COSEWIC
Assessment and Status Report

on the

Rocky Mountain Sculpin
Cottus sp.

Pacific populations
Saskatchewan - Nelson River populations
Missouri River populations

in Canada

Pacific populations - SPECIAL CONCERN
Saskatchewan - Nelson River populations - THREATENED
Missouri River populations - THREATENED
2019

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. 2019. COSEWIC assessment and status report on the Rocky Mountain Sculpin *Cottus* sp., Pacific populations, Saskatchewan - Nelson River populations and Missouri River populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxi +67 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

Previous report(s):

COSEWIC. 2010. COSEWIC assessment and status report on the Rocky Mountain Sculpin *Cottus* sp., Westslope populations, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 30 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC 2005. COSEWIC assessment and status report on the “eastslope” sculpin (St. Mary and Milk River population) *Cottus* sp. in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 30 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment and Climate Change Canada
Ottawa, ON
K1A 0H3

Tel.: 819-938-4125
Fax: 819-938-3984
E-mail: ec.cosepac-cosewic.ec@canada.ca
www.cosewic.ca

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Rocky Mountain Sculpin — Photo by Tyana Rudolfsen.

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COSEWIC
Assessment Summary

Assessment Summary – November 2019

Common name
Rocky Mountain Sculpin - Pacific populations

Scientific name
Cottus sp.

Status
Special Concern

Reason for designation
This small freshwater fish is restricted to a small number of streams within the Flathead River basin in southeastern British Columbia. It is sedentary as an adult and is susceptible to habitat degradation and sediment inputs from forest fires, road building and use, off-road activities, and droughts and warming temperatures due to climate change. It may qualify for Threatened if factors suspected of negatively impacting the species' persistence are not effectively managed.

Occurrence
Biritsh Columbia

Status history
Designated Special Concern in April 2010. Population name changed to Pacific populations in November 2019; status re–examined and confirmed as Special Concern.

Assessment Summary – November 2019

Common name
Rocky Mountain Sculpin – Saskatchewan - Nelson River populations

Scientific name
Cottus sp.

Status
Threatened

Reason for designation
This small freshwater fish has a very restricted area of occurrence in the St. Mary River in southern Alberta, where it has been impacted by invasive species, habitat loss, and degradation from water diversion. These conditions have been exacerbated in recent years by drought conditions likely exacerbated by climate change and water management activities. While meeting criteria for Endangered, this species was designated Threatened because the primary threats are not likely to lead to extirpation in the short term.

Occurrence
Alberta

Status history
The species was considered a single population unit (Eastslope populations) and designated Threatened in November 2005. When the species was split into separate units in November 2019, the "Saskatchewan - Nelson River populations" unit was designated Threatened.

Assessment Summary – November 2019

Common name
Rocky Mountain Sculpin - Missouri River populations

Scientific name
Cottus sp.

Status
Threatened

Reason for designation
This small freshwater fish has a very restricted area of occurrence in the Milk and North Milk Rivers in southern Alberta, where it has been impacted by invasive species, habitat loss, and degradation from water diversion. These conditions have been exacerbated in recent years by drought conditions likely related to climate change and water management activities. While meeting criteria for Endangered, this species was designated Threatened because the primary threats are not likely to lead to extirpation in the short term.

Occurrence
Alberta

Status history
The species was considered a single population unit (Eastslope populations) and designated Threatened in November 2005. When the species was split into separate units in November 2019, the “Missouri River populations” unit was designated Threatened.

COSEWIC
Executive Summary

Rocky Mountain Sculpin
Cottus sp.

Pacific populations
Saskatchewan - Nelson River populations
Missouri River populations

Wildlife Species Description and Significance

Rocky Mountain Sculpin is a small freshwater sculpin found only in three watersheds in Canada. Historically, its taxonomy has been in dispute, but recent genetic and morphological findings suggest that Rocky Mountain Sculpin is a distinct sculpin species that has yet to be formally described. Rocky Mountain Sculpin represents an important component of the genetic diversity found in the western sculpin complex. Further, the distribution of Rocky Mountain Sculpin is unlike any other freshwater fish. Within the Flathead River system there appear to be multiple independent zones where Slimy Sculpin and Rocky Mountain Sculpin come in contact and hybridize. Such a large number of replicate hybridization zones in this small area is interesting from an evolutionary biology perspective.

Distribution

Rocky Mountain Sculpin are found in three watersheds in Canada; the Flathead River watershed in British Columbia, and the St. Mary and Milk River watersheds in Alberta. Rocky Mountain Sculpin is the only sculpin species in the St. Mary and Milk river watersheds. Previously, Rocky Mountain Sculpin were separated into two designatable units (DUs): the Eastslope DU encompassing the Milk and St. Mary river systems and the Westslope DU referring to the Flathead River system. Recent data shows that the Milk River populations are biogeographically, morphometrically, and genetically discrete from the St. Mary River populations, leading to the division of the Eastslope DU into two DUs. All DUs have now been renamed according to their respective National Freshwater Biogeographic Zones (NFBZ). The Flathead River populations are now named the Pacific DU, the St. Mary populations are the Saskatchewan - Nelson River DU, and the Milk River populations are the Missouri River DU. Rocky Mountain Sculpin's presence in the St. Mary River system above the St. Mary Reservoir and in the Milk River system appears to be limited in part by its preference for cooler water and clean rocky substrates. The Pacific DU shares the Flathead River with the Slimy Sculpin, and this competitive interaction and cold-water habitat may limit Rocky Mountain Sculpin's distribution to the lower reaches of the watershed.

Habitat

Rocky Mountain Sculpin are found in moderately cool streams with riffle habitat, rocky or gravel substrate and a wide range of currents. This species is usually absent from pools with predominantly sand or clay bottoms. The greatest alterations to sculpin habitat in the St. Mary and Milk river systems are related to water diversions, reservoirs and water removal for irrigation. These factors in combination with frequent droughts experienced in southern Alberta affect the availability of sculpin habitat. Little of the area occupied is under public control, and protection measures would depend on legislation and regulation designed for habitat protection. Habitat in the Flathead River is potentially limited by competition with Slimy Sculpin.

Biology

Life history information for Rocky Mountain Sculpin is extremely limited, and much of the information available is based on a small number of studies of *Cottus* populations from other western systems. One study noted that all *Cottus* species in Alberta including Rocky Mountain Sculpin spawn during the late spring. The males excavate a nest under rocks, may mate with several females, and then guard the eggs. The fecundity of Rocky Mountain Sculpin specimens collected from the North Milk and St. Mary rivers generally ranged from 100 to 250 eggs. The eggs are large (about 2.5 mm in diameter), and require about 3 to 4 weeks to hatch at temperatures above 7.0ºC. Young-of-the-year reach 30 to 40 mm in total length by the end of their first summer. Their maximum lifespan is about 7 years, but most individuals live less than 5 years. Sexual maturity in females is reached in 2 to 3 years and in males is reached in 2 years. Aquatic insect larvae appear to be the primary food source, but molluscs, small fish, and eggs are also consumed. Neither juvenile nor adult Rocky Mountain Sculpin appear to undergo extensive migrations, and adults rarely move more than 50 m.

Population Sizes and Trends

Although there are no quantitative data on the abundance of Rocky Mountain Sculpin in the Flathead River system (Pacific DU), the population appears to be relatively stable. This stability is inferred from their distribution: they are still found at the sites where they were first collected over 50 years ago, and more recent sampling has expanded their distribution. In the Saskatchewan - Nelson River DU and Missouri River DU, Rocky Mountain Sculpin appear to be locally abundant where present. More recent sampling has increased the upstream distribution in Lee Creek, a tributary to the St. Mary River in the Saskatchewan - Nelson River DU. No changes have been observed in its distribution in the St. Mary River and it is currently found only above the St. Mary Reservoir. Sampling conducted in the 2000s in the Milk River system (Missouri River DU) expanded its downstream distribution in the Milk River, although it remains absent in the furthest downstream sections. Since then, distribution in the upper Milk River above the confluence with the North Milk River may be contracting.

Threats and Limiting Factors

The Pacific DU may be threatened by increasing water temperature associated with climate change or a combination of water temperature and competitive interactions with Slimy Sculpin. Sedimentation from logging road construction and use is a potential threat to habitat quality. Additionally, the increased risk of forest fires in the area can lead to bank erosion and carbon deposits, affecting water quality and turbidity. The Saskatchewan - Nelson River DU and Missouri River DU are also threatened by the effects of climate change causing more frequent droughts and reducing habitat availability. Water removal, diversions and reservoirs associated with irrigation have likely impacted population size and distribution.

Protection, Status and Ranks

The Pacific DU of Rocky Mountain Sculpin was assessed as “Special Concern” by COSEWIC in April 2010 and reassessed as Special Concern in November 2019. This DU is also listed under Schedule 1 of the *Species at Risk Act* as “Special Concern,” and is on British Columbia’s Red List, with a provincial ranking of S2 (imperilled). The recently amended *Fisheries Act* provides improved protection for all fishes in the Canadian portion of the Flathead River. In addition, a provincial park (Akamina-Kishinena Park) on the southeastern edge of the Flathead Valley provides some protection for the headwaters of one tributary stream, Kishinena Creek. In 2004, the BC government created a 38,000 hectare no coal-staking reserve in the lower Flathead Valley. This reserve protects a large portion of the Pacific DU from coal development. In 2011, the BC government approved the *Flathead Watershed Area Conservation Act*, protecting the Flathead Valley from mining and oil and gas development (CPAWS 2010). Most recently, a management plan was published in 2018 outlining present and required management actions for Rocky Mountain Sculpin.

In 2005, COSEWIC assessed the Alberta Rocky Mountain Sculpin as “Threatened”. These populations were also listed as “Threatened” under the Albert*a Wildlife Act* in June 2004 and under Schedule 1 of the *Species at Risk Act* in August 2006. In view of Rocky Mountain Sculpin’s limited distribution in Alberta, a provincial management plan was developed in the 1990s to aid in protecting existing populations. More recently, the Fish and Wildlife Division of Alberta Sustainable Resource Development commissioned surveys in the Milk River (2000 to 2002) to help determine the status of several non-game fish species including Rocky Mountain Sculpin and to provide recommendations for protection. In 2012, Fisheries and Oceans Canada produced a Recovery Strategy detailing how to counteract declines in abundance and recover populations. In November 2019, COSEWIC designated the Saskatchewan - Nelson River populations as “Threatened” and the Missouri River populations as “Threatened”.

TECHNICAL SUMMARY – Pacific populations

Cottus sp.

Rocky Mountain Sculpin - Pacific populations

Chabot des montagnes Rocheuses, Populations du Pacifique

Range of occurrence in Canada: British Columbia - Flathead River and its tributaries in southeastern 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)	4 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown, but the species is still relatively easy to collect in most previously sampled sites.
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. NA b. NA c. NA
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	542 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	80 km² (Discrete) 180 km² (Continuous)
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No

Number of "locations"∗ (use plausible range to reflect uncertainty if appropriate)	1-10 locations Flathead River Howell Creek Cabin Creek Burnham Creek Commerce Creek Sage Creek Kishinena Creek Couldrey Creek Harvey Creek Middlepass Creek The number of locations varies, with only one if climate change is the most serious plausible threat and ten if localized sedimentation from logging and transportation corridors.
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"∗?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Sub-population structure is unknown. Assuming limited dispersal, possible populations are: Flathead River, Sage Creek, Commerce Creek, Cabin Creek, Burnham Creek, Couldrey Creek, Kishinena Creek, Middlepass Creek, Harvey Creek, and Howell Creek.	Unknown
Total	Unknown

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

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown

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

i. Natural System Modifications.

- Increased frequency and severity of forest fires can alter riparian habitat and facilitate bank erosion, river sedimentation, and carbon/silt deposition. This can lead to overly turbid water conditions and the infilling of rock crevices that Rocky Mountain Sculpin use for refuge and the construction of nests during spawning.
- Human use of the area, particularly road construction, off-road activities, and all-terrain vehicle river crossings can embed cobble and increase turbidity of the river system.

ii. Climate Change and Severe Weather

- Changes in temperatures could impact the timing of spawning. This could possibly lead to spawning occurring during high flow runoff period and potentially reduce spawning survival.
- Droughts resulting from lower snowpack, reduced precipitation and warmer temperatures are leading to lower water levels and flow rates. This could reduce available habitat.
- Prolonged heat waves and warmer temperatures could cause overly warm water temperatures.
- At present, climate change is imposing conflicting effects on Rocky Mountain Sculpin. Warming temperatures are potentially facilitating an apparent northward range expansion, but this positive effect may be tempered by a 30% reduction in water flow since 1925 and an increase in the frequency of forest fires.

The overall Threats Impact was assessed as Medium-Low.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Secure: the North Fork of the Flathead River in Montana forms the western boundary of Glacier National Park in the US
Is immigration known or possible?	Not likely
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	Unknown
Are conditions for the source (i.e., outside) population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

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

Data Sensitive Species

Is this a data sensitive species?	No

Status History

Designated Special Concern in April 2010. Population name changed to Pacific populations in November 2019; status re-examined and confirmed as Special Concern.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons for designation: This small freshwater fish is restricted to a small number of streams within the Flathead River basin in southeastern British Columbia. It is sedentary as an adult and is susceptible to habitat degradation and sediment inputs from forest fires, road building and use, off-road activities, and droughts and warming temperatures due to climate change. It may qualify for Threatened if factors suspected of negatively impacting the species' persistence are not effectively managed.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No information is available on the number of mature individuals.
Criterion B (Small Distribution Range and Decline or Fluctuation): Comes close to meeting Threatened with a small EOO and IAO (542 km² and 80-180 km², respectively) and 10 locations, but there is no clear evidence of a continuing decline in the range, quality of habitat or in the number of mature individuals, or increasing threats.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Not applicable. No information is available on the number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable. No information is available on the number of mature individuals.
Criterion E (Quantitative Analysis): Not applicable. Quantitative analyses have not been done.

TECHNICAL SUMMARY – Saskatchewan - Nelson River populations

Cottus sp.

Rocky Mountain Sculpin, Saskatchewan - Nelson River populations

Chabot des montagnes Rocheuses, Populations de la rivière Saskatchewan et du fleuve Nelson

Range of occurrence in Canada: Alberta - St. Mary River and its tributary, Lee Creek in Alberta

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2011) is being used)	4 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred
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. No b. No c. No
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	424 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	108 km² (Discrete) 172 km² (Continuous)
Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No

Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	1-2 locations St. Mary River Lee Creek The number of locations varies, with only one if climate change is the most serious plausible threat and two if impacts associated with water diversion/withdrawal.
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No. Observed increase, but likely due to increased sampling effort.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No. Observed increase but likely due to increased sampling effort.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] habitat?	Yes, observed and projected
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	Unknown
Are there extreme fluctuations in index of area of occupancy?	Unknown

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Lee Creek	Unknown
St. Mary River	Unknown
Total	Unknown

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown. Young and Koops (2013) estimated the Saskatchewan - Nelson River populations could be in decline with the possibility of going extinct in 70 years without recovery efforts.

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

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

Was a threats calculator completed for this species? Yes

i. Natural System Modifications
   - Loss of water flow (available habitat) due to impoundments, diversions and water removal.

ii. Invasive and Other Problematic Species and Genes
   - Introduction of predatory species including Walleye, Northern Pike, Yellow Perch and various trout species.

iii. Climate Change and Severe Weather
   - Changes in seasons could impact the timing of spawning. This could possibly lead to spawning occurring during high flow runoff period and potentially reduce spawning survival.
   - Droughts resulting from lower snowpack, reduced precipitation and warmer temperatures is leading to lower water levels and flow rates. This, along with increased water demand could lead to reduced available habitat.
   - Prolonged heat waves and warmer temperatures could lead to overly warm water temperatures.

The overall Threats Impact was assessed as Medium-Low.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Secure
Is immigration known or possible?	Possible from upper St. Mary River in the US
Would immigrants be adapted to survive in Canada?	Probably
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?+	Unknown, but possible
Are conditions for the source (i.e., outside) population deteriorating?+	Unknown
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely?	Yes

Data Sensitive Species

Is this a data sensitive species?	No

Status History

The species was considered a single population unit (Eastslope populations) and designated Threatened in November 2005. When the species was split into separate units in November 2019, the “Saskatchewan - Nelson River populations” unit was designated Threatened.

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

Status and Reasons for Designation:

Status: Threatened	**Alpha-numeric codes:** Meets criteria for Endangered, B1ab(iii)+2ab(iii), but designated Threatened, B1ab(iii)+2ab(iii), because the species is not at risk of imminent extirpation.
Reasons for designation: This small freshwater fish has a very restricted area of occurrence in the St. Mary River in southern Alberta, where it has been impacted by invasive species, habitat loss, and degradation from water diversion. These conditions have been exacerbated in recent years by drought conditions likely exacerbated by climate change and water management activities. While meeting criteria for Endangered, this species was designated Threatened because the primary threats are not likely to lead to extirpation in the short term.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No information is available on the number of mature individuals.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered, B1ab(iii)+2ab(iii), with very low EOO (424 km²) and IAO (108-172 km²), few locations (2), and there is an observed and projected decline in quality of habitat.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No information is available on the number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable. No information is available on the number of mature individuals.
Criterion E (Quantitative Analysis): Not applicable. Quantitative analyses have not been done.

TECHNICAL SUMMARY – Missouri River populations

Cottus sp.

