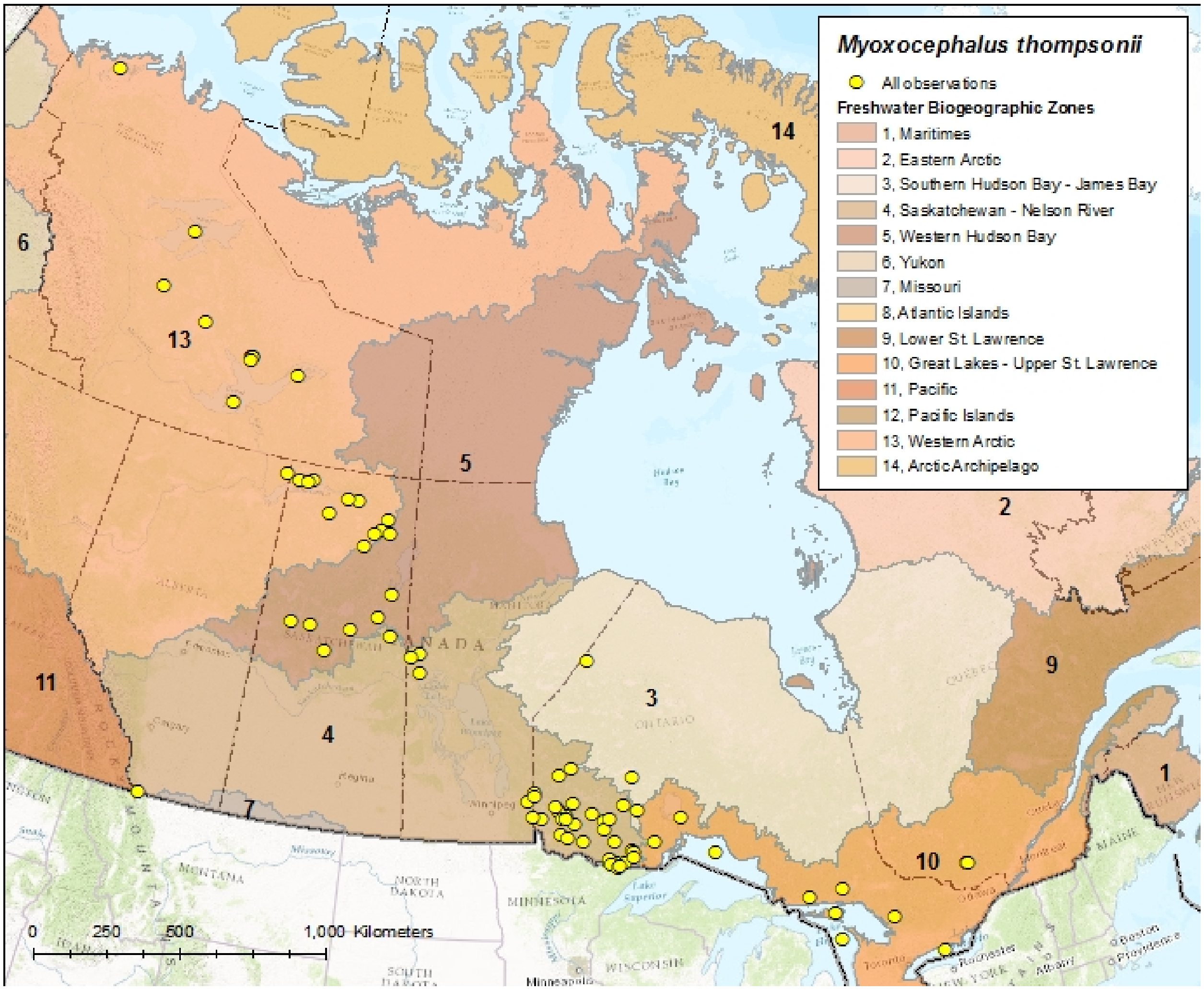

Figure 2. Distribution of the Deepwater Sculpin (*Myoxocephalus thompsonii*) in Canada in relation to the Canadian National Freshwater Biogeographic Zones.

S The Deepwater Sculpin is a lake-dwelling sculpin that serves as an important prey item of coldwater piscivores of commercial, recreational, or Aboriginal (CRA) value, such as Lake Trout (*Salvelinus namaycush*) and Burbot (*Lota lota*) (Stewart and Watkinson 2004; Lantry *et al*. 2007; Zimmerman and Krueger 2009). It is an indicator of general cold, deepwater habitat quality that is particularly sensitive to food web changes, climate change, and eutrophication. Deepwater Sculpin can be one of the most abundant deepwater fishes, representing a significant component of the deepwater biomass in many lakes (O. Gorman United States Geological Survey (USGS) pers. comm.; Gorman *et al*. 2012).

DISTRIBUTION

Global Range

Deepwater Sculpin is almost entirely restricted to Canada except for the American portions of the Laurentian Great Lakes, a few stable populations occurring in inland lakes in Michigan and Wisconsin, and some less stable populations in Indiana, Montana, Minnesota, New York, Pennsylvania, and Ohio (NatureServe 2016). Its range is limited because its postglacial dispersal was restricted to proglacial lakes and directly connected systems (Figure 3; Dadswell 1972; Parker 1988).

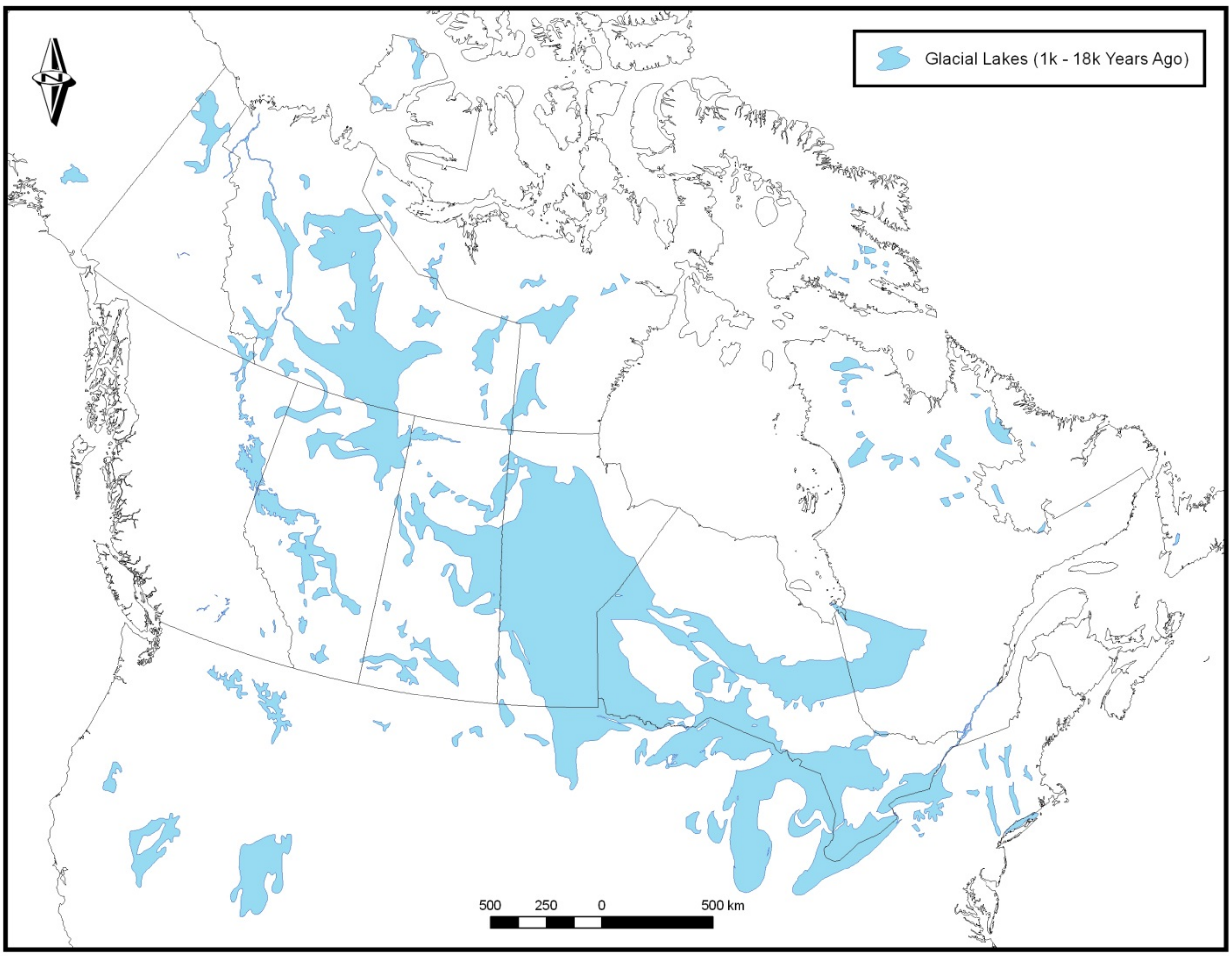

Figure 3. Distribution of glacial lakes between 1000 and 18000 years ago. (Mandrak unpubl. analysis based on Dyke *et al*. 2003.)

Canadian Range

The species is considered a glacial relict of its Arctic marine sister species, the Fourhorn Sculpin, and occurs in the formerly glaciated regions of southwestern Quebec, the Laurentian Great Lakes, Manitoba, Saskatchewan, and the Northwest Territories, (Parker 1988; Sheldon *et al*. 2008) (see Figure 3), spanning five COSEWIC NFBZ (Figure 2). Isolated populations also exist in at least two Alberta lakes (Table 1). All life stages of Deepwater Sculpin have been found in all of the Great Lakes except Lake Erie (Smith 1985), where it is thought to be vagrant as mature individuals have not been documented and only larval fish have been reported (e.g., Trautman 1981; Roseman *et al*. 1998; see below).

Table 1: Lakes with extant populations of Deepwater Sculpin in the six designatable units (DUs).

Lake	Province / Territory	DU	Year Last Seen	New since 2006 report
Grand lac Rond (formerly Lake Roddick)	QC	Great Lakes-Upper St. Lawrence	2016	N
Lac des Trente et Un Milles	QC	Great Lakes-Upper St. Lawrence	2005	N
Lac Heney	QC	Great Lakes-Upper St. Lawrence	pre-2006	N
Lake Superior	ON	Great Lakes-Upper St. Lawrence	2015	N
Lake Huron	ON	Great Lakes-Upper St. Lawrence	2015	N
Lake Ontario	ON	Great Lakes-Upper St. Lawrence	2015	N
Fairbank Lake	ON	Great Lakes-Upper St. Lawrence	2005	N
Lake Nipigon	ON	Great Lakes-Upper St. Lawrence	2005	N
Dog Lake	ON	Great Lakes-Upper St. Lawrence	2015	Y
Matinenda Lake	ON	Great Lakes-Upper St. Lawrence	2015	Y
High Lake	ON	Great Lakes-Upper St. Lawrence	pre-2006	N
Sturgeon Lake	ON	Southern Hudson Bay-James Bay	2015	Y
McCrea Lake	ON	Southern Hudson Bay-James Bay	2015	Y
Lake 259 (ELA)	ON	Saskatchewan-Nelson River	2005	N
Teggau (ELA)	ON	Saskatchewan-Nelson River	2005	N
Lake 310 (ELA)	ON	Saskatchewan-Nelson River	pre-2006	N
Eagle Lake	ON	Saskatchewan-Nelson River	2005	N
Burchell Lake	ON	Saskatchewan-Nelson River	2015	N
Saganaga Lake	ON	Saskatchewan-Nelson River	2005	N
William Lake	ON	Saskatchewan-Nelson River	pre-2006	N
Horseshoe Lake	ON	Saskatchewan-Nelson River	pre-2006	N
Dicker Lake	ON	Saskatchewan-Nelson River	pre-2006	N
Passover Lake	ON	Saskatchewan-Nelson River	pre-2006	N
Burton Lake	ON	Saskatchewan-Nelson River	pre-2006	N
Trout Lake	ON	Saskatchewan-Nelson River	2015	N
Raven Lake	ON	Saskatchewan-Nelson River	pre-2006	N
Squeers Lake	ON	Saskatchewan-Nelson River	pre-2006	N
Huston Lake	ON	Saskatchewan-Nelson River	pre-2006	N

