COSEWIC
Assessment and Status Report

on the

Pygmy Whitefish
Prosopium coulterii

Southwestern Yukon Beringian populations
Yukon River populations
Pacific populations
Western Arctic populations
Great Lakes – Upper St. Lawrence populations
Waterton Lake populations
Saskatchewan - Nelson Rivers populations

in Canada

Southwestern Yukon Beringian populations - DATA DEFICIENT
Yukon River populations - DATA DEFICIENT
Pacific populations - NOT AT RISK
Western Arctic populations - NOT AT RISK
Great Lakes – Upper St. Lawrence populations - THREATENED
Waterton Lake populations - SPECIAL CONCERN
Saskatchewan - Nelson Rivers populations - DATA DEFICIENT
2016

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. 2016. COSEWIC assessment and status report on the Pygmy Whitefish *Prosopium coulterii,* Southwestern Yukon Beringian populations, Yukon River populations, Pacific populations, Western Arctic populations, Great Lakes – Upper St. Lawrence populations, Waterton Lake populations and Saskatchewan - Nelson Rivers populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. iv + 69 pp. (http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Production note:
COSEWIC would like to acknowledge Jeff Sereda for writing the status report on Pygmy Whitefish, *Prosopium coulterii* in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Eric Taylor, former Co-chair and Nick 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 la Corégone pygmée (*Prosopium coulterii*), populations béringiennes du sud–ouest du Yukon, populations du fleuve Yukon, populations du Pacifique, populations de l'ouest de l'Arctique, populations des Grands Lacs et du haut Saint–Laurent, population du lac Waterton et populations de la rivière Saskatchewan et du fleuve Nelson au Canada.

Cover illustration/photo:
Cover image of Pygmy whitefish of approximately 12 cm total length (Dr. G. Court; used with permission).

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COSEWIC
Assessment Summary

Assessment Summary – November 2016

Common name
Pygmy Whitefish - Southwestern Yukon Beringian populations

Scientific name
Prosopium coulterii

Status
Data Deficient

Reason for designation
This freshwater fish is known from seven lakes in British Columbia and Yukon Territory, but may exist in others. Quantitative data on population sizes, geographic range, and known threats are too limited to determine status..

Occurrence
Yukon, British Columbia

Status history
Species considered in November 2016 and placed in the Data Deficient category.

Assessment Summary – November 2016

Common name
Pygmy Whitefish - Yukon River populations

Scientific name
Prosopium coulterii

Status
Data Deficient

Reason for designation
This freshwater fish is known from three lakes in Yukon Territory, but may exist in others. Quantitative data on population sizes, geographic range, and known threats are too limited to determine status.

Occurrence
Yukon

Status history
Species considered in November 2016 and placed in the Data Deficient category.

Assessment Summary – November 2016

Common name
Pygmy Whitefish - Pacific populations

Scientific name
Prosopium coulterii

Status
Not at Risk

Reason for designation
This small-bodied freshwater fish is relatively broadly distributed across many lakes and some rivers. Most lakes and rivers are relatively isolated from human impacts, and there are no known imminent threats to any population.

Occurrence
Yukon, British Columbia

Status history
Designated Not at Risk in November 2016.

Assessment Summary – November 2016

Common name
Pygmy Whitefish - Western Arctic populations

Scientific name
Prosopium coulterii

Status
Not at Risk

Reason for designation
This small-bodied freshwater fish is relatively broadly distributed across many lakes and some rivers. Most lakes and rivers are relatively isolated from human impacts, and there are very few known imminent threats to any population.

Occurrence
Northwest Territories, British Columbia, Alberta

Status history
Designated Not at Risk in November 2016.

Assessment Summary – November 2016

Common name
Pygmy Whitefish - Great Lakes – Upper St. Lawrence populations

Scientific name
Prosopium coulterii

Status
Threatened

Reason for designation
This small-bodied freshwater fish has experienced dramatic declines in abundance over the last several decades, with an overall estimated decline of 48% since 2000. The continued presence of invasive fishes and recovery of native predatory fishes may threaten or limit recovery, respectively.

Occurrence
Ontario

Status history
Designated Threatened in November 2016.

Assessment Summary – November 2016

Common name
Pygmy Whitefish - Waterton Lake populations

Scientific name
Prosopium coulterii

Status
Special Concern

Reason for designation
This small-bodied freshwater fish is known from a single lake in southwestern Alberta. The population size is relatively small and a change in water quality or habitat induced by local pollution or climate change could put the population at risk.

Occurrence
Alberta

Status history
Designated Special Concern in November 2016.

Assessment Summary – November 2016

Common name
Pygmy Whitefish - Saskatchewan - Nelson Rivers populations

Scientific name
Prosopium coulterii

Status
Data Deficient

Reason for designation
This freshwater fish has only recently been documented in four lakes in northwestern Ontario, but may exist in others. Quantitative data on population sizes, geographic range, and known threats are too limited to determine status.

Occurrence
Ontario

Status history
Species considered in November 2016 and placed in the Data Deficient category.

COSEWIC
Executive Summary

Pygmy Whitefish
Prosopium coulterii

Southwestern Yukon Beringian populations
Yukon River populations
Pacific populations
Western Arctic populations
Great Lakes – Upper St. Lawrence populations
Waterton Lake populations
Saskatchewan - Nelson Rivers populations

Wildlife Species Description and Significance

The Pygmy Whitefish (*Prosopium coulterii*) is the smallest species within the whitefishes with a maximum size of approximately 150 mm total length (TL) for the “regular” form and up to 260 mm TL for the “giant” form. It is typically brownish green along the back with silvery sides and a white belly. In cross-section the depth of the body is less than twice its width, and the eye is relatively large; its diameter is larger than the snout length. Except in the largest individuals, there are 7 to 14 dark patches along their side and 12 to 14 along their back. The Pygmy Whitefish is a glacial relict with genetically distinct populations originating from different refugia (DU1, Beringia refugium, and DUs 2-7, Pacific and Mississippi refugia).

Distribution

The Pygmy Whitefish may have the most discontinuous range of any freshwater fish in North America (~2,200 km from Yukon to Lake Superior). Populations exist within: portions of the Columbia River system in British Columbia, Washington, Montana, and Idaho; Fraser, Skeena, Peace, Alsek, and Yukon River systems in British Columbia and Yukon; Chignik and Ugashik river systems in southwestern Alaska; Lake Athabasca in Alberta and Saskatchewan; Upper Waterton Lake and portions of the Athabasca River in Alberta; Great Bear and Bluefish lakes in the Northwest Territories; Lake Superior in Michigan, Wisconsin, Minnesota and Ontario; and four lakes in northwestern Ontario. In addition to its vast North American range, the species is found across a small area outside North America in the Amguen River system in the Chukotsk Peninsula, Siberia.

Habitat

Pygmy Whitefish typically inhabits cold, deep, boreal and montane lakes of low productivity. It is usually found at depths greater than 30 m, but has been located at depths <5 m and as great as 168 m. Pygmy Whitefish is most often encountered at water temperatures below 10°C and oxygen concentrations above 5 mg/l. Pygmy Whitefish is also recorded from moderate to fast-moving, clear or silted, montane rivers where it occupies depths of 0.5 to 1 m in nearshore eddies along the edge of faster mainstream flow.

Biology

Pygmy Whitefish tends to be relatively short-lived with life expectancies ranging between 3 and 10 years (median 7 years). It generally matures at a young age and small size. Males mature at 1 to 3 years of age and 58 to 130 mm total length (TL), whereas females mature at 2 to 4 years of age and 61 to 228 mm TL. Spawning occurs annually between September and December, but can occur as late as January when water temperatures are between 2 and 5°C. Eggs are broadcast over coarse gravel in shallow water in rivers or along lake shorelines at night. Egg production scales with body size; individual females may produce between about 100 to 1,000 eggs. Pygmy Whitefish is a generalist carnivore typically feeding on a variety of benthic invertebrates. In some populations, Pygmy Whitefish may forage on zooplankton in the pelagic zone.

Population Sizes and Trends

The small size of the Pygmy Whitefish and the great depths at which it is found often makes its capture through conventional fishing methods difficult. Consequently, little information exists on its population size or trends across the range and population estimates typically do not exist. Nonetheless, it has been estimated that about 2,000 individuals reside within Alberta (range in estimate, 700 to 3,000). Annual trawl surveys conducted in Lake Superior indicate that Pygmy Whitefish densities have ranged from 1.5 to 135 fish per surveyed hectare since 1963. Systematic trawling surveys suggest that the Lake Superior population has declined over the past three generations (16 yrs).

Threats and Limiting Factors

The Pygmy Whitefish is a cold-water stenotherm, typically preferring water temperatures < 10 °C and dissolved oxygen levels > 5 mg/l; therefore, the distribution of this species is likely limited, in part, by a general lack of tolerance to conditions where these parameters are exceeded. Degradation of habitat including water quality associated with forestry, hydroelectric, oil, gas and mining development, agriculture, and urbanization pose the greatest potential anthropogenic threats to Pygmy Whitefish, although few specific threats have been identified. Stocking with non-native fishes negatively affects Pygmy Whitefish populations, particularly in smaller closed-basin lakes where refugia from predation may be limited. Fishes with limited dispersal ability and stenothermic tolerances, such as Pygmy Whitefish, could be at the greatest risk of extinction following the loss of coldwater habitats from global warming.

Protection, Status and Ranks

The Pygmy Whitefish may receive protection under the federal *Fisheries Act* because although it is unlikely to be considered to be of direct significance to Commercial, Recreational, or Aboriginal fisheries, its status as a forage fish means it likely supports such fisheries. Currently, Pygmy Whitefish are ranked as secure, G5 and N5 for global and national populations, respectively. Regionally, Pygmy Whitefish is ranked S1 in Alberta, S4 in British Columbia and the Yukon, and SU in Ontario and the Northwest Territories. Pygmy Whitefish is considered a non-game fish throughout Canada and, therefore, anglers generally have no restriction on the number of Pygmy Whitefish that they may keep, except in British Columbia where there is a maximum daily limit of 15. Only five populations of Pygmy Whitefish (in Jasper, Waterton, Yoho, and Kluane national parks) are protected from overexploitation. Under the National Park Sport Fishing Regulations, Pygmy Whitefish is not specifically listed in the catch-and-possession limits and, therefore, falls into the category of “other species” that have no limit on retention. Habitat is protected by the *National Parks Act* where it occurs in a national park or national park reserve.

TECHNICAL SUMMARY: DU 1

Prosopium coulterii

Pygmy Whitefish
Southwestern Yukon Beringian populations

Corégone pygmée
Populations béringiennes sud-ouest du Yukon

Range of occurrence in Canada (province/territory/ocean): Yukon, British Columbia

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) Based on Alberta populations	5.5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? No compelling reasons to suspect declines from historical levels	Unknown, but unlikely
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
[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. not applicable b. not applicable c. not applicable
Are there extreme fluctuations in number of mature individuals?	Unknown, but likely not

Extent and Occupancy Information

Estimated extent of occurrence	51,747 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	28 km² (discrete) 2,624 km² (continuous)

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. Yes
Number of “locations”* (use plausible range to reflect uncertainty if appropriate) Known from seven lakes, YT and BC, but search effort has been very low and there are no known threats to these populations.	Unknown, but at least 7 (could be 10 or more)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of “locations”*? Suspected to increase with greater survey effort (underway)	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Unknown, but likely not
Are there extreme fluctuations in number of subpopulations?	Unknown, but likely not
Are there extreme fluctuations in number of “locations”*?	Unknown, but likely not
Are there extreme fluctuations in extent of occurrence?	Unknown, but likely not
Are there extreme fluctuations in index of area of occupancy?	Unknown, but likely not

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Aishihik Lake	Unknown
Atlin Lake	Unknown
Bates Lake	Unknown
Kathleen Lake	Unknown
Little Salmon Lake	Unknown
Mush Lake	Unknown
Tagish 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

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

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Overall threat impact was unknown and all threat categories were unknown. Was a threats calculator completed for this species and if so, by whom? Yes; Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angèle Cyr (recorder)

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. The only other known Beringian clade Pygmy Whitefish are found in southwestern Alaska, which are isolated by major watershed divides	Not applicable (Alaska S4)
Is immigration known or possible?	Not possible
Would immigrants be adapted to survive in Canada?	Not applicable
Is there sufficient habitat for immigrants in Canada?	Not applicable
Are conditions deteriorating in Canada?[+]	No
Are conditions for the source population deteriorating?[+]	Not applicable
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: Species considered in November 2016 and placed in the Data Deficient category.

Status and Reasons for Designation:

Status: Data Deficient	**Alpha-numeric codes:** Not applicable
Reasons for designation: This freshwater fish is known from seven lakes in British Columbia and Yukon Territory, but may exist in others. Quantitative data on population sizes, geographic range, and known threats are too limited to determine status.	

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 and IAO thresholds and there are an unknown number of locations and no evidence of extreme fluctuations or decline in habitat quality, quantity, or adult population sizes.

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

Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Insufficient data to assess thresholds.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds IAO threshold and number of locations is highly uncertain.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

TECHNICAL SUMMARY: DU 2

Prosopium coulterii

Pygmy Whitefish
Yukon River populations

Corégone pygmée
Populations de la rivière Yukon

Range of occurrence in Canada (province/territory/ocean): Yukon

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) Based on estimates from Alberta populations	5.5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown, but likely not
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
[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. not applicable b. not applicable c. not applicable
Are there extreme fluctuations in number of mature individuals?	Unknown, but likely not

Extent and Occupancy Information

Estimated extent of occurrence	28,151 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	12 km² (discrete) 892 km² (continuous)
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. Yes

Number of "locations"* (use plausible range to reflect uncertainty if appropriate) Known from three lakes, YT, but search effort has been very low and there are no known threats to these populations.	Unknown, but at least 3 (could be 10 or more)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Unknown, but likely not
Are there extreme fluctuations in number of subpopulations?	Unknown, but likely not
Are there extreme fluctuations in number of "locations"∗?	Unknown, but likely not
Are there extreme fluctuations in extent of occurrence?	Unknown, but likely not
Are there extreme fluctuations in index of area of occupancy?	Unknown, but likely not

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Marsh Lake	Unknown
Mayo Lake	Unknown
Teslin 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

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Overall threat impact was unknown and all threat categories were unknown.

Was a threats calculator completed for this species and if so, by whom? Yes; Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angèle Cyr (recorder)

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

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. Populations are isolated from other DUs and non-Canadian populations by the watershed divides.	Not applicable
Is immigration known or possible?	Not possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	No
Are conditions for the source population deteriorating?[+]	No
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: Species considered in November 2016 and placed in the Data Deficient category.

Status and Reasons for Designation:

Status: Data Deficient	**Alpha-numeric codes:** Not applicable
Reasons for designation: This freshwater fish is known from three lakes in Yukon Territory, but may exist in others. Quantitative data on population sizes, geographic range, and known threats are too limited to determine status.	

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 IAO from known populations are below thresholds for Endangered, the geographic range may be more extensive and there are an unknown number of locations and no evidence of extreme fluctuations or decline in habitat quality, quantity, or adult population sizes.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Insufficient data to assess thresholds.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds IAO threshold and number of locations is highly uncertain.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

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

TECHNICAL SUMMARY: DU 3

Prosopium coulterii

Pygmy Whitefish
Pacific populations

Corégone pygmée
Populations du Pacifique

Range of occurrence in Canada (province/territory/ocean): British Columbia, Yukon.

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) Based on estimates from Alberta populations	5.5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown, but likely not
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
[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. not applicable b. not applicable c. not applicable
Are there extreme fluctuations in number of mature individuals?	Unknown, but likely not

Extent and Occupancy Information

Estimated extent of occurrence	206,839 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	52 km² (discrete) 1,092 km² (continuous)

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. Yes
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	12
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? Some lakes may have experienced habitat degradation in past (e.g., Okanagan Lake, Kootenay Lake, Arrow Lakes), but, overall, habitat is likely stable.	Probably not
Are there extreme fluctuations in number of subpopulations?	Unknown, but likely not
Are there extreme fluctuations in number of “locations”∗?	Unknown, but likely not
Are there extreme fluctuations in extent of occurrence?	Unknown, but likely not
Are there extreme fluctuations in index of area of occupancy?	Unknown, but likely not

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Upper and Lower Arrow Lake, BC	unknown
Chapman Lake, BC	unknown
Cluculz Lake, BC	unknown
Jack of Clubs Lake, BC	unknown
Kicking Horse River, BC	unknown
Kootenay Lake, BC	unknown
McLeese Lake, BC	unknown
Moose Lake, BC	unknown

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

Okanagan Lake, BC	unknown
Owen Lake, BC	unknown
Tyhee Lake, BC	unknown
Yellowhead Lake, BC	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

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Overall threat impact was unknown and all threat categories were either negligible or unknown.

Was a threats calculator completed for this species and if so, by whom? Yes; Jeff Sereda, Bruce Bennett, Tom Jung, Greg Wilson, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angèle Cyr (recorder)

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. Populations are isolated from other DUs and non-Canadian populations by the watershed divides.	Idaho (SNR), Montana (S3), Washington (S1S2)
Is immigration known or possible?	Possible through the Okanagan and Kootenay Rivers, but improbable given the distance of travel required
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	No
Are conditions for the source population deteriorating?[+]	No
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

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

Status

COSEWIC Status History: Designated Not at Risk in November 2016.

Status and Reasons for Designation:

Status: Not at Risk	**Alpha-numeric codes:** Not applicable
Reasons for designation: This small-bodied freshwater fish is relatively broadly distributed across many lakes and some rivers. Most lakes and rivers are relatively isolated from human impacts and there are no known imminent threats to any population.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No data to detect declines or their magnitude.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although IAO is below the threshold for Endangered, thresholds for all other criteria are exceeded.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Population sizes unknown, but likely exceed criteria and no evidence of continuing declines.
Criterion D (Very Small or Restricted Population): Not applicable. All criteria exceeded.
Criterion E (Quantitative Analysis): Not performed. Data not available to conduct analysis.