Rocky Mountain Sculpin, Missouri River populations

Chabot des montagnes Rocheuses, Populations de la rivière Missouri

Range of occurrence in Canada: Alberta - Milk River in southern Alberta.

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2011) is being used)	4 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred
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. No b. No c. No
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	1159 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	84 km² (Discrete) 404 km² (Continuous)
Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No

Number of “locations”∗ (use plausible range to reflect uncertainty if appropriate)	1-2 locations Milk River North Milk River The number of locations varies, with only one if climate change is the most serious plausible threat and two if impacts associated with water diversion/withdrawal.
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?	Yes, range contraction in the downstream portion of the Milk River.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] habitat?	Yes, observed and projected
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of “locations”∗?	No
Are there extreme fluctuations in extent of occurrence?	Unknown
Are there extreme fluctuations in index of area of occupancy?	Unknown

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Milk River	Unknown
Total	Unknown

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown. Young and Koops (2013) estimated the Missouri River populations may be in decline. It is not known if recent protection and management practices have offset this estimate.

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

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

Was a threats calculator completed for this species? Yes i. Natural System Modifications • Loss of water flow (available habitat) due to impoundments, diversions and water removal. ii. Invasive and Other Problematic Species and Genes • Introduction of predatory species including Walleye, Northern Pike, Yellow Perch and various trout species. iii. Climate Change and Severe Weather • Changes in seasons could impact the timing of spawning. This could possibly lead to spawning occurring during high flow runoff period and potentially reduce spawning survival. • Droughts resulting from lower snowpack, reduced precipitation and warmer temperatures is leading to lower water levels and flow rates. This, along with increased water demand, could lead to reduced available habitat. • Prolonged heat waves and warmer temperatures could lead to overly warm water temperatures. The overall Threats Impact was assessed as Medium-Low.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Secure
Is immigration known or possible?	Possible from upper Milk River in the US
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?+	Yes
Are conditions for the source (i.e., outside) population deteriorating?+	Unknown
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely?	Yes

Data Sensitive Species

Is this a data sensitive species?	No

Status History

The species was considered a single population unit (Eastslope populations) and designated Threatened in November 2005. When the species was split into separate units in November 2019, the "Missouri River populations" unit was designated Threatened.

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

Status and Reasons for Designation:

Status: Threatened	**Alpha-numeric codes:** Meets criteria for Endangered, B1ab(iii)+2ab(iii), but designated Threatened, B1ab(iii)+2ab(iii), because the species is not at risk of imminent extirpation.
Reasons for designation: This small freshwater fish has a very restricted area of occurrence in the Milk and North Milk Rivers in southern Alberta, where it has been impacted by invasive species, habitat loss, and degradation from water diversion. These conditions have been exacerbated in recent years by drought conditions likely related to climate change and water management activities. While meeting criteria for Endangered, this species was designated Threatened because the primary threats are not likely to lead to extirpation in the short term.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No information is available on the number of mature individuals.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered, B1ab(iii)+2ab(iii), with very low EOO (1159 km^2) and IAO (84-404 km^2), few locations (2), and there is an observed decline in quality of habitat.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No information is available on the number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable. No information is available on the number of mature individuals.
Criterion E (Quantitative Analysis): Not applicable. No data available. Not applicable. Quantitative analyses have not been done.

PREFACE

In previous assessment reports, Rocky Mountain Sculpin (*Cottus* sp.) had two designatable units (DUs): the Eastslope DU, which referred to the populations in the St. Mary and Milk river watersheds, and the Westslope DU, which referred to the Flathead River watershed. The most recent COSEWIC status assessment of Rocky Mountain Sculpin was in 2010. Since then, new research regarding its physiology, ecology, genetics and behaviour has improved our understanding of Rocky Mountain Sculpin. Genetic and morphological studies support the existence of three DUs that should be assessed separately. This report refers to the new DUs according to National Freshwater Biogeographic Zone (NFBZ): the Westslope DU is now the Pacific DU (Flathead River drainage) and the Eastslope DU is now split into the Saskatchewan - Nelson River DU (St. Mary River drainage) and the Missouri River DU (Milk River drainage). Multiple hybrid zones between Rocky Mountain Sculpin and Slimy Sculpin (*Cottus cognatus*) as well as an apparent range expansion have been reported in the Pacific DU. Conversely, a reduction in area of occupancy is noted in the Missouri River DU. Laboratory-based swim tests have emphasized the limited metabolic capacity to withstand rapid changes in flow. Mark-recapture studies found that Rocky Mountain Sculpin move very small distances (typically < 50 m per year) as adults during the open water season, leaving them vulnerable to local disturbances.

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
(2019)

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

Rocky Mountain Sculpin
Cottus sp.

Pacific populations
Saskatchewan - Nelson River populations
Missouri River populations

in Canada

2019

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Actinopterygii

Order: Scorpaeniformes

Family: Cottidae

Genus: *Cottus*

Species: Scientific name not assigned

Scientific name: *Cottus* sp.

Common names:
English (for the species): Rocky Mountain Sculpin (Nelson, J.S.)
French (for the species): Chabot des montagnes Rocheuses

Morphological Description

Rocky Mountain Sculpin has a distinct morphology that reflects the bottom-dwelling nature of the cottid family. Rocky Mountain Sculpin lacks an air bladder and has a large-head with a body that tapers toward the tail (Figure 1; Peden 2000, 2001). Both their dorsal and pelvic fins have protective spines (Scott and Crossman 1973). The maximum total length (TL) recorded for Rocky Mountain Sculpin in Alberta is 114 mm from the Milk River (R.L. & L. 2002). Standard length (SL) is 3.1 to 4.4 times their head length (HL), 4.2 to 6.0 times their mouth width, and 12.7 to 15.0 times their caudal peduncle depth. There are two median chin pores and usually a single postmaxillary pore. The first and second dorsal fins typically are weakly conjoined, with 8 or 9 spines in the first dorsal fin and 17 to 19 rays in the second dorsal fin. There are 12 to 14 (usually 13 or 14) anal fin rays and 13 to 15 (usually 14) pectoral fin rays. Pelvic fins have 1 spine and 4 rays. The lateral line is incomplete and has 20 to 25 pores. The pectoral axial is usually without prickles but occasionally there are 1, or rarely 2, axial prickles. Palatine teeth are present but are not connected to the vomerine tooth patch. The occipital region usually is covered with small, fleshy papillae (COSEWIC 2010).

Rocky Mountain Sculpin are morphologically similar to Mottled Sculpin (*C. bairdii*) and the Shorthead Sculpin (*C. confusus*), and are difficult to differentiate from one another visually. Moreover, there is significant morphological variation within the species throughout its range, making the classification of the species even more problematic. For example, Rudolfsen *et al.* (2018) found that Rocky Mountain Sculpin varied significantly in body shape, pore counts, and number of fin rays across the North Milk, St. Mary, and Flathead rivers in Canada. However, Rocky Mountain Sculpin can usually be identified using the following features: (1) no prickles covering the entire body (i.e., only found behind the pectoral fin); (2) well-developed pelvic fin rays; (3) vomerine and palatine teeth; (4) 11 to 15 anal fin rays and 13 to 16 pectoral fin rays; and (5) an upper preopercular spine not strongly hooked (summarized in Peden 2001).

Figure 1. Lateral and ventral view of Rocky Mountain Sculpin (*Cottus* sp.). Specimen is from the lower Flathead River (near the British Columbia/Montana Border). Photo credit: Tyana Rudolfsen.

Historically, Rocky Mountain Sculpin were thought to be one of two forms of Mottled Sculpin in western Canada: 1) the Columbia Mottled Sculpin, now recognized as the Columbia Sculpin (*C. hubbsi*), which is endemic to the Columbia Basin (Bailey and Dimick 1949; Nelson *et al.* 2004), and 2) the Rocky Mountain form, previously named *C. bairdii punctulatus,* but now known as Rocky Mountain Sculpin (*Cottus* sp.) (Troffe 1999; Peden 2000). Rocky Mountain Sculpin is distinguished from the Columbia Sculpin based on several morphological features. The Columbia Sculpin has a complete lateral line with an average of 29 ± 3 pores, and prickles are present behind the pectoral fin (Troffe 1999; Peden 2000). In contrast, the lateral line of specimens from the Flathead and St. Mary rivers is not complete, with an average of 22 ± 3 pores, and no prickles behind the pectoral fin (Troffe 1999; Peden 2000).

Rocky Mountain Sculpin is usually geographically separated from the Slimy Sculpin (*Cottus cognatus*) in the Flathead River; however, their distributions overlap in some areas. Morphologically, Rocky Mountain Sculpin is distinguished from the Slimy Sculpin by the presence of palatine teeth (absent in *C. cognatus*) and the absence of axillary scales (present in *C. cognatus*), but examining palatine teeth in the field is difficult. In these instances, a combination of other features can generally distinguish Rocky Mountain Sculpin from Slimy Sculpin, as Rocky Mountain Sculpin have one median occipital pore (*C. cognatus* has two) and a lower head length-width ratio (Hughes and Peden 1984).

Colouration is variable, but the back usually is dark (brown or olive) with slightly darker, indistinct saddles under the soft dorsal fin, and the lower flanks usually are pale. In breeding males, the first dorsal fin is black with a yellow or orange edge and the body often is black. In non-breeding adults, the first dorsal fin has two dark spots (one anterior and one posterior) that usually are partially coalesced.

Population Spatial Structure and Variability

<u>Nuclear DNA</u>

In 1981, a study was directed at distinguishing Rocky Mountain Sculpin (in the study referred to as the Shorthead Sculpin, *C. confusus*) from Slimy Sculpin (Zimmerman and Wooten 1981). With the exception of one site below the confluence of the North and Middle forks of the Flathead River just downstream of the Hungry Horse Dam, there were five loci with fixed differences between Rocky Mountain Sculpin and the Slimy Sculpin. The authors interpreted the one site where the normally fixed alleles were polymorphic as a narrow hybridization zone, and suggested that the hybridization was a result of the disturbance of the natural hydrographic and temperature regimes below the dam. However, Taylor and Gow (2008) and Rudolfsen *et al.* (2019) reported hybrids in Canadian portions of the Flathead River which suggests that hybrid zones may also form naturally.

COSEWIC (2001) summarizes data attributed to Ruth Withler (Fisheries and Oceans Canada) and Alex Peden (Royal British Columbia Museum) focusing on the genetic relationships among sculpin in western Canada that were formerly known either as *Cottus bairdii* or as a subspecies of *Cottus bairdii* (i.e., the Saskatchewan - Nelson River, Missouri

River, and Pacific DUs of Rocky Mountain Sculpin, and two putative subspecies of *Cottus bairdii*). At the time, Rocky Mountain Sculpin were thought to be *C. b. punctulatus*, and the sculpin in the Columbia, Kettle and Similkameen rivers were thought to be *C. b. hubbsi*. The analysis in the COSEWIC (2001) status report supports the view that the Pacific DU, Saskatchewan - Nelson River DU, and Missouri River DU represent the same species: Nei's genetic distances between the Pacific DU and the Saskatchewan - Nelson River DU and Missouri River DU ranged from 0.03 to 0.05. The same analysis found evidence of hybridization between Rocky Mountain Sculpin and the Slimy Sculpin at the upstream end of the contact zone between the two species in the Flathead River system.

In 2017, population genetics were compared across three rivers (St. Mary River, North Milk River, and Flathead River) and Lee Creek (a tributary of St. Mary River) in Canada (Ruppert *et al.* 2017). Using nine microsatellite loci from 1,015 genetic samples across Rocky Mountain Sculpin's range, four discrete groups were found, each associated with a unique river/creek. The average observed heterozygosity (H_o) for the Flathead River (H_o=0.26), St. Mary River (H_o=0.59), Lee Creek (H_o=0.55), and Milk River (H_o=0.54) and Bayesian clustering analysis suggested four distinct groups with limited gene flow between them. The genetic differences are likely due to the species' sedentary behaviour, biogeographic distance, and geographic barriers. The connection of St. Mary River and Milk River through the diversion canal did not lead to any indication of genetic mixing between the groups. Population genetics were most similar between the St. Mary River and Lee Creek subpopulations, especially at their confluence, suggesting some gene flow due to river connectivity and close proximity of subpopulations.

Mitochondrial DNA

Genetic distances based on 1,140 base pair sequences of the cytochrome *b* gene were calculated for Rocky Mountain Sculpin from the Saskatchewan - Nelson River DU (St. Mary River), an upper Missouri tributary (Ruby Creek), and the Pacific DU (Flathead River system) and compared to those of several other species (McPhail unpublished data, COSEWIC 2010). The sequence differences between Rocky Mountain Sculpin populations on the east and west sides of the Continental Divide were small and typical of populations that have diverged postglacially (e.g., genetic distances of less than 0.5%). In contrast, the genetic distances between Slimy Sculpin and Rocky Mountain Sculpin were large (>3%) and typical of species that diverged 2 to 3 million years ago. Taylor and Gow (2008) examined mitochondrial and nuclear DNA sequences from a further 11 Rocky Mountain Sculpin sampled from the Pacific DU, Saskatchewan - Nelson River DU, and Missouri River DU. They reported virtually identical results; 0 to 0.21% mtDNA divergence between Rocky Mountain Sculpin DUs, 3.5 to 3.7% between Rocky Mountain and Slimy Sculpin, and up to 7% compared to sculpin outside the *bairdii* group. Genetic distances among recognized *Cottus* species that are based on mitochondrial sequences typically range from 2.5 to 6.0% (Yokoyama and Goto 2005; Yokoyama *et al.* 2008). Further, Rocky Mountain Sculpin shared identical s7 intron (nuclear DNA) sequences that were distinguished from the Slimy Sculpin by 17 base substitutions and a 150 base pair deletion in the latter species (Taylor and Gow 2008).

Young *et al.* (2013) confirmed that all DUs had small enough mitochondrial differences using both cytochrome *c* oxidase subunit 1 (COI) and cytochrome *b* mtDNA analyses. Further, they concluded that Rocky Mountain Sculpin are monophyletic and most closely related to other species that are commonly mistaken for *C. bairdii.* Most notably, Rocky Mountain Sculpin exhibited only a 0.48 to 0.65% genetic distance from C. *hubbsi.* This is a relatively small distance considering the intraspecific genetic distance was 0.32%.

Summary of genetic studies

The genetic evidence argues that Rocky Mountain Sculpin in southwestern Alberta and southeastern BC are not only the same species but also that the depth of their divergence is consistent with a postglacial separation. Both the nuclear and mitochondrial evidence support a relatively recent connection between the Flathead and upper Missouri rivers, possibly from postglacial drainage connections across the Continental Divide.

Designatable Units

COSEWIC guidelines provide three criteria that may be considered to establish whether an entity is a designatable unit (DU): 1) subspecies or varieties, 2) discreteness, and 3) evolutionary significance. New findings suggest that Rocky Mountain Sculpin meets the discreteness and evolutionary significance criteria and therefore qualifies for three DUs. One of these DUs is in British Columbia, and the other two are in Alberta.

Rocky Mountain Sculpin in Canada fulfill the “discreteness” criterion in the following ways: 1) the populations are sufficiently genetically and morphologically distinct from populations in Alberta (Ruppert *et al.* 2017, Rudolfsen *et al.* 2018), and 2) they occupy three distinct ecoregions whereby connectivity is unlikely to occur or prevent local adaptations. Based on the COSEWIC National Freshwater Biogeographic Zone (NFBZ) classification, Rocky Mountain Sculpin are found in three separate NFBZs: the Pacific, Saskatchewan - Nelson River, and Missouri River NFBZ. While the St. Mary canal was originally thought to connect the Saskatchewan - Nelson NFBZ to the Missouri NFBZ populations and facilitate genetic mixing between populations, Ruppert *et al.* (2017) reported significant genetic differences at the NFBZ level between the populations.

Rocky Mountain Sculpin fulfill the “evolutionary significance” criterion in the following ways: 1) There are relatively deep, intraspecific phylogenetic divergences between the groups (see **Population Spatial Structure and Variability** section), and 2) the groups persist in unique ecosystems that are likely to have promoted local adaptations. For example, Veillard *et al.* (2017) conducted swim tests on Rocky Mountain Sculpin from the Flathead River, St. Mary River, Lee Creek, and North Milk River. They found that Rocky Mountain Sculpin from the Flathead River (highest natural flows) were able to maintain position in significantly higher simulated flows than sculpin from the other two DUs. Rudolfsen *et al.* (2018) observed significant differences in functional morphological and meristic features related to differential hydrological characteristics of these systems.

Given the justification for three DUs divided by NFBZ, the DUs are named accordingly. The former Westslope (BC) population of Rocky Mountain Sculpin is now named the Pacific DU. What was formerly recognized as the Eastslope DU is now divided into the Saskatchewan - Nelson River DU (St. Mary River and Lee Creek) and the Missouri River DU (Milk River).

Special Significance

Rocky Mountain Sculpin has a very limited distribution in Canada, present in only three river systems (St. Mary and Milk rivers in Alberta, and the Flathead River in British Columbia). East of the Continental Divide in the US, this species occurs in most headwaters of the Missouri River system but its range does not extend far onto the Great Plains (Figure 2). West of the Continental Divide it is confined to the North and Middle forks of the Flathead River system in BC and Montana, as well as the Blackfoot and lower Clark Fork rivers in Montana. Thus, its distribution is not only limited but is also unique—no other of the estimated 2,365 freshwater fish species in Canada and the continental US (Nelson *et al.* 2004) has a similar geographic distribution.