Lake	Province / Territory	DU	Year Last Seen	New since 2006 report
Lake Manitou	ON	Saskatchewan-Nelson River	pre-2006	N
Cliff Lake	ON	Saskatchewan-Nelson River	2015	Y
Agnes Lake	ON	Saskatchewan-Nelson River	2015	Y
Kakagi Lake	ON	Saskatchewan-Nelson River	2015	Y
Otukamamoan Lake	ON	Saskatchewan-Nelson River	2015	Y
Poohbah Lake	ON	Saskatchewan-Nelson River	2015	Y
Sarah Lake	ON	Saskatchewan-Nelson River	2015	Y
Big Sawbill Lake	ON	Saskatchewan-Nelson River	2015	Y
Sheridan Lake	ON	Saskatchewan-Nelson River	2015	Y
This Man Lake	ON	Saskatchewan-Nelson River	2015	Y
Pipestone Lake	ON	Saskatchewan-Nelson River	2015	Y
Sparkling Lake	ON	Saskatchewan-Nelson River	2015	Y
Titmarsh Lake	ON	Saskatchewan-Nelson River	2015	Y
Victoria Lake	ON	Saskatchewan-Nelson River	2015	Y
Mameigwess Lake	ON	Saskatchewan-Nelson River	2015	Y
Indian Lake	ON	Saskatchewan-Nelson River	2015	Y
Sandybeach Lake	ON	Saskatchewan-Nelson River	1990	Y*
Red Lake	ON	Saskatchewan-Nelson River	1990	Y*
Westhawk Lake	MB	Saskatchewan-Nelson River	2005	N
George Lake	MB	Saskatchewan-Nelson River	2005	N
Lake of the Woods	MB	Saskatchewan-Nelson River	pre-2006	N
Clearwater Lake	MB	Saskatchewan-Nelson River	2005	N
Cranberry Lakes	MB	Saskatchewan-Nelson River	2005	N
Lake Athapapuskow	MB	Saskatchewan-Nelson River	2005	N
Upper Waterton Lake	AB	Waterton Lake	2005	N
Mirond Lake	SK	Western Hudson Bay	pre-2006	N
Lac La Ronge	SK	Western Hudson Bay	pre-2006	N
Reindeer Lake	SK	Western Hudson Bay	2015	N
Laonil Lake	SK	Western Hudson Bay	pre-2006	N
Canoe Lake	SK	Western Hudson Bay	pre-2006	N
Hatchet Lake	SK	Western Hudson Bay	pre-2006	N
Milliken Lake	SK	Western Hudson Bay	pre-2006	N
Waterbury Lake	SK	Western Hudson Bay	pre-2006	N
MacKay Lake	SK	Western Hudson Bay	pre-2006	N
Lac La Plonge	SK	Western Hudson Bay	2005	N
Yalowega Lake	SK	Western Hudson Bay	pre-2006	N
McLenna Lake	SK	Western Hudson Bay	pre-2006	N
Wollaston Lake	SK	Western Hudson Bay	2005	N
Lake Athabasca	SK	Western Arctic	pre-2006	N
Black Lake	SK	Western Arctic	pre-2006	N
Riou Lake	SK	Western Arctic	pre-2006	N
Beaverlodge Lake	SK	Western Arctic	pre-2006	N
South McMahon Lake (formerly C1)	SK	Western Arctic	pre-2006	N

Lake	Province / Territory	DU	Year Last Seen	New since 2006 report
Colin Lake	AB	Western Arctic	2001	Y *
Chitty Lake	NT	Western Arctic	2008	Y
Baptiste Lake	NT	Western Arctic	2008	Y
Drygeese Lake	NT	Western Arctic	2008	Y
Alexie Lake	NT	Western Arctic	2005	N
Great Slave Lake	NT	Western Arctic	2005	N
Lac La Marte	NT	Western Arctic	pre-2006	N
Keller Lake	NT	Western Arctic	pre-2006	N
Great Bear Lake	NT	Western Arctic	pre-2006	N
Prosperous Lake	NT	Western Arctic	pre-2006	Y *
Husky Lakes	NT	Western Arctic	pre-2006	Y *

** populations discovered prior to 2006 but not included in the 2006 COSEWIC report*

Note: pre-2006 populations were documented in the 2006 report but have not been surveyed since

Extent of Occurrence and Area of Occupancy

The overall extent of occurrence (EOO) of Deepwater Sculpin has increased in Canada since the 2006 report (from 3,439,746 km² to 4,525,964 km², respectively) because of the identification of several new populations, and is now divided among 6 DUs instead (Figure 3) of the 2 DUs presented in the previous report. This report identifies 29 inland lakes with previously unknown or undocumented populations: in the Great Lakes-Upper St. Lawrence DU, EOO increased from 373,187 km² to 375,070 km² (Figure 4); in the Southern Hudson Bay-James Bay DU, EOO remained unchanged at 10 100 km² (Figure 5); in the Saskatchewan-Nelson River DU, EOO increased from 126,898 km² to 163,618 km² (Figure 6); in the Waterton Lake DU, EOO is a single lake of 24 km²(Figure 7); in the Western Hudson Bay DU, EOO increased from 18,772 km² to 67,865 km² (Figure 8); and, although there were new observations in the Western Arctic DU since 2006, the EOO stayed the same at 561,783 km² (Figure 9). Many new records result from recent incorporation of small-mesh gillnets sets in deep waters of small- and medium-sized lakes as part of standard index surveys, and more discoveries are likely to occur.

The Index of area of occupancy is > 2,000 km² in all DUs, except for the Southern Hudson Bay-James Bay DU at 300 km² and the Waterton Lake DU at 24 km².

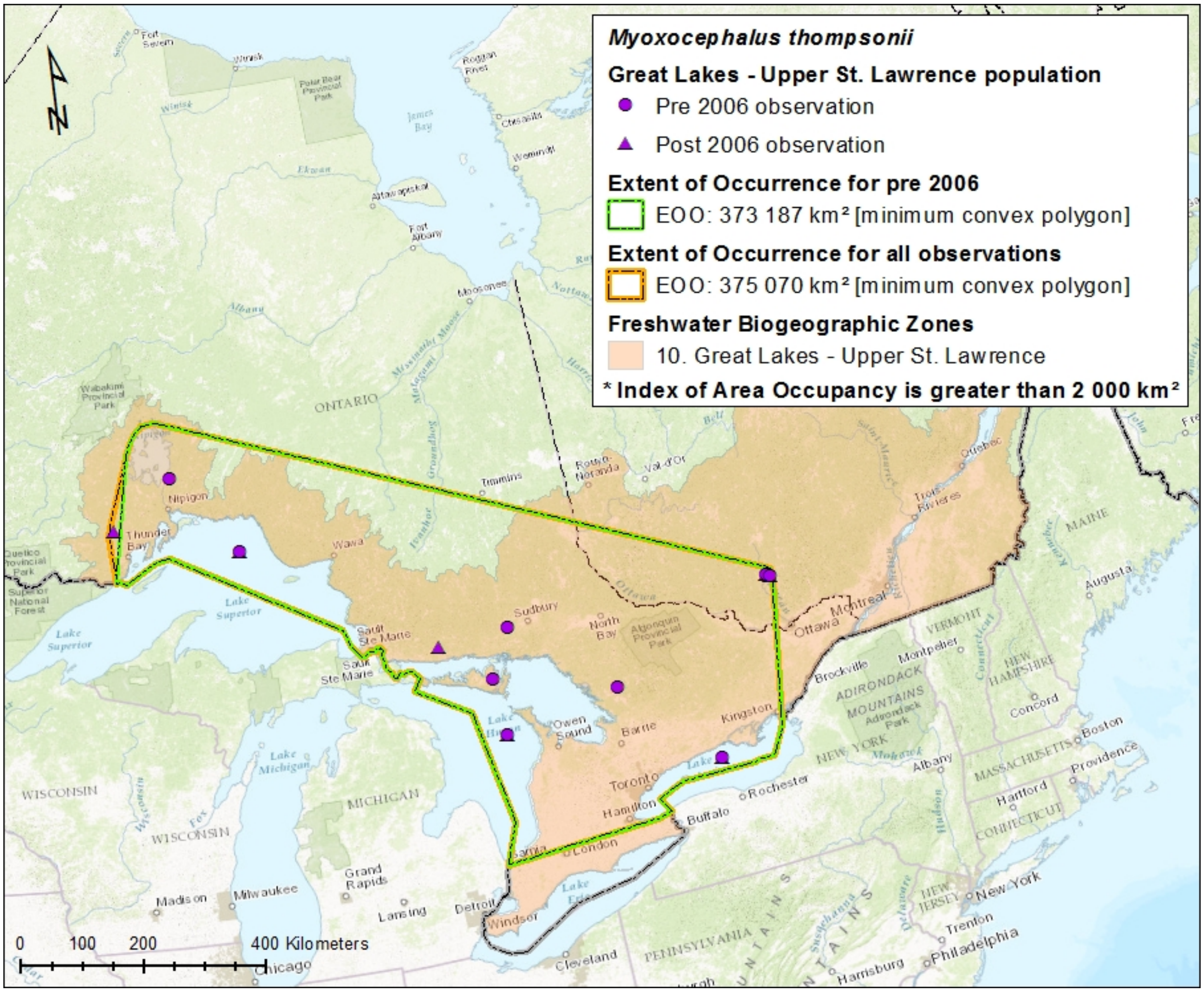

Figure 4. Extent of occurrence for Deepwater Sculpin in the Great Lakes – Upper St. Lawrence DU. Circles represent pre-2006 observations, triangles represent all observations to present.

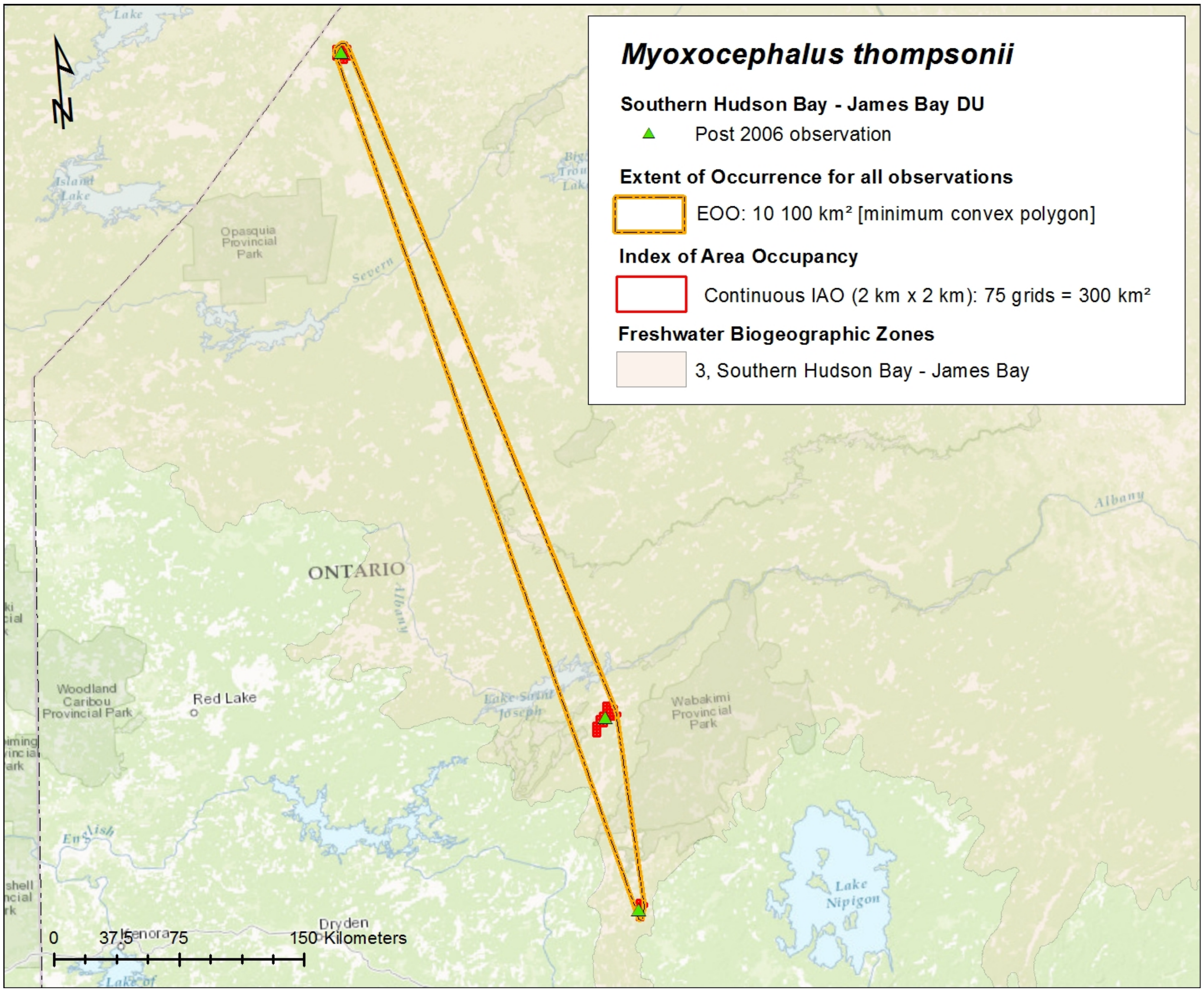

Figure 5. Extent of occurrence for Deepwater Sculpin in the Southern Hudson Bay – James Bay DU.