TECHNICAL SUMMARY: DU 4

Prosopium coulterii

Pygmy Whitefish
Western Arctic populations

Corégone pygmée
Populations de l'ouest de l'Arctique

Range of occurrence in Canada (province/territory/ocean): Alberta, British Columbia, 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) Based on information from Dina Lake #1 population	Males 2+, Females 3+
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Potential for some declines in heavily impacted areas such as upper Athabasca River watershed.	Unknown, but likely not
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
[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. not applicable b. not applicable c. not applicable
Are there extreme fluctuations in number of mature individuals?	Unknown, but likely not

Extent and Occupancy Information

Estimated extent of occurrence	1,394,815 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	<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. Yes
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	22
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of "locations"*? Possibly Dina Lake #1 has experienced a decline following heavy stocking of predatory Rainbow Trout	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? Probably not for most areas, but notable exceptions (e.g., Athabasca River) exist	Probably not
Are there extreme fluctuations in number of subpopulations?	Unknown, but likely not
Are there extreme fluctuations in number of "locations"*?	Unknown, but likely not
Are there extreme fluctuations in extent of occurrence?	Unknown, but likely not
Are there extreme fluctuations in index of area of occupancy?	Unknown, but likely not

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Athabasca River, AB (one 46 km section)	267 (95% C.I = 50 - 450)
Aiken Lake, BC	Unknown
Arctic Lake, BC	Unknown
Bluefish Lake, NWT	Unknown
Chuchi Lake, BC	Unknown
Dina lake #1, BC	Unknown
Elliot Lake, BC	Unknown
Great Bear Lake, NWT	Unknown
Kwadacha River, BC	Unknown
Lake Athabasca, AB/SK	Unknown

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

Lower Mason Lake, BC	Unknown
Lower Tacheeda Lake, BC	Unknown
Monkman Lake, BC	Unknown
Quentin Lake, BC	Unknown
Thutade Lake, BC	Unknown
Tutizzi Lake, BC	Unknown
Upper Liard River, BC/YT	Unknown
Upper Mason Lake, BC	Unknown
Upper Tacheeda Lake, BC	Unknown
Uslika Lake, BC	Unknown
Weissener Lake, BC	Unknown
Williston Reservoir, BC	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

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Overall threat impact was unknown and all threat categories were either negligible or unknown. Was a threats calculator completed for this species and if so, by whom? Yes; Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angèle Cyr (recorder)

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. Populations are isolated from other DUs and non-Canadian populations by watershed divides.	Not applicable
Is immigration known or possible?	Not possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	No
Are conditions for the source population deteriorating?[+]	No
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

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

Is this a data sensitive species? No

Status History

COSEWIC Status History: Designated Not at Risk in November 2016.

Status and Reasons for Designation:

Status: Not at Risk	**Alpha-numeric codes:** Not applicable
Reasons for designation: This small-bodied freshwater fish is relatively broadly distributed across many lakes and some rivers. Most lakes and rivers are relatively isolated from human impacts, and there are very few known imminent threats to any population.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No data to detect declines or their magnitude.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although IAO is below the threshold for Endangered, thresholds for all other criteria are exceeded.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Populations sizes unknown, but likely exceed criteria, and there is no evidence of continuing declines.
Criterion D (Very Small or Restricted Population): Not applicable. All criteria exceeded.
Criterion E (Quantitative Analysis): Not performed. Data not available to conduct analysis.

TECHNICAL SUMMARY: DU 5

Prosopium coulterii

Pygmy Whitefish
Great Lakes – Upper St. Lawrence populations

Corégone pygmée
Populations des Grands Lacs et du haut Saint-Laurent

Range of occurrence in Canada (province/territory/ocean): Ontario (Lake Superior)

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) Based on information from Alberta populations	5.5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Trawl surveys suggest decline over last three generations over all age classes	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
Suspected percent reduction in total number of mature individuals over the last [10 years, or 3 generations]. Possible decline of 48% in all age classes collected by trawl surveys	48%
[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. No b. No c. No
Are there extreme fluctuations in number of mature individuals?	Unknown, but likely not

Extent and Occupancy Information

Estimated extent of occurrence	39,407 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	>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) Population structure within Lake Superior is poorly known and this vast lake could contain several isolated spawning subpopulations. Locations could be as few as one if invasive species are the principal threat to several if threats act independently at different spawning areas.	1
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?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of subpopulations? Population substructure is unknown	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Unknown, but likely not
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?	Unknown, but likely not
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?	Unknown, but likely not

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Lake Superior	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

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

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Overall threat impact was unknown and all threat categories were either negligible or unknown. Was a threats calculator completed for this species and if so, by whom? Yes Bill Tonn, Dwayne Lepitzki (moderator) and Angèle Cyr (recorder)

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Wisconsin S2 Minnesota SNR Michigan S4
Is immigration known or possible?	Possible (likely)
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?	No
Are conditions for the source population deteriorating?	No
Is the Canadian population considered to be a sink?	No
Is rescue from outside populations likely? Canadian population is probably continuous with fish from US side of Lake Superior, but US populations suffering similar trend of decline in trawl catches	Probably

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC Status History: Designated Threatened in November 2016.

Status and Reasons for Designation:

Status: Threatened	**Alpha-numeric codes:** A2be+4be
Reasons for designation: This small-bodied freshwater fish has experienced dramatic declines in abundance over the last several decades, with an overall estimated decline of 48% since 2000. The continued presence of invasive fishes and recovery of native predatory fishes may threaten or limit recovery, respectively.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Threatened, A2be+4be, because the index of abundance has declined by 48% over the past three generations.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO and IAO exceed criteria and the number of locations is unknown. There is no evidence of significant declines in habitat quality.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Population sizes unknown, but likely exceed criteria.

Criterion D (Very Small or Restricted Population): Not applicable. Exceeds criteria.
Criterion E (Quantitative Analysis): Not performed. Data not available to conduct analysis.

TECHNICAL SUMMARY: DU 6

Prosopium coulterii

Pygmy Whitefish
Waterton Lake populations

Corégone pygmée
Populations du lac Waterton

Range of occurrence in Canada (province/territory/ocean): 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) Based on information from Alberta populations	5.5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown, but likely not
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[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. not applicable b. not applicable c. not applicable
Are there extreme fluctuations in number of mature individuals?	Unknown, but likely not

Extent and Occupancy Information

Estimated extent of occurrence	44 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	44 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. Yes
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	1
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?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown, but likely not
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, but likely not
Are there extreme fluctuations in number of subpopulations?	Unknown, but likely not
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?	Unknown, but likely not

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Waterton Lake, AB	1,800 (750-3,300 95% C.I.)
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 (actual or imminent, to populations or habitats, from highest impact to least)

Overall threat impact was unknown and all threat categories were unknown.

Was a threats calculator completed for this species and if so, by whom? Yes; Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angèle Cyr (recorder)

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

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. Populations are isolated from other DUs and non-Canadian populations by watershed divides.	Not applicable
Is immigration known or possible?	Not possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	No
Are conditions for the source population deteriorating?[+]	No
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC Status History: Designated Special Concern in November 2016.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons for designation: This small-bodied freshwater fish is known from a single lake in southwestern Alberta. The population size is relatively small and a change in water quality or habitat induced by local pollution or climate change could put the population at risk.	

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 44 km^2) are below thresholds and population exists at a single location, no subcriteria are met.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Although there is evidence that the population has fewer than 10,000 mature individuals and may be lower than 2,500, there is no evidence of continuing declines in abundance.
Criterion D (Very Small or Restricted Population): Not applicable. Although comes close to qualifying for Threatened, D2, the population is not at risk of extinction in a short period of time.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis

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

TECHNICAL SUMMARY: DU 7

Prosopium coulterii

Pygmy Whitefish
Saskatchewan - Nelson Rivers populations

Corégone pygmée
Populations de la rivière Saskatchewan et du fleuve Nelson

Range of occurrence in Canada (province/territory/ocean): 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) Based on information from Alberta populations	5.5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown, but likely not
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
[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. not applicable b. not applicable c. not applicable
Are there extreme fluctuations in number of mature individuals?	Unknown, but likely not

Extent and Occupancy Information

Estimated extent of occurrence	4,843 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	16 km² (discrete) 324 km² (continuous)
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. Yes

Number of "locations"* (use plausible range to reflect uncertainty if appropriate) May increase with increased survey efforts; known locations discovered only within last 10 years	Unknown (at least 4)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in index of area of occupancy? Has increased with recent discoveries	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Unknown, but likely not
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Unknown, but likely not
Are there extreme fluctuations in number of subpopulations?	Unknown, but likely not
Are there extreme fluctuations in number of "locations"*?	Unknown, but likely not
Are there extreme fluctuations in extent of occurrence? Known distribution only recently resolved	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**
Delaney Lake, ON	Unknown
Mameigwess Lake, ON	Unknown
Silver Lake, ON	Unknown
Winnange Lake, ON	Unknown
Total	Unknown

Quantitative Analysis

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

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Overall threat impact was unknown and all threat categories were unknown. Was a threats calculator completed for this species and if so, by whom? Yes; Bill Tonn, Dwayne Lepitzki (moderator) and Angele Cyr (recorder)

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

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. Populations are isolated from other DUs and non-Canadian populations by watershed divides.	Not applicable
Is immigration known or possible?	Not possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	No
Are conditions for the source population deteriorating?[+]	No
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC Status History: Species considered in November 2016 and placed in the Data Deficient category.

Status and Reasons for Designation:

Status: Data Deficient	**Alpha-numeric codes:** Not applicable
Reasons for designation: This freshwater fish has only recently been documented in four lakes in northwestern Ontario, but may exist in several others. Quantitative data on population sizes, geographic range, and known threats are too limited to determine status.	

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 EOO and IAO from known populations are below thresholds for Endangered, the geographic range may be more extensive and there are an unknown number of locations and no evidence of extreme fluctuations or decline in habitat quality, quantity, or adult population sizes.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Insufficient data to assess thresholds.
Criterion D (Very Small or Restricted Population): Not applicable. Exceeds IAO threshold and number of locations is highly uncertain.
Criterion E (Quantitative Analysis): Not performed. No data to conduct quantitative analysis.

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

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
(2016)

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
Environnement et Changement climatique Canada
Service canadien de la faune
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

Pygmy Whitefish
Prosopium coulterii

Southwestern Yukon Beringian populations
Yukon River populations
Pacific populations
Western Arctic populations
Great Lakes – Upper St. Lawrence populations
Waterton Lake populations
Saskatchewan - Nelson Rivers populations

in Canada

2016

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Phylum: Chordata

Class: Actinopterygii

Order: Salmoniformes

Family: Salmonidae

Genus: *Prosopium*

Species: *Prosopium coulterii*, Eigenmann and Eigenmann, 1892

English Common Name: Pygmy Whitefish

French Common Name: Corégone pygmée

Morphological Description

The Pygmy Whitefish is the smallest of all the species within the subfamily Coregoninae (whitefishes) with a maximum size of approximately 150 mm TL for the "regular" form, but adults can be as large as 260 mm TL for the "giant" form (see below). Its back is typically brownish green and it has silvery sides and a white belly. In cross-section, the depth of its body is less than twice its width (Scott and Crossman 1973). Its head length is greater than the body depth and the diameter of the eye is larger than the snout length (Scott and Crossman 1973) (Figure 1). Eye position is slightly upward or slightly on top of head. Pygmy Whitefish has 50 to 70 scales along its lateral line and 13 to 33 pyloric caeca. Individuals typically exhibit 7 to 14 parr marks along their sides and 12 to 14 along their back (Sullivan 2011). Both sexes develop orange ventral fins (Heard and Hartman 1965) and breeding tubercles on the head, back, sides and pectoral fins (Weisel and Dillon 1954) during breeding season. *Prosopium* species are distinguished from other coregonines by a single flap between the nostrils and a ventral notch in the adipose eyelid (Figure 2) (Sullivan 2011). Pygmy Whitefish can be distinguished from Mountain Whitefish (*Prosopium williamsoni*) by having six rows of scales above the lateral line rather than 11, and from the Round Whitefish (*P. cylindraceum*) by its more elongate head, large eye, blunt snout, and relatively small adipose fin.

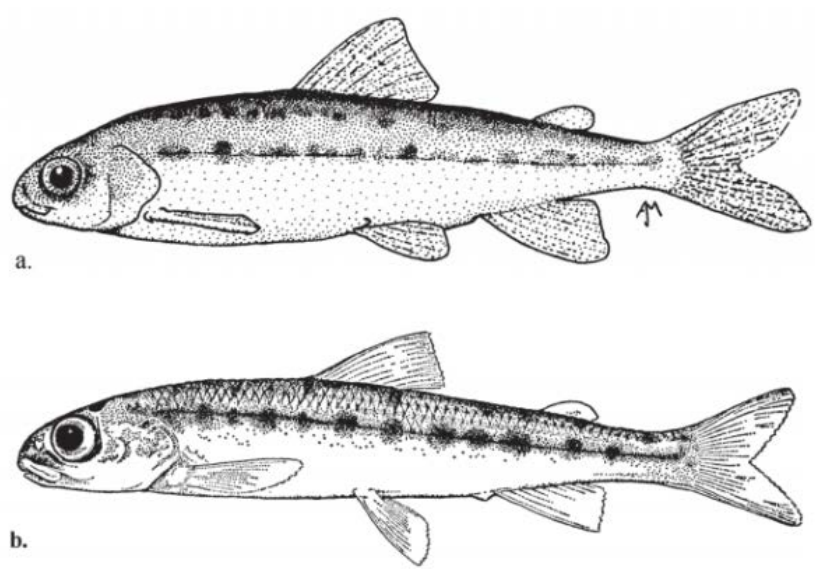

Figure 1. Pygmy Whitefish from a) Nelson and Paetz (1992) and b) Scott and Crossman (1973).

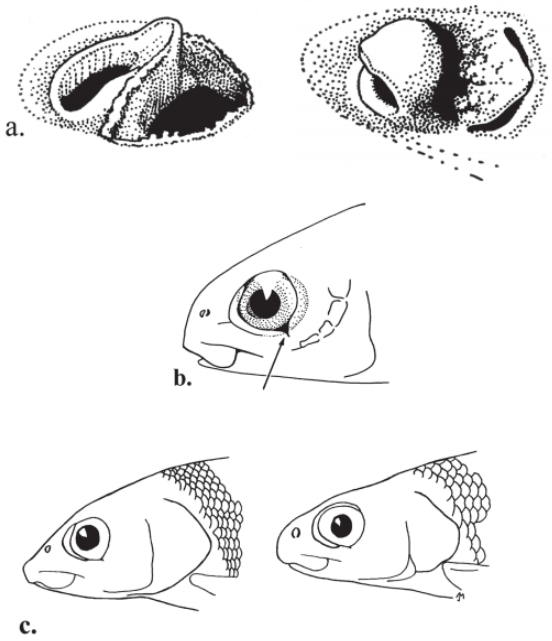

Figure 2. Anatomical features distinguishing Pygmy Whitefish from other coregonines: a) single nasal flap between nostrils of *Prosopium* spp. (left) and two nasal flaps present on other coregonines (from McPhail and Lindsey 1970); b) ventral notch in adipose eyelid of *Prosopium* spp. (from McPhail and Lindsey 1970); c) profile of head of a Mountain Whitefish (left) and Pygmy Whitefish (right) (from Nelson and Paetz 1992).

Population Spatial Structure and Variability

Pygmy Whitefish has arguably the greatest discontinuous range of any freshwater fish in North America (Eschmeyer and Bailey 1955). Populations appear to be highly isolated from each other through residency in remote, deep, lakes and, as a result, have diverged morphologically and genetically (McCart 1970; Taylor *et al*. 2011; Witt *et al*. 2011). The current diversity of Pygmy Whitefish likely results from isolation in, and postglacial dispersal from, three glacial refugia: Beringian, Pacific, and Mississippi refugia (Figure 3; Table A1).

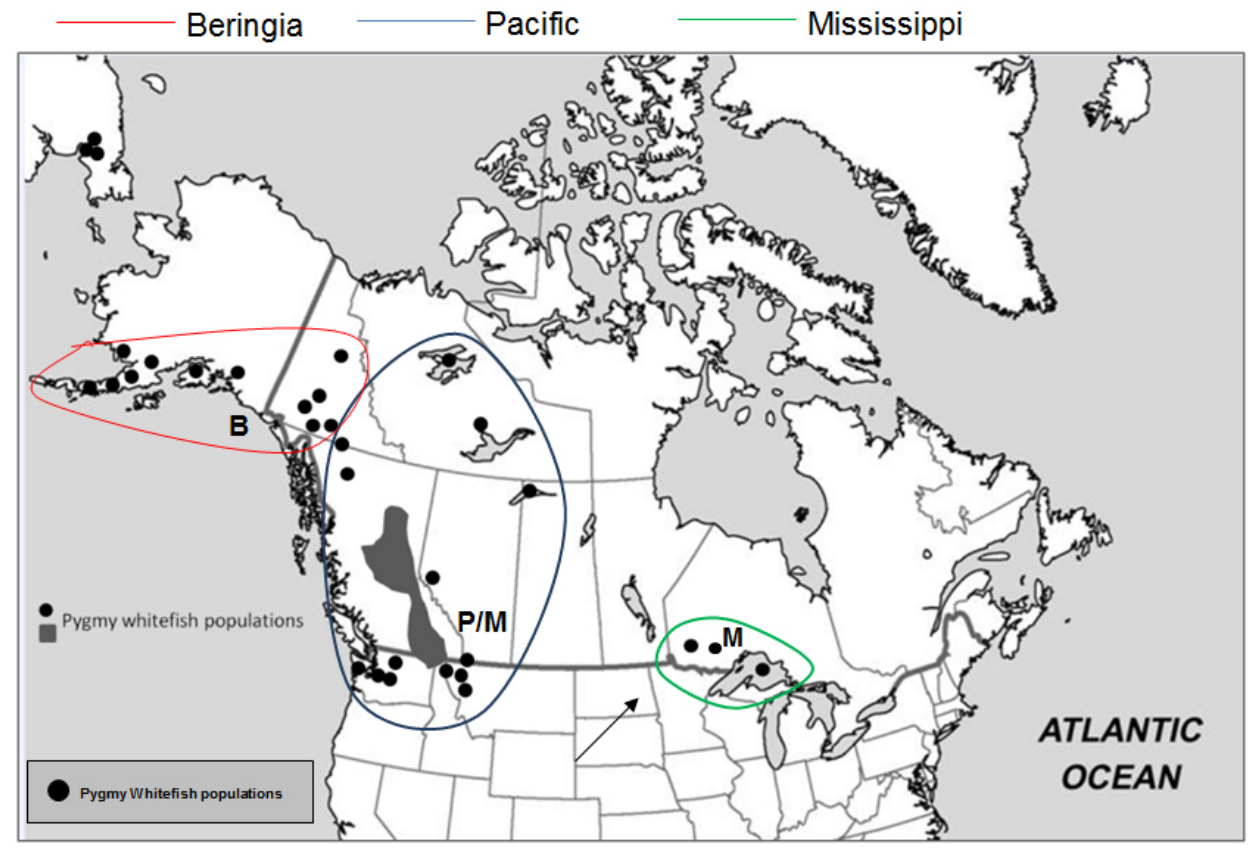

Figure 3. Global distribution of Pygmy Whitefish. Glacial refugia from which Pygmy Whitefish populations likely originated are shown: red = Bering Refuge (B); blue = Pacific Refuge and/or Mississippi Refuge (P/M), green = Mississippi Refuge (M). Figure modified from Blanchfield *et al*. (2014).

Two morphological forms (the “high-raker” and “low-raker”) of Pygmy Whitefish have been identified based on a combination of the numbers of gill rakers, caudal peduncle scales, and dorsal fin rays (McCart 1970; Figure 4). High-raker and low-raker forms were thought to represent populations isolated within different refugia, the Beringian and the Pacific, respectively (McCart 1970). The continental distribution of high-raker and low-raker forms, as well as their coexistence in an Alaskan lake originating from a single refuge (see below) brought the separate refugium hypothesis for the origin of gill-raker morphs into question (Gowell *et al*. 2012). Two major clades have since been identified through mitochondrial and nuclear DNA sequence analysis: one derived from populations in southwestern Alaska (Clade 1); and another derived from populations in Cascadia, Peace River drainage, Lake Superior, and northwestern Ontario (Clade 2) (Table A1; Witt *et al*. 2011; Blanchfield *et al.* 2014). Additionally, it has been proposed that morphological differences may result from niche partitioning. Specifically, differences in diet between gill-raker forms have been identified, with benthivorous and planktivorous whitefish being low-raker and high-raker forms, respectively (Gowell *et al*. 2012).