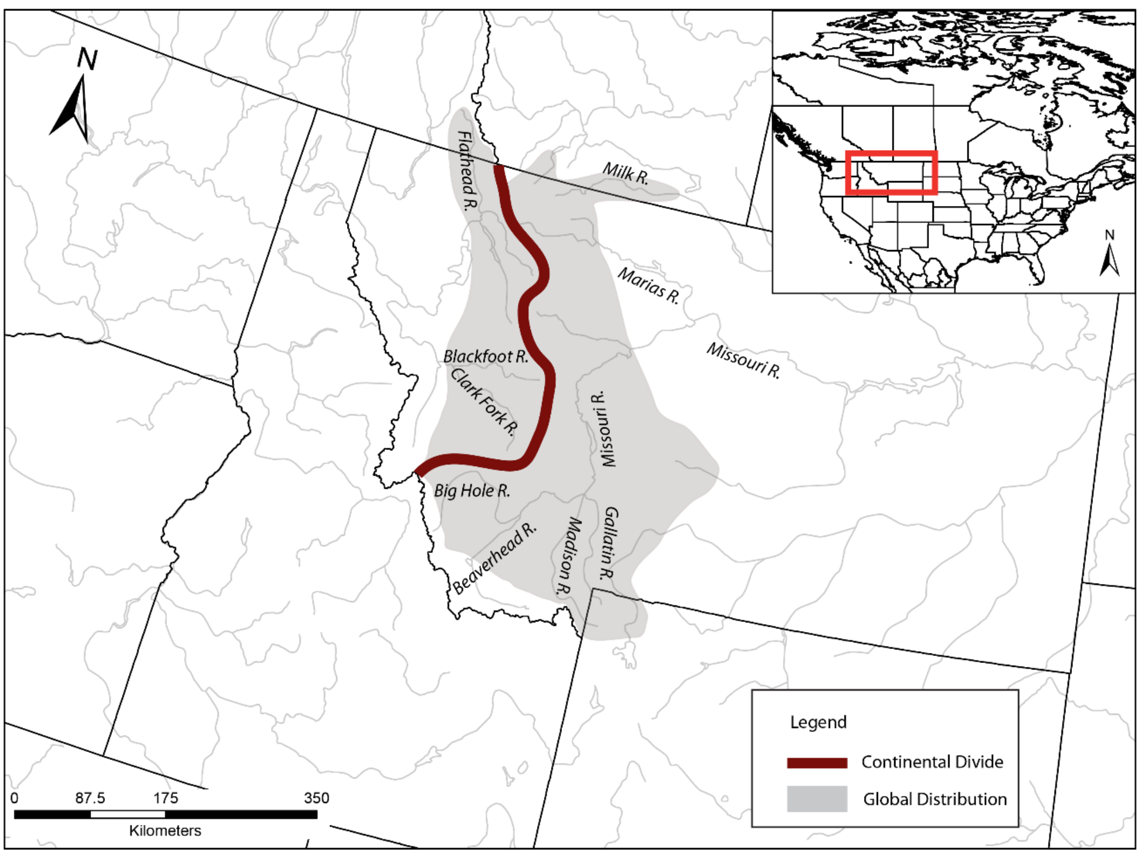

Figure 2. Global distribution of Rocky Mountain Sculpin. Modified from Young *et al.* (2013).

With the exception of the Flathead watershed, Rocky Mountain Sculpin are the only sculpin species in their respective watersheds. Additionally, Rocky Mountain Sculpin are one of few fish species in the Flathead watershed, making it a valuable prey source. Recreationally targeted fish such as Bull Trout (*Salvelinus confluentus*) are dependent on Rocky Mountain Sculpin as a prey source (McPhail 2007).

The species is also of scientific interest. Its unique distribution provides an opportunity to document divergence rates among sculpin populations in various environments and on different sides of the Continental Divide. Additionally the Pacific DU's distribution of sculpin (Slimy Sculpin in the upper reaches and Rocky Mountain Sculpin in the lower reaches) provide a replicate series of undisturbed contact zones. Such contact zones are of great significance in attempts to understand the ecology and evolution of species coexistence (e.g., Jiggins and Mallet 2000).

The life history and behaviour of Rocky Mountain Sculpin suggest a relatively sedentary species with limited dispersal (Ruppert *et al.* 2017). This feature along with their preference for cooler waters and clean rocky substrates would mean that their presence is indicative of a healthy stream ecosystem.

As a genetically distinct species with a limited Canadian distribution, Rocky Mountain Sculpin is an important component of our national biological heritage. The Pacific DU's distribution is unlike that of any other BC fish, as it is restricted to the last relatively pristine large watershed in southeastern BC. This makes it a special component of the BC freshwater fish fauna. The genetically distinct Rocky Mountain Sculpin represents an evolutionarily important component of species diversity for fish fauna in Canada and should therefore receive a high level of protection.

DISTRIBUTION

Global Range

Rocky Mountain Sculpin is endemic to both the east and west slopes of the Rocky Mountains and is common in a variety of biogeographic regions from montane to lowland plains. It is found primarily in the United States, but a small portion of its range extends into Alberta and British Columbia (Figure 2). The majority of the species' range occupies thirteen watersheds in Montana (Young *et al.* 2013). These watersheds are the upper Missouri, lower Clark Fork, Teton, Swan, Ruby, Smith, north fork Flathead, Madison, Gallatin, Blackfoot, Big Hole, Belt, and Beaverhead river watersheds. The northern part of the Flathead River basin (headwaters) originates in southeastern BC and constitutes the Pacific DU. The Saskatchewan-Nelson River basin encompasses the majority of central Alberta, but only a small portion of this watershed extends into the United States. The Missouri River basin slightly extends into southern Alberta and is the Missouri River DU.

Canadian Range

Although Rocky Mountain Sculpin occurs on both sides of the Continental Divide, its Canadian range is not large. The Pacific DU occupies the Flathead River and some of its tributaries: Kishinena, Sage, Couldrey, Burnham, Howell, Cabin, Middlepass, Harvey, and Commerce creeks. Of the Flathead tributaries known to contain Rocky Mountain Sculpin, two are tributaries to larger creeks: Couldrey Creek is a tributary of Burnham Creek, and Cabin Creek is a tributary of Howell Creek.

In the Flathead River, Rocky Mountain Sculpin are the only sculpin found in the first 20 km of the mainstem upstream of the US border. From about 20 km to 35 km above the border, Rocky Mountain Sculpin are still the numerically dominant sculpin in the mainstem; however, the frequency of Slimy Sculpin (*C. cognatus*) gradually increases in the upstream direction. At about 35 km upstream there is a relatively abrupt increase in the frequency of Slimy Sculpin. Previously, it was found that by about 28 km above the US border the Slimy Sculpin is the only sculpin species found in the mainstem, but recent surveys show that there is no longer purely a Slimy Sculpin population at this point, and Rocky Mountain Sculpin can be found well into the upper reaches (Figure 3; Rudolfsen *et al.* 2019). Findings show Rocky Mountain Sculpin has expanded its range several kilometres (approximately 20 km) upstream since the last study by Hughes and Peden (1984) (Rudolfsen *et al.* 2019). There are similar findings for Kishinena Creek.

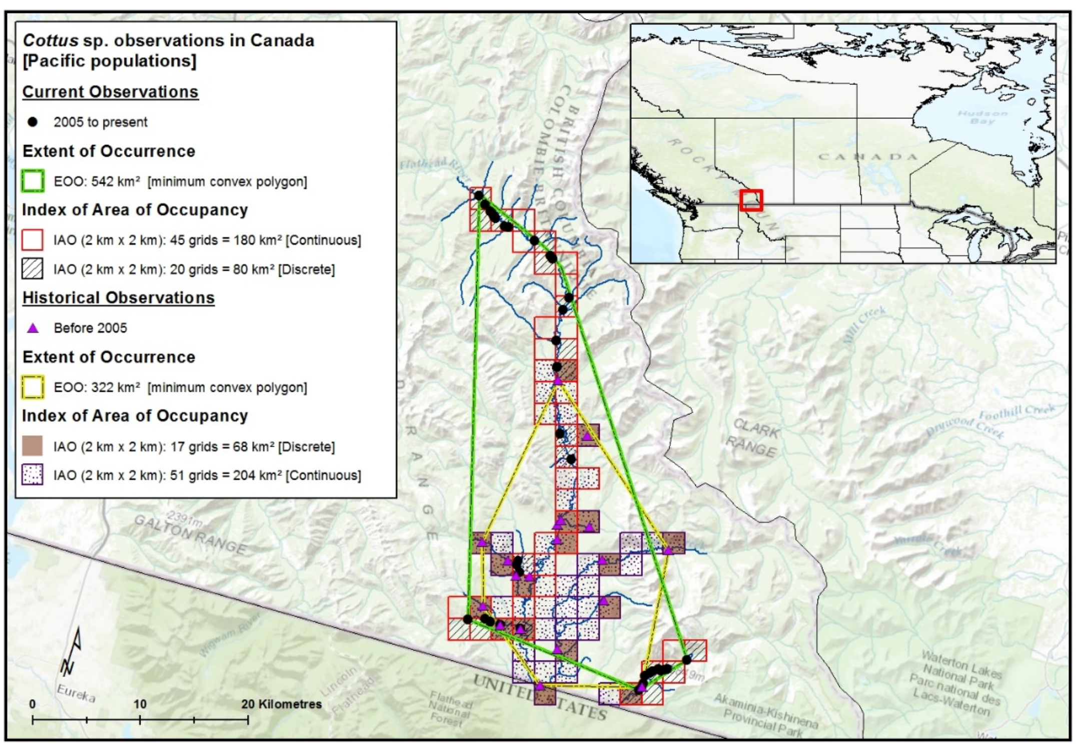

Figure 3. Historical and present extent of occurrence and index of area of occupancy for Rocky Mountain Sculpin (*Cottus* sp.) Pacific DU. Historical data represents collection records prior to 2005 (created by the COSEWIC Secretariat).

The biogeography of the Saskatchewan - Nelson River DU and the Missouri River DU is complex and theories regarding glacial refugia and dispersal routes vary. The present distribution suggests that Rocky Mountain Sculpin survived in two or three refugia (i.e., Missourian, Mississippian and Columbian) (Bailey and Allum 1962; Crossman and McAllister 1986). Willock (1969) proposed that the isolated occurrence of Rocky Mountain Sculpin outside the Missouri system in the St. Mary River reflects a post-glacial arrival, probably occurring fairly recently. An alternative view is that Rocky Mountain Sculpin may have entered the Milk River from the St. Mary River through the diversion canal in Montana (Nelson and Paetz 1992; Paetz 1993; W. Roberts, pers. comm. 2003). This movement may happen annually and could have stimulated the apparent downstream expansion of sculpin observed in the Milk River over a recent 20-year span (Paetz 1993). Recent genetic work by Ruppert *et al.* (2017) has established that there are significant differences between the St. Mary and Milk River populations suggesting this theory is unlikely.

Extent of Occurrence and Area of Occupancy

Pacific DU

The Pacific DU has undergone an apparent range expansion (Figure 3). Its EOO is 542 km^2, which is an increase from the prior estimate (sampling prior to 2005) of 322 km^2. The continuous IAO is 180 km^2, compared to the historical IAO of 204 km^2. This larger historical IAO suggests a range contraction, but this is due to lack of recent sampling effort in Sage Creek, and is therefore misleading.

Saskatchewan - Nelson River DU

Due to a recent discovery of Rocky Mountain Sculpin in the more upstream portion of Lee Creek, the EOO of this DU has increased from 186 km^2 (prior to 2005) to 424 km^2 (2005 to present; Figure 4). Similarly, the IAO has increased from 40 km^2 (discrete) and 100 km^2 (continuous) to 108 km^2 and 172 km^2, respectively.

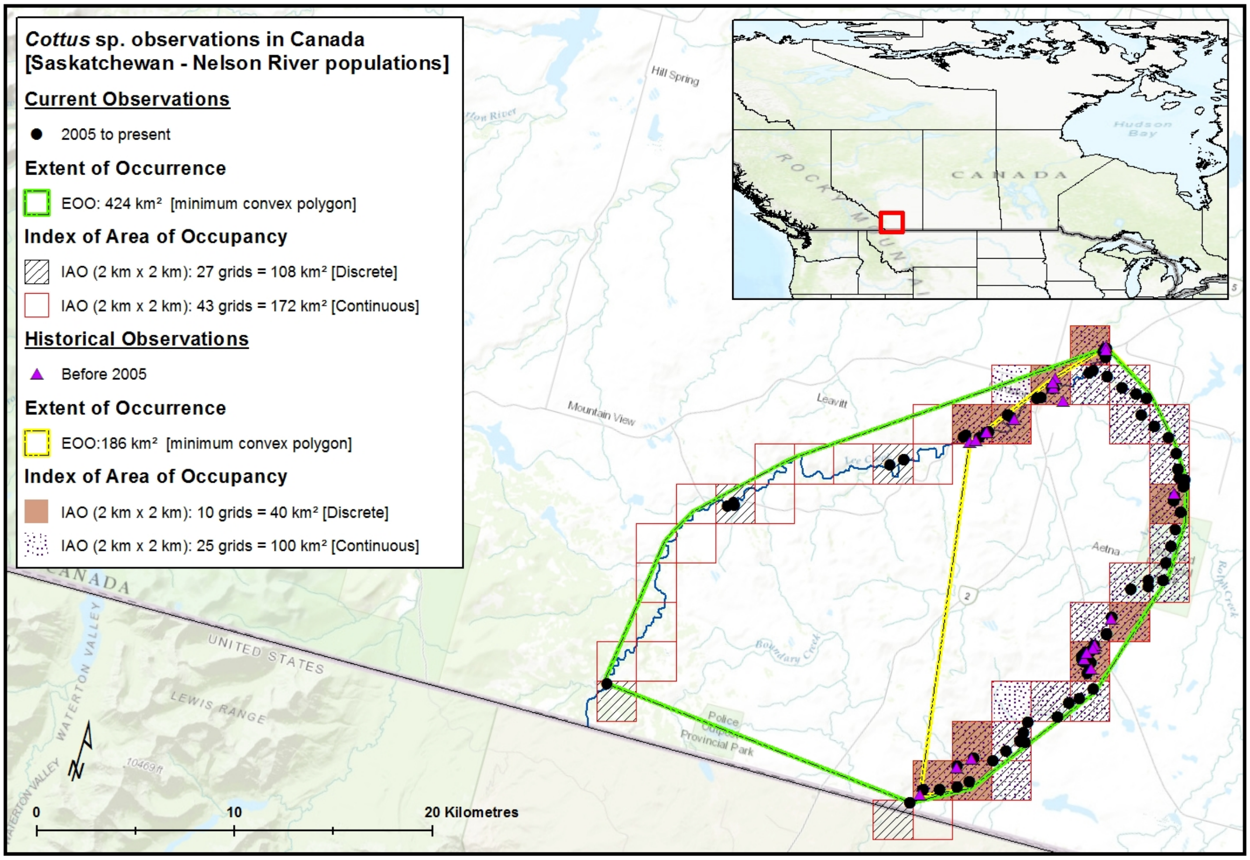

Figure 4. Historical and present extent of occurrence and index of area of occupancy for Rocky Mountain Sculpin (*Cottus* sp.) in the Saskatchewan - Nelson River DU (created by the COSEWIC Secretariat). Historical data represents collection records prior to 2005.

Missouri River DU

The Milk River has a current EOO of 1,159 km2, having decreased by 313 km2, in part due to a lack of recent sampling effort in the upper Milk River (Figure 5; see Search Effort section). The IAO also shows an overall decline, decreasing from 144 km2 (discrete) and 500 km2 (continuous) to 84 km2 and 404 km2, respectively.