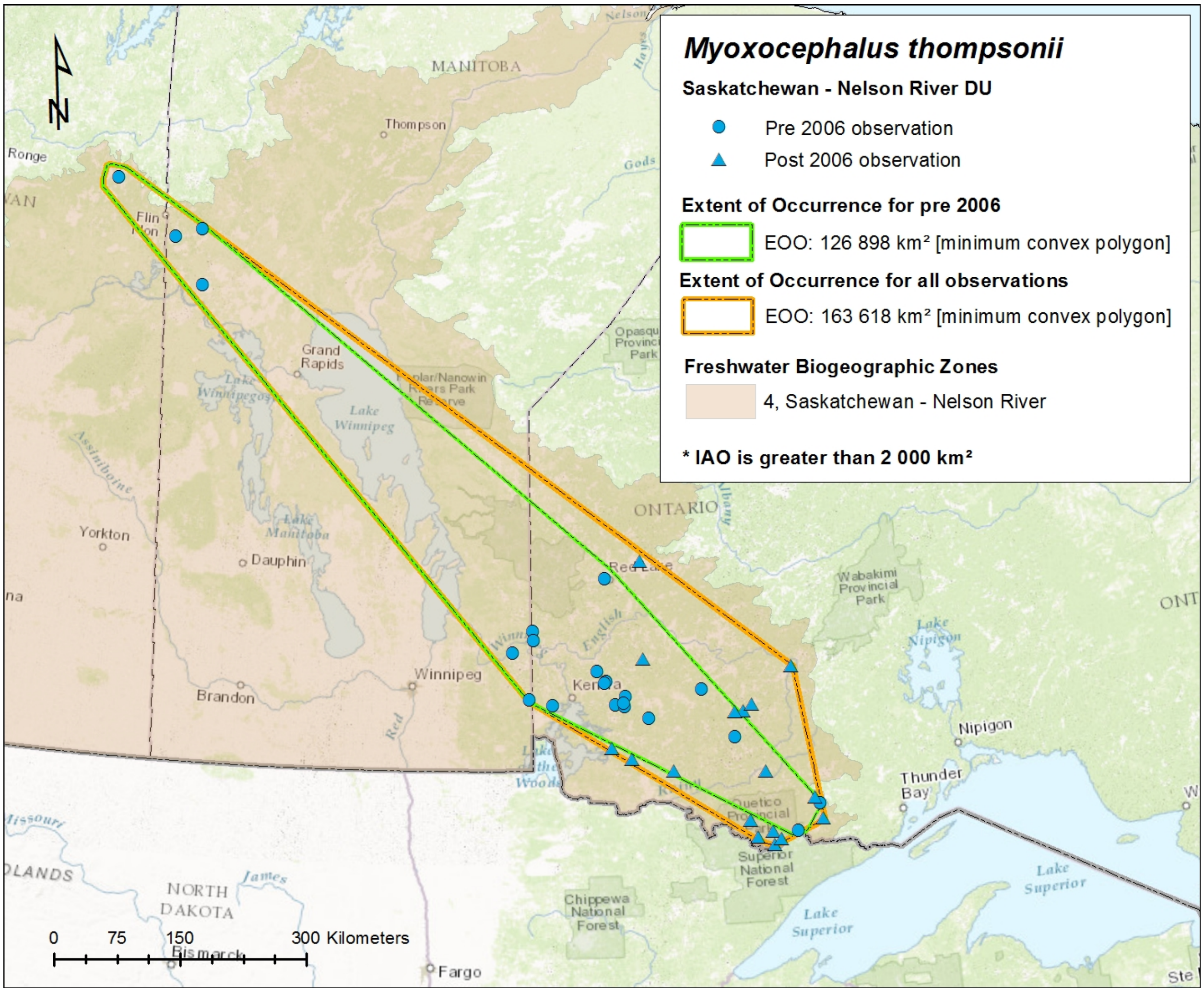

Figure 6. Extent of occurrence for Deepwater Sculpin in the Saskatchewan – Nelson River DU. Circles represent pre-2006 observations, triangles represent all observations to present. Note: Upper Waterton Lake is represented separately in the Waterton Lake DU.

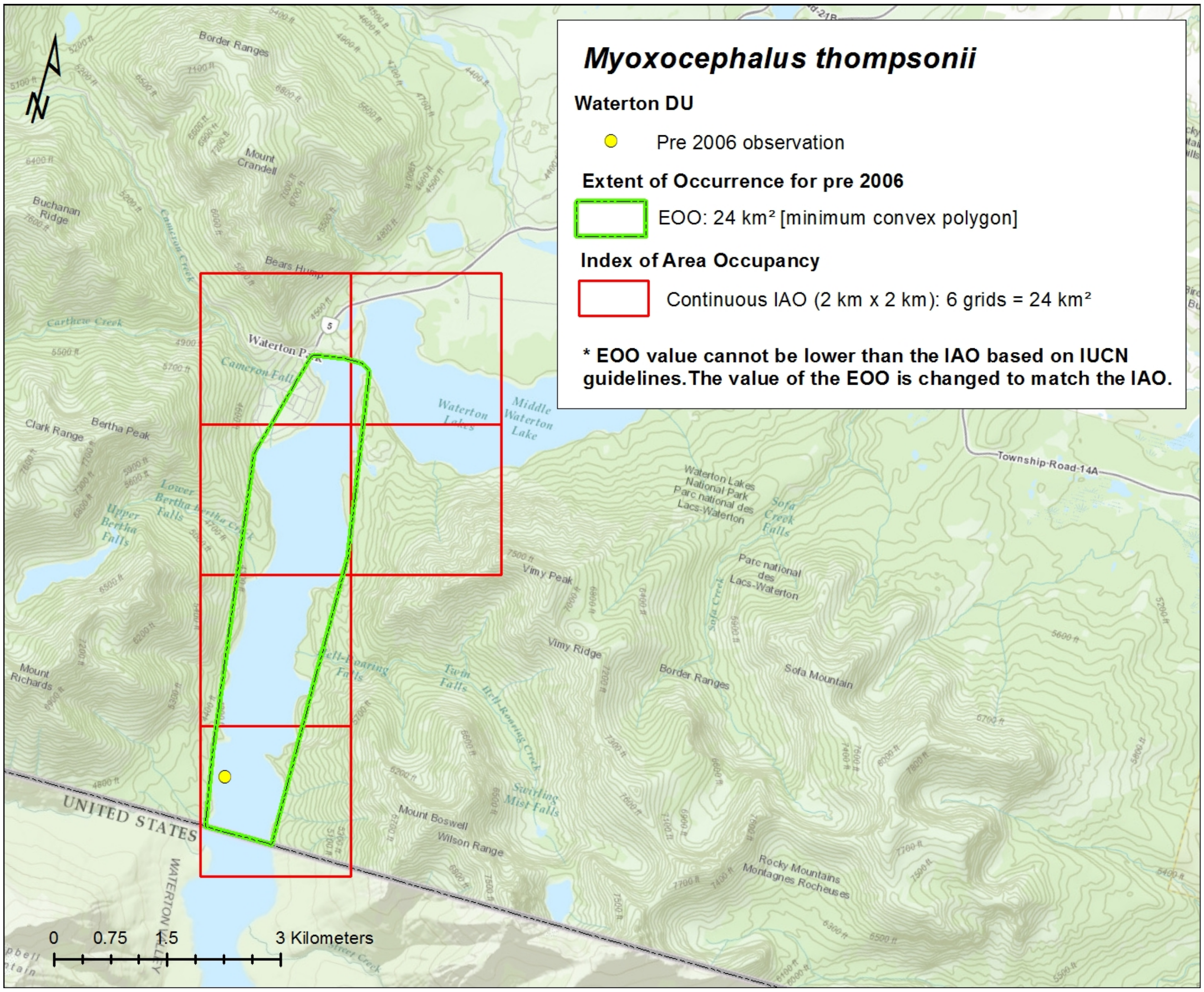

Figure 7. Extent of occurrence for Deepwater Sculpin in Waterton Lake DU.

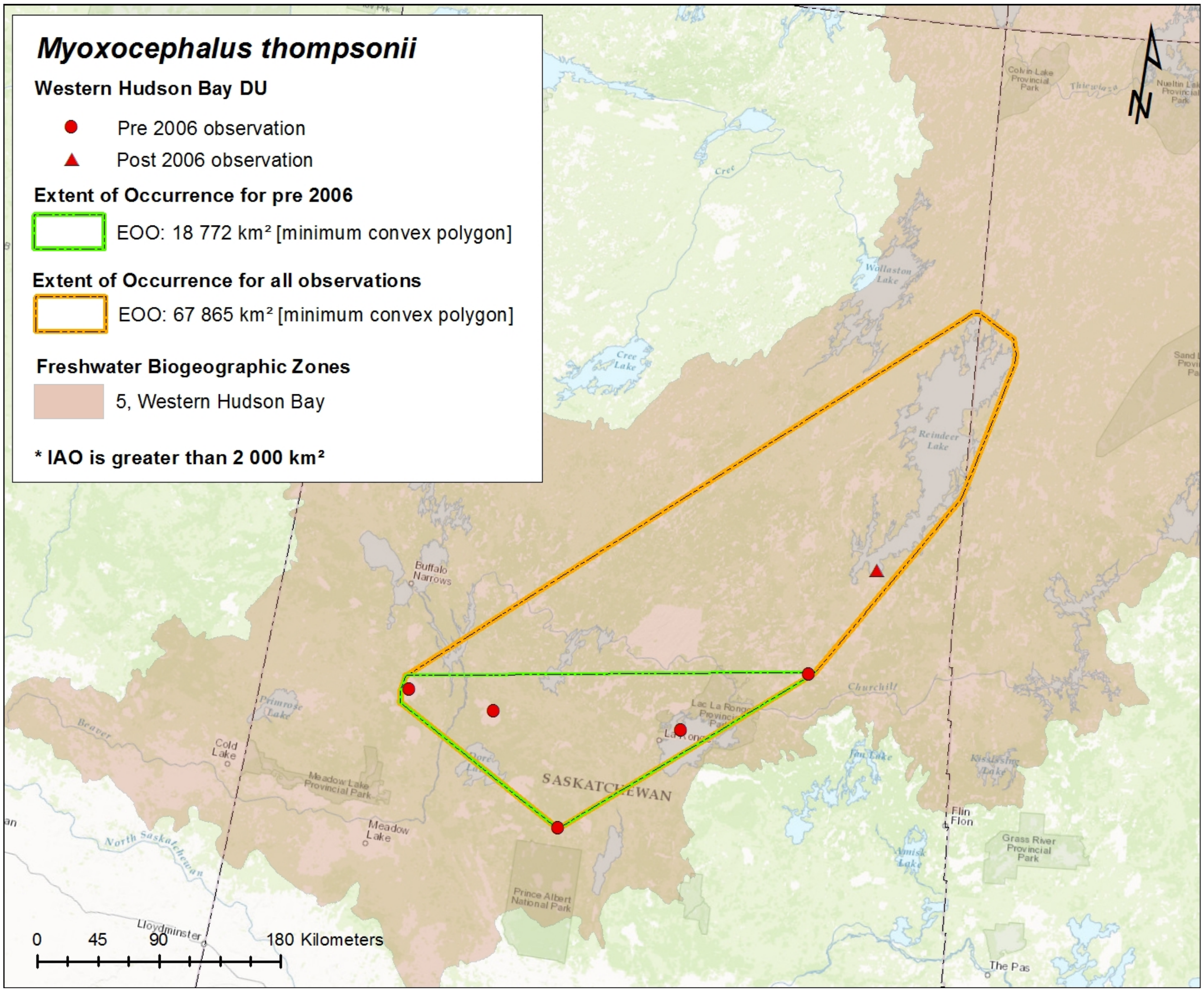

Figure 8. Extent of occurrence for Deepwater Sculpin in the Western Hudson Bay DU. Circles represent pre-2006 observations, triangles represent all observations to present.