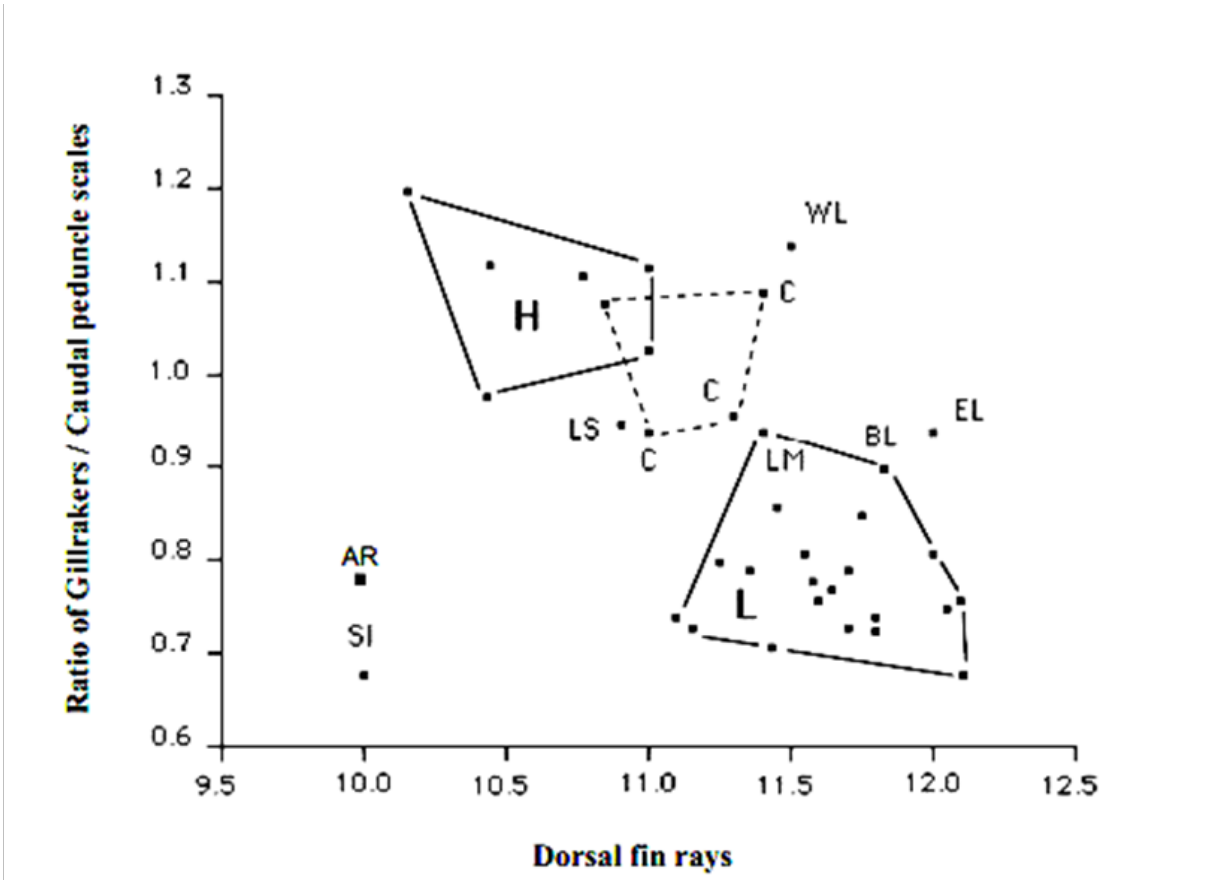

Figure 4. Plot of high- and low-raker forms of Pygmy Whitefish. H = high-raker form; L = low-raker form; AR= Athabasca River, AB; C = Copper River, AK; WL = Waterton Lake AB; EL = Elliot Lake, YT; LS = Lake Superior, MI; BL – Bull Lake, MT; LM = Lake McDonald, MT; SI = Snake Indian River, AB. Reproduced from Mayhood (1992).

Designatable Units

Seven designatable units (DU) are recognized in Pygmy Whitefish based on the discrete and significance criteria (COSEWIC 2014). First, the two major clades differ from each other by more than 3% mtDNA sequence divergence and also form distinct nDNA clades, which strongly suggests that they are pre-glacial in origin (i.e., at least several hundreds of thousands of years old), Witt et al. 2011). Consequently, they have likely resulted from isolation, divergence, and dispersal from distinct glacial refugia (Figure 3). The fact that the discreteness of these clades represents relatively ancient divergences, and is thus of phylogeographic significance, supports the recognition of a distinct DU (DU 1), particularly because many lakes in southern and eastern portions of the Pygmy Whitefish's distribution have been examined and found not to contain this divergent clade (Taylor *et al.* 2011; Witt *et al.* 2011; E.B. Taylor, Dept. of Zoology, University of British Columbia, Vancouver, unpubl. data). All other occurrences of Pygmy Whitefish apparently contain only fish characterized as belonging to Clade 2, but can be further subdivided by their occurrence in five National Freshwater Biogeographic Zones (NFBZ; Figures 5-9: Pacific, Western Arctic, Yukon, Saskatchewan - Nelson, and Great Lakes - Upper St. Lawrence (COSEWIC 2014). Each of the NFBZ has been defined based on their discrete drainage patterns and their distinctive freshwater fish faunas that are the product of historical isolation and recolonization during and following the Pleistocene glaciations (Scott and Crossman 1973; COSEWIC 2014). The discrete distribution of Pygmy Whitefish within these NFBZ is associated with distinctive abiotic and biotic characteristics and biogeographic histories. For example, the Western Arctic NFBZ (DU4) encompasses numerous lakes with a distinctive zoogeographic assemblage of fishes (being a variable mix of largely Bering and Great Plains species). The Great Lakes - Upper St. Lawrence populations (DU5) represents the only known occurrence of Pygmy Whitefish within the Atlantic basin. Furthermore, the isolation of Pygmy Whitefish in distinct biogeographic zones has likely resulted in the evolution of potentially adaptive traits (e.g., the "giant" Pygmy Whitefish, fish of exceptionally large body size, found in some lakes within DU3, e.g., McCart 1965) a common characteristic of salmonid fishes (see Taylor 1991; Fraser *et al*. 2011). Finally, the Saskatchewan-Nelson NFBZ contains Pygmy Whitefish that consist of two components (one within one lake, the other found in two lakes) that are separated by a natural range disjunction of over 1,400 km (Figure 5) and that exist in very different ecological conditions (e.g., elevation differences of > 1,000 m; sub-alpine lake versus boreal forest, lowland lakes). Consequently, the Waterton Lake populations (DU6) and the Nelson River populations (DU7), although both part of the Saskatchewan-Nelson Rivers Watershed NFBZ, have been placed in separate DUs. In summary, seven designatable units are recognized: Southwestern Yukon Beringian (DU1), Yukon River (DU2), Pacific (DU3), Western Arctic (DU4), Great Lakes - Upper St Lawrence (DU5), Waterton Lake (DU6), and Saskatchewan - Nelson Rivers (DU7) (Figures 5-9).

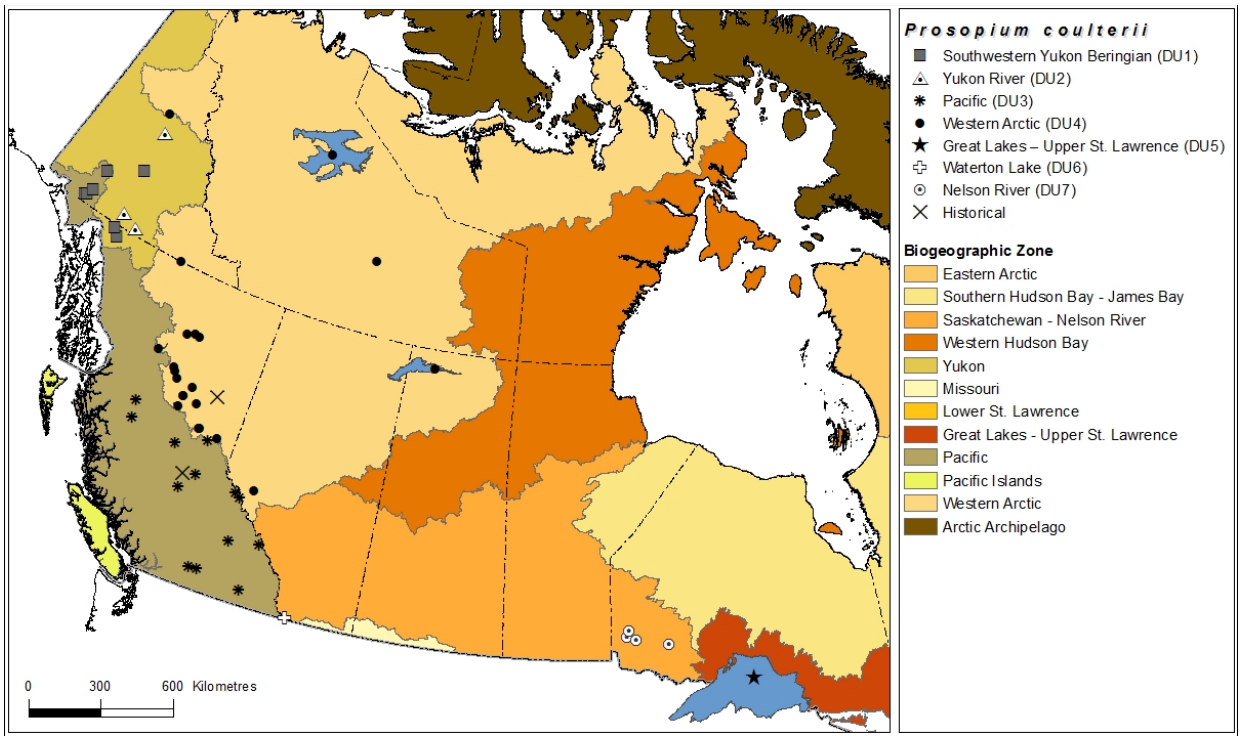

Figure 5. Distribution of Pygmy Whitefish designatable units in Canada in relation to national freshwater biogeographic zones. More detailed maps are provided for DU1 (Figure 6), DU2 (Figure 7), DU3 (Figure 8), and DU7 (Figure 9).

Special Significance

Pygmy Whitefish is a glacial relict with one of the greatest discontinuous ranges of any freshwater fish in North America (Eschmeyer and Bailey 1955) with genetically unique populations stemming from different refugial origins: DU1, the Beringia refugium, DUs 2-4 (Pacific refugium), and DUs 5-7 (Mississippi refugium). Like many small-bodied fishes, the Pygmy Whitefish plays a role as a forage fish for larger-bodied predatory fishes (Dryer *et al*. 1965; Fraley and Shepard 1989).

DISTRIBUTION

Global Range

The Pygmy Whitefish has a disjunct global distribution across North America (~2,200 km) and is also found in a small portion of the Amguen River system in the Chukotsk Peninsula, Siberia, in northeastern Russia (Chereshnev and Skopets 1992).

Canadian Range

The Pygmy Whitefish has a scattered and disjunct distribution within Canada. Known populations exist within some central British Columbia lakes; portions of the Columbia, Fraser, Upper Peace, Liard, Skeena, Alsek, and Yukon river systems in British Columbia and Yukon (Pacific and Yukon NFBZ); Upper Waterton Lakes and a portion of the Athabasca River between Snaring River and Solomon Creek in Alberta (Western Arctic and Saskatchewan-Nelson NFBZ); the Saskatchewan portion of Lake Athabasca (Western Arctic NFBZ); Bluefish and Great Bear lakes in the Northwest Territories (Western Arctic NFBZ); Lake Superior in Ontario (Great Lakes-Upper St. Lawrence NFBZ; and, four lakes in northwestern Ontario (Saskatchewan-Nelson NFBZ) (McPhail 2007; Witt *et al*. 2011; Blanchfield *et al*. 2014). The distribution of Pygmy Whitefish continues to be better understood as lakes containing extant populations have been recently identified through incidental capture (e.g., Winnange and Mameigwess lakes in Ontario and Bluefish Lake, NWT, see Blanchfield *et al.* 2014 and Vecsei and Panayi 2015). Approximately 90% of the global range of Pygmy Whitefish lies within Canada.

Extent of Occurrence and Area of Occupancy in Canada

The EOO and IAO were estimated for each DU according to the COSEWIC guidelines (i.e., using the minimum convex polygon method for EO, and using an overlaid grid of cells 2 km x 2 km for IAO). All IAO calculations are minimum estimates based on confirmed Pygmy Whitefish observations.

The Southwestern Yukon Beringian DU includes seven lakes in the southwestern Yukon and northern British Columbia. Its EOO has been estimated as 51,747 km² and the IAO is 28 km² (discrete) and 2,624 km² (continuous) (Figure 6). This DU includes ~2% of the lakes known to contain Pygmy Whitefish.

The Yukon River DU contains about ~7% of the lakes known to contain Pygmy Whitefish: Marsh, Mayo, and Teslin lakes. In this DU, the EOO has been estimated as 28,151 km² and the IAO is 12 km² (discrete) and 892 km² (continuous) (Figure 7).

The Pacific DU encompasses about ~34% of the lakes known to contain Pygmy Whitefish which are found in lakes within the Columbia, Fraser, and Skeena River drainages in British Columbia. The EOO of this DU has been estimated as 206,839 km² and the IAO is 52 km² (discrete) and 1,092 km² (continuous) (Figure 8).

The Western Arctic DU includes numerous lakes within the Williston Reservoir Watershed (upper Peace River) of British Columbia, Lake Athabasca and Athabasca River in Alberta, Bluefish and Great Bear lakes in the Northwest Territories, and Elliot Lake in the Yukon. The EOO of this DU has been estimated as 1,394,815 km² and the IAO is in excess of 2,000 km². This DU includes ~50% of the lakes known to contain Pygmy Whitefish.

The Great Lakes - Upper St. Lawrence DU represents the only known population in the Laurentian Great Lakes in Lake Superior. This DU comprises ~2% of the lakes known to contain Pygmy Whitefish. Its EOO has been estimated as 39,407 km² and the IAO is in excess of 2,000 km².

The Waterton Lake DU comprises ~2% of the lakes known to contain Pygmy Whitefish. Its EOO and IAO have been estimated as 44 km².

The Saskatchewan - Nelson River DU includes four lakes in northwestern Ontario. Its EOO has been estimated at 4,843 km² and the IAO is 16 km² (discrete) and 324 km² (continuous). This DU contains ~5% of the lakes known to contain Pygmy Whitefish (Figure 9).

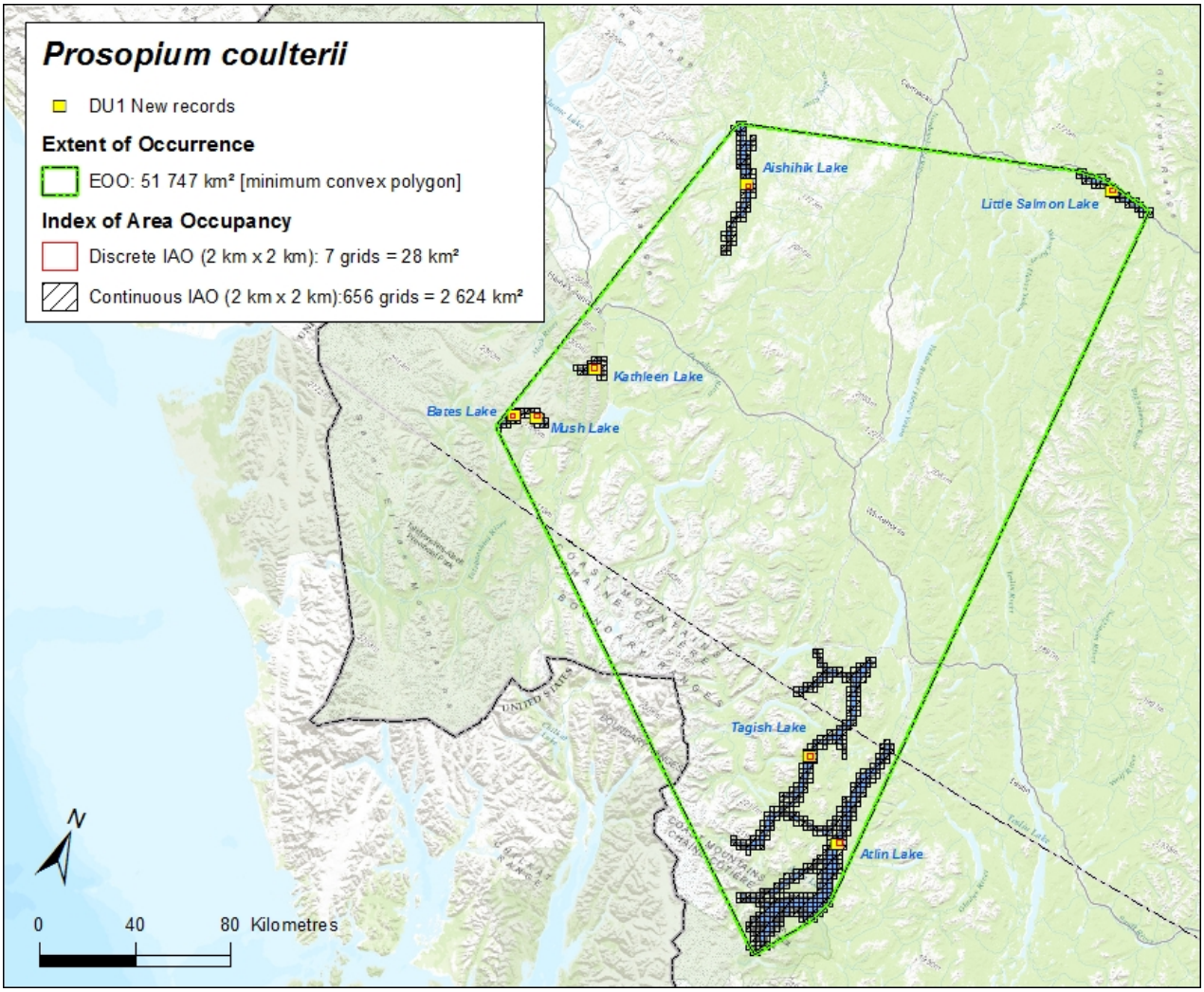

Figure 6. Extent of occurrence and area of occupancy for Pygmy Whitefish in DU1 - Southwestern Yukon Beringian populations.