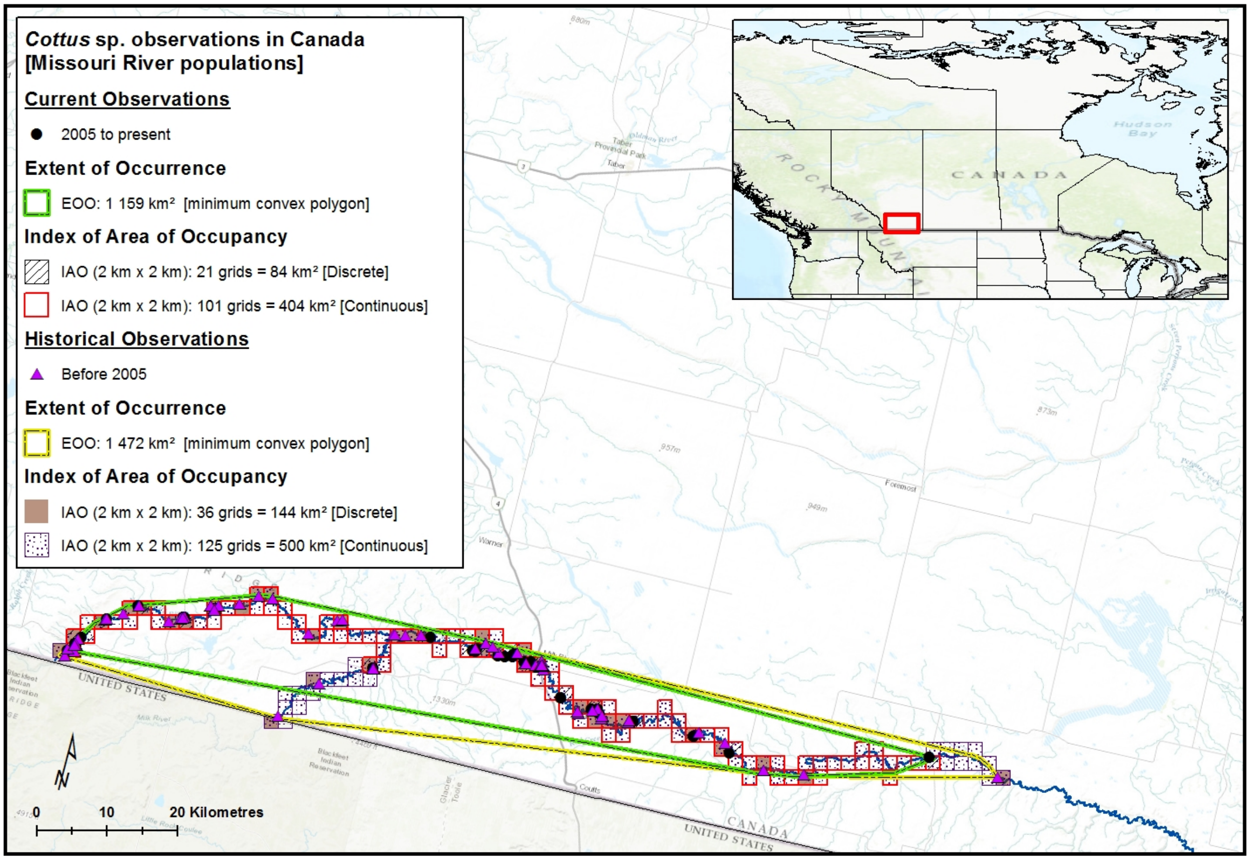

Figure 5. Historical and present extent of occurrence and index of area of occupancy for Rocky Mountain Sculpin (*Cottus* sp.) in the Missouri River DU (created by the COSEWIC Secretariat). Historical data represents collection records prior to 2005.

Search Effort

Comprehensive search effort data for the Pacific DU has only recently been conducted. Over 100 collection sites exist in the Pacific DU. During the summers of 2014 and 2015, Rudolfsen *et al.* (2019) backpack electrofished 95 sites throughout the Flathead drainage and found Rocky Mountain Sculpin in 77. The sites were 300 m long and each site was randomly electroshocked for 300 seconds. The average CPUE within the 77 sites was 0.57 Rocky Mountain Sculpin per minute of electroshocking. The only other semi-quantitative information on sampling effort in the Pacific DU is by Peden and Hughes (1984), where a number of riffles were electrofished in August resulting in an average of 4.8 Rocky Mountain Sculpin per minute of shocking. It is difficult to compare the CPUE of the two studies, as Peden and Hughes (1984) targeted Rocky Mountain Sculpin habitat, whereas Rudolfsen *et al.* (2019) sampled random quadrats.

Extensive fish sampling since the 1960s has produced a fairly well-defined distribution range for the Rocky Mountain Sculpin in the Saskatchewan - Nelson River DU and Missouri River DU. Rocky Mountain Sculpin was first identified as *C. bairdii* in the Milk River in 1966 (University of Alberta Museum of Zoology Ichthyology Collection, “3771”). Its presence in Alberta is limited to the St. Mary River system above the reservoir and to the Milk River except for the furthest downstream portion (i.e., the lowermost 85 km in the Milk River) (Roberts 1988; Nelson and Paetz 1992; Paetz 1993).

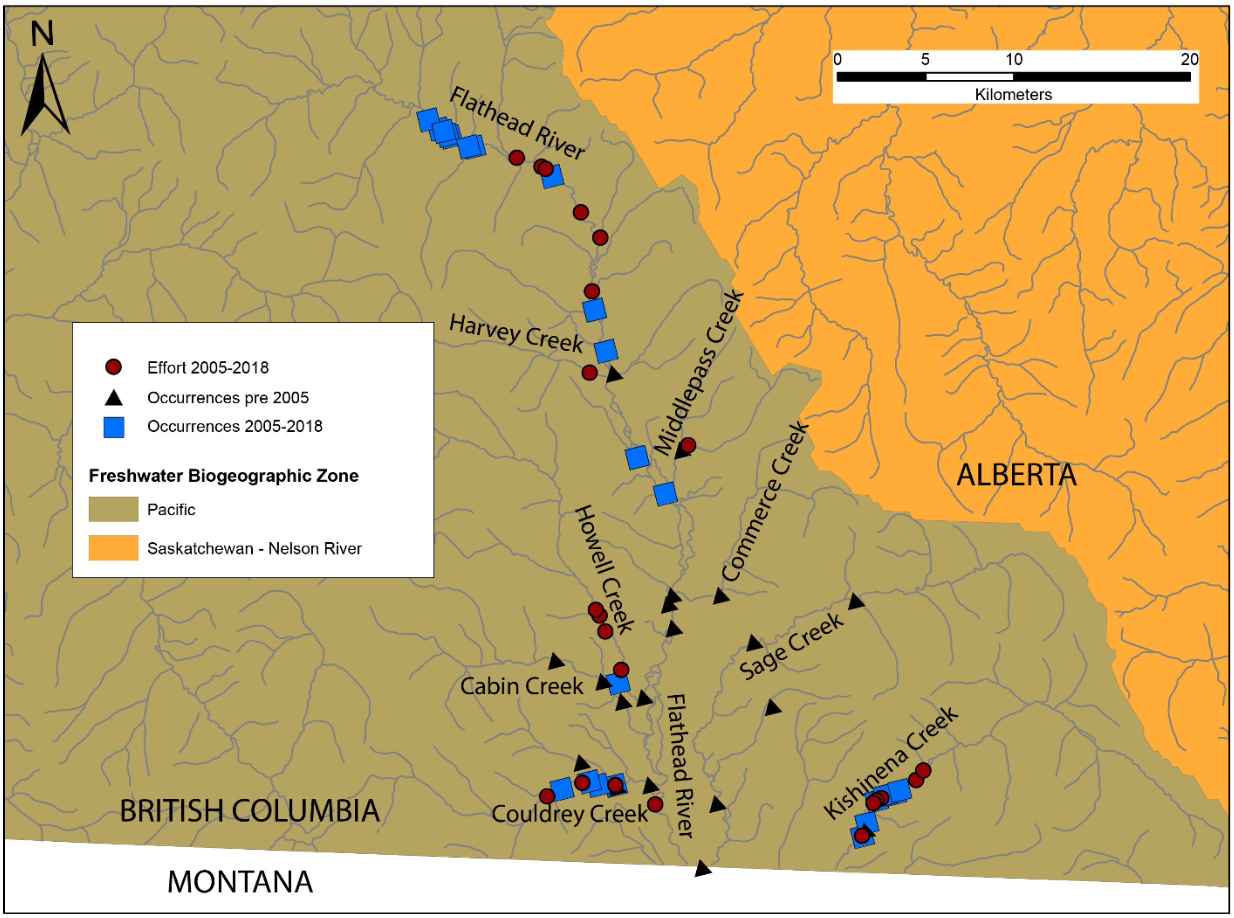

Figure 6. Sampling effort and Rocky Mountain Sculpin occurrences in the Pacific DU before and after 2005 (map created by the COSEWIC Secretariat).

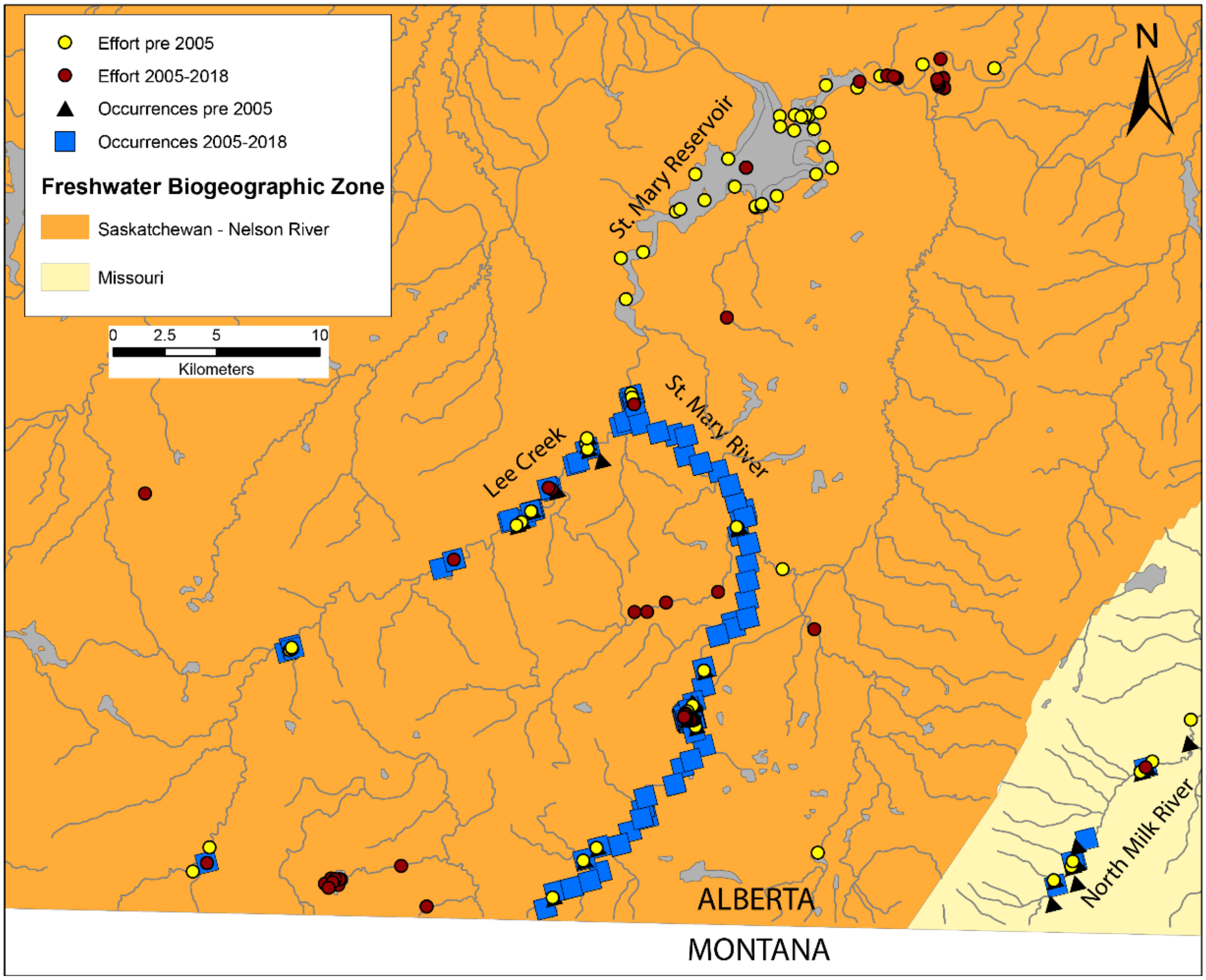

Figure 7. Sampling effort and Rocky Mountain Sculpin occurrences in the Saskatchewan - Nelson River DU before and after 2005 (map created by the COSEWIC Secretariat).

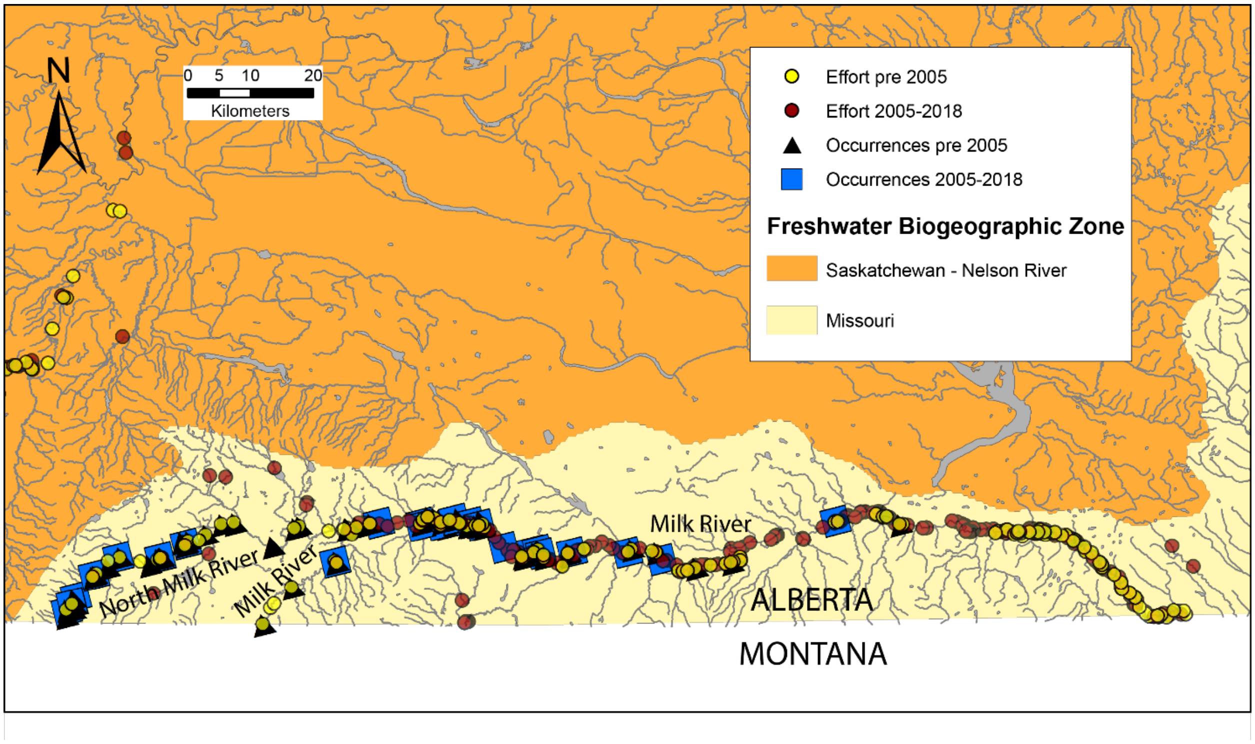

Figure 8. Sampling effort and Rocky Mountain Sculpin occurrences in the Missouri River DU before and after 2005 (created by the COSEWIC Secretariat).

Some changes in distribution appear to have occurred in the Milk River since the 1960s, with significant downstream expansion in the mainstem, and possible extirpation in the upper Milk River. In contrast, no changes in distribution are apparent in the St. Mary River, but the possibility exists that sculpin were present downstream of the reservoir before its construction.

The earliest published study within the Milk River found Rocky Mountain Sculpin only in the upper reaches of the North Milk River and at the international border in the upper Milk River above the confluence with the North Milk River (Willock 1969). A later study also documented the presence of sculpin at three sites in the upper Milk River (Clayton and Ash 1980). In 1986, a survey documented Rocky Mountain Sculpin throughout the North Milk River as far downstream as a site approximately 100 km upstream of the international border and at one upstream site in the upper Milk River (R.L. & L. 1987). Paetz (1993) confirmed the sculpin's presence in the North Milk River and mainstem, but for the first time noted an absence in the upper Milk River. It was believed that sculpin in the Alberta portion of the upper Milk River had been eradicated as a result of the depletion of water flows south of the international border in Montana Paetz (1993).

Recent assessments have found that Rocky Mountain Sculpin is widely distributed throughout most of the North Milk River and Milk River mainstem, except for the lowermost section (0 to 85 km upstream of the international border) where it is absent (R.L. & L. 2002). This is consistent with earlier studies (Clayton and Ash 1980, R.L. & L. 1987; Paetz 1993), suggesting that the distribution in these sections has not changed in recent years, with the exception of the upper Milk River above the confluence with the North Milk River. Studies in 2000 and 2001 found this section of the Milk River dry as a result of severe drought conditions and the operation of the St. Mary Canal (R.L. & L. 2002), reflecting the findings of Paetz (1993). On evaluating the sample sites of more recent surveys on the Milk River, there is an apparent decline in distribution in the downstream section.

Alberta fisheries' catch records in the St. Mary River prior to 1980 did not document any Rocky Mountain Sculpin downstream of the St. Mary Reservoir (summarized in Paetz 1993). Paetz (1993) confirmed the sculpin's presence in the St. Mary River above the reservoir and in the lower 10 km of Lee Creek. He also noted its absence in the St. Mary River downstream of the reservoir and in upper Lee Creek, as well as the Belly, Waterton and Oldman rivers. Similarly, Rocky Mountain Sculpin had not been observed in the reservoir. The St. Mary Reservoir is likely a major obstacle to downstream dispersal in the St. Mary River (Paetz 1993). Paetz (1993) suggested that the absence of sculpin downstream of the reservoir reflected a relatively recent movement of Rocky Mountain Sculpin into Alberta waters. However, it has also been suggested that Rocky Mountain Sculpin likely occurred downstream of the reservoir before its construction and that altered habitat conditions (e.g., silty substrate) have resulted in its extirpation there (W. Roberts, pers. comm. 2003). No historical records are available to support either hypothesis. Studies conducted in 2000 also found Rocky Mountain Sculpin to be common throughout the entire section of the St. Mary River above the St. Mary Reservoir to the international border (Figure 4; R.L. & L. 2002). However, in Lee Creek (a major tributary of the St. Mary River), distribution was limited to the lower sections, with the uppermost extent being 6 km upstream of the settlement of Cardston (R.L. & L. 2002). A survey by Veillard (FWMIS Project ID 21164) found Rocky Mountain Sculpin in Lee Creek upstream of Beazer, AB, closer to the international border.