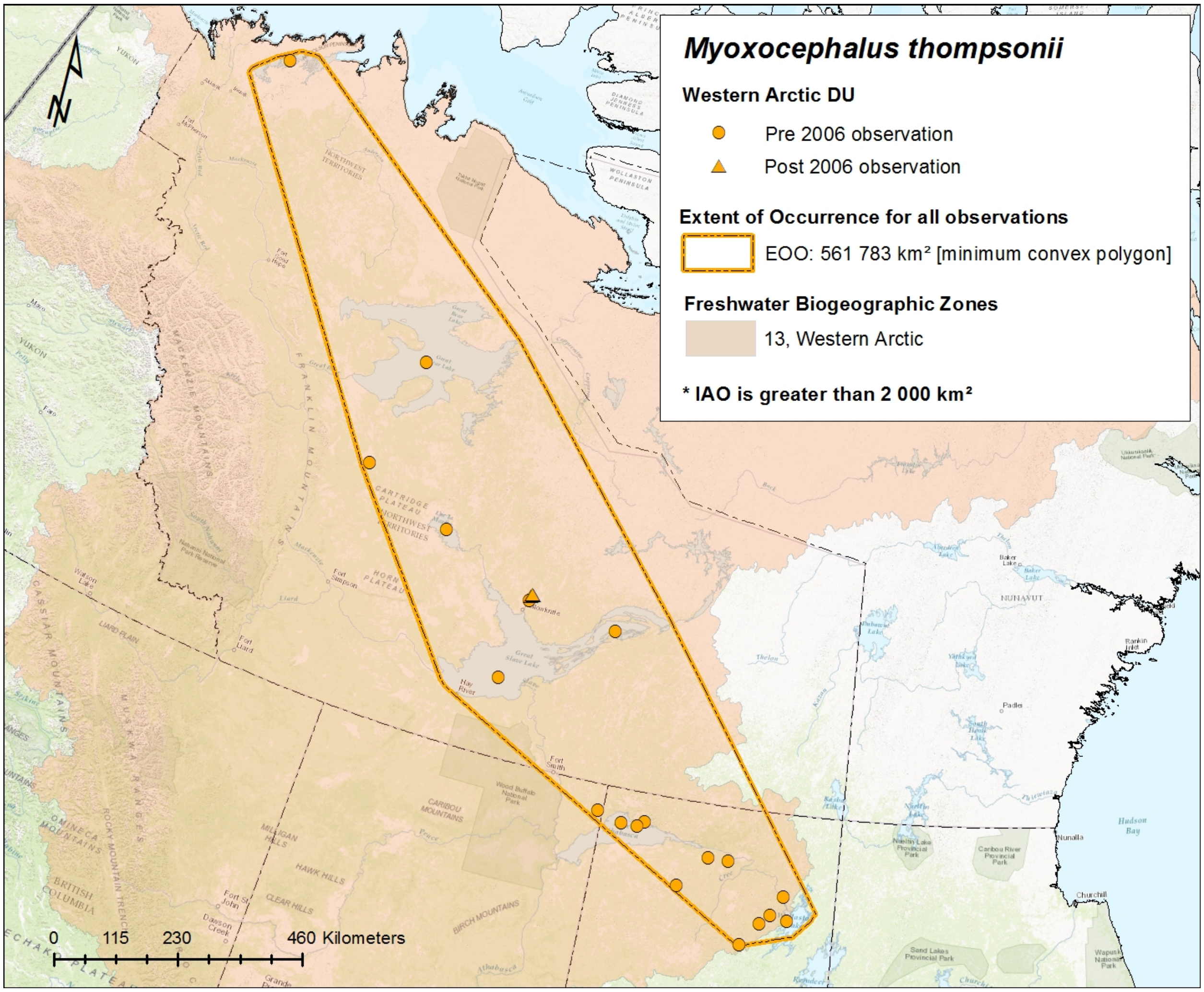

Figure 9. Extent of occurrence for Deepwater Sculpin in the Western Arctic DU. Circles represent pre-2006 observations, triangles represent all observations to present.

Search Effort

Few surveys have actively targeted Deepwater Sculpin since the 2006 report, but several existing populations have been found that were not previously documented. The most extensive targeted survey to date, of 35 lakes from the NWT to QC, was conducted in 2004, prior to the 2006 report, and used modified sampling gear to target Deepwater Sculpin (Sheldon *et al*. 2008). Exploratory sampling in two deep postglacial lakes in Quebec (Lac des Cerfs and Poisson Blanc) did not detect the Deepwater Sculpin (Kilgour and Associates 2017). Recently, the Ontario Ministry of Natural Resources and Forestry (OMNRF) has begun to set small-mesh gillnets, in addition to its large-mesh gillnets, across all depth strata as part of their broad-scale monitoring (BSM) program. Since this program started in 2008, the OMNRF has located 22 'new' Deepwater Sculpin populations in Ontario alone. The BSM program surveys lakes on a 5-year cycle. Cycle 1 of the BSM program ran from 2008 to 2012. In that cycle, the NA1 nets (large mesh) were deployed at all depths and the ON2 nets (small mesh) were deployed only in the upper 20 m strata. Total number of lakes surveyed was around 800. Cycle 2 (5 years) runs from 2013 to 2017. In this cycle, both NA1 and ON2 nets are deployed at all depths. The total number of lakes surveyed is about the same as in cycle 1, and a high percentage of the lakes (> 80%) are the same lakes as in the first cycle, but some new lakes are added (T. Johnson OMNRF pers. comm.). Given the BSM protocol, the likelihood of more populations being found is high. Of the 22 new Ontario lakes where Deepwater Sculpin were discovered since 2014, catches of this species were rarely over one individual despite having 18-60 gillnet gangs set per lake (OMNRF, unpubl. data). This suggests that catches are still relatively rare and that it is likely that this species occurs in more lakes than is currently known. Advancements in camera technology may also facilitate observations. In 2015, sculpin, almost certainly Deepwater Sculpin, were observed in ≈ 30m of water in Reindeer Lake, SK using a remote operated vehicle (ROV) (C. Prestie, Saskatchewan Ministry of Environment, pers. comm.).

With the exception of Lake Ontario, Deepwater Sculpin is not targeted in the Laurentian Great Lakes, but is sometimes caught incidentally in index-survey trawls and deepwater gillnet sets. Index trawls are a standard fisheries assessment method carried out in both American and Canadian waters. Deepwater trawls (in depths where Deepwater Sculpin would be susceptible) have not been historically common but are occurring with greater frequency, including the internationally collaborative lake-wide benthic surveys (J. Holden, OMNRF, pers. comm).

The state of knowledge regarding the distribution of Deepwater Sculpin is limited. Additional populations will likely continue to be found, enlarging the documented area of occupancy. In many cases, distributional data have been derived from incidental catch reports (Sheldon *et al*. 2008). Also, misidentification, combined with a lack of focus on small-bodied fishes in conventional surveys, could also be contributing to the limited knowledge of the inland distribution of this species. It is difficult to identify Deepwater Sculpin collected in the gut contents of deepwater piscivores, as the identifying characteristics are often digested away, such that identification requires genetic techniques (D. Fraser Concordia University pers. comm.).

HABITAT

Habitat Requirements

Deepwater Sculpin is a bottom-dwelling, stenothermic, coldwater species found only in northern lakes of North America (Stewart and Watkinson 2004). It is distinct from other freshwater cottids in that its distribution is limited to deepwater lacustrine environments because of its requirements for cold waters (Sheldon *et al*. 2008). In inland lakes, Deepwater Sculpin is commonly found from a depth of 50 m to the maximum depth of the lake, or in the deepest 20% of the lake when maximum depth did not exceed 50 m (Sheldon *et al*. 2008). However, as latitude increases, this relationship weakens and Deepwater Sculpin is also found at shallower depths, probably because of colder shallow-water temperatures (McPhail and Lindsey 1970; Sheldon *et al*. 2008). Little is known about its habitat requirements for spawning.

Deepwater Sculpin is usually found in depths from 60 to 150 m in the Great Lakes, but this varies. For example, in Lake Ontario densities increase with depth and are highest below 150 m (Weidel *et al*. 2017) and in Lake Superior, it is found as deep as 407 m (Selgeby 1988). More recent surveys are finding Deepwater Sculpin most frequently at depths of greater than 110 m in Lake Ontario (OMNRF, unpubl. data). However, drifting larvae have been found in much shallower waters. Larvae were collected drifting in the St. Clair River and in the shallow west end of Lake Erie in 1995 in 2 to 5 m depth, but this is probably atypically shallow for the life stage and species (Roseman *et al*. 1998).

Habitat Trends

There is evidence that eutrophication is reducing the availability of well-oxygenated habitat for Deepwater Sculpin in some regions, but this is mostly restricted to the southeastern part of their range. Lac Heney (southwestern Quebec), where Deepwater Sculpin has been present historically but not found recently, has become more eutrophic over the past two decades, with deepwater dissolved oxygen levels of 3.18 and 6.07 mg/L observed in 2004, below the ranges in lakes where Deepwater Sculpin is known to occur (6.7-14.4 mg/L: Sheldon *et al*. 2008). One form of Rainbow Smelt (*Osmerus mordax*) has also apparently disappeared from this lake, further suggesting that changes to this lake could be negatively impacting its ichthyofauna (D. Fraser Concordia University pers. comm.). It is likely that the loss of suitable habitat is the reason why Deepwater Sculpin was not found in the 2004 or 2016 surveys in this lake. Furthermore, lack of connectivity between suitable lakes makes it difficult for Deepwater Sculpin to exploit new habitats because of its reliance on deep, coldwater habitats (Parker 1988).

Trawl survey catches suggest that populations in lakes Huron and Michigan are declining, but this is likely because Deepwater Sculpin are shifting to deeper waters (away from trawls) in response to Quagga Mussel (*Dreissena bugensis*) invasion (C. Madenjian USGS pers. comm.; Madenjian *et al*. 2014) and consequent local reductions in *Diporeia*, and *Mysis* as a result of competition for space, which are primary prey items of Deepwater Sculpin (O'Brien *et al*. 2009). Although adult Deepwater Sculpin are moving into deeper habitats in Lake Huron, the nearshore waters have been identified as important nursery habitats for this species (Roseman 2013; Roseman and O'Brien 2013). Deepwater Sculpin populations are recovering in Lake Ontario, but this is likely due to reduced predation on larvae and adults from planktivores and deepwater piscivores or other yet to be determined environmental factors, rather than improved habitat (Lantry *et al*. 2007). New sampling techniques in deeper waters have also increased the catch of Deepwater Sculpin (Weidel *et al*. 2017).

BIOLOGY

The biology of Deepwater Sculpin is poorly understood as it is difficult to sample and is not sought for recreational purposes. Most studies have focused on single lakes, such as Lake Michigan, Lake Superior, Lake Ontario, or Burchell Lake in northwestern Ontario (Black and Lankester 1981; Brandt 1986; Kraft and Kitchell 1986; Selgeby 1988; Geffen and Nash 1992). Single-lake studies are potentially problematic because evidence of observed variability in Deepwater Sculpin biology (see sections below).