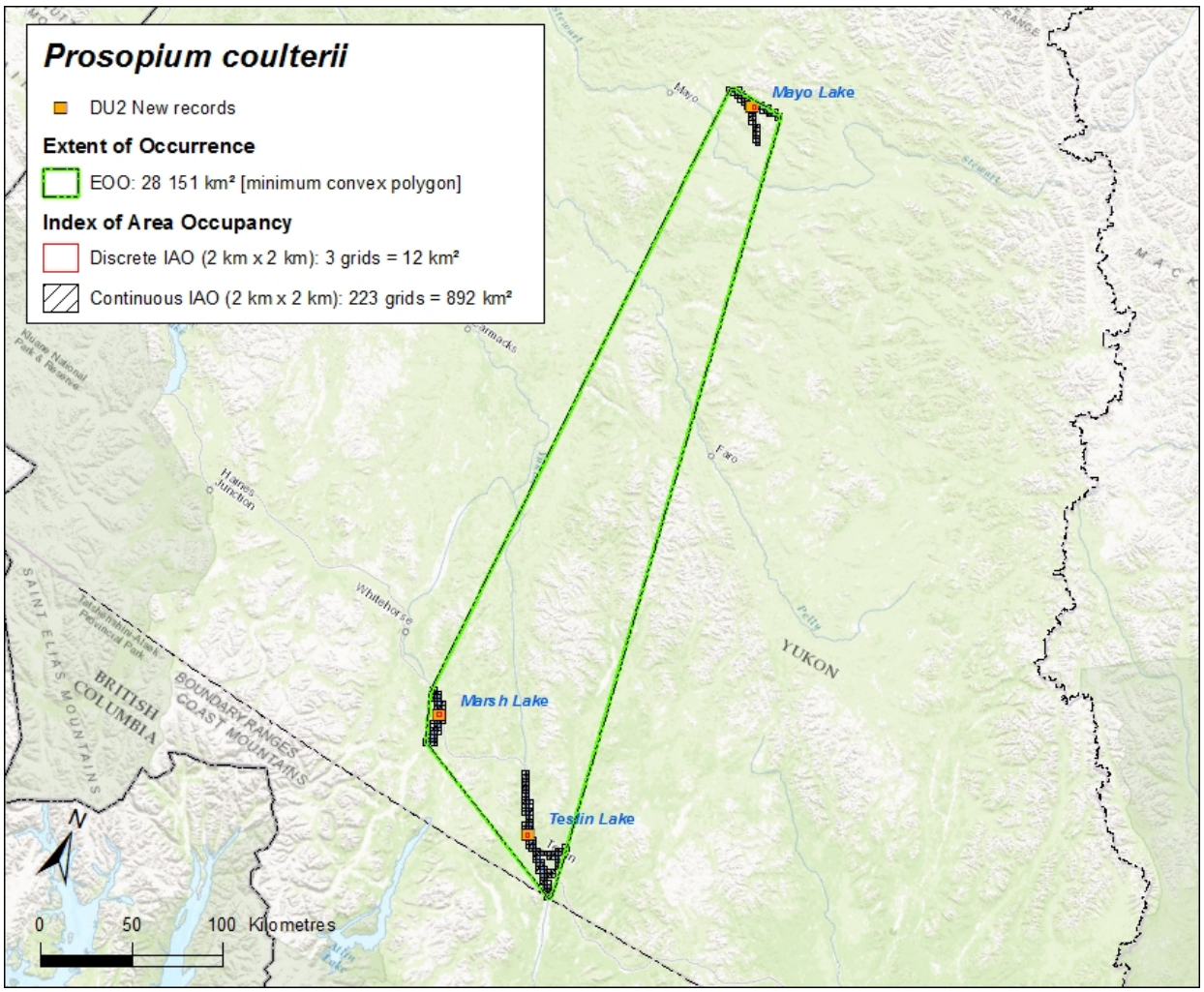

Figure 7. Extent of Occurrence and Area of Occupancy for Pygmy Whitefish in DU2 – Yukon River populations.

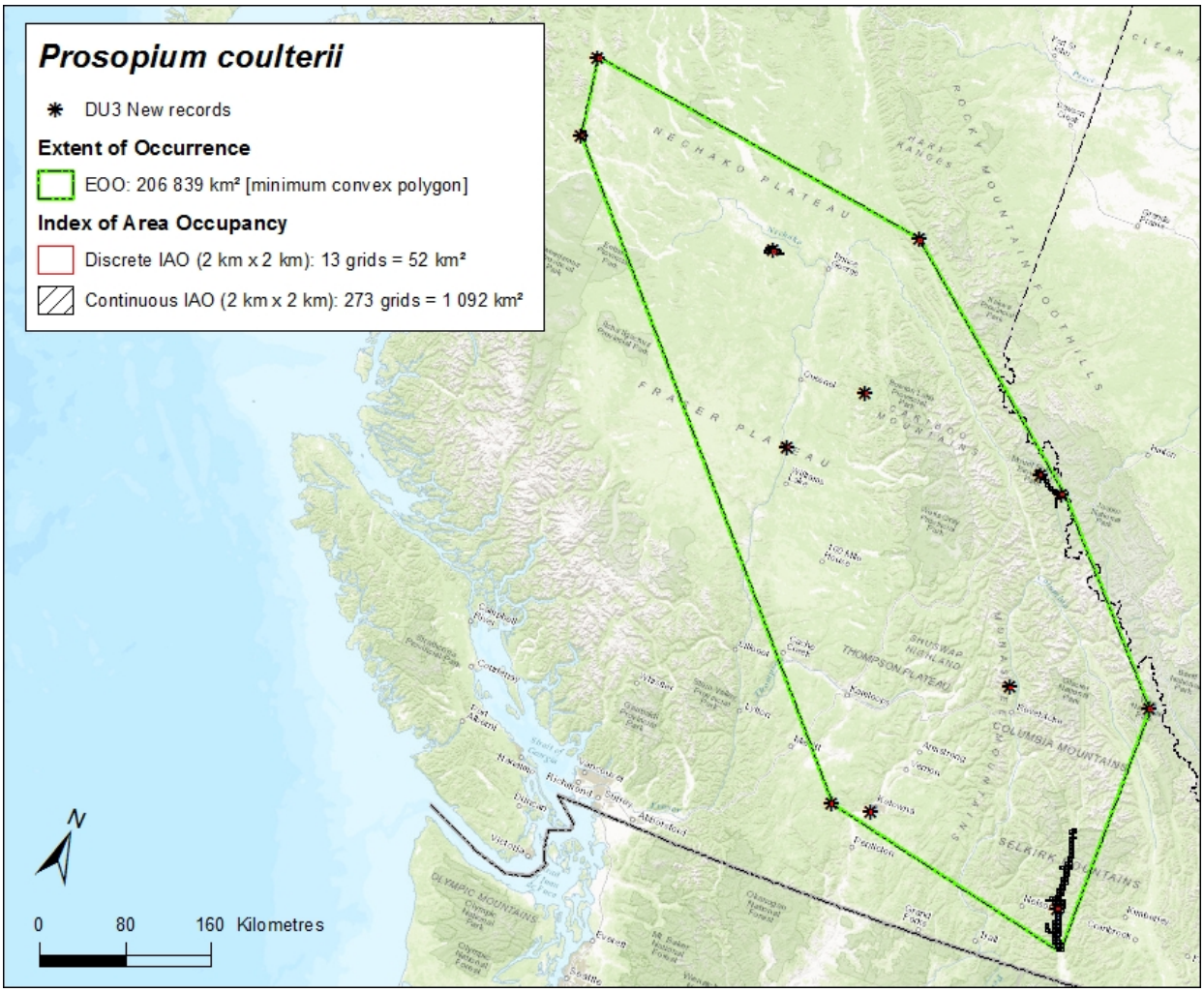

Figure 8. Extent of occurrence and area of occupancy for Pygmy Whitefish in DU3 – Pacific populations.

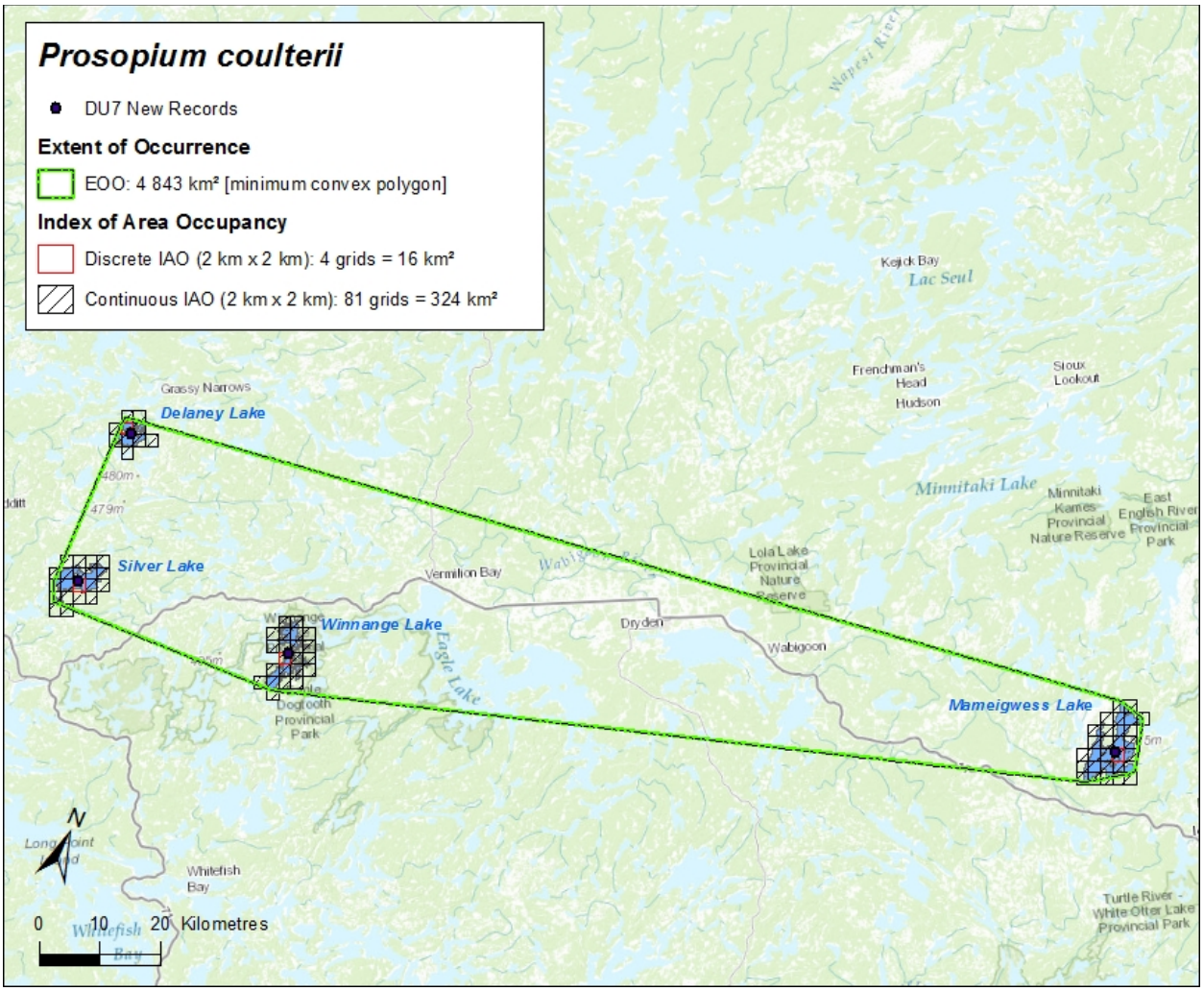

Figure 9. Extent of occurrence and area of occupancy for Pygmy Whitefish in DU7 – Saskatchewan - Nelson Rivers populations.

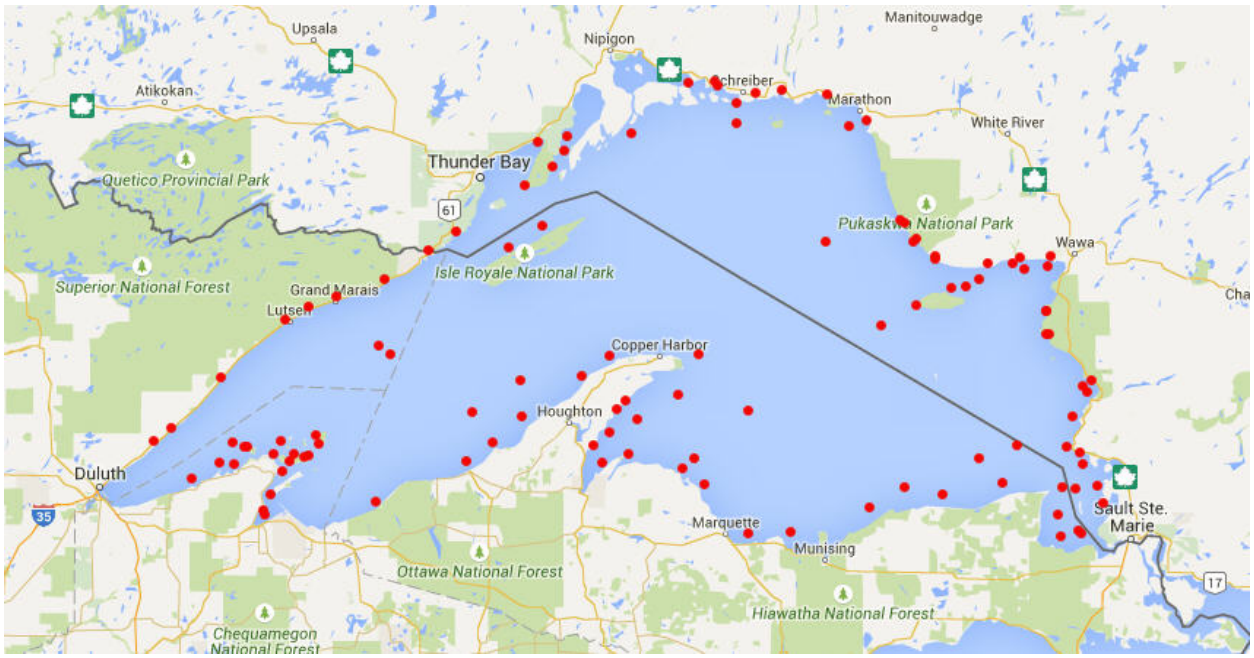

Figure 10. Location of trawl surveys in Lake Superior that have captured Pygmy Whitefish since the 1960s. Trawls were conducted by the USGS in Lake Superior with expansion to more sites in Canada beginning in 1989. Data courtesy of Mark Vinson (USGS).

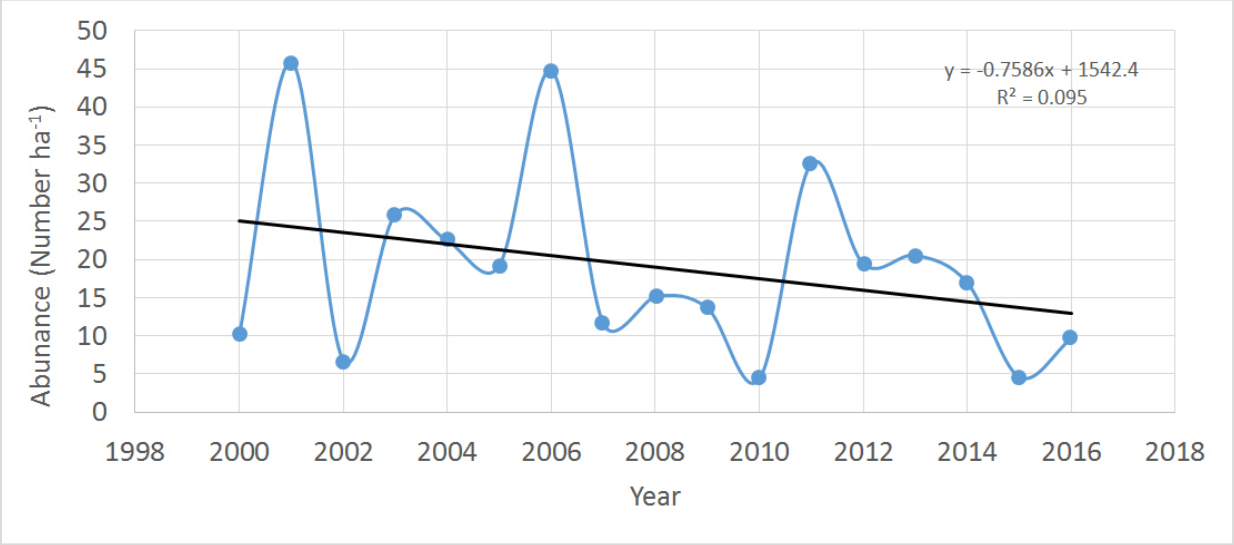

Figure 11. Annual Pygmy Whitefish density (fish per surveyed hectare) in Lake Superior as determined by nearshore trawl surveys completed by the USGS, indicating a 48% decline for the last three generations of Pygmy Whitefish, 2000-2016. Data courtesy of Mark Vinson (USGS).

Search Effort

In general, and with only a few exceptions, search effort for Pygmy Whitefish has been very low across its range (Table 1). The low search effort results from a combination of its lack of importance as a commercial or recreational fishery species and its occurrence in often remote or very deep lakes. Typically, when search efforts have been made in suitable habitats, more populations of Pygmy Whitefish have been discovered (e.g., Zemlak and McPhail 2006; Blanchfield *et al*. 2014; Vecsei and Panayi 2014).

Table 1. Historical search effort for Pygmy Whitefish. Waterbody, year sampled, number captured, catch-per-unit-effort (CUPE), if Pygmy Whitefish were the target species (Y/N), and the number of mature individuals are listed.