Search effort in Alberta has been well documented over the last two decades. In 2002, a total of 23 sites were sampled along the St. Mary River, Lee Creek, and Milk River (R.L. & L. 2002). Catch per unit effort (CPUE) was higher in the upper reaches of the watersheds. Similarly, Fisheries and Oceans Canada electroshocked several sites within the Saskatchewan - Nelson River DU and the Missouri River DU between 2005 and 2009 (Watkinson unpublished data). In the Saskatchewan - Nelson River DU, 12 sites out of 452 had Rocky Mountain Sculpin. Of the sites where Rocky Mountain Sculpin were found, there was a catch rate of 1.7 fish per minute of electroshocking. St. Mary River sampling resulted in 5.6 Rocky Mountain Sculpin per minute of electroshocking with 734 occurrences out of 1892. Lee Creek resulted in only 0.89 Rocky Mountain Sculpin per minute of electroshocking, with five occurrences out of eight sites.

HABITAT

Habitat Requirements

Rocky Mountain Sculpin are nocturnal and tend to remain under the cover of rocks during daylight hours (McPhail 2001). They are found in moderately cool streams with riffle habitat, rocky or gravel substrate and weak to fast currents. An older study by Bailey (1952) on the Rocky Mountain Sculpin in southwestern Montana found these fish to be most abundant in riffle habitat where rubble and boulders were predominant. They were usually absent from pools where bottoms were entirely sand or clay (Bailey 1952). Little information is available regarding temperature preferences for Rocky Mountain Sculpin, but they have been found in streams with average summer temperatures of 5°C to 15°C and winter temperatures of 0°C to 2°C in British Columbia (Rudolfsen unpublished data).

Rudolfsen *et al.* (2019) found adult Rocky Mountain Sculpin in generally similar habitat conditions to Slimy Sculpin in the Flathead River system, but Rocky Mountain Sculpin were also found in warmer, slower moving, more turbid waters (Table 1). These findings, while helpful, should only be considered alongside the potential competitive influence that Slimy Sculpin may have on habitat selection in the Flathead River system. Also, these findings may not be entirely accurate for the Saskatchewan - Nelson River DU and Missouri River DU, which are biogeographically different and do not have other sculpin species to compete with.

Table 1. Average habitat parameters where Rocky Mountain Sculpin (*Cottus* sp.) (RMS) were found versus Slimy Sculpin (*Cottus cognatus*) (SS) in the Flathead River from 2014 to 2015 (Rudolfsen *et al.* 2019). Asterisks (*) indicate environmental variables that are significantly different between Rocky Mountain Sculpin and Slimy Sculpin ($p \leq 0.05$).

Variables	Units	RMS		SS	
		Mean	SD	Mean	SD
Elevation	m	1369.9	97.6	1363.9	69.7
Sample Depth	cm	31.3	12.6	31.1	12.7
Velocity*	m/s	0.45	0.31	0.51	0.30
Turbidity*	NTU	0.45	0.28	0.19	0.22
Conductivity*	μS/cm	141.5	33.7	134.4	27.3
Dissolved Oxygen*	mg/L	9.1	0.5	9.0	0.5
Small Gravel*	%	5.0	8.5	8.2	9.5
Large Gravel*	%	13.4	16.0	20.0	16.9
Boulder	%	12.2	17.3	11.1	15.5
Summer Water Temperature*	°C	12.5	2.0	9.2	0.9

Spawning, rearing and feeding habitats are not believed to be limited throughout the St. Mary, Flathead, or the upstream portion of the Milk River where sculpin are found (R.L. & L. 2002). The only study describing spawning habitat was in southwestern Montana (Bailey 1952). Nests consisted of holes under rocks that ranged from 0.12 m to 0.38 m in diameter. Eggs were usually attached to rocks, but other substrates including aquatic vegetation, wood and debris were also utilized (Bailey 1952). Water depth of nests was over 0.3 m, and surface water velocities ranged from 0 m/s to 1.6 m/s. Interestingly, Willock (1969) noted a disproportionately large number of young sculpin in muddy areas with low gradient in the Milk River, suggesting that these areas might be used for rearing. A similar observation was made by Bailey (1952), who noted that some small specimens of Rocky Mountain Sculpin were found in quiet waters near the shore. It was proposed that these small sculpin could stir up clouds of silt for cover.

Since the 1960s, studies on the St. Mary and Milk rivers have described the habitat features preferred by Rocky Mountain Sculpin. Willock (1969) stated that the colder temperatures and increased water clarity in the upper Milk River accounted for the presence of Rocky Mountain Sculpin. These habitat characteristics are associated with higher rainfall, higher elevation and gradient, more vegetation and less erosion because of the presence of more resistant sandstone substrate in the upstream reaches of the Milk River compared to further downstream reaches (Willock 1969). However, habitat availability can become significantly reduced during periods of extreme drought when certain river sections are completely dry or flow is critically low. Conversely, critically high water velocity can also be detrimental to habitat availability for Rocky Mountain Sculpin. Paetz (1993) noted that sculpin in the North Milk River and the St. Mary River were most common among silt-free, rocky substrate near stream margins (where currents were slower), whereas no sculpin were found in the main river current. In Lee Creek, sculpin appeared to prefer the slightly silty stream margins where currents were slower compared to the mid-creek section, which was silt-free but had higher velocity (Paetz 1993). Paetz (1993) also noted that sculpin used areas where instream sedges and bankside shrubs trailed in the slower current in the middle Milk River if rocky substrates and cobbles were absent, particularly near the town of Milk River. Other habitats utilized consisted of debris anchored by an obstruction such as roots in the streambed. Clayton and Ash (1980) noted that Rocky Mountain Sculpin appeared to prefer clean substrates, but lower numbers were also found in quiet pools with silty substrate.

A detailed habitat evaluation for Rocky Mountain Sculpin was conducted in 2000 and 2001 in the St. Mary and Milk river systems (R.L. & L. 2002). Some variability in habitat selection appeared to be drainage-specific and dependent on habitat type, availability, and water level. In general, sculpin were present in predominantly shallow runs and riffles, as well as runs of boulder gardens (larger boulders providing in-stream cover). A statistical analysis of microhabitat characters found that rather than being associated with a particular type or range of character values, Rocky Mountain Sculpin appeared to be more of a generalist (R.L. & L. 2002). Water depths in capture sites tended to be shallow (range 0.05 to 0.42 m, mean of 0.19 m), and velocities were low (range 0 to 0.6 m/s, mean of 0.22 m/s). Silt depths were typically low (range 0 to 0.02 m deep), rock was the predominant cover type (10 to 40%), turbidity was low (range 0 to 5%), and substrate consisted mainly of gravel and cobble (R.L. & L. 2002). Fisheries and Oceans Canada (DFO) conducted sampling in August 2009 with backpack electrofishers in up to 1 m deep water and a mean water column velocity of 1.8 m/s (Fisheries and Oceans Canada 2012, Watkinson unpublished data). Results from this sampling effort showed that gravel was the primary substrate occupied by Rocky Mountain Sculpin of all life stages. The second most common substrate to find Rocky Mountain Sculpin among was cobble for sub-adult and adult fish (>32 to <55 mm TL) and silt for young-of-the-year (YOY). YOY were most abundant in water depths of 0.1 to 0.6 m (mean 0.38 m) and water velocities of 0.2 to 0.4 m/s (mean 0.43 m/s). Juvenile fish were most abundant in water depths of 0.2 to 0.8 m (mean 0.46 m), and water velocities of 0.6 to 1.2 m/s (mean 0.69 m/s). Adult fish were most abundant in water depths of 0.3 to 0.8 m, and water velocities of 0.6 to 1.4 m/s.

Although these habitat descriptions are useful in locating Rocky Mountain Sculpin, a few caveats exist. First, most fluvial sculpin are nocturnal, and Rocky Mountain Sculpin are no exception. They spend most of the daylight hours sheltering in or amongst rocky substrate, and most scientific collections are made during the day. Consequently, typical representations of habitat are only reliable as descriptions of the daytime sheltering habitat, and how this equates to habitat use in general is largely unknown. Only a few casual nocturnal observations are available, but in both the St. Mary (Saskatchewan - Nelson River DU) and Flathead (Pacific DU) rivers, adult Rocky Mountain Sculpin were active at night in quiet water areas less than 20 cm deep (McPhail 2007). The second caveat is that most observations pertain to adults. Generally, sculpin young-of-the-year are partially segregated from adults by depth and proximity to shore (Watkinson unpublished data). This segregation is probably driven by predation (adults on young) rather than differences in habitat preference (Freeman and Stouder 1989). Beyond this, little is known about how juveniles differ from adults. The third caveat is that no winter habitat observations are available for this species, but suitable overwintering sites are likely to be crucial for their survival.

Habitat Trends

The Pacific DU has undergone relatively few habitat alterations. The first collections of Rocky Mountain Sculpin in the Canadian portion of the Flathead River were made in 1955 and 1957 (University of British Columbia Beaty Biodiversity Museum, “UBC 55-0277”, “UBC 57-0327”). These early samples were taken at sites that have been resampled in the 1980s, 1990s, and early 2000s. The sparse biophysical data recorded from the earliest collections corresponds closely to the present biophysical conditions. This suggests that there have been no major changes in the river over the ensuing years. Although the Flathead River is often cited as the last remaining pristine large river in southeastern BC (Angelo 2008), commercial logging, mining, and oil and gas development has occurred in the valley since the late 1890s. In 2011, the Government of British Columbia passed the *Flathead Watershed Area Conservation Act*, which bans any mining or oil and gas related activity within the Flathead basin. While logging operations continue, their impacts on Rocky Mountain Sculpin appear to be minor, as water quality of the Flathead River drainage remains in good condition and Rocky Mountain Sculpin persist in locations near active logging. Despite this, the cumulative effect of logging operations with associated infrastructure (i.e. construction and use of roads and camps) and other environmental factors, however, could potentially alter river habitat.

The Missouri River and Saskatchewan - Nelson River DUs have experienced more habitat alterations associated with human activity than the Pacific DU. The greatest alterations to sculpin habitat in the St. Mary, North Milk and Milk rivers are related to water diversions, reservoirs and water removal for irrigation. These factors, in combination with the frequent droughts experienced in southern Alberta, seriously affect the availability of sculpin habitat. The construction of the St. Mary Reservoir in 1951 significantly altered the type of habitat available to fish species in the St. Mary River. Rocky Mountain Sculpin are not known to be present in the reservoir or downstream of the reservoir. Future expansion into downstream habitats is unlikely as the reservoir formed by the dam is not suitable habitat for Rocky Mountain Sculpin.

The biggest alteration to habitat in the North Milk and Milk rivers occurred after 1917, when the St. Mary Canal was constructed in Montana to divert water from the St. Mary River to the North Milk River for irrigation purposes. In most years, the canal diverts water from April to September, increasing the water volume in the North Milk River and the Milk River proper. Before construction of the canal, the Milk River was probably a typical small prairie stream with low turbidity and intermittent flows (Willock 1969). Although the volume of water may have increased downstream of the canal outflow in the North Milk River, this has become a highly managed flow. The canal may be closed off prematurely during the open water months if canal repairs are required or if there are floods in the Missouri or Mississippi River in the United States (Palliser Environmental Services Ltd. 2019). These closures in combination with the drought conditions increasingly common to this region can result in the severe reduction in habitat availability in the Milk River. In addition, the ongoing removal of water in Montana from the upper Milk River, which is above the confluence with the North Milk River, may be partly responsible for the near disappearance of sculpin in this section of the mainstem (Paetz 1993). The Milk River above the confluence of the North Milk River can be reduced to isolated pools without surface flow (Environment and Climate Change Canada 2018; gauge 11AA025). Survival of sculpin in this reach of the river would be dependent on sufficient ground water. Similarly, the tributaries of the North Milk and Milk rivers in Canada are ephemeral most years (Environment and Climate Change Canada 2018; gauges 11AA029, 11AA028, 11AA037, 11AA038).

No other major changes to habitat have been observed since the construction of the St. Mary Reservoir. Instead, the availability of habitat, particularly for overwintering in the Milk River, is highly variable from year to year and dependent on adequate water flows. The combination of severe drought conditions and water flow management associated with the St. Mary Canal can lead to extremely low flow conditions, as observed in the late summer and fall of 2000 and 2001 (R.L. & L. 2002). A potential threat to existing sculpin habitat in the Milk River is the proposal (still under consideration) to construct a dam on the Milk River upstream of the town of Milk River for irrigation purposes. Such a dam may provide water security below it during drought events or unexpected canal closures, thereby preserving aquatic habitat (Palliser Environmental Services Ltd. 2019), but it would destroy habitat within the footprint of a reservoir, restrict upstream movement and may negatively affect water temperatures below the dam.

BIOLOGY

For an unnamed species, a surprising amount of biological information is available on Rocky Mountain Sculpin; however, care must be taken in accessing the information because most of it is published under other specific and subspecific names (e.g., Bailey 1952 as *C. bairdii punctulatus*; Hughes and Peden 1984 and Peden and Hughes 1984 as *C. confusus*, and McCleave 1964 as *C. bairdii*). Because further research and genetic testing has shown that Rocky Mountain Sculpin are the only species in most of their river systems (barring Slimy Sculpin in the Flathead River), the biological data presented in these studies are assignable to Rocky Mountain Sculpin. Except for Hughes and Peden (1984), Peden and Hughes (1984), and Rudolfsen *et al.* (2018, 2019), most of the available biological information on this species pertains to populations east of the Continental Divide.

Life Cycle and Reproduction

<u>Spawning period</u>

Like other North American freshwater sculpin, Rocky Mountain Sculpin spawn in the spring. Both sexes are believed to be sexually mature at around 2 to 3 years (Roberts 1988; Young and Koops 2013). These observations are consistent with data collected for *C. confusus* and *C. bairdii* elsewhere. The youngest age of first maturation for *C. confusus* in British Columbia is 2 years, with the smallest standard length recorded at 42 mm for a mature female (Peden 2001). The only mature two-year-old female collected from the Flathead River was 71.4 mm SL (Hughes and Peden 1984). The smallest mature female examined from the Milk and St. Mary rivers was 52.3 mm in TL, but age was not estimated (Roberts 1988). Rocky Mountain Sculpin can reach up to 114 mm TL (The Alberta Rocky Mountain Sculpin Recovery Team 2013).

In BC, the exact time of spawning is unknown; however, in the West Gallatin River in eastern Montana (east of the Continental Divide) the spawning season was reported to span all of June (Bailey 1952) where some males were producing milt as early as March 25. Water temperatures over this period ranged from 7.8 to 12.7°C. Clint Muhlfeld (US Geological Survey) provided daily temperature data from 2008 about 60 km upstream of the Canada/US border. In June the minimum daily average temperature was 2.3°C and the maximum (reached June 30) was 9.8°C, and the average daily temperature did not exceed 6.0ºC until June 21. Temperature data collected approximately 50 km from the US border in 2015 showed that average daily water temperatures were exceeding 6.0°C by May 25, with a June range of 5.3 to 13.7°C (Rudolfsen, unpublished data). Whether this earlier warming in 2015 reflected seasonal variation or the effects of climate change in the Flathead Valley is unknown. Regardless, both the 2008 and 2015 data suggest that the Pacific DU of Rocky Mountain Sculpin probably spawn at least a month later (in mid- to late June) than the Saskatchewan - Nelson River DU and Missouri River DU.

Spawning sites

Bailey (1952) described spawning sites in the West Gallatin River (eastern Montana) as holes under rocks. Presumably, males excavated, or at least enlarged these holes. The rocks ranged in diameter from 13 to 38 cm and the surface velocities over nests ranged from 0.0 to 1.4 m/s. Bailey (1952) did not define "surface velocity" as either above-ground water, or the surface of the water column. This makes the flow measurement difficult to interpret because in many river systems, flow can vary by depth and Rocky Mountain Sculpin are benthic fish. Regardless, it was noted that the nests were predominantly located where flow was fast enough to prevent sediment deposition. The water depths over the nests were usually greater than 40 cm.

Spawning behaviour

Rocky Mountain Sculpin are estimated to mature at 2 to 3 years of age on average, with a maximum reported age of 8 years (Roberts 1988; Young and Koops 2013). Typically, males excavate a nest cavity under rocks, woody debris, or vegetation and court females. The courtship is complex and involves rapid changes in male colour, acoustical, and behavioural signals (Savage 1963; Whang and Jannsen 1994). Usually, males spawn with several females. In the West Gallatin River (eastern Montana), Bailey (1952) estimated up to five females deposited eggs in a single nest. Eggs are a pale yellow or orange-yellow colour, and 2.5 mm in diameter (The Alberta Rocky Mountain Sculpin Recovery Team 2013). Males fan and guard the eggs while ensuring they do not accumulate silt until they hatch.

Fecundity

In the Saskatchewan - Nelson River DU and Missouri River DU, average annual female fecundity at sexual maturity (2 to 3 years) is around 64 eggs, which increases to about 518 eggs maximum by 8 years (Young and Koops 2013). As the average age of adults is 4 years, however, the majority of sexually mature females are likely to have an average fecundity of around 184 eggs. Typically, egg counts do not exceed 400 (The Alberta Rocky Mountain Sculpin Recovery Team 2013).