Life Cycle and Reproduction

The maximum age of Deepwater Sculpin has been reported as 7 years in Lake Superior (Selgeby 1988) and 5 years in Burchell Lake (Black and Lankester 1981), but they can live up to 9 years (Lake Ontario Prey Fish Working Group, OMNRF, unpubl. data). Relative growth is greatest during the first year and, in following years, is only 35 to 40% of that (Selgeby 1988). Weight increment is significantly higher than isometric growth, increasing each year to age 6 (Selgeby 1988). There was an early suggestion that size decreases with latitude from the Great Lakes (McPhail and Lindsey 1970; Scott and Crossman 1973; Black and Lankester 1981; Selgeby 1988), but this was based on a single large individual from Lake Ontario (235 mm in TL) compared to smaller sizes of Deepwater Sculpin from Great Slave Lake (maximum of 69 mm). No such trend was recorded in the 2004 survey and the largest specimens were from Wollaston Lake SK at up to 110 mm TL, while specimens reached 75 mm TL in Great Slave Lake NWT and 98 mm TL in Alexie Lake NWT (Sheldon 2006). Total length at maturity for Deepwater Sculpin in Lake Ontario is estimated at 116 mm (Weidel *et al*. 2017).

The reproductive cycle of the species is not fully understood. Black and Lankester (1981) estimated the age at maturity as 3 years for females and 2 years for males from individuals from Burchell Lake ON, but this may vary in the Great Lakes or other lakes. McAllister (1961) hypothesized that spawning occurred in late summer or early fall (based on presence of eggs). However, Selgeby (1988) suggested that spawning occurred in Lake Superior from late November to mid-May based on the appearance of eggs/ovaries and the presence of young-of-the-year Deepwater Sculpin caught in early spring. The latter is similar to what Black and Lankester (1981) found in an inland Ontario lake, suggesting spawning occurred in late fall or early winter. Similar timing has been observed in Lake Michigan, with larvae hatching in March and then moving to shallower waters to return to deeper waters by late fall (Geffen and Nash 1992). However, a gravid female was caught in shallower waters of Lake Ontario (30 m) on June 22, 1996 (COSEWIC 2006). The reason for these discrepancies has not been resolved.

Diet

Deepwater Sculpin almost always co-occurs with the relict crustaceans *Mysis diluviana* and *Diporeia* spp. with these species comprising a large part of its diet in varying proportions (O'Brien *et al*. 2009; Pothoven *et al*. 2011). In Burchell Lake, *Diporeia* spp. occurred in 71% of the Deepwater Sculpin stomachs examined, while *Mysis diluviana* occurred in only 3% (Black and Lankester 1981). Similarly, in Lake Superior, *Diporeia* spp. and *Mysis diluviana* comprised 73% and 26%, respectively, of the biomass of stomach contents of Deepwater Sculpin (Selgeby 1988). Stomach content analysis of Deepwater Sculpin captured during the 2004 survey also indicated that *Diporeia* spp. comprised the vast majority of the diet, followed by *Mysis diluviana* (Sheldon *et al*. 2008). However, populations in Huron and Michigan show a preference toward *Mysis diluviana* (Gamble *et al*. 2011; Hondorp *et al*. 2011). This preference may have allowed it to avoid resource limitation and/or to coexist with Slimy Sculpin (*Cottus cognatus*), which preferentially feed on *Diporeia* spp. (Hondorp *et al*. 2011) and, perhaps, chironomids and copepods (O'Brien *et al*. 2009; Mychek-Londer and Bunnell 2013). Chironomid larvae are also a common food item found in stomachs of Deepwater Sculpin (Sheldon *et al*. 2008).

Parasitism

Parasitism of Deepwater Sculpin by copepods (*Ergasilus* spp.) on the gills, cestodes (*Bothriocephalus* spp., *Proteocephalus* spp.) in the intestine, digeneans in the intestine, nematodes in the liver (*Raphidascaris* spp.), and acanthocephalans (*Echinorhynchus* spp.) in the stomach and intestine have been observed (Carney et al. 2009). Host size, age, and sex had no significant effect on parasitism, suggesting the parasites had little effect on the host (Carney et al. 2009). Cestode parasites have also been observed in Deepwater Sculpin in Burchell Lake, along with trematodes (*Diplostomulum* spp.) and nematodes (*Cystidicola stigmatura*, *Spirurine* larva) (Black and Lankester 1981). There have been no studies that have investigated the health effects of these parasites on Deepwater Sculpin.

Predation

Deepwater Sculpin is an important item in the diet of deepwater piscivores, such as Lake Trout and Burbot (Stewart and Watkinson 2004; Lantry *et al*. 2007), and eggs are eaten by Rainbow Smelt (Smith 1970).

Physiology and Adaptability

There is very little information on the physiology and adaptability of Deepwater Sculpin. Although downstream transport of larval individuals into new habitats may occur (e.g., from Lake Huron into Lake Erie), no reproducing populations of Deepwater Sculpin have been confirmed in sites other than the preferred deep, cold, highly oxygenated habitats. The only specific study of Deepwater Sculpin physiology suggests that the species can reduce its polychlorinated biphenyl (PCB) load by as much as 10% by forming methosulfonyl ($MeSO_2$) PCB metabolites, a presumably novel biochemical pathway for freshwater fish species (Stapleton *et al*. 2001).

Dispersal and Migration

Historically, dispersal of Deepwater Sculpin occurred via proglacial lakes and interconnections (Dadswell 1972; Parker 1988). There is no known potential for migration or dispersal of adults between inland lakes; however, there is evidence that drift of larvae occurs in some cases (between Lake Huron and Lake Erie) (Roseman *et al*. 1998).

Interspecific Interactions

It was suggested that the disappearance of Deepwater Sculpin from Lake Ontario during the 1950s was due to the loss of deepwater piscivores (Lake Trout and Burbot) from the lake, resulting in monopolization of benthic habitats and being outcompeted for resources by Slimy Sculpin (Brandt 1986). More recent trends of increasing occurrence in Lake Ontario do not support this contention, as it has been suggested that diet shifts to *Mysis diluviana* may have allowed Deepwater Sculpin to coexist with Slimy Sculpin, which preferentially feed on *Diporeia* spp. (Hondorp *et al*. 2011) and, perhaps, chironomids and copepods (O'Brien *et al*. 2009; Mychek-Londer and Bunnell 2013). Smith (1970) suggested that the disappearance of Deepwater Sculpin in Lake Ontario might have been due to increased Alewife (*Alosa pseudoharengus*) and Rainbow Smelt predation on its eggs and larvae. Recently observed increases in Deepwater Sculpin densities have been associated with low numbers of native Burbot and Lake Trout (Lantry *et al*. 2007). There has also been some suggestion that Spoonhead Sculpin (*C. ricei*) and Deepwater Sculpin rarely coexist (Sheldon, 2006), suggesting competitive exclusion between the two species. However, this is not always the case as Deepwater, Slimy, and Spoonhead sculpin were found co-occurring in four small lakes in the NWT, where they were collected using deep-set small-mesh experimental gillnets (Cott *et al*. 2011). In one of these lakes, Alexie Lake, Deepwater Sculpin has a more pelagic-influenced diet and feeds higher in the food chain than both Slimy and Spoonhead sculpins, suggesting some amount of diet segregation (Arciszewski *et al*. 2015). Deepwater Sculpin do not appear to co-exist well with Quagga Mussel in the Great Lakes that outcompete its prey, forcing the prey and, consequently, the Deepwater Sculpin into deeper waters (Madenjian *et al*. 2014).

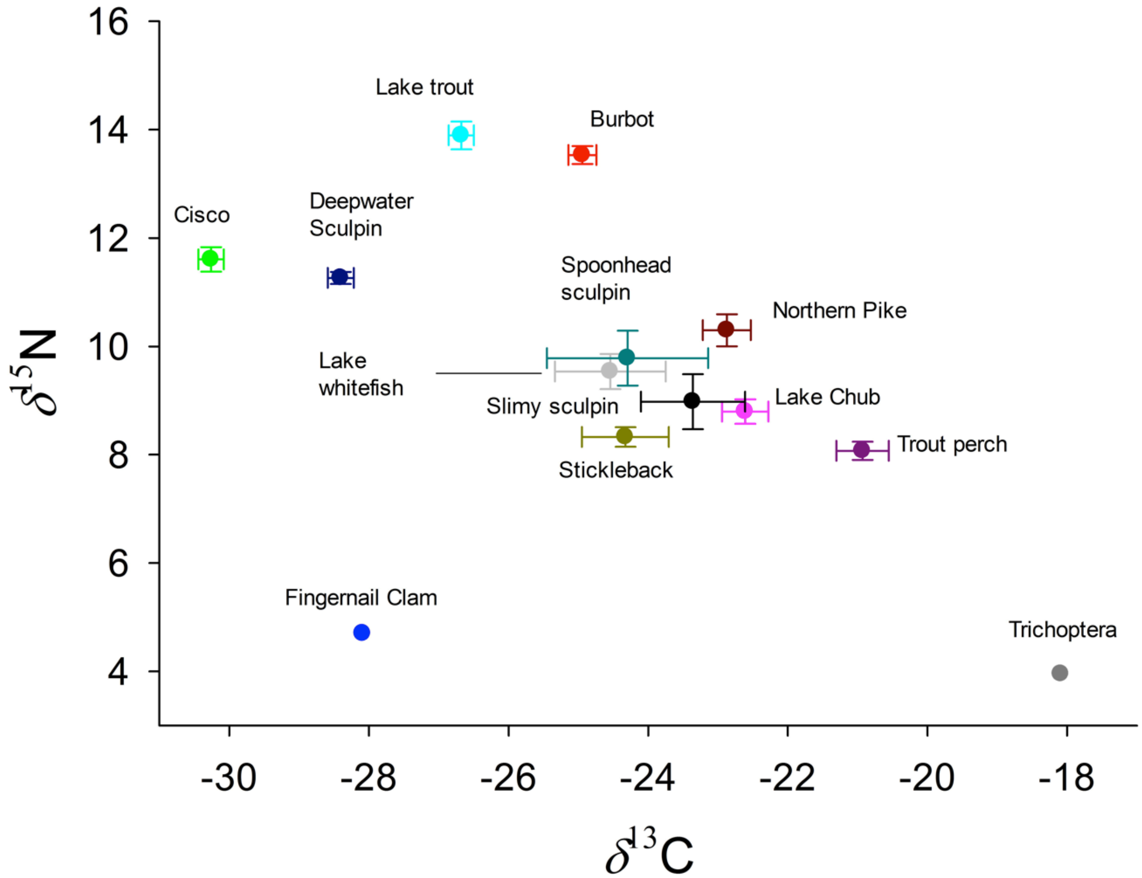

Figure 10. Food web position of Deepwater Sculpin and various co-occurring biota in Alexie Lake, NWT, based on $\delta^{15}N$ and $\delta^{13}C$ isotope ratios (error bars indicate standard error) (from Arciszewski *et al*. 2015).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

There are few standardized, repeated surveys that use gears that would capture, and none that target, Deepwater Sculpin.

<u>Great Lakes-Upper St. Lawrence DU</u>

In Quebec, Deepwater Sculpin was historically documented in Lac Heney, but was captured during 2004, 2005, or 2016 surveys (Ministère des Forêts, de la Faune et des Parcs (MFFP), unpublished; Sheldon *et al*. 2008; Kilgour and Associates 2017). It was observed in Lac Trente et Un Milles and Grand lac Rond in 2016 (Kilgourand 2017).

In the Laurentian Great Lakes, Deepwater Sculpin is not targeted, other than recently in Lake Ontario, but caught in index survey trawls and gillnets (OMNRF 2016). Index trawls are routinely conducted cooperatively by the American federal and state agencies and the OMNRF. It should be noted that, until recently, trawl programs in Canada generally did not fish sites as deep as where the highest density of Deepwater Sculpin is currently observed (i.e., > 150 m; Weidel *et al* 2017). For example, on the Canadian side of Lake Ontario, the deepest trawls (100 m) were only conducted at one site prior to 2014, with two additional site added in 2014. In 2015, deep trawl sites were added at 10 m depth increments from 80 to 140 m, in addition to a collaborative lake-wide benthic survey during the fall that had previously only been conducted by the USGS (J. Holden, OMNRF, pers. comm). It has been suggested by MFFP that, considering the low detection rate using conventional gear types, eDNA sampling could be investigated as a means to determine Deepwater Sculpin presence.

Other Designatable Units

No known standardized, repeated surveys.