Reference	Waterbody	Year Sampled	Fishing Method	Number Captured	CPUE	Targeted Y/N	No. of mature Individuals
Government of Alberta status report, 2011	Athabasca River, AB	2008	1	15	0.17 fish/100m of river	Y	267 (50-450 95% C.L.)
	Upper Waterton Lakes, AB	2009	2	42	N/A	Y	1800 (750-3300 95% C.L.)
Zemlak and Cowie, 2013	Dina Lake #1, BC	2000/2001 (combined data)	3a	742	18.5 fish/ 100 m of net	Y	129
		2001	3b	2214	0.17 fish/ per net/hr	Y	56
		2004	3a	39	N/A	Y	N/A
		2006	3a	70	N/A	Y	18
	Quentin Lake. BC		3a	59	N/A	Y	N/A
	Weissener Lake	2003	3a	37	N/A	Y	N/A
	Thutade Lake	2003	3a	0	0	Y	N/A
	Peace Reach – Williston Reservoir, BC	2004	3a	90	N/A	Y	N/A
	Tacheeda Lake North, BC	2004	3a	25	N/A	Y	N/A
		2005	3a	130	N/A	Y	N/A
	Tacheeda Lake South, BC	2004	3a	39	N/A	Y	N/A
		2005	3a	55	N/A	Y	N/A
	Aiken Lake, BC	2005	3a	59	N/A	Y	N/A
	Tutizzi Lake, BC	2005	3a	67	N/A	Y	N/A
	Manson Lakes (Upper), BC	2005	3a	65	N/A	Y	N/A
	Manson Lakes (Lower), BC	2005	3a	71	N/A	Y	N/A
	Uslika Lake, BC	2006	4	59	11.7 fish/ 100 m of net	Y	N/A

Reference	Waterbody	Year Sampled	Fishing Method	Number Captured	CPUE	Targeted Y/N	No. of mature Individuals
	Omineca Arm-Williston Lake, BC	2006	4	55	24.3 fish/100 m of net	Y	N/A
	6 mile Bay – Williston Reservoir, BC	2006	4	32	7.8 fish/100 m of net	Y	N/A
	Chuchi Lake, BC	2006	4	32	11.2 fish/100 m of net	Y	N/A
	Arctic Lake, BC	2006	4	6	3.3 fish/100 m of net	Y	N/A
Weir pers. comm., 2014	Kootenay Lake. BC	'93, '97, '00, '03, '05, 09	5	8	N/A	N	N/A
	Lower Arrow Lake, BC	'89, '90, '92, '98, '00, '01, '02, '03, '09, '11	5	159	N/A	N	N/A
	Upper Arrow Lake, BC	'90, '93, '02, '06, '08, '09	5	15	N/A	N	N/A
	Okanagan Lake, BC	'89, '91, '94, '98, '99, '00	5	35	N/A	N	N/A
	Slocan Lake, BC	2002	5	4	N/A	N	N/A
Blanchfield *et al*., 2014	Winnange Lake, ON	2008	6a	3	N/A	N	N/A
		2009	6a	1	N/A	Y	N/A
		2010	6a,b	10	2.5/100m of net	Y	N/A
Sheldon *et al*., 2008	Lake 258, ON	2004	6	0	n/a	N	N/A
	Lake 259,ON	2004	7	0	n/a	N	N/A
	Lake 310,ON	2004	7	0	n/a	N	N/A
	Eagle Lake, ON	2004	7	0	n/a	N	N/A
	Teggau Lake, ON	2004	7	0	n/a	N	N/A
Vecsei and Panayi, 2014	Bluefish Lake, NWT	2012	8	6	1.3/100m of net	N	N/A

Fishing Method: 1) Boat electrofishing conducted over 5 reaches covering ~45 km river known to contain Pygmy Whitefish; **2)** Standard multi-mesh gillnet set overnight; **3a)** Sinking monofilament gill nets consisting of three 2.4 m deep x 15.24 m long panels of 14, 19, and 25 mm were set depth stratified; shallow (perpendicular to shore) and deep to assess spatial distribution of Pygmy Whitefish. Additional nets of 32 and 38 mm were deployed to target larger fish. Nets set perpendicular to shore had the 14 mm net shallowest and the 25 mm net directed towards deeper waters; **3b)** Trap nets (4 m long, 6.1 m side wings and a 30.5 m center wing, mesh size 3.1 mm) set on the lake bottom and fished for 24h; **4)** Sinking monofilament gill nets consisting of three 2.4 m deep x 15.24 m long panels of 14, 19, and 25 mm were set perpendicular to shore with the 14 mm net shallowest and the 25 mm net directed towards deeper waters; **5)** Mid-depth for Kokanee (*Oncorhynchus nerka*) – incidental capture, number of fish captured is summed for all years sampled; **6a)** Overnight sets of single gang variable mesh experimental gill nets: 1.8 m high and consisting of 6 duplicate panels (each 7.5 m long) of 3 different mesh sizes 13, 19, and 25 mm. Nets were set parallel to shore in 25-40 m of water; **6b)** Overnight sets of gill nets: 1.8 m high consisting of 2 gangs, each 12.5 long that consisted of five 2.5 m panels of the following mesh sizes 13, 19, 25, 32, and 38 mm. Nets were set on the bottom at 4 depth strata (1-3, 3-6, 6-12,12-20m) and perpendicular to depth contours; **7)** In each lake: 15-30 collapsible fish traps baited with dog biscuits set for at least 12 h and reset up to 5 times; a 10 mm gill net (1m high x 15 m long) set on lake bottom for 12 h; and a minimum of two 10 minute bottom trawls (weather permitting); **8)** Bottom-set, graded-mesh gill nets (1.8 m high x 75 m long) composed of five 15 m panels of 21.5, 45.8, 70.1, 97.5 and 120.4 mm stretched mesh. Nets were set overnight for <12 h.

DU1 – Southwestern Yukon Beringian populations

Search effort to identify populations within DU1 has been very low; the presence of the divergent clade within Canada is based on samples from seven lakes in southwestern Yukon and northern British Columbia, but the clade is widespread in several lakes in adjacent regions of southwestern Alaska (Witt *et al*. 2011; Gowell *et al*. 2012). The occurrence of this DU requires further genetic analyses and it may well expand into other nearby Yukon lakes (e.g., Sekulmnn Lake, Kluane Lake). A sample of 329 fish from an additional 12 Yukon lakes analyzed in 2016 led to the identification of five (of the 7) additional lakes with Pygmy Whitefish in this clade (Taylor pers. comm. 2016).

DU2 – Yukon River populations

Pygmy Whitefish have been found in the stomachs of Lake Trout (*Salvelinus namaycush*) and captured incidentally in YT, but studies directed towards its capture have not been conducted.

DU3 – Pacific populations

Pygmy Whitefish have been captured incidentally in trawls targeting Kokanee (freshwater resident Sockeye Salmon, *Oncorhynchus nerka*) in Kootenay, Okanagan, and Upper and Lower Arrow lakes between 1989 to 2011 (Table 1; Weir pers. comm. 2014). Surveys targeting Pygmy Whitefish have not been conducted in DU3.

DU4 – Western Arctic populations

General fish surveys have been conducted in approximately 360 lakes within the Williston Reservoir Watershed. As part of the Peace/Williston Fish and Wildlife Compensation Program many lakes and the Williston Reservoir have been sampled with multimesh gillnets and downhaul traps (Zemlak and McPhail 2006). Of these, 13 lakes along with Williston Reservoir and the Kwadacha River have been confirmed to contain Pygmy Whitefish. Sinking monofilament gill nets were set depth stratified; shallow (perpendicular to shore) and deep to assess spatial distribution of Pygmy Whitefish. Additional nets were deployed to target larger fish (Zemlak and McPhail 2006). Trap nets (were set on the lake bottom and fished for 24h (Zemlak and McPhail 2006). The watershed is large (~70,000 km^2), many lakes are accessible only by air, and fish identification in historical records is questionable (Zemlak and McPhail 2006). Consequently, the distribution of Pygmy Whitefish within the Williston Reservoir watershed may be broader, but additional targeted surveys are required.

Boat electrofishing surveys were conducted along five separate reaches of the Athabasca River between Snaring River and Solomen Creek in 2008. A total of 11,240 m were sampled capturing 19 Pygmy Whitefish (overall catch rate of 0.17 Pygmy Whitefish/100 m) (Sullivan 2011).

Recent observations of Pygmy Whitefish from Bluefish Lake, NWT, were a result of incidental capture (Table 1) in bottom-set gillnets (Vecsei and Panayi 2014).

DU5 – Great Lakes – Upper St. Lawrence populations

The United States Geological Survey (USGS) has conducted daytime nearshore bottom trawl surveys (12-m Yankee bottom trawl) annually in Lake Superior throughout Canada and the U.S. since 1963. Trawl depths had a range of 2.8 m to 168 m. Seven to 89 trawls successfully captured Pygmy Whitefish annually (data courtesy of Vinson 2014). Trawl surveys are part of a long-term study monitoring trends of relative abundance and biomass of the fish community in Lake Superior; as such, trawls were not specifically targeting Pygmy Whitefish.

DU6 – Waterton Lake populations

Pygmy Whitefish surveys were conducted in Waterton Lake in 2007 using standard multi-mesh gillnets set overnight, capturing 42 individuals (Rasmussen *et al.* 2009).

DU7 – Saskatchewan - Nelson River populations

Sampling occurred in the summer and fall of 2008, 2009, and 2010 in Winnange Lake, ON (Blanchfield *et al.* 2014). Sampling conducted in 2008 and 2009 used overnight sets of single, gang, variable mesh experimental gill nets set parallel to shore in 25 - 40 m of water. In 2010, nets were set on the bottom at four depth strata (1 - 3, 3 - 6, 6 - 12, and 12 -20m) and perpendicular to depth contours (Blanchfield *et al.* 2014). In 2014, a single specimen was captured from Mameigwess Lake, ON, as part of the Ontario Ministry of Natural Resources and Forestry (OMNRF) broad-scale monitoring program (BSM) (Royal Ontario Museum Accession Number 8049). Approximately 10% of the 752 lakes in northwestern Ontario with potentially suitable deep, coldwater habitat (identified by the presence of Lake Trout, *Salvelinus namaycush*) is regularly sampled by the OMNRF BSM program (Chu pers. comm. 2016). In 2016, Pygmy Whitefish was found in two additional lakes (Delaney Lake, Silver Lake) (Reid pers. comm. 2016).

HABITAT

Habitat Requirements

Throughout most of its range in Canada, the Pygmy Whitefish primarily inhabits cold, deep, lakes and, to a lesser extent, fast flowing rivers of low productivity. Access to shallow water with gravel or rocky substrate is required for spawning. It is considered a coldwater stenotherm that prefers water temperatures below 10°C and oxygen concentrations above 5 mg/l (McPhail and Carveth 1992). Pygmy Whitefish is usually found at depths greater than 30 m but have been located at depths <5 m (along lake shorelines) and as great as 168 m (Heard and Hartman 1965). Lacustrine habitat requirements are similar throughout their global range. Pygmy Whitefish, however, has been documented to undergo diurnal

migrations in some lakes and may occupy shallower habitats and temporarily occupy areas of warmer water (12-18°C) and oxygen concentrations below 1 mg/l (Zemlak and McPhail 2006), indicating some variability in habitat use.

In the Athabasca River (part of DU4), Pygmy Whitefish was generally located at depths of 0.5 – 1 m in nearshore eddies along the edge of faster mainstream flow (Sullivan 2011). This reflects the difficulty of capturing Pygmy Whitefish in deepwater riverine habitat using conventional sampling methods and not necessarily a preference for shallow water habitat in rivers (Sullivan 2011). Riverine habitat requirements are likely similar throughout its global range, although search effort in rivers has not been documented outside Alberta. In the Williston Reservoir Watershed (also part of DU4) effective management of Pygmy Whitefish genetic diversity likely requires the maintenance of stream networks that interconnect lakes (Taylor *et al*. 2011).

Habitat Trends

Pygmy Whitefish inhabit isolated lakes resulting in a fragmented distribution. The availability/suitability of boreal and montane lakes appears stable and a trend in habitat availability is not discernable in any of the DUs. Its habitat is likely secure within much of Canada because of the relative remoteness of most of the lakes involved, but localized exceptions probably occur. For instance, the water quality of portions of the Athabasca River has recently been shown to be degraded with attendant effects on fish health that may also affect Pygmy Whitefish (Schwalb *et al.* 2014).

BIOLOGY

In general, the biology of Pygmy Whitefish has been best studied in lakes, there is comparatively little information on the biology of the species in stream habitats, other than some study of spawning migrations upstream from lakes (McPhail 2007).

Life Cycle and Reproduction

Pygmy Whitefish generally matures at a young age and small size. Males mature at 1-3 years of age and 58-130 mm TL, whereas females mature at 2-4 years of age and 61-228 mm TL (Weisel and Dillon 1954, Eschmeyer and Bailey 1955; Heard and Hartman 1965; Weisel *et al*. 1973; Zemlak and McPhail 2004).

Migrations by Pygmy Whitefish tend to be only up-river for spawning (Northcote 1997). Migrations, when occurring, take place entirely within fresh water (i.e., Pygmy Whitefish are potamodromous). Spawning schools will travel 1 to 4 km up rivers to spawn (Barnett and Paige 2014). Spawning schools tend to be skewed towards male dominance, and schools generally spawn in close proximity (300 to 800 m) to other schools (Barnett and Paige 2014). Spawning occurs annually between September and December (McPhail 2007), but can occur as late as January (Weisel *et al*. 1973), when water temperatures are between 2 and 5°C (Barnett and Paige 2014). Eggs are broadcast over coarse gravel in shallow water

in rivers or along lake shorelines at night (Barnett and Paige 2014) and are fertilized in the water. Fecundity is related to body size with egg production ranging between 97 to 1,000 eggs per female (Eschmeyer and Bailey 1955; Weisel *et al*. 1973; McPhail and Zemlak 2001). Eggs size ranged from 1.3 to 1.8 mm in diameter in the month of October (McPhail and Zemlak 2001). Pygmy Whitefish tends to be short-lived with a life expectancy between 3 and 10 years (median 7 years) (Eschmeyer and Bailey 1955; Heard and Hartmann 1965; McCart 1970; Hallock and Mongillo 1998; Rankin 1999; McPhail and Zemlak 2001). A generation time of 5.5 yrs has been calculated for Alberta populations (Sullivan 2011) and 2+ and 3+ years for males and females, respectively in Dina Lake No. 1, British Columbia (McPhail and Zemlak 2001). Information required for calculating generation time of other Canadian populations is insufficient.

Diet and Feeding Behaviour

Pygmy Whitefish is a generalist carnivore on aquatic invertebrates. It appears to be quite adaptable in feeding habits (Scott and Crossman 1973) with crustaceans, aquatic insects, particularly chironomids, and small molluscs being key prey items. Fish eggs may form part of the diet as well (Scott and Crossman 1973; Gowell *et al.* 2012). Pygmy Whitefish tends to be a deepwater inhabitant and feeds on benthic invertebrates. In some lakes, different morphological forms (so-called “high” and “low” gill-raker counts types may specialize on zooplankton and benthic invertebrates, respectively, and, thereby, occupy different trophic positions (McCart 1965; Gowell *et al.* 2012). Populations in streams and rivers apparently also feed on chironomid larvae and pupae, but may also feed on nymphs and various aquatic insects (McPhail 2007).

Physiology and Adaptability

Pygmy Whitefish is considered a coldwater stenotherm; tolerance limits for other water quality parameters are unknown. As more populations are studied, however, a greater range of environmental tolerances, in terms of water temperature and oxygen levels (e.g., see Zemlak and McPhail 2006), is apparent, which suggests some degree of environmental adaptability.

Dispersal and Migration

Spawning migrations of 1 to 4 km up rivers have been documented (Barnett and Paige 2014); however, dispersal and migration abilities of Pygmy Whitefish in general are unknown. Given its small size (typically ~150 mm TL), its ability to disperse and establish new populations rapidly is likely low (see discussion in Taylor *et al.* 2011).

Interspecific Interactions

Pygmy Whitefish can be prey items for most predatory fishes, particularly for other salmonid species with which it shares habitat (Dryer *et al*. 1965; Fraley and Shepard 1989). For example, Pygmy Whitefish was found in the stomach contents of nearly 1,500 Lake Trout examined from Lake Superior (Dryer *et al*. 1965), the stomach contents of Lake Trout

from Kathleen Lake, YT, (Millar pers. comm.), and it is suspected that the low density of Pygmy Whitefish in Atlin Lake, YT, is the result of predation by Lake Trout (Barker pers. comm.). Rainbow Trout (*Oncorhynchus mykiss*) was reported to feed on Pygmy Whitefish in Dina Lake No. 1, BC (McPhail and Zemlak (2001). In addition, Bull Trout (*Salvelinus confluentus*), Northern Pike Minnow (*Ptychocheilus oregonensis*), and Northern Pike (*Esox lucius*) are likely major predators of Pygmy Whitefish where they co-exist. The impact predation has on Pygmy Whitefish population size/structure is unknown.

Parasites that have been found on, or within, Pygmy Whitefish include: as an intermediate host, *Henneguya zschokkei* (a myxosporean parasite) in intermuscular connective tissue (Mitchell 1989); and, as a definitive host, *Tetraonchus variabilis* (Trematoda) on the gills (Mudry and Anderson 1977), and *Neoechinorhynchus rutili* (Acanthocephala) in the intestines (McDonald and Margolis 1995). Unidentified cestode larvae have been found in stomachs and livers (McPhail and Zemlak 2001).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

There has been little repeated sampling of the vast majority of the Pygmy Whitefish populations, so data to assess trends in abundance are generally not available. Mark-recapture field studies have been completed for only two waterbodies: Waterton Lake (in the northern basin), and a short reach of the Athabasca River (Sullivan 2011; Table 1). Annual nearshore trawl surveys conducted in Lake Superior by the United States Geological Survey (USGS) have been conducted since 1963 and provide density (fish per trawled hectare) estimates. The remaining studies provide information sufficient to calculate catch-per-unit-effort (CPUE) only (Table 1).

Abundance

The small size of the Pygmy Whitefish and the great depths that it generally inhabits makes its capture using conventional fishing methods difficult. Consequently, most reports documenting Pygmy Whitefish are a product of incidental capture resulting in presence/absence data only (Table 1).

<u>DU1, DU2, DU3, and DU7 – Southwestern Yukon Beringian, Yukon River, Pacific, and Saskatchewan - Nelson River populations</u>

The repeated sampling field studies required for population estimates have not been completed for these populations so data consist of presence/absence data across multiple years.

DU4 – Western Arctic populations

Most of the information on abundance in DU4 consists of surveys in the Athabasca River population. Population estimates were derived from electrofishing data collected within a 45.6 km section of the Athabasca River previously known to contain Pygmy Whitefish (Sullivan 2011). The number of Pygmy Whitefish marked and recaptured was insufficient to derive a catchability coefficient. It was, therefore, assumed that Mountain Whitefish and Pygmy Whitefish have similar catchability, and that a catchability coefficient calculated for Mountain Whitefish from the same study could be used for population estimates of Pygmy Whitefish (Sullivan 2011). The population of catchable size Pygmy Whitefish within a 45.6 km reach was estimated as 1,000, with a maximum likelihood estimate of 267 adults (95% confidence limits: 50 - 450 adults, Sullivan 2011) and the remainder being sub-adult fish.

DU5 – Great Lakes - St. Lawrence populations

The USGS has conducted nearshore trawl surveys annually in Lake Superior throughout Canada and the U.S. since 1963. Trawl depths had a range of 2.8 m to 168 m with 7 to 89 trawls successfully capturing Pygmy Whitefish annually. In 1989, this sampling extended to more preferred, deeper habitat on the Canadian side of the lake beginning in 1989; therefore, the large differences in densities before and after 1989 are considered to be an effect of sampling rather than a demographic trend.

DU6 – Waterton Lake populations

Population estimates presented in Sullivan (2011) for Pygmy Whitefish in Waterton Lake were derived from mark-recapture data presented in Rasmussen *et al*. (2009) and based on the following assumptions: 1) the vulnerability of Pygmy Whitefish to capture in gillnets is similar to Lake Trout; and 2) Pygmy Whitefish were vulnerable to only 36% of the gillnets (i.e., 4 of the 11 panels being appropriately sized mesh). A density of 5.5 Pygmy Whitefish per hectare was calculated, translating into ~1,900 individuals, 1,800 of which were mature (based on 94% maturity ratio, Rasmussen *et al*. 2009). A measure of variance was calculated using actual catch data from 12 individual nets and bootstrapping to derive 10,000 possible mean catch rates (Sullivan 2011). The resulting 95% confidence intervals for a population size estimate of 1,800 were 750 and 3,300 fish (Sullivan 2011). Assessing population trends is not possible as Rasmussen *et al*. (2009) completed the only quantitative study on Pygmy Whitefish for Waterton Lake.