Incubation period

The incubation period is dependent on temperature. At water temperatures ranging from 7.8 to 17.2ºC the eggs take about 3 to 4 weeks to hatch (Bailey 1952). The eggs are large (about 2.5 mm in diameter). If Rocky Mountain Sculpin is like other western sculpin that produce large eggs, the larvae probably burrow into the gravel after hatching (at about 6 to 8 mm) and remain there for about two weeks before they emerge as miniature (about 10 mm TL) versions of the adults (McPhail 2007).

Age structure

In 2013, 134 Rocky Mountain Sculpin from both the Saskatchewan - Nelson River DU and the Missouri River DU were measured and aged using otoliths (Young and Koops 2013). Before the end of their first year, Rocky Mountain Sculpin were 32 mm in standard length (SL) on average. By 2 years of age, they averaged at 54 mm and were usually sexually mature. Rocky Mountain Sculpin were found to be as old as 8 years, where they averaged about 99 mm long. It has been observed that Rocky Mountain Sculpin do not grow over the winter (Bailey 1952). These data are similar to that from the Flathead River, where young-of-the-year were on average 37.0 mm SL by late summer (Hughes and Peden 1984). In the Flathead River, one-year-old males were on average 64.4 mm SL and one-year-old females were 48.6 mm SL by October (Hughes and Peden 1984). Generation time is estimated to be 4.1 years (Young and Koops 2013).

Physiology and Adaptability

Although there are few data on the physiology of these sculpin, there is evidence that their distribution is dependent on water temperature. Willock (1969) postulated that water temperature was the most important factor affecting sculpin distribution. Temperature may also play a role in triggering spawning, with a threshold between 7.5°C and 15°C (Roberts 1988). In the Pacific DU, Rocky Mountain Sculpin are only present in the warmer parts of the Flathead drainage (although competition with Slimy Sculpin also may contribute to this distribution pattern). These “warmer” stretches of the river are still cool, however, with summer water temperatures that do not exceed 20°C (Rudolfsen unpublished data). East of the Continental Divide, they are also able to tolerate warmer water temperatures and extend farther onto the Great Plains than typical “cool” water species. Consistently warm temperatures, however, are not habitable by Rocky Mountain Sculpin. There is speculation that Rocky Mountain Sculpin existed in the St. Mary River downstream of the dam prior to construction of the St. Mary reservoir, but they would have been intolerant of the resultant higher water temperatures during construction and were consequently eradicated. Currently there is a hypolimnetic water release from the reservoir.

Water level also seems to be an important factor in the distribution of Rocky Mountain Sculpin (R.L. & L. 2002). For example, changes in distribution may have occurred since the 1960s as a result of inadequate water flow due to drought conditions, impoundments, diversions, and water removal (Paetz 1993; R.L. & L. 2002). Populations in the upper Milk River have been severely reduced as a result of inadequate water flow. The adjustment of water flow through dams, canals, irrigation, or stochastic events may require Rocky Mountain Sculpin to quickly adapt to changing flow regimes over short periods of time. A study by Veillard *et al.* (2017) investigated how well Rocky Mountain Sculpin can adapt to rapidly increasing flows, and the metabolic costs associated with station-holding. Overall findings were that Rocky Mountain Sculpin could not reach their prior maximum velocity after a 30-minute rest period, suggesting a rapid switch to anaerobic respiration. Overall, there is little to indicate that Rocky Mountain Sculpin are capable of adapting to quickly or drastically changing water flows, and juveniles (ages 0 to 2 years) are especially sensitive to such perturbations (Young and Koops 2013).

Dispersal and Migration

In general, Rocky Mountain Sculpin are recognized as sedentary. Bailey (1952) marked 75 Rocky Mountain Sculpin in Prickly Pear Creek (a small tributary of the upper Missouri River, Montana). Over the course of almost one year, 21 marked fish (28%) were recovered. Most of them were caught within the first three months of the study. Fifteen of the recaptures were within 50 m of the point of first capture, and the greatest distance moved was 145 m. Later, McCleave (1964) studied the movements of Rocky Mountain Sculpin in Trout Creek (a tributary of the East Gallatin River, Montana). Although his sample size was much larger (1,847 marked fish), the results were remarkably similar to Bailey's. Over the fall and winter (late August to early March) McCleave recaptured 441 of his marked fish (24%). Again, most of the recaptures were made within 50 m of the original marking site, and the maximum distance moved was 181 m. There was a slight but consistent tendency for the movements to be upstream rather than downstream.

Ruppert *et al.* (2017) conducted a mark-recapture study on 223 Rocky Mountain Sculpin in Lee Creek, Alberta using Passive Integrated Transponder (PIT) tags. The majority of sculpin recaptured moved no more than 10 m over 5 months (late spring to early fall), and the largest distance travelled was 240 m downstream from the release site. These findings corroborate previous evidence that Rocky Mountain Sculpin typically do not migrate far from relatively small home areas. For example, Peden (2001) found Rocky Mountain Sculpin at the same sites in British Columbia during spring, summer, fall and winter sampling. Peden (2000) noted that the home range was less than 5 m^2 for Rocky Mountain Sculpin in British Columbia.

To date, no quantitative study has examined the movements of young-of-the-year, which is the age group most likely to disperse before settling down to a more sedentary adult life. Peden and Hughes (1984) did not observe either juvenile or adult Rocky Mountain Sculpin to undergo extensive migrations. Also, genetic differences among small tributaries in British Columbia (based on allozyme electrophoresis) suggested virtually no movement (or at least no gene flow) among populations in tributaries 10 km or more apart (Peden 2000). Population genetics from the St. Mary River and Lee Creek, however, provide evidence of gene flow suggesting some possibility of downstream larval drift (Ruppert *et al.* 2017). There is also the possibility of limited downstream migration during low winter flows, but evidence is currently lacking to confirm this.

Interspecific Interactions

Sculpin are mainly nocturnal foragers, but foraging behaviour is somewhat dependent on the species. A study found that Shorthead Sculpin in the Columbia River tend to remain in the fast water areas during the night, where they forage on drifting insects on the upstream side of larger rocks (McPhail 2001). In general, food preferences of Rocky Mountain Sculpin appear to be similar to those of *C. bairdii* and *C. confusus* (Peden 2000, 2001). In the Saskatchewan - Nelson River DU and Missouri River DU, aquatic insect larvae such as midge larvae, caddisfly and mayfly nymphs, and crane fly larvae make up the majority of the diet, but molluscs, fishes, nematodes, and eggs also contribute (The Alberta Rocky Mountain Sculpin Recovery Team 2013). Rocky Mountain Sculpin have been found having eaten small fish such as Longnose Dace (*Rhinichthys cataractae*) and juvenile Rainbow Trout (*Oncorhynchus mykiss*) (The Alberta Rocky Mountain Sculpin Recovery Team 2013).

Sculpin form part of the diet of other fishes such as trout and bass as well as snakes (Deason 1939, Scott and Crossman 1973). Parasitic interactions are not known for Rocky Mountain Sculpin, but larval cestode (*Proteocephalus ambloplitis and P*. sp.), and trematode (*Tetracotyle* sp. and *Diplostomum* sp.) infections have been noted in *C. bairdii* from eastern Canada (Bangham and Hunter 1939; Bangham 1955), and it is a carrier of *Aeromonas salmonicida,* the bacterium responsible for furunculosis in fishes (Rabb and McDermott 1962). In addition to trematodes and cestodes, Hoffman (1967) lists several protozoans, nematodes, acanthocephalans, molluscs and crustaceans as associated parasites.

Hybridization

In the Pacific DU, the Flathead River system contains both Slimy and Rocky Mountain Sculpin. It was previously reported that the two species were sympatric for about 20 km of the Flathead River mainstem; however, recent sampling efforts show that they exist together along a greater portion of the mainstem (24 km) and over a 6 km span of Kishinena Creek, which is a larger tributary of the Flathead River (Rudolfsen *et al.* 2019). Smaller sympatric zones are found in Howell Creek and Couldrey Creek. At upstream sites, the numerically dominant species is the Slimy Sculpin, while at downstream sites, the numerically dominant species is Rocky Mountain Sculpin. In between, there is a patchy transition in relative numbers of the two species where they are known to hybridize with one another (Rudolfsen *et al.* 2019). Only Rocky Mountain Sculpin occur in the final 5 to10 km of the main river above the US border. Morphologically, some specimens from the upper part of the sympatric zone are difficult to identify as either Slimy or Rocky Mountain Sculpin. Recent genetic work has found this zone of sympatry to be a natural hybridization zone (Rudolfsen *et al.* 2019). Hughes and Peden (1984) documented similar shifts from predominately Rocky Mountain Sculpin to predominately (or exclusively) Slimy Sculpin in most streams that are tributary to the lower 20 km of the Pacific DU. There are now confirmed hybrid zones in Howell Creek and Kishinena Creek in addition to the Flathead River (Rudolfsen *et al.* 2019).

For about 110 km downstream of the US border, the only sculpin in the Flathead mainstem is Rocky Mountain Sculpin. In contrast to the naturally occurring hybridization zones in BC, there is a documented hybridization zone in the North Fork of the Flathead River in Montana, which appears to be human-made. Based on allozyme data, Zimmerman and Wooten (1981) located this hybridization zone immediately downstream of the confluence of the North and South forks of the Flathead River. Hungry Horse Dam is a short distance above this confluence. The dam causes changes in the thermal and hydrographic regime downstream and may have disrupted reproductive isolation between the species. Thus, both natural and human-made hybridization zones occur within the

Flathead drainage basin. Since the discovery of the hybridization zone near Hungry Horse Dam in Montana, at least six hybridization zones between Rocky Mountain Sculpin and Slimy Sculpin have been discovered in the Clark Fork River drainage (Adams *et al.* 2015). Natural water temperature regimes are thought to be facilitating the presence of these hybridization zones.

Competitive Interactions

There are no conclusive data on competitive interactions between Rocky Mountain Sculpin and Slimy Sculpin in the Flathead drainage; however, the distribution pattern of the species in both the Canadian and US portions of the drainage basin suggests that there is an interaction between these species. Whether this interaction is competitive or a reflection of differences in habitat preferences is unknown. In both the mainstem of the North Fork and in tributary streams, there is a shift from Rocky Mountain to Slimy Sculpin that is associated with altitude (Rudolfsen *et al.* 2019). Hughes and Peden (1984) suggested that this transition in species abundance occurs between 1300 and 1400 m elevation; however, Rudolfsen *et al.* (2019) found Rocky Mountain Sculpin exceeding 1900 m elevation. At least two physical factors change with altitude: gradient and temperature. With increasing altitude, either of these factors, or a combination of both, may shift the competitive balance between the species in favour of Slimy Sculpin in the cooler upstream reaches and in favour of Rocky Mountain Sculpin in warmer downstream reaches. It is uncertain, but gradually increasing average annual summer temperatures in the Flathead Valley may be the cause for Rocky Mountain Sculpin's apparent expansion to higher altitudes (Rudolfsen *et al.* 2019).

POPULATION SIZES AND TRENDS

Pacific Designatable Unit

Sampling Effort and Methods

Peden and Hughes (1984) electroshocked a number of riffles in August and reported an average of eight Rocky Mountain Sculpin per 100 seconds of shocking. Sites were selected by targeting suitable sculpin habitat. Rudolfsen *et al.* (2019) sampled 95 sites throughout the Flathead drainage over the summers of 2014 and 2015. Each site consisted of 30 randomly placed 1 m^2 quadrats along a 300 m stretch of the river/tributary. The quadrats were electroshocked for 10 seconds each, and the sculpin were collected with a stop net.

Abundance

Unfortunately, there are no comparative quantitative data on the abundance of Rocky Mountain Sculpin in the Pacific DU. Though the species has been collected sporadically in the Flathead drainage since 1955, the collections are not comparable because the methodologies and search efforts differ. For example, one of the earliest (1957) collections in the Pacific DU was made with rotenone. Later collections involved electroshockers that were used in both directed and random sampling. Rudolfsen *et al.* (2019) reported the highest sculpin densities to be in the Flathead mainstem and Kishinena Creek. The Flathead River had on average 7.5 Rocky Mountain Sculpin per 30 m^2 of sampling, and the Kishinena had on average 14 per 30 m^2. Howell Creek and Couldrey Creek had the lowest average abundances, at 3.5 and 5.6 Rocky Mountain Sculpin per 30 m^2, respectively.

<u>Fluctuations and Trends</u>

Without temporal population estimates, population fluctuations and trends cannot be evaluated. Regardless, the distribution of Rocky Mountain Sculpin in the Pacific DU has exhibited an apparent expansion upstream since it was last sampled in the 1980s (Hughes and Peden 1984; Rudolfsen *et al.* 2019). There is no known stochastic event to facilitate rapid expansion, so it can be postulated that this was a gradual migration over the past 35 years, potentially due to warmer water resulting from climate change.

<u>Rescue Effect</u>

Although Rocky Mountain Sculpin are relatively sedentary, there are no barriers to movement (or gene flow) between the Pacific DU in BC and downstream populations in Montana. Thus, in the event of localized fish kills (barring a major catastrophe that affects the entire river system) immigrants from tributary streams and from downstream mainstem populations could slowly repopulate parts of the Pacific DU's range. If the physical or chemical environments in the mainstem Flathead River are permanently altered to be unsuitable, however, recolonization would be unlikely.

Saskatchewan - Nelson River Designatable Unit

<u>Sampling Effort and Methods</u>

R. L. & L. Environmental Services Ltd. electroshocked along the St. Mary River and Lee Creek in 2000 and 2001 (R. L. & L. 2002). From 2006 to 2009, DFO electroshocked nine different sites in Lee Creek and 298 sites along the St. Mary River, electroshocking for 20 to 740 seconds at each site (Watkinson unpublished data). A variety of methods were used including boat and backpack electroshockers. Sampling varied between directed and randomized.

<u>Abundance</u>

Surveys in 2000 and 2001 found that Rocky Mountain Sculpin had the highest or second highest relative abundance of all fish species encountered in the North Milk and St. Mary rivers, although abundance was dependent on season (R. L. & L. 2002). There is no evidence to suggest the population in the St. Mary River has experienced a change in abundance, although a significant increase in Rocky Mountain Sculpin abundance was observed in Lee Creek (R. L. & L. 2002). They reported an average CPUE of 2.4 to 4.2 fish per minute in the St. Mary River, and 3.0 fish per minute in Lee Creek. Fisheries and

Oceans Canada found an average CPUE of 1.9 Rocky Mountain Sculpin per minute of electroshocking in the St. Mary River and 0.6 per minute in Lee Creek between 2006 and 2009 (Watkinson unpublished data).

Fluctuations and Trends

The Saskatchewan - Nelson River DU has experienced a number of habitat alterations including the St. Mary Canal, built in 1917, which decreased water flow in the St. Mary River (ISMMRAMTF 2006). Despite some contention that populations remain relatively steady (Fisheries and Oceans Canada 2012), modelling estimates by Young and Koops (2013) suggested that populations in the Saskatchewan - Nelson River DU may be declining and could possibly go extinct in 70 years without the introduction of recovery efforts. It is unknown if present regulations have improved this outlook. The most notable impact on populations was the construction of the St. Mary Dam and Reservoir in Alberta in 1951 (Gilpin 2000). This undoubtedly eliminated suitable habitat for Rocky Mountain Sculpin as their distribution extends to the reservoir and, to date, there are no records of Rocky Mountain Sculpin in the reservoir.

Rescue Effect

Natural recolonization of the St. Mary River from the North Milk River would likely be impossible given the design of the St. Mary Canal, which would require significant upstream migrations in high flow environments. Recolonization from Montana is possible, but would be a slow process due to the sedentary behaviour of Rocky Mountain Sculpin.

Missouri Designatable Unit

Sampling Effort and Methods

R.L. & L. Environmental Services Ltd. electroshocked along the Milk River in 2000 and 2001 (R.L. & L. 2002). Between 2005 and 2007, DFO sampled 91 different sites along the Milk and North Milk River, electroshocking for 10 to 1690 seconds at each site (Watkinson unpublished data). A variety of methods were used including boat and backpack electroshockers. Sampling varied between directed and randomized.

Abundance

Surveys in 2000 and 2001 found that Rocky Mountain Sculpin had the highest or second highest relative abundance of all fish species encountered in the North Milk River, although abundance was dependent on season (R.L. & L. 2002). They reported an average CPUE of 0.7 to 1.8 Rocky Mountain Sculpin per minute in the Milk River. In these surveys of the Milk River system, the highest abundance values were observed in the North Milk River and decreased downstream to where they were absent in the lowest section of the Milk River mainstem (R.L. & L 2002). A similar pattern was observed in earlier surveys (R.L. & L. 1987), and is likely due to higher abundance of suitable spawning and rearing habitat in the upper reaches (R.L. & L. 1987). These assessments of abundance were conducted before the extreme drought conditions experienced, particularly for the Milk River, in fall 2001. However, limited surveys in October 2002 did not indicate a noticeable change in abundance (P&E 2002). These latter surveys were conducted to evaluate fish populations in the Milk River and were concentrated mainly in the furthest downstream section of the Milk River (i.e., from the international border to 57 km upstream), as well as in the lower North Milk River and at the confluence of the Milk River and North Milk River. DFO sampling showed extremely low capture rates in the Milk River between 2003 and 2007, having only caught 30 Rocky Mountain Sculpin in 116 hours of boat electroshocking (Watkinson unpublished data). The North Milk River, however, had an average CPUE of 4.7 sculpin per minute of electroshocking.