Abundance

Great Lakes-Upper St. Lawrence DU

Deepwater Sculpin appears to be abundant in Lake Superior (O. Gorman and C. Madenjian USGS pers. comm.; Gamble *et al*. 2011; Gorman *et al*. 2012) and Lake Huron (C. Madenjian USGS pers. comm.), and has been dramatically increasing in numbers and distribution throughout Lake Ontario (J. Hoyle, OMNRF, pers. comm.; Lantry *et al*. 2007; Weidel 2016). In Lake Ontario, Deepwater Sculpin habitat begins at 140 m, which is effectively the deepest water within the Canadian portion of the lake (J. Holden OMNRF pers. comm.) (Figs. 8 and 9). It is uncertain if the species was ever established in Lake Erie (C. Madenjian USGS pers. comm.; Zimmerman and Krueger 2009), and individuals there are considered to be vagrants (K. Oldenburg OMNRF pers. comm.; Roth *et al*. 2013). Reports of Deepwater Sculpin in Lake Erie have been rare and are only of larval individuals (young-of-the-year) (Roseman *et al*. 1998). Two specimens were incidentally caught in a larval fish-sampling program in Ohio waters of western Lake Erie in 1995, probably from downstream transport from Lake Huron (Lantry *et al*. 2007; Roseman and Riley 2009). No abundance data exist for the other Great Lakes.

Catches of Deepwater Sculpin during BSM index netting of inland lakes are low, rarely more than 1 or 2 specimens per survey, not enough to estimate abundance.

Other Designatable Units

No known standardized, repeated surveys.

Fluctuations and Trends

Great Lakes-Upper St. Lawrence (DU 1)

USGS bottom-trawl data suggest that Deepwater Sculpin abundances are stable in Lake Superior, but there was a slight decrease in density in 2014 (Vinson *et al*. 2015), which should be monitored in the coming years. Catches have been declining in Lake Huron since 1994 (Roseman and Riley 2009), with a recent rapid decline and populations dropping to record low levels between 2006 and 2015 (Madenjian *et al*. 2014; Roseman *et al*. 2015). One hypothesis for the recent reduced catches of Deepwater Sculpin in Lake Huron (and in Lake Michigan) is that its prey (*Mysis*) is moving to deeper water in response to the invading Quagga Mussel, making it less susceptible to survey-trawl transects that sample to a maximum depth of 110 m (C. Madenjian USGS pers. comm.; Madenjian *et al*. 2014; Weidel *et al*. 2017). This theory is supported by high sculpin catches in experimental trawls in waters >100 m by the USGS (C. Madenjian USGS pers. comm.; Bunnell *et al*. 2015).

The population trend for Lake Ontario is positive, with Deepwater Sculpin now a common catch in survey trawl (C. Lake and J. Hoyle OMNRF pers. comm.). Deepwater Sculpin was not reported in southern Lake Ontario between 1943 and 1971 despite previously high abundance, and Christie (1973) reported that the last specimens identified from northern Lake Ontario were taken in 1953. Crossman and Van Meter (1979) suggested it was still present in the lake, but noted that it was extremely rare and considered endangered. It was not seen until 1996 when one gravid female was caught in the outlet basin signaling the reappearance of the species (Casselman and Scott 2003; Lantry *et al*. 2007). The USGS began catching it in American waters as well (Owens *et al*. 2003). Casselman *et al*. (1999) suggested that there was a substantial shift in the open-water fish community during the 1990s and that the reappearance of Deepwater Sculpin was among these changes. The population remained low until the early 2000's when catches in survey trawls in Lake Ontario began to increase (Weidel *et al*., 2017). This increase in Lake Ontario has continued steadily from 1996 (C. Lake and J. Hoyle OMNRF pers. comm.; Lantry *et al*. 2007) at an estimated rate of close to 60% per year (Weidel *et al*. 2017). Currently, its biomass is equal to that of Slimy Sculpin (Weidel *et al*. 2013) Deepwater Sculpin in the other Great Lakes (Weidel *et al*., 2017). It is thought to have re-established from a small relict population or from larval drift from Lake Huron (Lantry *et al*. 2007; Roseman 2013, Welsh *et al.* 2017). A recent genetic analysis based om eight microsatellites suggests that Deepwater Sculpin currently in lake Ontario are more closely related to those in Lake Huron than those that historically occurred in Lake Ontario, supporting the larval drift recolonization hypothesis (Welsh *et al.* 2017). The reason for their recent success is uncertain but may be due to reduced predation on larvae and adults (Lantry *et al*. 2007). Some speculate that the increased catches may be a sampling-related artifact due to trawl surveys being conducted in deeper water (Weidel *et al*. 2016b), although similar surveys are conducted throughout the Great Lakes and Deepwater Sculpin appear to be declining in Lake Huron and stable in Lake Superior.

In Quebec, Deepwater Sculpin was historically documented in Lac des Îles and Lac Heney, but was not captured during 2004, 2005, or 2016 surveys (Sheldon *et al*. 2008; Kilgour and Associates, 2017). A subsequent survey was conducted in 2016 using the same methods, finding Deepwater Sculpin in Grand lac Rond and Lac des Trente et Un Milles, but not in Heney Lake. Low dissolved oxygen concentrations suggest degradation of deep water habitat in this lake (Kilgour and Associates 2017).

<u>Southern Hudson Bay-James Bay (DU 2) and Saskatchewan-Nelson River (DU 3)</u>

New information has identified previously unrecognized populations in three lakes in the Southern Hudson Bay-James Bay DU, and 17 lakes in the Saskatchewan-Nelson River DU. These populations likely represent previously existing, unrecognized populations instead of an expansion of Deepwater Sculpin, and no other trend information is available for these inland lakes.

<u>Western Arctic (DU 6)</u>

New information has identified previously unrecognized populations in six lakes in the Western Arctic DU. These populations likely represent previously existing, unrecognized populations instead of an expansion of Deepwater Sculpin, and no other trend information is available for these inland lakes.

<u>Western Hudson Bay (DU5) and Waterton Lake (DU4)</u>

No trend information is available for these DUs.

Rescue Effect

The numbers of Deepwater Sculpin collected in survey catches on both the Ontario and New York sides of Lake Ontario have been steadily increasing since 2006 (Weidel *et al*. 2017). The recolonization of Deepwater Sculpin in Lake Ontario may be one of the few tangible examples of a rescue effect (Welsh *et al.* 2017). Rescue is not possible in lakes outside of the Laurentian Great Lakes. Deepwater Sculpin has not been collected on the American side of Upper Wateron Lake (http://fieldguide.mt.gov/speciesDetail.aspx?elcode=AFC4E04020); therefore, the potential for rescue effect from there is unknown.

THREATS AND LIMITING FACTORS

Threats

The threats calculator results varied substantially across the DUs. The overall threats were high-medium for the Great Lakes-Upper St. Lawrence DU (Appendix 1) and Waterton Lake DU (Appendix 4), low-low for the Saskatchewan-Nelson River DU (Appendix 3) and Western Arctic DU (Appendix 6), and non for the Southern Hudson Bay-James Bay DU (Appendix 2) and Western Hudson Bay DU (Appendix 6).

The main threat to Deepwater Sculpin is eutrophication (Pollution) from urban sources (Waterton Lake, Saskatchewan-Nelson River, and Great Lakes-Upper St. Lawrence DUs) and agricultural sources (primarily in the Great Lakes-Upper St. Lawrence DU).

Quagga Mussel impacts (Natural System Modifications) are a possible threat to Deepwater Sculpin in the Great Lakes-Upper St. Lawrence DU, in that it is forcing prey into deeper habitat. It was suggested in the 2006 report that declines in the amphipod *Diporeia*, a main food source for Deepwater Sculpin, may also have been a factor limiting recovery in Lake Ontario, although mysids seem to be filling that diet niche (J. Hoyle OMNRF pers. comm.; O'Brien *et al*. 2009; Hondorp *et al*. 2011). Quagga Mussel now appears to be influencing the habitat for Deepwater Sculpin in lakes Huron and Michigan. The observed decline in Deepwater Sculpin may be the result of its occupying deeper waters than before the mussel invasion (C. Madenjian USGS pers. comm.; Madenjian *et al*. 2014) and avoiding survey trawls, but the consequences of this possible habitat shift on Deepwater Sculpin are unknown.

Increasing water temperatures (Climate Change and Severe Weather) are a threat to Deepwater Sculpin in all DUs. While the effect is yet unknown, greater impact may be expected in more southern and shallower lakes where cold water habitat is more limited.

Predation (Invasive and other Problematic Species and Genes) was listed as a major concern for Great Lakes populations in the 2006 report, which cited temporal trends in the abundance of Deepwater Sculpin in Lake Michigan during the 1960s through 1980s to be best explained by Alewife and Burbot predation (Madenjian *et al*. 2002, 2005). It was also noted that a rapid increase in population size of Deepwater Sculpin in Lake Michigan in the 1970s and early 1980s was most likely attributable to a decrease in Alewife abundance at that time (Madenjian *et al*. 2002). However, predation (as both a threat and a natural limiting factor) may now be lower for the Great Lakes populations since the 2006 report. A reduction in Alewife, an invasive plankton predator that consumes larval sculpin, and a decline in native predatory Burbot Lake Trout, may be contributing to the recovery of Deepwater Sculpin in Lake Ontario (J. Hoyle OMNRF pers. comm.; Lantry *et al*. 2007; Weidel *et al*. 2013). Upper Waterton Lake has five introduced predatory fish species that may prey on Deepwater Sculpin: Arctic Grayling (*Thymallus arcticus*), Brook Trout (*Salvelinus fontinalis*), Brown Trout (*Salmo trutta*), Cutthroat Trout (*Oncorhynchus clarkii*), Lake Trout, and Rainbow Trout (*O. mykiss*) (http://www.watertonpark.com/activities/fishing.htm).

None of the other threat categories are considered significant for Deepwater Sculpin in any of the DUs.

Limiting Factors

Deepwater Sculpin is limited by the availability of deep, cold, highly oxygenated water (Parker 1988). This constrains its dispersal, as there is limited connectivity between postglacial lakes and other lakes that meet this habitat condition (Parker 1988). The requirement of deepwater habitat also makes the possibility of dispersal between lakes minimal even where connections exist. Its present distribution indicates no secondary dispersal from postglacial lake boundaries throughout Canada (Sheldon *et al*., 2008) (see Figure 3). It is likely that dispersal of Deepwater Sculpin has not occurred since the late stages of the proglacial lake phase of the Wisconsinan glaciation (Sheldon 2006).

Number of Locations

Deepwater Sculpin occurs in at least 83 lakes throughout its Canadian range. As the main threats are eutrophication, caused by urban and agricultural pollution, and invasive species and these threats will occur largely independently at the individual lake level, each lake should be considered a separate location. These locations are assigned to specific DUs in the technical summaries.

Great Lakes-Upper St. Lawrence (DU 1) (11 lakes)

Grand lac Rond, Lac des Trente et Un Milles, Lake Superior, Lake Huron, Lake Ontario, High Lake, Fairbank Lake, Dog Lake, Lake Matinenda, Lake Nipigon.

Southern Hudson Bay-James Bay (DU 2) (3 lakes)

Echoing Lake, Sturgeon Lake, and McCrea Lake.

Saskatchewan-Nelson River (DU 3) (39 lakes)

Raven Lake, Lake Manitou, Lake 259 (ELA), Teggau Lake (ELA), Lake 310 (ELA), William Lake, Horseshoe Lake, Dicker Lake, Passover Lake, Burton Lake, Trout Lake, Eagle Lake, Burchell Lake, Saganaga Lake, Squeers Lake, Huston Lake, Cliff Lake, Agnes Lake, Kakagi Lake, Otukamamoan Lake, Pipestone Lake, Poohbah Lake, Sarah Lake, Sawbill Lake, Sheridan Lake, This Man Lake, Sparkling Lake, Titmarsh Lake, Victoria Lake, Mameigwess Lake, Red Lake, Sandybeach Lake, Indian Lake,
Lake of the Woods, Lake Athapapuskow, Cranberry Lakes, Westhawk Lake, George Lake, and Clearwater Lake.

Waterton Lake (DU 4) (1 lake)

Upper Waterton Lake

Western Hudson Bay (DU 5) (13 lakes)

Minrod Lake, Lac la Ronge, Reindeer Lake, Wollaston Lake, Canoe Lake, Hatchet Lake, Laonil Lake, Milliken Lake, Waterbury Lake, Yalowega Lake, Lac la Plonge, MacKay Lake, McLenna Lake.