Fluctuations and Trends

Pygmy Whitefish densities (number of fish per hectare trawled) in Lake Superior (DU5) have ranged from 4.3 to 54.6 fish·ha^{-1} since 1989 when sampling was extended into preferred deeper habitat on the Canadian side of the lake. Since the mid-1990s, however, the density of Pygmy Whitefish appears to have declined dramatically. Based on the fitted trend line based on data for the whole lake, density has decline 48% over the last three generations (16 years) (2000 – 25.2 fish·ha^{-1} vs. 2016 – 13.1 fish·ha^{-1}). In contrast to the

increase in density recorded when lake surveys were expanded lake-wide in 1989, the post-1994 decline has occurred during a time when sampling was consistent across the lake and is interpreted as a demographic trend rather than an artifact of sampling (Vinson pers. comm. 2015).

The population dynamics of Pygmy Whitefish in the remaining waterbodies cannot currently be assessed considering that detailed population data has only been collected from single populations with limited sampling effort, or through incidental captures. Consequently, the CPUE may not accurately reflect Pygmy Whitefish numbers in a given waterbody across longer time periods.

Rescue Effect

Populations of Pygmy Whitefish tend to be highly isolated from one another by residency in remote, deep lakes. Little or no potential exists for adjacent populations to recolonize habitats should Pygmy Whitefish populations become lost or degraded in Alberta, Northwest Territories, or the Yukon, and most localities within British Columbia. Immigration from the United States through the Kootenay River (known as Kootenai River in the U.S.) and Okanagan rivers into British Columbia is possible, but likely limited by the extensive distance separating U.S. and Canadian populations. The Williston watershed in British Columbia is another potential exception, where 14 populations have some historical interconnectedness, but contemporary movement between lakes appears to be limited (Taylor *et al*. 2011). Canadian populations of Pygmy Whitefish in Lake Superior could experience some rescue effect from fish spawning in American waters.

THREATS AND LIMITING FACTORS

Threats and limiting factors for Pygmy Whitefish discussed herein are, in general, poorly documented, but potential threats are probably applicable to most DUs. Threats and limiting factors that are region- or DU-specific are highlighted in the following DU-specific subsections but, again, are poorly known. The International Union for the Conservation of Nature's threats calculator (Salafsky *et al.* 2008) returned overall threat impact estimates of "Unknown" for all DUs (see Appendix II).

Naturally Occurring Limiting Factors

Pygmy Whitefish is considered to be a cool-coldwater stenotherm (i.e., water temperatures less than 10°C and dissolved oxygen concentrations greater than 5 mg/l) and water temperature may be the greatest natural factor limiting its distribution. The dispersal and migration abilities of Pygmy Whitefish in general are unknown. Given its small size (maximum ~150 mm TL for the "regular" form and 260 mm TL for the rare "giant" form), its ability to disperse into upstream areas of watersheds is likely limited. For example, spawning migrations are typically only 1 to 4 km upriver (Barnett and Paige 2014). Pygmy Whitefish can be prey items for most predatory fishes, particularly other salmonid species with which they share habitat (Dryer *et al*. 1965; Fraley and Shepard 1989). Pygmy

Whitefish has been documented in the stomach contents of Lake Trout collected from Atlin Lake (Barker pers. comm. 2014) and likely is a common prey item wherever the two species coexist. Because of the high Lake Trout density and the low numbers of Lake Whitefish (*Coregonus clupeaformis*) in Atlin Lake, it is suspected Pygmy Whitefish may be supporting the Lake Trout population as a prey item (Barker pers. comm. 2014). There are, however, no data with which to quantify what, if any impact predation may be having on Pygmy Whitefish populations. The recovery of Lake Trout to pre-1940s levels in Lake Superior (Krueger and Ebner 2004; OMNR 2010) may, in part, be responsible for observed declines in Pygmy Whitefish since the 1990s (see **Fluctuations and Trends**).

Anthropogenic Threats

Risks associated with anthropogenic threats were derived from expert opinion (consultation of seven regional biologists/scientific researchers who are familiar with the species within their regions: two from each Yukon, British Columbia, and Ontario, and one from the Northwest Territories). Actual impacts of anthropogenic activities on Pygmy Whitefish populations have, however, not been quantified.

Degradation and Loss of Habitat

Degradation of habitat associated with disruptive land-use practices, such as commercial forestry, hydroelectric, oil, gas and mining development, agriculture, and urbanization pose the greatest potential anthropogenic threats to Pygmy Whitefish. Siltation of spawning streams or lake shorelines would limit successful spawning, and eliminate interstitial spaces for overwintering. Nutrient enrichment from local agriculture and urban run-off could result in excessive algal growth and depression of oxygen levels in deeper waters, rendering habitat unsuitable for Pygmy Whitefish. Nutrient enrichment and siltation both may stem from poor forest-management practices and increased urban and rural land development. Construction of roads, bridges, dams and other in-stream structures may disrupt spawning migrations; however, the extent to which Pygmy Whitefish access rivers for spawning within their Canadian range is unknown.

Water-level fluctuations associated with hydroelectric production may restrict access to foraging or spawning habitat, and/or leave Pygmy Whitefish eggs and fry stranded; particularly during fall and winter reductions in water levels. Only four waterbodies known to contain Pygmy Whitefish in Canada have hydroelectric facilities with water level reductions (“drawdowns”) significant enough to potentially impact Pygmy Whitefish (Atlin Lake, YT (DU1), and Mayo Lake, YT (DU2), Kootenay Lake, BC (DU3), and Williston Reservoir, BC (DU4)). As such, the current threat to Pygmy Whitefish from hydroelectric dams does not appear widespread**.**

Introduced Species

Pygmy Whitefish can be prey items for most predatory fishes, particularly other salmonid species with which it shares habitat (Dryer *et al*. 1965; Fraley and Shepard 1989; McPhail and Zemlak 2001). Pygmy Whitefish has persisted in Dina Lake No. 1, BC, despite 20 years of intentional stocking of exotic Rainbow Trout and Brook Trout (*Salvelinus fontinalis*) (Zemlak and McPhail 2006). It is unknown, however, if the population size is depressed below what it would be in the absence of stocking, nor is it known if other populations of Pygmy Whitefish could sustain a similar stocking pressure. Intentional and unintentional stocking with non-native predatory fish may affect Pygmy Whitefish populations negatively, particularly in smaller closed basin lakes where refuge from predation may be limited.

Climate Change

Global warming associated with climate change in North America is likely to exceed global means in most areas, with projected warming ranges lying between 3°C and 5°C over most of the continent to the year 2100 (Christensen *et al*. 2007). Impacts of climate change on coldwater habitat generally will appear locally as changes in habitat quality and regionally as range contractions northwards as thermal warming exceeds species' preferences or tolerances (Thomas et al. 2004; Reist *et al*. 2006). Temperatures preferred by Pygmy Whitefish are generally present below the thermocline, i.e., in the hypolimnion (McPhail and Carveth 1992; Selegby and Hoff 1996). Surface temperatures of lakes are predicted to increase as mean air temperatures rise resulting in a deeper thermocline, reduced hypolimnetic volume and increased risk of hypolimnetic anoxia. This may reduce or eliminate habitat for many Pygmy Whitefish populations that are stenothermic and unable to adapt and survive such changes, although specific scenarios have not been modelled for Pygmy Whitefish (cf. Chu *et al.* 2005).

Temperature has a major controlling effect on physiological processes and on reproduction in particular. Spawning activity of cold water species is expected to be negatively impacted by an increase in fall water temperature. For example, an increase in fall water temperatures of 1°C and 3°C decreased Lake Trout survival at hatching by 2.4 and 20.1 times, respectively (Casselman 2002). The effects of increasing water temperature on reproductive success of Pygmy Whitefish has not been documented, but could be similar to that of Lake Trout given that both are generally characterized as coldwater stenotherms.

Overexploitation

Pygmy Whitefish is not considered a sport fish within Canada nor is it listed in the possession limit section of provincial or territorial sport fishing regulations, meaning they are considered non-game fish and, therefore, anglers have no restriction on the number of Pygmy Whitefish they may keep. Only five populations of Pygmy Whitefish in Jasper, Waterton, Yoho, and Kluane National Parks are protected from exploitation (see Legal Protection and Status below). In British Columbia, recreational fishery regulations, however,

limit the daily catch of whitefish (all species combined) to 15. This, coupled with the small size of Pygmy Whitefish and remoteness of most waterbodies, renders them less susceptible to overexploitation.

Potential Threats to Specific DUs

DU1 – Southwestern Yukon Beringian populations

Threats to these populations are not well known, but may exist from the early winter drawdown of water level released from the dam on Canyon Lake, just downstream of Aishihik Lake. Draw-down may leave eggs stranded and/or restrict access to foraging habitat. There are no known threats to the Kathleen Lake population.

Pygmy Whitefish populations in Atlin Lake may experience water-level fluctuations on the order of 2.5 m/year as levels are drawn down to supply water for the hydroelectric facility on the Yukon River during the ice-covered period. Of particular concern, is the dewatering of eggs laid in late autumn (Barker pers. comm. 2014). Unfortunately, data do not exist to quantify what, if any impact water-level fluctuations may be having on Pygmy Whitefish populations.

DU2 – Yukon River populations

Little information exists on Pygmy Whitefish in the Yukon River making it difficult to assess specific threats to this population (Barker pers. comm. 2014). In the Yukon, there is little disturbance related to oil and gas, or to forestry (Barker pers. comm. 2014). The most pertinent threats would come from mining. Threats presented by hard-rock mining are likely limited and would be in the form of chronic or catastrophic release of contaminated water (Barker pers. comm. 2014). Placer mining threats would be most likely to take the form of sediment deposit from rivers and creeks onto critical areas (e.g. spawning, rearing,) and the release of deleterious substances (e.g., fuel, oil) from equipment. There are, however, no specific cases where this is known to be occurring (Barker pers. comm. 2014).

DU3 – Pacific populations

Degradation of habitat associated with disruptive land use practices, such as commercial forestry, hydroelectric and mining development, agriculture, and urbanization pose the greatest potential anthropogenic threats to Pygmy Whitefish. Within DU3, Kootenay, Okanagan, and McLeese lakes have extensive urban, recreational (e.g., cottage), agriculture (e.g., orchards) and/or forestry development within their watershed (BCMOE 2014). Nutrient input from non-point sources (e.g., agriculture, forest harvesting, and septic tank systems), run-off of road pollutants (e.g., salts, oil), and accidental spills of fuel and fertilizers from urban/rural centers are the greatest potential threats to Pygmy Whitefish and their habitat. Accidental spills of fuel or oil from recreation boats also pose a risk, but this risk is more pertinent to DU3 as a whole.

Increasing development pressure on Kootenay Lake has resulted in the Regional District of Central Kootenay (RDCK) and Fisheries and Oceans Canada (DFO) documenting baseline conditions of Kootenay Lake to help develop shoreline-planning policies (Schleppe 2011). Similarly, water-quality objectives for Okanagan Lake have been established to protect the lake from deterioration with the intention of protecting water quality for recreation and aesthetics, drinking water and aquatic life (fisheries) (Nordin 2005). A proactive approach to managing/protecting water quality and aquatic habitat in these lakes suggests the risk from anthropogenic activities may be low.

Corra Linn Dam is a hydroelectric facility located on the Kootenay River west of Nelson, BC. Water levels are drawn down as much as 2 m over the course of winter (Riseh 2006). Water-level fluctuations such as this may restrict access to foraging or spawning habitat, and/or leave Pygmy Whitefish eggs and/or fry stranded. It is unknown, however, what, if any impact water-level changes have had on the Pygmy Whitefish population.

Placer mining occurs adjacent to Jack of Clubs Lake (BCMOE 2014). Threats from placer mining would include sediment deposit from rivers and creeks onto spawning, rearing, and foraging habitat, and the release of deleterious substances (e.g., fuel, oil) from equipment. Placer mining operations in the region are small (relative to the Yukon) and impacts may be minimal. It is unknown if placer mining has had an impact on Pygmy Whitefish in Jack of Clubs Lake.

Stocking non-native predatory fish may negatively affect Pygmy Whitefish populations. Rainbow Trout is stocked regularly into 29% of the lakes in DU3 containing Pygmy Whitefish (e.g., Cluculz, Jack of Clubs, Moose, and Tyhee Lakes) (BCMOE 2014). Rainbow Trout may prey on Pygmy Whitefish, but more likely interact as competitors because both Pygmy Whitefish and Rainbow Trout are insectivores. Nonetheless, the impact of Rainbow Trout on Pygmy Whitefish population size/structure in these and other lakes are unknown. Rainbow Trout was stocked into Yellowhead and Okanagan lakes in the 1950s and 60s, respectively; however, there has been no recent stocking. Stocking does not occur in the remainder of the lakes containing Pygmy Whitefish in DU3.

DU4 – Western Arctic populations

The reach of the upper Athabasca River is paralleled by a major pipeline and railway corridor (Sullivan 2011). The frequency of pipeline and railway spills/accidents were estimated to occur at 0.29 and 1.5 per year as extrapolated from Alberta and Canadian statistics, respectively (Sullivan 2011). Consequently, accidental spills of deleterious substances (e.g., fuel, chemicals, fertilizer) from pipelines and railways have been identified as a significant risk to Pygmy Whitefish (Sullivan 2011).

Forestry activity likely poses the greatest threat to Pygmy Whitefish within the Williston Reservoir watershed (Davidson and Dawson 1990). Poor forestry practices can degrade Pygmy Whitefish habitat through siltation of spawning streams or lake shorelines. Nutrient enrichment from overland run-off could result in excessive algal growth and depression of oxygen levels in deeper waters. Several lakes in the Williston watershed are accessible by air only (Aiken, Quentin, Tutizzi, Weissener lakes, BC) and, thus, presumed generally isolated from anthropogenic impacts.

Water levels in Williston Reservoir are regulated by the W.A.C. Bennett Dam (a hydroelectric facility). Water levels fluctuate, 11 m annually on average (Water Survey of Canada 2015). Such extreme fluctuations in water level may pose a risk to the Pygmy Whitefish population by restricting tributary access to foraging habitat in the spring. In addition, with the creation of the reservoir, it is uncertain how it may act as a "barrier" for migration between river systems (Taylor *et al.* 2011). Several uranium mines are located near Lake Athabasca. Chronic or catastrophic release of contaminated water from retention ponds and/or leaching of heavy metals from tailings are of particular concern. The effects of heavy-metal exposure on fishes may include mortality, reduced fertility, slower growth and development. In addition, heavy metals alter various developmental processes during the embryonic period resulting in reductions of offspring quantity and quality (Jezierska *et al*. 2009). Stocking with non-native fishes may negatively affect Pygmy Whitefish populations through predation or competition. Two lakes in DU4 (Dina Lake No. 1 and Manson Lakes, BC) have been stocked (Rainbow Trout in each lake) in the last decade (BCMOE 2014). Although Pygmy Whitefish continue to persist in these lakes, it is unclear what if any impact stocking may have on population size or structure.

<u>DU5 – Great Lakes – Upper St. Lawrence populations</u>

Lake Superior has been historically less impacted by anthropogenic activities than the other Great Lakes and most serious issues are specific to particular shoreline areas near urban developments (USEPA 2016). For instance, extensive shoreline development is one of the most pressing issues facing Lake Superior (USEPA 2005b). Discharges of deleterious substances from point and non-point sources (e.g., waste water, sewers, fertilizers, and pesticides), recreation and commercial boats (e.g., oil and gas), and run-off of road pollutants are potential threats to Pygmy Whitefish and their habitat. Concentrations of dieldrin, mercury, PCBs, and toxaphene in Lake Superior continue to exceed the Environment Canada and US Environmental Protection Agency water-quality standards (USEPA 2014). Pharmaceuticals, personal-care products and flame retardants are being detected in the lake and are of emerging concern for fishes (USEPA 2014). Many of these compounds are endocrine disruptors affecting reproduction and development (Brausch and Rand 2011). Actual impacts of pharmaceuticals, personal-care products, and flame retardants on Pygmy Whitefish in Lake Superior are not known. However, given the area (82,100 km^2) and volume (12,000 km^3) of Lake Superior, and high degree of intact forest cover (85%), long-term impacts on water quality for the lake as a whole are considered to be minor (USEPA 2014).

Surface-water temperatures have increased approximately 3.5°C over the past 35 to 40 years and average annual ice-cover has decreased 79% since the 1970s (USEPA 2016). The spawning activities of coldwater species, such as Pygmy Whitefish, may be negatively impacted by rising fall water temperature if such changes, for instance, alter developmental rates such that a mismatch occurs between the timing of critical developmental stages and environmental conditions that promote survival of young (e.g., prey species availability).

Lake Superior contains several invasive fish species that may negatively affect Pygmy Whitefish through predation or competition. These species include: Rainbow Smelt (*Osmerus mordax*), Round Goby (*Neogobius melanostomus*), Eurasian Ruffe (*Gymnocephalus cernua*), and Pacific salmon (*Oncorhynchus* spp). Low-head barriers introduced to control invasive Sea Lamprey (*Petromyzon marinus*) may also impact Pygmy Whitefish if they use rivers to spawn.

DU6 – Waterton Lake

Upper Waterton Lake is contained entirely within a National Park. No significant development is occurring at present or is planned in the near to medium future (Sullivan 2011); consequently, local threats to habitat from anthropogenic disturbance are likely low.

The hamlet of Waterton Park (located on the shore of Upper Waterton Lake), however, has a permanent population of 160 and experiences approximately 380,000 visitors annually (Sullivan 2011). Consequently, Pygmy Whitefish and its habitat may be threatened by accidental discharges of deleterious substances from the town, boats, and run-off of road pollutants (Sullivan 2011). Waterton Lake is unique from other lakes occupied by Pygmy Whitefish in that its oligotrophic status may be maintained by low water temperatures and not low nutrient concentrations (Anderson and Dokulil 1977). Increases in lake temperature as a result of climate warming could shift the trophic state of the lake, such that it is no longer suitable for Pygmy Whitefish (Sullivan 2011).

DU7 – Nelson River

Winnange Lake is contained entirely within a Provincial Park, whereas the three other lakes are located on undeveloped, but non-park, Crown lands. Winnange Lake is an undeveloped park with no services or roads into its interior. Consequently, local threats to habitat from anthropogenic disturbance are likely low. No known exotic species have been introduced (e.g. via live-bait introductions) to the four lakes.

Methyl mercury is a contaminant of concern, even in pristine water bodies like Winnange Lake, ON, because of atmospheric deposition (Blanchfield pers. comm. 2014). Methyl mercury concentrations measured in precipitation across northwestern Ontario ranged between 0.010 to 0.179 mg/l (St. Louis *et al.* 1995). Nearly all methylmercury accumulation in tissues of fishes in the Experimental Lakes Area was found to originate from mercury deposited directly to the lake surface (i.e., precipitation) (Harris *et al.* 2007). Although Pygmy Whitefish is generally a small-bodied fish, studies of European Whitefish (*Coregonus lavaretus*) have demonstrated accumulation of mercury both in pelagic and benthic, non-piscivorous feeding forms (Amundsen *et al.* 2011). Effects of methylmercury exposure on wildlife can include mortality, reduced fertility, slower growth and development, and changes in age at maturation (Weis 2009; Amundsen *et al*. 2011). It is unknown, however, what, if any impact methyl mercury may be having on the Pygmy Whitefish population in northwestern Ontario lakes.