Estimates of abundance may be influenced by season, and high discharge likely decreases the ability of survey crews to capture fish. It is therefore currently difficult to determine whether the populations in the Milk River are stable, declining or increasing. Given the recent drought conditions, the populations may have experienced at least a slight decline in numbers even though the most recent catches in October 2002 (P&E 2002) suggest that Rocky Mountain Sculpin are still one of the most abundant species in the lower North Milk River.

Fluctuations and Trends

Trends in population size are difficult to evaluate given the limited information available and the variability in season and location of sampling. Some variation in relative abundance over time is evident, but these changes do not appear to be consistent. For example, fall relative abundance values based on CPUE appeared to have increased in the upper North Milk River when comparing the results of a survey conducted in 1986 to those of 2000-2001 (R.L. & L. 2002). More recent sampling, however, would suggest that CPUE has a tendency to fluctuate depending on year and location (Table 2). The fall CPUEs collected from 2002 (0.5 to 2.4 fish/min) and 2006 (6.0 fish/min) suggest a slight increase in abundance near the confluence of the North Milk River and in the lower North Milk River compared to sites near the confluence sampled in 1986 (0 to 0.59 fish/min.). However, all subsequent (2000 to 2009) summer values in the North Milk River are much lower than summer values collected in 1989 by Paetz (1993). Similarly, summer values for the Milk River have remained considerably lower since 1989. Fall values are relatively consistent, staying similar and low for the lower Milk River since 1986. Due to numerous threats including droughts and water diversion/withdrawal, overall, estimates show that populations in the Missouri River DU are likely declining (Young and Koops 2013).

Table 2. Comparison of catch-per-unit-effort (CPUE) values (fish/minute) for Rocky Mountain Sculpin encountered in the Milk River and North Milk River systems over time. (Method of capture – backpack electrofishing.)

Year	Season	System	Location	CPUE	Reference
1989	Summer	Milk River	Town of Milk R.	3.0	Paetz 1993
2000	Summer	Milk River	Town of Milk R.	0.3	Stantec 2000
2000	Summer	Milk River	Town of Milk R.	0.3	R.L. & L. 2002
2005	Summer	Milk River	km 3 to 96	0	DFO
2006	Summer	Milk River	km 207 to 238	0	DFO
2006	Summer	Milk River	Overall	1.7	Fisheries Management
2014	Summer	Milk River	Overall	0.1	ACA
1986	Fall	Milk River	Lower Section[3]	0-2.1	R.L. & L. 1987
2003	Fall	Milk River	Overall	0.2	ACA
2003	Fall	Milk River	Overall	0.3	Mainstream Aquatics Ltd.
2004	Fall	Milk River	Overall	0.3	Mainstream Aquatics Ltd.
2005	Fall	Milk River	Overall	0.1	ACA
2006	Fall	Milk River	Overall	0.2	DFO
1989	Summer	N. Milk River	Upper Site[1]	4.6	Paetz 1993
2000	Summer	N. Milk River	Upper Site[1]	0.8	R.L. & L. 2002
2006	Summer	N. Milk River	km 289 to 323	0.9	DFO
2009	Summer	N. Milk River	Overall	0.8	Royal Alberta Museum
1986	Fall	N. Milk River	Overall	0-1.9	R.L. & L. 1987
1986	Fall	N. Milk River	Confluence	0-0.6	R.L. & L. 1987
2000-2001	Fall	N. Milk River	Overall	3.7-10.8	R.L. & L. 2002
2002	Fall	N. Milk River	Overall	1.2	P&E 2002
2002	Fall	N. Milk /Milk	Confluence Area[2]	0.5-2.4	P&E 2002
2006	Fall	N. Milk River	km 289 to 324	6.0	DFO

[1]Approximately 5 km downstream of the international border.

[2]Includes four sites collected in the lower north Milk River and one site immediately downstream of the confluence.

[3]Sites between the town of Milk River and approximately 90 km upstream of the international border.

Rescue Effect

Ruppert *et al.* (2017) found that, based on genetic evidence, Rocky Mountain Sculpin movement was likely extremely limited between the Saskatchewan - Nelson River DU and the Missouri River DU. It is slightly possible, however, that fish from the United States upstream of the Saskatchewan - Nelson River DU could be entrained in the St. Mary irrigation canal and move downstream into the North Milk River on an annual basis. Recolonization of the Milk River mainstem from the North Milk River would likely be a slower process (i.e., 10 or more years), based on previous reports documenting changes in distribution (Willock 1969; Clayton and Ash 1980). It is also possible for the North Milk River to be naturally recolonized by Rocky Mountain Sculpin further upstream in Montana. Natural recolonization of the Milk River mainstem from the upper Missouri system in Montana is not possible, however, given the absence of sculpin in the Milk River downstream of the international border and the presence of six or more impassable dams (Stash 2001).

THREATS AND LIMITING FACTORS

Pacific DU

- Natural System Modifications (Medium – Low Impact)
    - Ecosystem Modifications
- Climate Change and Severe Weather (Low Impact)
    - Drought

Saskatchewan – Nelson River DU and Missouri River DU

- Natural System Modifications (High – Low Impact)
    - Dams and Water Management/Use
- Invasive and Other Problematic Species and Genes (Low Impact)
    - Invasive Non-Native/Alien Species/Diseases
- Climate Change and Severe Weather (Low Impact)
    - Droughts and Temperature Extremes

Pacific DU

<u>Natural System Modifications</u>

Ecosystem Modifications

Sedimentation of the Flathead River is an ongoing concern. Logging development is the primary activity in the Flathead Valley, since mining and oil and gas development was prohibited in 2011. Logging, however, has increased in the valley over the last 6 to 8 years (G. Mowat, pers. comm. 2018). While the logging activities are adequately distanced from Rocky Mountain Sculpin habitat, the associated erosion and road development could increase river turbidity. The valley's sediments are easily eroded and have the potential to accumulate and fill cobble crevices that Rocky Mountain Sculpin require for nest construction and refuge. Additionally, the increase in road development allows recreational access throughout the drainage. Although unquantified, a noted threat to water quality in the Flathead River Valley is from uncontrolled all-terrain vehicle (ATV) use (COSEWIC 2010). A large portion of the river valley is now part of two access management areas (East Flathead and Upper Flathead), where many abandoned logging roads are closed to the public as a reclamation measure. Despite this measure, monitoring public compliance with the closures is difficult given the area's remoteness, and almost all of the main roads are open to motor vehicles year round. Also, a number of ATV trails with water crossings exist throughout the drainage. Presently, off-road activity is regarded as relatively minor, but there is little to mitigate increased recreational use of the area.

Increasing frequency and severity of forest fires in the Flathead Valley is a relatively new notable threat that can alter Rocky Mountain Sculpin habitat. The increase in atmospheric temperature due to climate change is causing more frequent and severe forest fires in North America (Flannigan *et al.* 2000). The Flathead Valley is no exception, experiencing three major forest fires and multiple small fires over the last two years (Mowat, G., pers. comm. 2018). A severe fire has the potential to drastically alter aquatic habitats through bankside erosion and carbon/silt inputs (Gresswell 1999). These occurrences can be detrimental to local Rocky Mountain Sculpin populations, but recolonization could occur depending on fire severity, duration, and size.

<u>Climate Change and Severe Weather</u>

Droughts

Climate change can alter the timing of seasons and reduce their predictability. Earlier spring water temperatures would trigger earlier spawning activity. This may have an impact on spawning success due to the timing and severity of snowmelt runoff, but overall effects are not known. Warming temperatures could also reduce the amount of winter snowpack, and consequently limit water availability to the Flathead River. A reduction in water level would restrict the amount of habitat available to Rocky Mountain Sculpin. This is already occurring, with about a 30% reduction in Flathead River water levels since 1925 (Environment and Climate Change Canada 2018; gauge 08NP001). Lower water levels could also exacerbate warmer water temperatures. While warmer water in the Flathead River could be assisting the apparent range expansion of Rocky Mountain Sculpin (Rudolfsen *et al.* 2019), prolonged periods of critically warm temperatures could impact their overall survival.

Saskatchewan - Nelson River DU and Missouri River DU

Threats in the Saskatchewan - Nelson River DU and Missouri River DU are shared. Specifically, habitat loss and degradation, dams and water management associated with the St. Mary diversion, surface water extraction, invasive and other problematic species, and climate change could pose a threat to Rocky Mountain Sculpin in the St. Mary and Milk River systems.

Natural System Modifications

Dams and Water Management/Use

The apparent absence of Rocky Mountain Sculpin from the St. Mary Reservoir and reaches of the river downstream suggests the species was locally eradicated from within the impoundment and possibly for some distance downstream. While there is no current proposal, the feasibility of developing a dam on the Milk River upstream of the town of Milk River has been investigated. The dam is intended to improve the security of the water supply for existing and future withdrawal demands and reduce the impacts of droughts (The Alberta Rocky Mountain Sculpin Recovery Team 2013).

The St. Mary Diversion has greatly modified the natural hydrograph of the North Milk River and Milk River downstream of the confluence of the two rivers. An additional dam constructed on the Milk River would add another level of flow control. Effects could be positive or negative, depending upon their timing and volume and the resultant effects on fish habitat. Impoundments alter fish habitat, flow regimes, sediment load, microbiota, and water temperatures and may also increase the risk of species introductions (McAllister *et al.* 2000; Quist *et al.* 2004). The management of flow often produces systems that are narrower, clearer, more consistent in temperature and flow, and less productive with less substrate movement (Cross *et al.* 1986; Pflieger and Grace 1987; Quist *et al.* 2004). Water released from storage reservoirs is often withdrawn from near the bottom of the reservoir (hypolimnetic withdrawals), creating significantly cooler water conditions in downstream areas. The predicted effect of an impoundment on sculpin habitat downstream would depend on how water releases are managed and the footprint of the reservoir.

While the construction of a dam upstream of the town of Milk River could potentially limit recolonization both upstream and downstream of the impoundment, it could also preserve aquatic habitat by enhancing flow during droughts. Due to its poor and aging structural condition, the St. Mary canal is increasingly requiring repairs (Palliser Environmental Services Ltd. 2019). The canal is not operating at its designed capacity of 24.1 m^3/s, but instead at a capacity of about 18.4 m^3/s and is in need of maintenance and reconstruction (Alberta Environment 2004; U.S. Bureau of Reclamation 2004). Work has begun to bring the structure to design capacity, which will increase flow by almost 27%. Demand for water withdrawal during low flow periods due to unexpected canal maintenance and increasing drought occurrences could imperil aquatic species such as Rocky Mountain Sculpin (Palliser Environmental Services Ltd. 2019). Canal closures for maintenance could not only deprive the Milk River of sufficient flow, but also cause water temperature to increase and dissolved oxygen level to decrease beyond the species' requirements. The Milk River dam would reduce the species' range to wherever the reservoir backwatered the river, but would also secure water for downstream aquatic habitat during low flow events and support sufficient flow for overwintering habitat.

Temporary Diversion Licences (TDLs) for non-irrigation purposes are issued throughout the year including (though rarely) during critically low flow periods (The Alberta Rocky Mountain Sculpin Recovery Team 2013). Oil and gas companies, for example, may be licensed to remove water from the river for fracking. Overwintering habitat for Rocky Mountain Sculpin may be vulnerable to this type of extraction. TDLs also occur during the augmented flow period, when it may not be an issue unless the St. Mary diversion is prematurely or temporarily closed. Under such conditions, some TDLs may be revoked to mitigate impacts of reduced flow on sculpin habitat during critically low flows (The Alberta Rocky Mountain Sculpin Recovery Team 2013). TDLs are more prevalent in the Milk River as opposed to the St. Mary River and Lee Creek.

<u>Invasive and Other Problematic Species and Genes</u>

Invasive Non-Native/Alien Species/Diseases

The impact of non-native species on Rocky Mountain Sculpin is dependent on the suitability of sculpin habitat for invading species (The Alberta Rocky Mountain Sculpin Recovery Team 2013). In Montana, authorized stocking of non-native fishes in the St. Mary River began early in the 20th century and continued until mid-century (Marnell 1988; Mogen and Kaeding 2005). Stocking continues in some waters of the Blackfoot Reservation, mainly in isolated ponds and lakes (The Alberta Rocky Mountain Sculpin Recovery Team 2013). The Milk River and its tributaries have not been stocked for more than a decade. Unauthorized introductions have not been documented in these watersheds. Non-native fishes that have established self-sustaining populations in Canadian reaches of the St. Mary River and Milk River include Walleye (*Sander vitreus*), Northern Pike (*Esox lucius*), Yellow Perch (*Perca flavescens*), and various trout species (Clements 1973). All these fishes are piscivorous and could impact Rocky Mountain Sculpin abundance. Two invertebrate species of current concern are the New Zealand Mud Snail (*Potamopyrgus antipodarum*) and Northern or Virile Crayfish (*Orconectes virilis*) (The Alberta Rocky Mountain Sculpin Recovery Team 2013). The New Zealand Mud Snail can disrupt invertebrate populations and cause a marked shift in diet and abundance of Rocky Mountain Sculpin (Cada 2004). Introduction of crayfish could modify the aquatic macrophyte, macroinvertebrate and, ultimately, fish communities (McCarthy *et al.* 2006; Chambers *et al.* 1990; Hanson *et al.* 1990).

In 2002, at least 12 species of fish from the St. Mary River were entrained at the diversion outlet in Montana and transferred into the canal (Mogen and Kaeding 2002). The number of fish entrained annually is unknown and likely varies, but some of these fish may eventually move downstream into the Milk River (The Alberta Rocky Mountain Sculpin Recovery Team 2013). Increasing the annual flow in the diversion might further facilitate movement of biota from the St. Mary River into the Milk River; however, the potential impacts on Rocky Mountain Sculpin in the Milk River system are unknown. To date, Trout-perch (*Percopsis omiscomaycus*) and Walleye are the only introduced fish species that have been observed in the Milk River where Rocky Mountain Sculpin occurs (The Alberta Rocky Mountain Sculpin Recovery Team 2013). While transfer of Rocky Mountain Sculpin from the St. Mary River to the Milk River by the canal is possible, population genetics indicates that this is unlikely or rare (Ruppert *et al.* 2017).

Blooms of the diatom *Didymosphenia geminata* (Bacillariophyceae), commonly known as "Rocksnot," are an emerging threat to headwaters in Alberta with low turbidity and nutrient levels (Kirkwood *et al.* 2007). These blooms can result in dense algal mats that cover the river bottom, impacting ecosystem structure and function and negatively affecting other trophic levels. Recent studies identify low dissolved reactive phosphorus as a primary determinant of these blooms (Kilroy and Bothwell 2012; Bothwell *et al.* 2014); however, it is arguable whether or not the appearance of these blooms is due to human-induced introductions, or the alteration of river conditions to promote the proliferation of naturally occurring, sparse populations (Taylor and Bothwell 2014; Bergey and Spaulding 2015). If these algal blooms occur in river habitat occupied by Rocky Mountain Sculpin, they can alter the cover, food, and spawning habitats available and possibly displace them. These blooms have already occurred in the St. Mary River. Currently, impacts are considered to be localized and of short duration, so this threat as a whole is not thought to be severe (The Alberta Rocky Mountain Sculpin Recovery Team 2013).

Climate Change and Severe Weather

Droughts and Temperature Extremes

Climate change has the potential to impact water availability, temperature, and a broad range of other ecosystem processes (Schindler 2001), thereby affecting the availability and quality of Rocky Mountain Sculpin habitat. Natural recurring conditions such as droughts and anoxia can have broad negative effects on Rocky Mountain Sculpin abundance and range. Southern Alberta is susceptible to extreme drought conditions, particularly during the late summer and early fall. The impact of this threat to Rocky Mountain Sculpin would depend on the severity and duration of the drought, but can affect overwinter survival by limiting water availability and flow. Winter oxygen concentrations under the ice in the lower Milk River have been low (1.6 mg/L), perhaps due to oxidization by organic debris or inflow of anoxic ground water (Noton 1980; R.L. & L. Environmental Services Ltd. 2002). Droughts and heat waves could exacerbate these low oxygen levels. Additionally, warmer temperatures could reduce snowpack and limit spring water runoff, which the river systems are reliant on as a major water source.

Limiting Factors

A general limitation to Rocky Mountain Sculpin is its lack of migratory behaviour. Studies suggest that individuals have a small home range and a sedentary life history (Peden 2000; Ruppert *et al.* 2017), leaving them vulnerable to threatening conditions such as climate change and increased temperature extremes (see **Threats** section). In light of their limited mobility, these threats could negatively affect both the species' distribution and abundance.

A comparison of habitats occupied by other sculpin species in the Oldman River (Paetz 1993) suggests that favourable habitat exists beyond Rocky Mountain Sculpin's current distribution (e.g., Upper Belly River, Waterton River above the Waterton Reservoir and the Oldman River mainstem upstream of Fort McLeod). However, expansion into these habitats is blocked by the presence of various barriers including the St. Mary Reservoir, Waterton Reservoir and dam, and unfavourable conditions downstream of the reservoirs (e.g., low water flows, high summer water temperatures and silted substrate) (Paetz 1993; W. Roberts, pers. comm. 2003).

Number of Locations

In the Pacific DU, the most plausible threats for Rocky Mountain Sculpin that could impact the species are climate change and logging infrastructure. If climate change is accepted as the most serious plausible threat then there is one location, otherwise 10 locations: the mainstem Flathead River and Cabin, Howell, Couldrey, Kishinena, Commerce, Burnham, Middlepass, Harvey, and Sage creeks. Recent sampling in five sites along Harvey Creek and four sites in Middlepass Creek in 2014 and 2015 found no Rocky Mountain Sculpin, but this does not discount their occurrence (in low abundances) in the creeks (Rudolfsen unpublished data). While climate change could impact all 10 locations, sedimentation resulting from logging road construction and use would occur more locally at the individual watershed level.