Western Arctic (DU 6) (16 lakes)

Lake Athabasca, Black Lake, Riou Lake, Beaverlodge Lake, Colin Lake, South McMahon Lake (formerly C1), Great Slave Lake, Great Bear Lake, Lac la Marte, Keller Lake, Prosperous Lake, Alexie Lake, Chitty Lake, Drygeese Lake, Baptiste Lake, and the Husky Lakes.

Note: Deepwater Sculpin are possibly vagrant in Lake Erie (larval drift from Lake Huron). Historical records in Cedar Lake and Gloucester Pool, ON, and Lac des Îles, QC, are likely erroneous.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In 2006, COSEWIC designated the population formerly known as Deepwater Sculpin Great Lakes-Western St. Lawrence as “Special Concern” (renamed Great Lakes-Upper St. Lawrence population in April 2017) and it is listed on schedule 1 of the *Species at Risk Act*; and the Western populations unit was designated “Not at Risk”. Neither designation offers any specific protection to the species and its habitat. In April 2017, COSEWIC assessed the Great Lakes-Upper St. Lawrence population as Threatened, and the former ‘Western populations’ unit was divided into 5 new designatable units (see technical summaries for information on status designation).

The new *Fisheries Act* protects fishes and fish habitat that are part of, or support, commercial, recreational, or Aboriginal fisheries. Although not subject to a CRA fishery, this species and its habitat support CRA fishery species and, thus, it is afforded protection under the *Fisheries Act* (Hutchings and Post 2013). Populations found in Upper Waterton Lake in Waterton National Park are partially protected under the *National Parks Act*. For Deepwater Sculpin within Fathom Five National Marine Park and Lake Superior National Marine Conservation Area, fishes and habitat would be under the *Canada National Marine Conservation Areas Act*.

Non-Legal Status and Ranks

Deepwater Sculpin has a global NatureServe conservation rank of G5 (secure), and a rank of N5 (secure) in the US and N4N5 (secure to apparently secure) in Canada. The populations in each designatable unit have not been specifically ranked, but the species has provincial/territorial rankings of S3 (vulnerable) in NWT, S2S3 (vulnerable to imperilled) in Manitoba, S5 (secure) in Saskatchewan, S3 (vulnerable) in Ontario, and S1S2 (imperilled to critically imperilled) in Quebec. It is listed as SU (unrankable) in Alberta. Outside Canada, it is ranked S1S2 (imperilled to critically imperilled) in Indiana, S3 (vulnerable) in Montana, S5 (secure) in Michigan and Wisconsin, S1 (critically imperilled) in New York, and SX (extirpated) in Pennsylvania. It is not ranked in Minnesota or Ohio.

Habitat Protection and Ownership

In Canada, the Deepwater Sculpin occurs in public waters, and co-occurs with CRA fisheries. The habitat of CRA fisheries species are protected by sections of the federal *Fisheries Act.* Further, the *Canadian Environmental Assessment Act, Canadian Environmental Protection Act,* and *Canada Water Act* may also generally protect the Deepwater Sculpin and/or its habitat. Habitat within Upper Waterton Lake in Waterton National Park is partially protected under the *National Parks Act*.

Recovery Efforts since 2006

In 2006, COSEWIC designated the Deepwater Sculpin Great Lakes-Western St. Lawrence DU as “Special Concern”; since then, the proposed Management Plan has been posted on the SARA registry (DFO 2016).

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Erik Szkokan-Emilson is a Research Associate with the Ecosystems and Global Change Group at the University of Cambridge. Erik received his PhD from Laurentian University where he studied the watershed ecology of aquatic ecosystems impacted by metal mining and forest disturbance. Erik currently splits his time between Cambridge, England and northeastern Ontario, where he studies the impacts of watershed disturbance and climate change on carbon cycling and food webs in aquatic ecosystems.

Pete Cott worked with the Department of Fisheries and Oceans for over 15 years, based out of Yellowknife, Northwest Territories. He is currently the environmental advisor for the Department of National Defence – Joint Taskforce North, and an adjunct professor with the University of Alberta. Pete received his PhD from Laurentian University where he studied the reproductive ecology of Burbot. He is a member of the COSEWIC Freshwater Fish Species Specialist Subcommittee.

Erik and Pete co-wrote the status appraisal summary reports on the Deepwater Sculpin (which morphed into this report) and River Redhorse (*Moxostoma carinatum*) for COSEWIC and are currently working on the status report for the Bering Cisco (*Coregonus laurettae*).

COLLECTIONS EXAMINED

No collections were examined in the preparation of this report.

Appendix 1. IUCN Threats Classification and Assessment Calculator for the Deepwater Sculpin – Great Lakes-Upper St. Lawrence Populations

Species or Ecosystem Scientific Name	Deepwater Sculpin - Great Lakes-Upper St. Lawrence populations			
Element ID		**Elcode**		
Date (Ctrl + ";" for today's date):	21/06/2016			
Assessor(s):	Nick Mandrak (SSC co-chair), Jennifer Heron (moderator and Arthropods SSC co-chair), Erik Szkokan-Emilson (writer), Pete Cott (writer and SSC member), Bill Tonn, Doug Watkinson and Tim Haxton (SSC members), Scott Reid (Ontario jurisdictional member for COSEWIC), Jeff Keith (contact for Saskatchewan), Blair Wasylenko (OMNR expert) and Angèle Cyr (Secretariat).			
References:				

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	1	0
C	Medium	1	2
D	Low	1	1
Calculated Overall Threat Impact:		High	Medium

Assigned Overall Threat Impact:	
Impact Adjustment Reasons:	
Overall Threat Comments	4-5 yr generation time so 12-15 yrs projection into future. Could be up to 9 yrs but research is unpublished and not yet peer reviewed.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas						larval sculpin use inshore habitat. Some development in these areas may be a threat.
2	Agriculture & aquaculture		Unknown	Large (31-70%)	Unknown	High (Continuing)	
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching		Unknown	Large (31-70%)	Unknown	High (Continuing)	Eutrophication from agriculture, particularly in inland Quebec lakes is accounted for under threat 9 as it might be caused by cottage activity. Unknown source of this threat. Tom Sheldon research available on this threat to DWS in Quebec. Might be a past threat to Lac Heney.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Some aquaculture in QC range but not a significant threat to DPSC
3	Energy production & mining						
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying						not applicable
3.3	Renewable energy						not applicable
4	Transportation & service corridors		Not a Threat	Large (31-70%)	Neutral or Potential Benefit	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
4.1	Roads & railroads						not applicable
4.2	Utility & service lines						not applicable
4.3	Shipping lanes		Not a Threat	Large (31-70%)	Neutral or Potential Benefit	Moderate (Possibly in the short term, < 10 yrs/3 gen)	not applicable
4.4	Flight paths						not applicable
5	Biological resource use		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						buffer zone required along waterways so likely not a threat
5.4	Fishing & harvesting aquatic resources		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Collected in deep water research survey trawls in Great Lakes. Unlikely to catch otherwise. Significant research in the GL. Some surveys conducted in inland lakes using small mesh gillnets may catch DPSC. Not many targeted surveys for this species. Insignificant threat.
6	Human intrusions & disturbance						
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities						bycatch from research accounted for under 5.4
7	Natural system modifications	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use		Not a Threat	Large (31-70%)	Neutral or Potential Benefit	High (Continuing)	Water control via locks in the GL. May affect dispersal. Though this may be positive. Likely not applicable or a past threat. Upstream migration would have been prevented regardless.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.3	Other ecosystem modifications	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	Quagga Mussel occurring in deep water forcing prey of DPSC into deeper habitat. In Lake Erie, deep water anoxia is occurring from decaying algae. Lake Huron and Lake Ontario could be subject to this threat in the future. Not documented but plausible.
8	Invasive & other problematic species & genes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Quagga Mussel in Lake Huron changing food availability for sculpin accounted for under 7.3. Alewife and Rainbow Smelt predation on DPSC but less threatening compared to Quagga Mussel. Mostly historical since populations of Alewife crashed in Great Lakes.
8.2	Problematic native species/diseases		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Burbot and Lake Trout predation but may be a limiting factor rather than a threat.
8.3	Introduced genetic material						not applicable
8.4	Problematic species/diseases of unknown origin						not applicable
8.5	Viral/prion-induced diseases						not applicable
8.6	Diseases of unknown cause						not applicable
9	Pollution	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	
9.1	Domestic & urban waste water	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	Eutrophication from urban sources, particularly in inland Quebec lakes from cottage development. Insignificant range of EOO but significant proportion of the IAO affected by this threat.
9.2	Industrial & military effluents						not applicable
9.3	Agricultural & forestry effluents		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Eutrophication from agriculture, particularly in inland lakes
9.4	Garbage & solid waste						Net entanglement is not an issue as commercial fishing gillnet mesh is too large for DPSC. Not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Large (31-70%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration						Accounted for under ecosystem modification.
11.2	Droughts						not applicable
11.3	Temperature extremes		Unknown	Large (31-70%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	increasing temperatures, particularly in more southern and shallower lakes
11.4	Storms & flooding						not applicable
11.5	Other impacts						not applicable

Appendix 2. IUCN Threats Classification and Assessment Calculator for the Deepwater Sculpin – Southern Hudson Bay-James Bay Populations

Species or Ecosystem Scientific Name	Deepwater Sculpin - Southern Hudson Bay-James Bay DU		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	27/09/2016		
Assessor(s):	Nick Mandrak (SSC co-chair), Dave Fraser (moderator), Erik Szkokan-Emilson (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (Quebec MRRF), Angèle Cyr (Secretariat).		
References:			

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	Level 1 Threat Impact Counts: low range
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	0	0
	Calculated Overall Threat Impact:		

Assigned Overall Threat Impact:	
Impact Adjustment Reasons:	
Overall Threat Comments	4-5 yr generation time so 12-15 yrs projection into future. Could be up to 9 yrs but research is unpublished and not yet peer reviewed.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas						not applicable
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						not applicable
2.4	Marine & freshwater aquaculture						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
3.1	Oil & gas drilling						Fracking unlikely an issue as DPSC occur mainly in shield lakes with little oil and gas exploration.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Diamond and metal mining is performed under lakes and around where DPSC may occur, and could impact overall habitat quality.
3.3	Renewable energy						not applicable
4	Transportation & service corridors						
4.1	Roads & railroads						not applicable
4.2	Utility & service lines						not applicable
4.3	Shipping lanes						shipping lanes and dredging are not applicable to this DU
4.4	Flight paths						not applicable
5	Biological resource use		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						not applicable
5.4	Fishing & harvesting aquatic resources		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Infrequent catch from surveying.
6	Human intrusions & disturbance						
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities						not applicable
7	Natural system modifications						
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use						not applicable
7.3	Other ecosystem modifications						Potential for Zebra Mussel but no current overlap. Invasive in Lake Winnipeg now. Unlikely due to the calcium-limited shield lakes in this DU.
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species/diseases						Potential for Zebra Mussel accounted for under 7.3.
8.2	Problematic native species/diseases						No problematic native species. Limiting factor.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.3	Introduced genetic material						not applicable
8.4	Problematic species/diseases of unknown origin						not applicable
8.5	Viral/prion-induced diseases						not applicable
8.6	Diseases of unknown cause						not applicable
9	Pollution		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
9.1	Domestic & urban waste water		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Eutrophication from urban sources. Mostly cottage country.
9.2	Industrial & military effluents						not applicable
9.3	Agricultural & forestry effluents						Eutrophication from agriculture possible but negligible.
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
11.1	Habitat shifting & alteration						not applicable
11.2	Droughts						not applicable
11.3	Temperature extremes		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Increasing temperatures, particularly in more southern and shallower lakes. Latitude is higher in this DU and likely a trade off from cooler lakes. So less threatening driver to deeper habitat in comparison to the other DU.
11.4	Storms & flooding						not applicable
11.5	Other impacts						not applicable

Appendix 3. IUCN Threats Classification and Assessment Calculator for the Deepwater Sculpin – Saskatchewan-Nelson River Populations

Species or Ecosystem Scientific Name	Deepwater Sculpin - Saskatchewan-Nelson River populations (excluding Waterton Lake)		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	27/09/2016		
Assessor(s):	Nick Mandrak (SSC co-chair), Dave Fraser (moderator), Erik Szkokan-Emilson (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (QC MRRF) and Angèle Cyr (Secretariat).		
References:			

Overall Threat Impact Calculation Help:

		Level 1 Threat Impact Counts	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	2	2
Calculated Overall Threat Impact:		Low	Low

Assigned Overall Threat Impact:	
Impact Adjustment Reasons:	
Overall Threat Comments	4-5 yr generation time so 12-15 yrs projection into future. Could be up to 9 yrs but research is unpublished and not yet peer reviewed.