Number of Locations

Pygmy Whitefish is located primarily in small, deep, boreal and montane lakes and the number of locations is interpreted in terms of a single threatening event that could rapidly affect all individuals. Given the various threats discussed above and the likelihood that the scope and intensity of each plausible threat would act independently within each lake or river, each lake or river occurrence of Pygmy Whitefish is considered a separate location. Some individual lakes and rivers, however, are quite large (e.g., Atlin Lake, Okanagan Lake, Kootenay Lake, upper Athabasca River, Lake Superior) and if more localized threats are documented, the number of locations within any one lake or river may be greater than one.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

The protection afforded by the federal *Fisheries Act* is uncertain because the Pygmy Whitefish is unlikely to be considered to be of direct significance to Commercial, Recreational, or Aboriginal (CRA) fisheries. It may, however, receive protection if it can be demonstrated to be supporting a CRA fishery species.

Provincially (Alberta, Ontario) and territorially (Yukon, Northwest Territories), Pygmy Whitefish is not considered a sport fish, nor is it listed in the possession-limit section of sport fishing regulation synopses; i.e., they are considered non-game fish, which generally means that anglers have no restriction on the number of Pygmy Whitefish they may keep. Within British Columbia, Pygmy Whitefish is included in the daily limit of 15 whitefish (all species combined). The “giant” form of Pygmy Whitefish has been listed as Threatened in British Columbia (Cannings and Ptolemy 1998).

Under the National Park Sport Fishing Regulations (Minister of Justice 2010) Pygmy Whitefish is not specifically listed in the catch-and-possession limits and, therefore, falls into the category of “other species” that have a retention limit of zero. Five populations of Pygmy Whitefish within Jasper, Waterton, Yoho, and Kluane national parks are, therefore, protected from exploitation. Habitat is protected by the *National Parks Act* where it occurs in a national park or national park reserve

Non-Legal Status and Ranks

From NatureServe (2017):

Globally G5
Canada N5

Canada

Alberta S1
British Columbia S4, Yellow in BC Conservation Data Centre
Northwest Territories SU
Ontario SU
Yukon S4

United States

Alaska S4
Washington State S1S2
Montana S3
Idaho SNR
Wisconsin S2
Minnesota SNR
Michigan S4

Habitat Protection and Ownership

Yukon and Northwest Territories (DU1, 4)

Kathleen Lake is located within Kluane National Park. The other waterbodies known to contain Pygmy Whitefish are located on territorial-owned lands.

British Columbia (DU1-4)

Arctic Lake, Kickinghorse River, Quentin Lake, and Moose lakes are located in Arctic Lake Provincial Park, Yoho National Park, and Kwadacha Wilderness Provincial Park, respectively. The remaining 27 water bodies known to contain Pygmy Whitefish are on crown, non-park lands.

Alberta (DU4, 6)

Approximately 32 km (70%) of Upper Athabasca River with Pygmy Whitefish is located in Jasper National Park, whereas the Waterton Lakes is entirely within Waterton Lakes National Park in Canada and Glacier National Park in the US.

Saskatchewan (DU4)

Lake Athabasca straddles the border of Alberta and Saskatchewan and is within provincially owned lands.

Ontario (DU5, 7)

Winnange Lake is located within Winnange Lake Provincial Park, and the three other lakes in northwestern Ontario are located on provincially owned lands. Lake Superior straddles an international boundary. The percentage of Lake Superior used by Pygmy Whitefish within Canada is unknown. Approximately 33% of Canadian waters of Lake Superior is in the Lake Superior National Marine Conservation Area, which does not protect it from exploitation.

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INFORMATION SOURCES

Amundsen, P.A., N.A, Kashulin, P., Terentjev, K.Ø. Gjelland, I.M. Koroleva, V.A. Dauvalter, S. Sandimirov, A, Kashulin, R. and Knudsen, R., 2011. Heavy metal contents in whitefish (*Coregonus lavaretus*) along a pollution gradient in a subarctic watercourse. *Environmental Monitoring and Assessment* 182: 301-316.

Anderson, R., and M. Dokulil. 1977. Assessments of primary and bacterial production in three large mountain lakes in Alberta, Western Canada. International Revue der Gesamten Hydrobiologie 62: 97-108.

Barker, O., pers. comm. 2014. *Email correspondence to Jeff Sereda* April 2014. Senior Fisheries Biologist, Environment Yukon, Whitehorse, Yukon.

Barnett, H.K., and D.K. Paige. 2014. Characteristics of riverine broadcast spawning Pygmy Whitefish. Northwest Science 88: 155-168.

British Columbia Environment. 2007. Perch invasion closes eight Thompson-Nicola Lakes. British Columbia Ministry of Environment Information Bulletin. 2007ENV0072-000763, 8 June 2007.

Blanchfield, P.J., pers. comm. 2014. *Email correspondence to Jeff Sereda* January 2015. Fisheries Biologist, Fisheries and Oceans Canada, Winnipeg, Manitoba.

Blanchfield, P.J., pers. comm. 2015. *Email correspondence to Jeff Sereda* January 2015. Research Scientist, Fisheries and Oceans Canada, Winnipeg, Manitoba.

Blanchfield, P.J., E.B., Taylor, and D.A. Watkinson. 2014. Morphological and genetic analyses identify new record of a glacial relict: Pygmy Whitefish (*Prosopium coulterii*) from northwestern Ontario. Canadian Journal of Zoology 92: 267-271.

Brausch, J.M., and G.M. Rand. 2011. A review of personal care products in the aquatic environment: Environmental concentrations and toxicity. Chemosphere. 82: 1518-1532.

British Columbia Ministry of Environment (BCMOE). 2014. Fisheries Inventory Data Queries. Website: http://www.env.gov.bc.ca/fish/fidq/ [accessed October 2014.

Bronte, C.R., M.P. Ebener, D.R. Schreiner, D.S. DeVault, M.M. Petzold, D.A. Jensen, C. Richards, and S.J. Lozano. 2003. Fish community change in Lake Superior, 1970–2000. Canadian Journal of Fisheries and Aquatic Sciences. 60: 1552-1574.

Cannings, S.G., and J. Ptolemy. 1998. Rare freshwater fish of British Columbia. British Columbia Environment, Victoria, BC. 214 pp.

Casselman, J.M. 2002. Effects of temperature, global extremes,and climate change on year-class production of warmwater, coolwater and coldwater fishes in the Great Lakes basin. Fisheries in a changing climate (ed. by N.A. McGinn), pp. 39–60. American Fisheries Society, Symposium 32, Bethesda, Maryland.

Chereshnev, I.A, and M.B. Skopets. 1992. A new record of the Pygmy Whitefish, *Prosopium coulterii*, from the Amguem River basin (Chukotski Peninsula). Journal of Ichthyology 32: 46-55.

Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kollii, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr, and P. Whetton. 2007. Regional climate projections. Pp. 848-926 in S. Solomon, D. Quin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.). Climate Change 2007: the Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom.

Chu, C. pers. comm. 2016. *Email correspondence to Nick Mandrak* October 2016. Research Scientist, Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario.

Chu, C., N.E. Mandrak, and C.K. Minns. 2005. Potential impacts of climate change on the distributions of several common and rare freshwater fishes in Canada. Diversity and Distributions 11: 299-310.

COSEWIC. 2014. Guidelines for Recognizing Designatable Units. Website: http://www.cosewic.gc.ca/eng/sct2/sct2_5_e.cfm [accessed December 2014]

Davidson, P.W., and R. Dawson. 1990. Williston wildlife compensation program management plan, 1990. Peace/Williston Fish and Wildlife Compensation Program, Report No. 5. 44 pp.

Dryer, W., L. Erkkla, and C. Tetzloff. 1965. Food of lake trout in Lake Superior. Transactions of the American Fisheries Society 94: 169-176.

Eschmeyer, P.P., and R.M. Bailey. 1955. The Pygmy Whitefish, *Corgonus coulterii*, in Lake Superior. Transactions of the American Fisheries Society 84: 161-199.

Fraley, J., and B. Shepard. 1989. Life history, ecology and population status of migratory Bull Trout (*Salvelinus confluentus*) in the Flathead Lake and river system, Montana. Northwest Science 63:133-142.

Fraser, D.J., L.K. Weir, L. Bernatchez, M.M. Hansen, and E.B. Taylor. 2011. Extent and scale of local adaptation in salmonid fishes: review and meta-analysis. Heredity 106: 404-420.

Gowell, C.P., T.P. Quinn, and E.B. Taylor. 2012. Coexistence and origin of trophic ecotypes of Pygmy Whitefish, *Prosopium coulterii*, in a south-western Alaskan lake. Journal of Evolutionary Biology 25: 2432-2448.

Hallock, M., and P.E. Mongillo. 1998. Washington state status report for the Pygmy Whitefish. Washington Department of Fish and Wildlife, Olympia, Wash. 20 pp.

Harris, R.C, J.W.M. Rudd, M. Amyot, C.L. Babiarz, K. G. Beaty, P.J. Blanchfield, R.A. Bodaly, B.A. Branfireun, C.C. Gilmour, J.A. Graydon, A. Heyes, H. Hintelmann, J.P. Hurley, C.A. Kelly, D.P. Krabbenhoft, S.E. Lindberg, R.P. Mason, M.J. Paterson, C.L. Podemski, A. Robinson, K.A. Sandilands, G.R. Southworth, V.L. St. Louis, and M.T. Tate. 2007. Whole-ecosystem study shows rapid fish-mercury response to changes in mercury deposition. Proceedings of the National Academy of Sciences 104: 16586–16591.

Heard, W.R., and W.L. Hartman. 1965. Pygmy whitefish in the Naknek River system of southwest Alaska. Fishery Bulletin 65: 555-579 pp.

Jezierska, B., K. Ługowska, and M. Witeska. 2009. The effects of heavy metals on embryonic development of fish (a review). Fish Physiology and Biochemistry 35: 625-640.

Jung, T. *Email correspondence to E. Taylor* Dec. 9, 2015. Yukon Environment, Government of Yukon, Whitehorse.

Krueger, C. C. and M. Ebner. 2004. Rehabilitation of lake trout in the Great Lakes: past lessons and future challenges. pp. 37-56 In: J.M. Gunn, R.J. Stedman, and R.A. Ryder (eds.). Boreal Shield watersheds: Lake trout ecosystems in a changing environment. Lewis Publishers, Boca Raton, Florida.

Lindsey, C.C., and J.D. McPhail, 1986. Zoogeography of fishes of the Yukon and Mackenzie basins. pp. 639-674 In: C.H. Hocutt and E.O. Wiley (eds.). Zoogeography of North American freshwater fishes. John Wiley & Sons, New York, New York.

Mayhood, D.W. 1992. A preliminary assessment of the native fish stocks of Jasper National Park, Part 3 of a fish management plan for Jasper National Parks. Prepared for Canadian Parks Service, Jasper, Alberta. 296 pp.

McCart, P. 1965. Growth and morphometry of four British Columbia populations of Pygmy Whitefish (*Prosopium coulteri*). Journal of Fisheries Research Board Canada 22: 1229-1259.

McCart, P. 1970. Evidence for the existence of sibling species of Pygmy Whitefish (*Prosopium coulterii*) in three Alaskan lakes. pp. 81-98 In: C.C. Lindsey and C.S. Woods (eds.). Biology of Coregonid Fishes. University of Manitoba Press, Winnipeg, Manitoba. 560 pp.

McDonald, T.E., and L. Margolis. 1995. Synopsis of the parasites of fishes of Canada: Supplement (1978-1993). National Research Council of Canada, Ottawa, 1995. 265 pp.

McPhail, J.D. 2007. The freshwater fishes of British Columbia. University of Alberta Press, Edmonton. 620 pp.

McPhail, J.D., and C.C. Lindsey. 1970. Freshwater fishes of north-western Canada and Alaska. Fisheries Research Board of Canada, Bull 173, Ottawa, Ontario. 381 pp.

McPhail, J.D., and R. Carveth. 1992. A foundation for conservation: the nature and origin of the freshwater fish fauna of British Columbia. University of British Columbia, Department of Zoology, Vancouver, British Columbia, Canada. 39 pp.

McPhail, J.D., and R. Zemlak. 2001. Pygmy whitefish studies on Dina Lake #1, 2000.Peace/Williston fish and wildlife compensation program report No. 245.

Millar, N., pers. comm. 2014. *Email correspondence to Jeff Sereda* April 2014. Senior Fisheries Biologist, Environment Yukon, Whitehorse, Yukon.

Minister of Justice, 2010. National Parks of Canada Fishing Regulations (C.R.C., c. 1120). Website: http://laws-lois.justice.gc.ca [accessed June 2015].

Mitchell, L.G. 1989. Myxobolid parasites (Myxozoa: Myxobolidae) infecting fishes of western Montana, with notes on histopathology, seasonality, and intraspecific variation. Canadian Journal of Zoology 67: 1915-1922.

Mudry, D.R., and R.S. Anderson. 1977. Helminth and arthropod parasite of fishes in the mountain national parks of Canada. Journal of Fish Biology 11: 21-33.

NatureServe. 2017. NatureServe Explorer. Website: http://explorer.natureserve.org/. [accessed January 2017].

Nelson, J.S., and M.J. Paetz. 1992. The fishes of Alberta, 2nd ed. University of Alberta Press, Edmonton Alberta. 438 pp.

Nordin, R.N. 2005. Water quality objectives for Okanagan Lake – A first update. Limnos Water Associates. North Saanich, British Columbia, Canada. 135 pp.

Northcote, T.G. 1997. Potamodromy in Salmonidae-living and moving in the fast lane. North American Journal of Fisheries Management 17: 1029-1045.

Ontario Ministry of Natural Resources. 2010. State of resources reporting. Lake Trout in the upper Great Lakes. Ontario Ministry of Natural Resources Inventory, Monitoring and Assessment Section 300 Water Street, Peterborough, ON, K9J 8M5. Available at: https://dr6j45jk9xcmk.cloudfront.net/documents/3190/state-of-resources-reports-lake-trout-upper.pdf. [accessed March 28, 2016].

Rankin, L. 1999. Phylogenetic and ecological relationships between “giant” Pygmy Whitefish (*Prosopium* spp.) and Pygmy Whitefish (*Prosopium coulterii*) in north-central British Columbia. Master of Science Thesis, University of Northern British Columbia, August 1999. 132 pp.

Rasmussen, J.B., L. Brinkmann, and G. Scrimgeour. 2009. Waterton Lakes gill net survey program: towards a plan for a fish monitoring program. Report prepared for Resource Conservation, Western and Northern Service Centre. Parks Canada, Calgary, Alberta. 49 pp.

Reist, J., F. Wrona, T. Prowse, M. Power, J. Dempson, R. Beamish, J. King, T. Carmichael, and C. Sawatzky. 2006. General effects of climate change on Arctic fish populations. Ambio 35: 370-380.

Riseh, H.A. 2006. Optimization of the Kootenay River hydroelectric system with a linear programing model. M.Sc. dissertation. University of British Columbia, Vancouver, British Columbia.115 pp.

Salafsky, N., D. Salzer, A. J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S. H. M. Butchart, B. Collen, N. Cox, L. L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conservation Biology 22: 897-911.

Selegby, J.H. and M.H Hoff. 1996. Seasonal bathymetric distribution of 16 fishes in Lake Superior 1958-75. United States Department of the Interior National Biological Service, Science Report No. 7.

Schleppe, J. 2011. Foreshore inventory and mapping – Kootenay Lake Main Arm. Ecoscape Environmental Consultants Ltd, Kelowna, British Columbia. 86 pp.

Schwalb, A.N., A.C. Alexander, A.J. Paul, K. Cottenie, and J.B. Rasmussen. 2014. Changes in migratory fish communities and their health, hydrology, and water chemistry in rivers of the Athabasca oil sands region: a review of historical and current data. Environmental Reviews 23: 1-18.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bull. 184., Ottawa, Ontario. 966 pp.

St. Louis, V.L., J.W.M. Rudd, C.A. Kelly, and L.A. Barrie. 1995. Wet deposition of methyl mercury in northwestern Ontario compared to other geographic locations. Water Air, and Soil Pollution 80: 405-414.

Sullivan, M. 2011. Status of the Pygmy Whitefish (*Prosopium coulterii*) in Alberta. Wildlife Status Report No. 27. (Update 2011) Alberta Environment, Fisheries and Wildlife Management Division, and Alberta Conservation Association. Edmonton, Alberta. 61 pp.

Taylor, E.B. 1991. A review of local adaptation in Salmonidae with particular reference to Pacific and Atlantic salmon. Aquaculture 98: 185-207.

Taylor, E.B., J.L Gow, J. Witt, and R. Zemlak. 2011. Connectivity among populations of Pygmy Whitefish (*Prosopium coulterii*) in northwestern North America inferred from microsatellite DNA analysis. Canadian Journal of Zoology 89: 255-266.

Taylor, E.B. University of British Columbia, Department of Zoology. Personal communication, March 22, 2016.

Thomas, C., A. Cameron, R. Green, M. Bakkenes, L. Beaumont, Y. Collingham, B. Erasmus, M. SIqueira, A. Grainger, L. Hannah, L. Hughes, B. Huntley, A. Jaarsveld, G. Midgley, L. Miles, M. Ortega-Huerta, A. Peterson, O. Phillips, and S. Williams. 2004. Extinction risk from climate change. Nature 427: 145-148.

Transportation Safety Board of Canada. 2013. Statistical Summary - Railway Occurrences 2013. Catalogue No. TU1-2/2013E-PDF

United States Environmental Protection Agency (USEPA). 2005a. State of the Great Lakes 2005. Website: http://www.epa.gov/solec/indicator_sheets/superior.pdf [accessed January 2015].

United States Environmental Protection Agency (USEPA). 2005b. What are the current stressors impacting Lake Superior? United States Environmental Protection Agency. Available at https://archive.epa.gov/solec/web/pdf/superior.pdf. [accessed March 28, 2016].

United States Environmental Protection Agency (USEPA). 2016. Lake Superior Great Lakes Areas of Concern. United States Environmental Protection Agency. Available at https://www.epa.gov/greatlakes/lake-superior. [accessed March 28, 2016].

Vecsei, P, and D. Panayi. 2015. Range extension for Pygmy Whitefish (*Prosopium coulterii*) in the Northwest Territories, Canada. Canadian Field-Naturalist 129: 70–75.

Vinson, M. 2014. *Email correspondence to Jeff Sereda April 2014, E. Taylor September and November 2015, and Nick Mandrak, October 2016*. Station Chief United States Geological Survey, Lake Superior Biological Station Ashland, Wisconsin USA.

Water Survey of Canada. 2015. Water Office – Environment Canada Archived Hydrometric Data. 2015. Website: http://wateroffice.ec.gc.ca. [accessed February 2015].

Weir, T., pers. comm. 2014. *Email correspondence to Jeff Sereda* March 2014. Large Lakes Ecosystems Specialist, Ecosystems Protection and Sustainability Branch, Ministry of Environment, Vancouver, British Columbia.

Weis, J. 2009. Reproductive, development, and neurobehavioral effects of methylmercury in fish. Journal of Environmental Science and Health, Part C: Environmental Carcinogenesis and Ecotoxicology 27: 212-225.