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas						not applicable
2	Agriculture & aquaculture		Negligible				
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Wild rice farming. Grows in shallow water and could create a barrier to fish movements. Likely negligible threat to DPSC directly.
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						not applicable
2.4	Marine & freshwater aquaculture						not applicable

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining	Low	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
3.1	Oil & gas drilling					Fracking unlikely an issue as DPSC occur mainly in shield lakes with little oil and gas exploration.
3.2	Mining & quarrying	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Diamond and metal mining is performed under lakes and around where DPSC may occur, and could impact overall habitat quality.
3.3	Renewable energy					not applicable
4	Transportation & service corridors					
4.1	Roads & railroads					not applicable
4.2	Utility & service lines					not applicable
4.3	Shipping lanes					shipping lanes and dredging are not applicable to this DU
4.4	Flight paths					not applicable
5	Biological resource use	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals					not applicable
5.2	Gathering terrestrial plants					not applicable
5.3	Logging & wood harvesting					not applicable
5.4	Fishing & harvesting aquatic resources	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Infrequent catch from surveying.
6	Human intrusions & disturbance					
6.1	Recreational activities					not applicable
6.2	War, civil unrest & military exercises					not applicable
6.3	Work & other activities					not applicable
7	Natural system modifications					
7.1	Fire & fire suppression					not applicable
7.2	Dams & water management/use					not applicable
7.3	Other ecosystem modifications					Potential for Quagga mussels but no current overlap. Invasive in Lake Winnipeg now. Unlikely due to the calcium-limited shield lakes in this DU.
8	Invasive & other problematic species & genes					
8.1	Invasive non-native/alien species/diseases					Potential for Quagga mussels accounted for under 7.3.
8.2	Problematic native species/diseases					no problematic native species. Limiting factor.
8.3	Introduced genetic material					not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.4	Problematic species/diseases of unknown origin						not applicable
8.5	Viral/prion-induced diseases						not applicable
8.6	Diseases of unknown cause						not applicable
9	Pollution	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	
9.1	Domestic & urban waste water	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	Eutrophication from urban sources. Mostly cottage country. Sheldon 2006 suggests this is a serious threat.
9.2	Industrial & military effluents						not applicable
9.3	Agricultural & forestry effluents		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Eutrophication from agriculture possible but negligible.
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
11.1	Habitat shifting & alteration						not applicable
11.2	Droughts						not applicable
11.3	Temperature extremes		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Increasing temperatures, particularly in more southern and shallower lakes. Latitude is higher in this DU and likely a trade-off from cooler lakes. So less threatening driver to deeper habitat in comparison to the other DU.
11.4	Storms & flooding						not applicable
11.5	Other impacts						not applicable

Appendix 4 IUCN Threats Classification and Assessment Calculator for the Deepwater Sculpin – Waterton Lake Population

Species or Ecosystem Scientific Name	Deepwater Sculpin - Waterton Lake population		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	27/09/2016		
Assessor(s):	Nick Mandrak (SSC co-chair), Dave Fraser (moderator), Erik Szkokan-Emilson (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (Quebec MFFP), Angèle Cyr (Secretariat).		
References:			

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	Level 1 Threat Impact Counts: low range
A	Very High	0	0
B	High	1	0
C	Medium	0	1
D	Low	0	0
	Calculated Overall Threat Impact:	High	Medium

Assigned Overall Threat Impact:	
Impact Adjustment Reasons:	
Overall Threat Comments	4-5 yr generation time so 12-15 yrs projection into future. Could be up to 9 yrs but research is unpublished and not yet peer reviewed.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas						not applicable
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						not applicable
2.4	Marine & freshwater aquaculture						not applicable

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining	Unknown	Unknown	Unknown	Unknown	
3.1	Oil & gas drilling					not applicable
3.2	Mining & quarrying	Unknown	Unknown	Unknown	Unknown	not applicable
3.3	Renewable energy					not applicable
4	Transportation & service corridors					
4.1	Roads & railroads					not applicable
4.2	Utility & service lines					not applicable
4.3	Shipping lanes					not applicable
4.4	Flight paths					not applicable
5	Biological resource use	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals					not applicable
5.2	Gathering terrestrial plants					not applicable
5.3	Logging & wood harvesting					not applicable
5.4	Fishing & harvesting aquatic resources	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Infrequent catch from surveying.
6	Human intrusions & disturbance					
6.1	Recreational activities					Not applicable. Within the National Park. Unlikely disturbance.
6.2	War, civil unrest & military exercises					not applicable
6.3	Work & other activities					Not applicable. Some research but unknown in nature. Accounted for in 5.4
7	Natural system modifications	Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
7.1	Fire & fire suppression					not applicable
7.2	Dams & water management/use					not applicable
7.3	Other ecosystem modifications	Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Potential for Zebra Mussel but no current overlap. Invasive in Lake Winnipeg now. Unlikely an issue in this DU due to temperature and calcium limitations.
8	Invasive & other problematic species & genes					

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species/diseases						Potential for Zebra Mussel accounted for under 7.3. No other invasive species that have been identified for this species other than invasive algae (anoxia).
8.2	Problematic native species/diseases						No problematic native species. Limiting factor. Cladophora algae (eutrophication) that is accounted for under 9.1
8.3	Introduced genetic material						not applicable
8.4	Problematic species/diseases of unknown origin						not applicable
8.5	Viral/prion-induced diseases						not applicable
8.6	Diseases of unknown cause						not applicable
9	Pollution	BC	High - Medium	Pervasive - Large (31-100%)	Serious - Moderate (11-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
9.1	Domestic & urban waste water	BC	High - Medium	Pervasive - Large (31-100%)	Serious - Moderate (11-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Eutrophication from urban sources, Waterton Village and hotel. Septic system leak is a demonstrated threat that has occurred and potentially could reoccur but unsure about timing (frequency).
9.2	Industrial & military effluents						not applicable
9.3	Agricultural & forestry effluents						not applicable
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Pervasive - Large (31-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
11.1	Habitat shifting & alteration						not applicable
11.2	Droughts						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.3	Temperature extremes		Unknown	Pervasive - Large (31-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	increasing temperatures from climate change could warm waters
11.4	Storms & flooding						not applicable
11.5	Other impacts						not applicable

Appendix 5. IUCN Threats Classification and Assessment Calculator for the Deepwater Sculpin – Western Hudson Bay Populations

Species or Ecosystem Scientific Name	Deepwater Sculpin - Western Hudson Bay populations		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	27/09/2016		
Assessor(s):	Nick Mandrak (SSC co-chair), Dave Fraser (moderator), Erik Szkokan-Emilson (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC member), Frédéric Lecomte (Quebec MRRF) Angèle Cyr (Secretariat).		
References:			

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	0	0
Calculated Overall Threat Impact:			

Assigned Overall Threat Impact:	
Impact Adjustment Reasons:	
Overall Threat Comments	4-5 yr generation time so 12-15 yrs projection into future. Could be up to 9 yrs but research is unpublished and not yet peer reviewed.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas						not applicable
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.2	Wood & pulp plantations					not applicable
2.3	Livestock farming & ranching					not applicable
2.4	Marine & freshwater aquaculture					not applicable
3	Energy production & mining	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
3.1	Oil & gas drilling					Fracking unlikely an issue as DPSC occur mainly in shield lakes with little oil and gas exploration.
3.2	Mining & quarrying	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Hard rock mining is performed under lakes and around where DPSC may occur, and could impact overall habitat quality. Negligible.
3.3	Renewable energy					not applicable
4	Transportation & service corridors					
4.1	Roads & railroads					not applicable
4.2	Utility & service lines					not applicable
4.3	Shipping lanes					shipping lanes and dredging are not applicable to this DU
4.4	Flight paths					not applicable
5	Biological resource use	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals					not applicable
5.2	Gathering terrestrial plants					not applicable
5.3	Logging & wood harvesting					not applicable
5.4	Fishing & harvesting aquatic resources	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Infrequent catch from surveying.
6	Human intrusions & disturbance					
6.1	Recreational activities					not applicable
6.2	War, civil unrest & military exercises					not applicable
6.3	Work & other activities					not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7	Natural system modifications						
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use						not applicable
7.3	Other ecosystem modifications						Potential for Zebra Museel but no current overlap. Invasive in Lake Winnipeg now. Water chemistry (low calcium) and cold temperatures in the shield lakes in this DU would render invasion by Zebra Mussel unlikely.
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species/diseases						Potential for Zebra Mussel accounted for under 7.3.
8.2	Problematic native species/diseases						No problematic native species. Limiting factor.
8.3	Introduced genetic material						not applicable
8.4	Problematic species/diseases of unknown origin						not applicable
8.5	Viral/prion-induced diseases						not applicable
8.6	Diseases of unknown cause						not applicable
9	Pollution		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
9.1	Domestic & urban waste water		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Eutrophication from urban sources. Mostly cottage country.
9.2	Industrial & military effluents						not applicable
9.3	Agricultural & forestry effluents						Eutrophication from agriculture possible but negligible.
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
11.1	Habitat shifting & alteration						not applicable
11.2	Droughts						not applicable
11.3	Temperature extremes		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Increasing temperatures, particularly in more southern and shallower lakes. Latitude is higher in this DU and lakes are generally colder.
11.4	Storms & flooding						not applicable
11.5	Other impacts						not applicable

Appendix 6. IUCN Threats Classification and Assessment Calculator for the Deepwater Sculpin – Western Arctic Populations

Species or Ecosystem Scientific Name	Deepwater Sculpin - Western Arctic populations			
Element ID			**Elcode**	
Date (Ctrl + ";" for today's date):	27/09/2016			
Assessor(s):	Nick Mandrak (SSC co-chair), Dave Fraser (moderator), Erik Szkokan-Emilson (writer), Pete Cott (writer and SSC member), Bill Tonn (SSC members), Frédéric Lecomte (Quebec MRRF), Angèle Cyr (Secretariat).			
References:				

Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	0	0
	D	Low	1	1
		Calculated Overall Threat Impact:	Low	Low
		Assigned Overall Threat Impact:		
		Impact Adjustment Reasons:		
		Overall Threat Comments	4-5 yr generation time so 12-15 yrs projection into future. Could be up to 9 yrs but research is unpublished and not yet peer reviewed.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas						not applicable
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture						not applicable
3	Energy production & mining		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
3.1	Oil & gas drilling						Fracking unlikely an issue as DPSC occur mainly in shield lakes with little oil and gas exploration.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Diamond and metal mining is performed under lakes and around where DPSC may occur, and could impact overall habitat quality.
3.3	Renewable energy						not applicable
4	Transportation & service corridors						
4.1	Roads & railroads						not applicable
4.2	Utility & service lines						not applicable
4.3	Shipping lanes						shipping lanes and dredging are not applicable to this DU
4.4	Flight paths						not applicable
5	Biological resource use		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						not applicable
5.4	Fishing & harvesting aquatic resources		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Infrequent catch from surveying. Nothing active.
6	Human intrusions & disturbance						
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities						not applicable
7	Natural system modifications						
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.3	Other ecosystem modifications		Unknown	Unknown	Unknown	Moderate - Low	Potential for Quagga mussels but no current overlap. Invasive in Lake Winnipeg now. Unlikely due to the cold and calcium-limited shield lakes in this DU.
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species/diseases						Potential for Quagga mussels accounted for under 7.3.
8.2	Problematic native species/diseases						No problematic native species. Limiting factor.
8.3	Introduced genetic material						not applicable
8.4	Problematic species/diseases of unknown origin						not applicable
8.5	Viral/prion-induced diseases						not applicable
8.6	Diseases of unknown cause						not applicable
9	Pollution	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	
9.1	Domestic & urban waste water		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Eutrophication from urban sources but negligible.
9.2	Industrial & military effluents						not applicable
9.3	Agricultural & forestry effluents						not applicable
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
11.1	Habitat shifting & alteration						not applicable
11.2	Droughts						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.3	Temperature extremes		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Increasing temperatures, particularly in more southern and shallower lakes. Latitude is higher in this DU and lakes are generally colder.
11.4	Storms & flooding						not applicable
11.5	Other impacts						not applicable