Weisel, G.F., and J.B. Dillon. 1954. Observations of the Pygmy Whitefish, *Prosopium coulterii*, from Bull Lake, Montana. Copeia 1954: 124-127.

Weisel, G.F., D.A. Hanzel, and R.L. Newell. 1973. The Pygmy Whitefish, *Prosopium coulterii*, in western Montana. Fisheries Bulletin 71: 587-596.

Witt, J.D.S., R.J. Zemlak, and E.B. Taylor. 2011. Phylogeny and the origins of the range disjunctions in a north temperate fish, the Pygmy Whitefish (*Prosopium coulterii*), inferred from mitochondrial and nuclear DNA sequence analysis. Journal of Biogeography 38:1557-1569.

Zemlak, R.J. and J.D. McPhail. 2004. Pygmy Whitefish studies on Dina Lake #1, 2001. Peace/Williston Fish and Wildlife Compensation Program Report No. 279. 35 pp. plus appendices.

Zemlak, R.J., and J.D. McPhail. 2006. The biology of Pygmy Whitefish, *Prosopium coulterii*, in a closed sub-boreal lake: spatial distribution and diel movements. Environmental Biology of Fishes 76: 317-327.

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Jeff Sereda is a Senior Fisheries Habitat and Population Ecologist with the Water Security Agency (WSA) of Saskatchewan where he is responsible for mitigating impacts on fish and fish habitat related to WSA's activities. Jeff completed a Ph.D. in limnology from the University of Saskatchewan and an Aquaculture Technician Diploma from Sir Sandford Fleming College in Ontario. Jeff currently holds an Adjunct Professor position in the School of Environment and Sustainability at the University of Saskatchewan. Jeff has published 13 peer reviewed scientific papers and presented his research at 49 regional, national, and international conferences. Since 2008 he has taught Ichthyology at the University of Saskatchewan expanding the course curriculum into areas of fisheries ecology, conservation, invasive species, and aquaculture.

COLLECTIONS EXAMINED

No collections were examined.

Appendix I. Phylogroups of Pygmy Whitefish

Table A1. Phylogroups of Pygmy Whitefish. Table generated from Witt *et al*. (2011) and E.B. Taylor (Dept. of Zoology, University of British Columbia, Vancouver, unpubl. data*). Phylogroup [southern Alaska (SA), Cascadia/Mackenzie/Yukon (CMAY) and Lake Superior (LS)], lakes sampled, sample sizes (N), and mtDNA sequence haplotype present (H) for 169 Pygmy Whitefish assayed for variation at the ATPase subunit VI mitochondrial gene. Numbers in parentheses beside the haplotypes indicate their abundance in the sample.

Drainage (Phylogroup)	Lake	N	Clade	H
Cedar River (CMAY)	Chester Morse	2	2	H6(5)
Chignik River (SA)	Black	6	1	H23(1), H24(1), H25(4)
Chignik River (SA)	Chignik	25	1	H24(10), H25(12), 28 (1), 29 (1), 30 (1)
Ugashik River (SA)	Ugashik	6	1	H22(1), H25(3), H26(1)
Nushagak River (SA)	Iliamna	1	1	H31 (1)*
Wood River (SA)	Aleknagik	1	1	H27 (1)*
Alsek River (SA)	Aishihik	2	1	H21(2)
Alsek River (SA)	Kathleen	3	1	H32 (3)*
Columbia River (CMAY)	Arrow	7	2	H6(5), H10(1), H16(1)
Columbia River (CMAY)	Flathead	4	2	H5(1), H6(3)
Columbia River (CMAY)	Kootenay	4	2	H16(2), H19(2)
Fraser River (CMAY)	Cluculz	2	2	H16(1), H17(1)
Fraser River (CMAY)	Jack of Clubs	5	2	H16(5)
Fraser River (CMAY)	McCleese	4	2	H16(4)
Peace River (CMAY)	Arctic	6	2	H16(6)
Peace River (CMAY)	Aiken	5	2	H6(4), H16(1)
Peace River (CMAY)	Dina	6	2	H16(6)
Peace River (CMAY)	Lower Manson	6	2	H6(3), H16(3)
Peace River (CMAY)	Peace Reach	8	2	H14(1), H16(4), H17(1)
Peace River (CMAY)	Upper Manson	4	2	H6(2), H16(2)
Peace River (CMAY)	Chuchi	6	2	H4(1), H6(4), H9(1)
Peace River (CMAY)	Quentin	6	2	H15(5), H16(1)
Peace River (CMAY)	Kwadacha River	3	2	H15(2), H16(1)
Peace River (CMAY)	Lower Tacheeda	4	2	H1(1), H2(1), H3(1), H7(1)
Peace River (CMAY)	Upper Tacheeda	7	2	H6(7)
Peace River (CMAY)	Monkman	3	2	H13(1), H6(2)
Peace River (CMAY)	Six Mile Bay	6	2	H14(1), H16(4), H18(1)
Peace River (CMAY)	Tutizzi	5	2	H6(1), H11(1), H12(1),H16(2)
Peace River (CMAY)	Weissener	5	2	H6(4), H8(1)
Skeena River (CMAY)	Chapman	5	2	H10(1), H6(2), H16(2)

Drainage (Phylogroup)	Lake	N	Clade	H
Skeena River (CMAY)	Owen	5	2	H16(5)
Skeena River (CMAY)	Tyhee	3	2	H10(2), H16(1)
Great Lakes Basin (LS)	Superior	12	3	H20(7)

Appendix II. Threats calculators for Pygmy Whitefish, DU1-7.

Species or Ecosystem Scientific Name	Pygmy Whitefish *Prosopium coulterii:* DU1 - Southwestern Yukon Beringian populations
Element ID	
Elcode	
Date (Ctrl + ";" for today's date):	03/11/2015
Assessor(s):	Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angele Cyr (recorder)
References:	6-month interim

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:	**U = Unknown**	
	Impact Adjustment Reasons:		
	Overall Threat Comments		

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
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						
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						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
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						not applicable
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		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	DU1 Aishihik Lake water drawdown of 1 m during winter; dam has been there for 40 years (operating since 1975); populations of other fish including Lake Whitefish have been impacted, but practices have changed since that time.
7.3	Other ecosystem modifications						not applicable
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species						not applicable
8.2	Problematic native species						DU1- Lake Trout predation is not augmented by stocking and is a natural limiting factor.
8.3	Introduced genetic material						not applicable
9	Pollution						
9.1	Household sewage & urban waste water						not applicable
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 (71-100%)	Unknown	High (Continuing)	
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						There could be benefits to having rising temperature in terms of increased forage productivity.
11.4	Storms & flooding						not applicable

Species or Ecosystem Scientific Name	Pygmy Whitefish *Prosopium coulterii:* DU2 - Yukon River populations
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	03/11/2015
Assessor(s):	Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angele Cyr (recorder)
References:	6-month interim

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:	**U = Unknown**
Impact Adjustment Reasons:	
Overall Threat Comments	***Scope difficult to estimate in this DU because PW is being found at additional sites in this DU. Overall impact is unknown.***

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
3	Energy production & mining						
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying						Hard-rock mining. Additional mining activities for areas not currently mined? Placer mining in Mayo. Effluents from existing mines accounted for under threat 9.2.
3.3	Renewable energy						not applicable
4	Transportation & service corridors						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
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						
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						not applicable
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		Unknown	Small (1-10%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use		Unknown	Small (1-10%)	Unknown	High (Continuing)	Reservoir at Mayo, 2.5 m seasonal drawdown, but does not fluctuate otherwise.
7.3	Other ecosystem modifications						not applicable
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species						not applicable
8.2	Problematic native species						not applicable
8.3	Introduced genetic material						not applicable
9	Pollution		Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water						not applicable
9.2	Industrial & military effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	Hard-rock effluents leaching into PW habitat. Placer mining on tributaries of Mayo Lake. Placer mining impact would be localized. Unknown impact but potentially sediment impact related. Historical placer mining mostly. Small impact in the next 10 years.
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

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
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 (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration						not applicable
11.2	Droughts						not applicable
11.3	Temperature extremes						not applicable
11.4	Storms & flooding						not applicable

Species or Ecosystem Scientific Name	Pygmy Whitefish *Prosopium coulterii:* DU3 - Pacific populations
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	03/11/2015
Assessor(s):	Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Greg Wilson, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angele Cyr (recorder)
References:	6-month interim

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	0	0
	Calculated Overall Threat Impact:		

Assigned Overall Threat Impact:	**U = Unknown**
Impact Adjustment Reasons:	
Overall Threat Comments	***Large forms of Pygmy Whitefish in these lakes are in decline for unknown reasons. Don't know overall impact for this DU.***

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Potential for docks, marina developments, e.g., Okanagan Lake
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. Aquaculture is unlikely as is cattle trampoling.
3	Energy production & mining						
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying						Usually in rivers and coastal. Gravel or quarrying
3.3	Renewable energy						not applicable
4	Transportation & service corridors						
4.1	Roads & railroads						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.2	Utility & service lines						not applicable
4.3	Shipping lanes						Limited dredging. Mostly mechanical removal. Does affect spawning habitat by sediment disruption. Applicable to a lot fewer lakes than dock development. Eurasian milfoil clogging habitat, in some lakes, would be applicable under this threat category. Dredging in PW range for this DU is mainly for recreation use for water skiing. Dredging for milfoil is accounted for under 7.3.
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)	Recreational fishing is applicable, but minor as not a target species. Bycatch in trawls for Kokanee. Four lakes, but very little impact. Negligible.
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						DND exercises in Okanagan but unlikely impact.
6.3	Work & other activities		Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs)	Expected in the future? Possible for targeted PW research activities. Low impact. Appears to not be going on currently but possibly in the future.
7	Natural system modifications		Unknown	Small (1-10%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.2	Dams & water management/use		Unknown	Small (1-10%)	Unknown	High (Continuing)	Kootenay Lake dam (Corra Linn Dam is a hydroelectric facility located on the Kootenay River west of Nelson); could also include withdrawals for agriculture; rules consider effects on Kokanee fry and Pygmy Whitefish spawn in deeper water. Water drawdown is minimal. Water withdrawal is insignificant. Kootenay River has higher drawdown. Dams and water management use is more significant in this DU but still small. Big lakes in this DU. 1-10%. Not considered large or extreme for draw down
7.3	Other ecosystem modifications		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Milfoil. Some dredging for swimming and waterskiing that could affect spawning habitat in Okanagan Lake
8	Invasive & other problematic species & genes		Unknown	Large (31-70%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species		Unknown	Large (31-70%)	Unknown	High (Continuing)	Non-native Bluegill, Smallmouth and Largemouth Bass have been illegally stocked in Okanagan Lake. Other invasives also occur. Exposure to exotics between large and restricted. Widerange 29% of lakes stocked with Rainbow trout. Impact of Rainbow Trout is unknown. Potential threat.
8.2	Problematic native species						Lake Trout predation a natural limiting factor as opposed to threat. Conservation program on lake trout to help recover (populations are declining) but no stocking. Not a growing threat.
8.3	Introduced genetic material						not applicable
9	Pollution		Unknown	Large (31-70%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Large (31-70%)	Unknown	High (Continuing)	Leaching septic systems is applicable. Trophic system of Okanagan Lake has changed. Scope is large. Northern range of this DU is not exposed so much to threat of urban waste so overall impact is low. Three lakes: Kootenay, Okanagan, and McLeese Lakes have extensive urban, recreational
9.2	Industrial & military effluents		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Mining Jack of Clubs Lake basin. Small or negligible.
9.3	Agricultural & forestry effluents		Unknown	Large (31-70%)	Unknown	High (Continuing)	Wine industry in Okanagan.
9.4	Garbage & solid waste						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
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 (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration						not applicable
11.2	Droughts						not applicable
11.3	Temperature extremes						not applicable
11.4	Storms & flooding						not applicable

Species or Ecosystem Scientific Name	Pygmy Whitefish *Prosopium coulterii:* DU4 - Western Arctic populations
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	03/11/2015
Assessor(s):	Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angele Cyr (recorder)
References:	6-month interim

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	0	0
	Calculated Overall Threat Impact:		

Assigned Overall Threat Impact:	**U = Unknown**
Impact Adjustment Reasons:	
Overall Threat Comments	

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
3	Energy production & mining						
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying						No new mine construction.
3.3	Renewable energy						not applicable
4	Transportation & service corridors						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads						Some building of roads but won't affect PWF habitat. Not many bridges being built over lakes. One road exists over the Parsnip Reach of Williston Reservoir. Road/bridge is complete now.
4.2	Utility & service lines						Pacific Trail pipeline starts at Summit Lake. Proposed 480 km natural gas pipeline to Kitimat.
4.3	Shipping lanes						not applicable
4.4	Flight paths						not applicable
5	Biological resource use		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						Bycatch is likely a threat but most trawling is done in the pelagic zone so negligible.
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)	not applicable
6	Human intrusions & disturbance						
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities						Past research but nothing expected in the next 10 years for this DU. Alberta might do some monitoring since the species is provincially listed as Special Concern.
7	Natural system modifications		Unknown	Small (1-10%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use		Unknown	Small (1-10%)	Unknown	High (Continuing)	Dam and construction. Gold mine pollution from current mines. Future Site C (Peace River) for construction of dam. Huge part of the total population in this DU. 15m draw in this DU. Peace River may have egg loss but unknown impact. Connectivity is important in these lakes and rivers systems.
7.3	Other ecosystem modifications						not applicable
8	Invasive & other problematic species & genes		Negligible	Negligible (<1%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Stocking Brook Trout (sterile) in the past but only in closed systems if at all in the future. Stocking of Rainbow Trout as well.
8.2	Problematic native species						Lake Trout have difficulty with overharvesting. So unlikely that this is a limiting factor to PW in this DU.
8.3	Introduced genetic material						not applicable
9	Pollution		Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Some threat from urban waste water but negligible.
9.2	Industrial & military effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	Rail-car accidents, uranium mining, toxic substances. Pulp mill draws water from Williston Reservoir in Mackenzie but use has been variable over the past 15 years. This is accounted for under 7.2. Upper Athabasca is major corridor for effluent pathway.
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 (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration						…
11.2	Droughts						not applicable
11.3	Temperature extremes						not applicable
11.4	Storms & flooding						not applicable

Species or Ecosystem Scientific Name	Pygmy Whitefish *Prosopium coulterii:* DU5 - Great Lakes - Upper St. Lawrence populations (Lake Superior)
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	04/11/2015
Assessor(s):	Bill Tonn, Dwayne Lepitzki (moderator) and Angele Cyr (recorder)
References:	6-month interim

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:	**U = Unknown**
Impact Adjustment Reasons:	
Overall Threat Comments	Overall 48% decline over all the threats but unknown impact from specific threats.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Unknown	High (Continuing)	back country camping
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
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						
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	Negligible (<1%)	Unknown	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						not applicable
5.4	Fishing & harvesting aquatic resources		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Bycatch. Some commercial harvest of Lake Trout and whitefish fisheries using gillnet but possibly not applicable due to mesh size too large.
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities		Negligible	Negligible (<1%)	Unknown	High (Continuing)	General surveys by USGS for research in Lake Superior capture Pygmy Whitefish and includes sampling in Canadian waters.
7	Natural system modifications		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use						not applicable
7.3	Other ecosystem modifications		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Some shoreline development in Lake Superior. Scope would not be extensive.
8	Invasive & other problematic species & genes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Round Goby around Duluth. Sea Lamprey and Pacific salmonids (Pink, Chinook, Coho salmons & Rainbow Trout) predation.
8.2	Problematic native species						Stocking of Lake Trout (eggs) possibly? Unlikely problematic since stocking is restoration of the species.
8.3	Introduced genetic material						not applicable
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Restricted - Small (1-30%)	Unknown	High (Continuing)	Thunder Bay area most impacted in this DU. Duluth would also be considered under this threat. Restricted to waste water in some areas

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.2	Industrial & military effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	Likely from Thunder Bay area.
9.3	Agricultural & forestry effluents		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Forestry around Lake Superior. Erosion caused by forestry? Likely negligible.
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	airborne mercury
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 (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration						Surface-water temperatures have increased. Any positive effects of warmer temperatures? Some increased spawning temperatures over the fall positive? Less ice may be a benefit?
11.2	Droughts						not applicable
11.3	Temperature extremes						not applicable
11.4	Storms & flooding						not applicable

Species or Ecosystem Scientific Name	Pygmy Whitefish *Prosopium coulterii:* DU6 - Waterton Lake population
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	03/11/2015
Assessor(s):	Jeff Sereda, Bruce Bennett, Tom Jung, Randy Zemlak, Olive Barker, Bill Tonn, Dwayne Lepitzki (moderator), Angele Cyr (recorder)
References:	6-month interim

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:	**U = Unknown**
Impact Adjustment Reasons:	
Overall Threat Comments	

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
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						
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						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
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						not applicable
6	Human intrusions & disturbance		Unknown	Large (31-70%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities		Unknown	Large (31-70%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Possibility of regular surveys in this area in the next ten years. Parks Canada possibly.
7	Natural system modifications						
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use						not applicable
7.3	Other ecosystem modifications						not applicable
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species						not applicable
8.2	Problematic native species						not applicable
8.3	Introduced genetic material						not applicable
9	Pollution		Unknown	Large (31-70%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Large (31-70%)	Unknown	High (Continuing)	Large proportion of population in range of Waterton is in upper Waterton Lake and water flow is northward. This threat is applicable. Unknown impact.
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 (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration						…

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts						not applicable
11.3	Temperature extremes						not applicable
11.4	Storms & flooding						not applicable

Species or Ecosystem Scientific Name	Pygmy Whitefish *Prosopium coulterii:* DU7 – Saskatchewan - Nelson Rivers populations
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	04/11/2015
Assessor(s):	Bill Tonn, Dwayne Lepitzki (moderator) and Angele Cyr (recorder)
References:	6-month interim

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:	**U = Unknown**
Impact Adjustment Reasons:	
Overall Threat Comments	

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		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Back-country camplng
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
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						
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	Negligible (<1%)	Unknown	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						not applicable

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources	Negligible	Negligible (<1%)	Unknown	High (Continuing)	Back country fishing; may be some baitfish introductions in Mameigwess Lake, which has road access. Unlikely that Pygmy Whitefish are exploited directly given their small size.
6	Human intrusions & disturbance	Negligible	Negligible (<1%)	Unknown	High (Continuing)	
6.1	Recreational activities					not applicable
6.2	War, civil unrest & military exercises					not applicable
6.3	Work & other activities	Negligible	Negligible (<1%)	Unknown	High (Continuing)	Scientific sampling
7	Natural system modifications					
7.1	Fire & fire suppression					not applicable
7.2	Dams & water management/use					not applicable
7.3	Other ecosystem modifications					not applicable
8	Invasive & other problematic species & genes					
8.1	Invasive non-native/alien species					not applicable
8.2	Problematic native species					not applicable
8.3	Introduced genetic material					not applicable
9	Pollution	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water					not applicable
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	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Methyl mercury airborne from direct deposit (mining).
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 (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration					Undeveloped regions of Ontario privately owned land. Altering water regimes and temperature changes???
11.2	Droughts					not applicable
11.3	Temperature extremes					not applicable
11.4	Storms & flooding					not applicable