A similar approach is argued for the Saskatchewan - Nelson River DU and Missouri River DU. The Saskatchewan - Nelson River DU has 1 to 2 locations (St. Mary River and Lee Creek) and the Missouri River DU has 1 to 2 locations (North Milk River and Milk River). The most serious plausible threats in both cases include climate change, which has a broader effect, and altered ecosystems due to impoundments and diversions, which impact the species more locally.

Due to the biogeographical differences among the three DUs, it is unlikely that any one threat will impact these populations identically. For example, climate change affecting all DUs would impact each differently. The Pacific DU occupies a montane ecosystem and has some access to cooler water at higher altitudes. In contrast, the Saskatchewan - Nelson River DU and Missouri River DU waterbodies originate in the Rocky Mountains but flow through the prairies where there are more frequent heatwaves and droughts. In light of climate change, Rocky Mountain Sculpin in these DUs are likely to exceed their temperature tolerances before the Pacific DU. Population-specific threats, however, could affect all individuals in a given DU. For example, a direct impact such as the closure of the St. Mary Canal and/or severe drought conditions can directly impact all individuals in the North Milk River.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In June 2019, amendments to the *Fisheries Act* directed toward improved protection of Canada's fishes and fish habitats were approved (Fisheries and Oceans Canada 2019). Prior to the amendments, Rocky Mountain Sculpin was only entitled to incidental protection if its entire range was shared by commercial, recreational, or Indigenous fisheries. With the new amendments, all fish species and habitat are entitled to protective and restoration measures.

In fulfillment of one of the Species at Risk Program's objectives for Rocky Mountain Sculpin, a standardized monitoring protocol for its Canadian range was recently published (Macnaughton *et al.* 2019). The new protocol provides for consistent data collection and therefore a better understanding of the relative abundance and distribution of the species.

Pacific DU

A previous COSEWIC assessment of the Pacific DU of Rocky Mountain Sculpin (then identified as *Cottus confusus*) assigned a "Threatened" status in November 1983 (Peden and Hughes 1984). *Cottus confusus* was reassessed in 2001 (COSEWIC 2001), but the Pacific DU was not included in this second assessment. The Pacific DU was re-examined in April 2010 (then identified as Rocky Mountain Sculpin, Westslope population) and in November 2019 to be "Special Concern" by COSEWIC.

In 2017, the Pacific DU was listed as "Special Concern" under Schedule 1 of the *Species at Risk Act* (SARA). The resultant management plan was published in 2018, outlining the need for monitoring, research, management and public education (Fisheries and Oceans Canada 2018).

Provincially, Rocky Mountain Sculpin is on British Columbia's Red List as S2 (imperiled).

Saskatchewan - Nelson River and Missouri River DUs

A COSEWIC assessment was completed in May 2005 resulting in a status recommendation of "Threatened" (COSEWIC 2005). In August 2006, Rocky Mountain Sculpin were listed as "Threatened" under Schedule 1 of SARA. In November 2019, COSEWIC assessed the Saskatchewan - Nelson River populations as "Threatened" and the Missouri River populations as "Threatened".

The Saskatchewan - Nelson River and Missouri River Rocky Mountain Sculpin were given the Alberta general status category of "May Be at Risk" in 2000 (The Alberta Rocky Mountain Sculpin Recovery Team 2013). In December 2007, it was listed as "Threatened" under the Alberta *Wildlife Act* (The Alberta Rocky Mountain Sculpin Recovery Team 2013).

Fisheries and Oceans Canada developed a recovery strategy for the two DUs in 2012 and Alberta completed a provincial recovery strategy in 2013 (The Alberta Rocky Mountain Sculpin Recovery Team 2013). Both recovery strategies reflect similar priorities, including monitoring population and abundance, better understanding of life history, and increasing public awareness. The recovery strategies also look at mitigating the potential impacts of surface water management such as water diversions, flow interruptions, and extraction in the region.

Non-Legal Status and Ranks

Rocky Mountain Sculpin taxonomy has not been formally described; therefore, the Alberta DUs are named *Cottus* sp. 6 and the Pacific DU is named *Cottus* sp. 9 on NatureServe (2019). The Montana populations are recognized under the name *Cottus* sp. cf*. bairdii*. Because Rocky Mountain Sculpin populations are recognized by different species names, the national and global listings do not agree. Therefore, only the provincial listings are presented here and the state, national, and global rankings are omitted as they are not currently representative of the correct species in the US portion of Rocky Mountain Sculpin's range and are in conflict (NatureServe 2019).

BC Status: S3S4 (Vulnerable or Apparently Secure)
Alberta Status: S2 (Imperiled)

Habitat Protection and Ownership

Pacific DU

The Fish Habitat section of the *Fisheries Act* provides some general protection for fishes in the BC portion of the Flathead River system. In 2004, the BC government announced a 38,000 ha no coal-staking reserve in the lower Flathead Valley. This reserve protected half of the known distribution of the Pacific DU from coal mining; however, the coal-staking reserve did not prohibit coal development upstream of the reserve. In 2011 however, the BC government passed the *Flathead Watershed Area Conservation Act* that now bans mining as well as oil and gas development activities on all crown land within the Flathead Valley.

A provincial park (Akamina-Kishinena Park) on the southeastern edge of the Flathead Valley may also provide some protection. The park covers about 11,000 ha of the Kishinena Creek watershed. Kishinena Creek drains into the Flathead River about 6 km south of the United States border, and Rocky Mountain Sculpin is known to occur in its lower reaches; however, it is unlikely that this species occurs as far upstream as the park boundary. Nevertheless, the presence of the park probably provides some protection from environmental degradation to the Kishinena Creek watershed.

A proposal to fill what is called “the missing piece” in the chain of national parks that straddle the international border in the Rocky Mountains would align the western boundary of Waterton Lakes National Park with the western boundary of Glacier National Park in the US. This new park would add 247,000 ha to Waterton Lakes National Park—all of it in the Flathead River watershed. Thus, the potential park would protect most of the range of the Pacific DU, but it is still unknown if the park will be established.

In 2013, Teck Resources Ltd. purchased 992 ha of land (Flathead Townsite) on the Flathead River where Rocky Mountain Sculpin are found with the intention of conserving and maintaining the river (Fisheries and Oceans Canada 2018). Additionally, there are presently two access management areas in place by British Columbia Ministry of Environment to protect the upper and east Flathead Valley from the impacts of recreational ATV use (Fisheries and Oceans Canada 2018).

<u>Saskatchewan - Nelson River DU</u>

In the St. Mary River system, the majority of the land bordering Lee Creek and the St. Mary River is held privately (79% and 75% respectively), with the remainder publicly owned or part of the Blood Reserve (The Alberta Rocky Mountain Sculpin Recovery Team 2013).

<u>Missouri River DU</u>

In 2013, 56% of the land bordering the Milk and the North Milk rivers was publicly owned; the rest was held privately (The Alberta Rocky Mountain Sculpin Recovery Team 2013). Approximately 11% of the public land and 14% of the private lands have conservation plans that included riparian protection and the remaining land was used mainly for grazing, or for small areas of municipal development (e.g., town of Milk River). Of the public land along the river, 6% was designated as park land for public use and access during the summer but with restrictions on development.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Tyana Rudolfsen is a Research Biologist with Fisheries and Oceans Canada in Winnipeg. She achieved a B.Sc. in Animal Biology (2014) and M.Sc. in Conservation Biology (2017), both from the University of Alberta. The majority of her studies and work focus on freshwater conservation and species at risk. Her M.Sc. thesis and three subsequent publications focus on Rocky Mountain Sculpin.

Douglas Watkinson is a Research Biologist with Fisheries and Oceans Canada in Winnipeg. He obtained a B.Sc. (1998) and M.Sc. (2001) from the University of Manitoba. He has sampled fish in most of the major river systems of the Hudson Bay drainage. His current research focuses on species at risk and habitat impacts. He is also the co-author of the Freshwater Fishes of Manitoba.

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Appendix 1. Threats Assessment for Rocky Mountain Sculpin – Pacific populations.

Species or Ecosystem Scientific Name	*Cottus* sp. Rocky Mountain Sculpin - Pacific populations			
Element ID		**Elcode**		
Date (Ctrl + ";" for today's date):	1/24/2019			
Assessor(s):	John Post (co-chair), Dwayne Lepitzki (moderator), Tyana Rudolfsen (writer), Doug Watkinson (co-writer), Freshwater Fishes SSC members (Pete Cott, James Grant, Julien April, Doug Watkinson, Constance O'Connor), External Experts (Jeff Burrows, Shane Petry, Ken Miller), DFO (Karine Robert)			
References:	Draft calculator and draft report provided by report writers, December 5, 2018, telecon Feb 14, 2019			

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	1	0
D	Low	1	2
Calculated Overall Threat Impact:		Medium	Low
Assigned Overall Threat Impact:		**CD = Medium - Low**	
Impact Adjustment Reasons:		High range is from uncertainty. Medium to low concluded as overall impact.	
Overall Threat Comments		Generation time = 4 years therefore time frame for severity & timing = 12 years into the future; Pacific DU: no abundance estimates within range to help score scope except for some no./m electrofishing and more in lower reaches, proposing 1-10 locations.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						Very small portions of Rocky Mountain Sculpin habitat is developed and there are no known upcoming major projects that will directly affect their habitat. Some small cabins in the area.
1.2	Commercial & industrial areas						Very small portions of Rocky Mountain Sculpin habitat is developed and there are no known upcoming major projects that will directly affect their habitat.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.3	Tourism & recreation areas						The Flathead River has some maintained recreational campsites, public cabins, and day use areas along the river. Further development is expected to be limited. The majority of development is expected to be in the southeastern corner of their range.
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
2.1	Annual & perennial non-timber crops						NA. No known conversion of area to cropland.
2.2	Wood & pulp plantations						NA. No known wood or pulp plantations within the watershed.
2.3	Livestock farming & ranching		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	While some ranchers allow cattle to freely graze in the Flathead Valley, cattle numbers are low. Cattle crossing events are extremely rare.
2.4	Marine & freshwater aquaculture						NA. No aquaculture activities in the watershed.
3	Energy production & mining						
3.1	Oil & gas drilling						NA. The Flathead watershed is protected from oil and gas development under the *Flathead Watershed Area Conservation Act*.
3.2	Mining & quarrying						NA. No known mining or quarrying activities in the watershed.
3.3	Renewable energy						NA. No known renewable or energy activities in the watershed.
4	Transportation & service corridors		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	There is an increasing amount of fire incidences and forestry is continuing, therefore forest roads are continuously being constructed in the area. Many unused roads are closed as a reclamation measure.
4.2	Utility & service lines						NA. No utility lines or pipes in the area.
4.3	Shipping lanes						NA. No known shipping lanes or dredging activity in the watershed.
4.4	Flight paths						NA. No impact on aquatic species.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						NA. Hunting is common, but does not directly impact Rocky Mountain Sculpin.
5.2	Gathering terrestrial plants						NA. This activity is terrestrial and unlikely to impact Rocky Mountain Sculpin.
5.3	Logging & wood harvesting						NA. The Flathead Valley is thickly forested with a strong logging industry, but logging activity is generally distanced from the river. Overall impacts are thought to be negligible. Some parts of the river (i.e. higher elevation locations) do not have riparian buffer zones, potentially leaving RMS in these areas vulnerable.
5.4	Fishing & harvesting aquatic resources						Recreational fishing is present but RMS are not targeted. Fishing activities are unlikely to affect RMS overall, but could locally where access to the river exists. Baitfish collection is illegal in BC.
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Off-road and ATV use in the Flathead Valley is present. Sedimentation and habitat alteration due to this activity is a minor concern. Hunters will occasionally cross streams but impact is expected to be minimal.
6.2	War, civil unrest & military exercises						NA. No war, civil unrest or military activity present.
6.3	Work & other activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Scientific research as part of SARA and non-targeted sampling may occur, but is not likely to impact populations significantly. Permit systems are in place to mitigate direct impacts as the result of scientific sampling. Includes both lethal and non-lethal sampling.
7	Natural system modifications	CD	Medium - Low	Large - Restricted (11-70%)	Moderate - Slight (1-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.1	Fire & fire suppression		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Aerial spraying for fire suppression addressed under pollution. Some fire suppression is present in the form of logging practices. Logging impacts are addressed under logging and harvesting wood section. Forest fires in the Flathead Valley have the potential to impact local RMS populations. Increased fire occurrences can lead to carbon/silt inputs in the Flathead River, but re-colonization of directly impacted areas is likely. Very limited if any water withdrawal activities are occurring.
7.2	Dams & water management/use						NA. There are no dams on the Canadian extent of the Flathead River.
7.3	Other ecosystem modifications	CD	Medium - Low	Large - Restricted (11-70%)	Moderate - Slight (1-30%)	High (Continuing)	Possible human modifications for recreational use, but largely negligible. It is difficult to predict overall impacts on RMS. There is some potential for population recovery as long as fires aren't occurring annually. Fire could still alter habitat and riparian zones, however. Crayfish are present in the Flathead River in Montana and their potential migration into this DU could affect RMS habitat.
8	Invasive & other problematic species & genes		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	There are occasionally Lake Trout that swim upstream from the United States. Lake Trout predation on RMS occurs, but impact is negligible and RMS are likely to compensate for this impact. Crayfish are present downstream in Montana and could predate on larval forms of sculpin.
8.2	Problematic native species/diseases						NA. Rocky Mountain Sculpin are susceptible to predation by trout. Any activity that favours these species like flow augmentation could increase predation pressure on RMS, but this is not predicted to occur in the Flathead River. Hybridization with Slimy Sculpin is not a threat, and human activity resulting in habitat alterations may actually increase range expansion of RMS.
8.3	Introduced genetic material						NA. No stocking of Rocky Mountain Sculpin occurs.
8.4	Problematic species/diseases of unknown origin						NA. No known problematic species/diseases affecting Rocky Mountain Sculpin in this watershed.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.5	Viral/prion-induced diseases						NA. No known viral/prion-induced diseases affecting Rocky Mountain Sculpin.
8.6	Diseases of unknown cause						NA. No known diseases of unknown cause affecting Rocky Mountain Sculpin.
9	Pollution		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
9.1	Domestic & urban waste water		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	There are no urban locations along the Flathead River. There is some possibility of human effluent/leakage into the rivers, but it is unlikely to be significant enough to impact populations. Road salt inputs are minimal, as the Flathead Valley has dirt roads that are not plowed over winter. Sedimentation is of concern due to the construction of dirt roads.
9.2	Industrial & military effluents						There is very little industrial and military activity where Rocky Mountain Sculpin are distributed. Industrial activity is not likely to be an exposure source for selenium. Natural selenium levels in the Valley are not predicted to increase to toxic levels unless the mining/drilling moratorium is lifted.
9.3	Agricultural & forestry effluents		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Forestry effluents into the Flathead River appear to be minimal. Logging activity is distanced from the rivers by a large forested buffer zone in most places. No known logging occurs directly along the river.
9.4	Garbage & solid waste						NA. No known directed solid waste deposits in any of the river system.
9.5	Air-borne pollutants						NA. Air pollutants are minimal as there is limited industrial activity. There is a potential for smoke due to wildfires, but the impact on RMS is likely to be insignificant.
9.6	Excess energy						NA. Noise and light pollution is extremely limited and unlikely to impact RMS.
10	Geological events						
10.1	Volcanoes						NA. No volcanoes nearby.
10.2	Earthquakes/tsunamis						NA. Earthquakes and tsunamis do not occur in the area.
10.3	Avalanches/landslides						NA. The potential for avalanches in the Flathead River Valley and some small bankside slippage is possible; however, there are no overall predicted impacts on RMS due to these events.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11	Climate change & severe weather	D	Low	Small (1-10%)	Extreme (71-100%)	High - Moderate	
11.1	Habitat shifting & alteration						NA. Alterations in seasons may have an impact on spawning and overall reproductive success due to timing of runoff, but generally impacts are unknown.
11.2	Droughts	D	Low	Small (1-10%)	Extreme (71-100%)	High - Moderate	Drought is becoming more prevalent across Rocky Mountain Sculpin's range. Below average snowpacks may lead to lower summer and fall river flows, thus reducing habitat availability. There is a noted decline in Flathead water levels by about 30% since 1925.
11.3	Temperature extremes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Rocky Mountain Sculpin are known to persist in seasonal temperature extremes throughout their range. Prolonged heat waves, however, may impact species survival, as they are sedentary and unable to move long distances to find cooler water. At this time, however, warmer temperatures are considered to be assisting range expansion of RMS.
11.4	Storms & flooding		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Storms and blizzards are common throughout the range, but increased flows are likely to be minimal. Moreover, Rocky Mountain Sculpin have been observed to move near the banks and margins of the rivers where the flow is less severe during spring runoff and rain-induced high water.
11.5	Other impacts						

Appendix 2. Threats Assessment for Rocky Mountain Sculpin – Saskatchewan - Nelson River populations.

Species or Ecosystem Scientific Name	*Cottus* sp., Rocky Mountain Sculpin – Saskatchewan - Nelson River populations			
Element ID		**Elcode**		
Date (Ctrl + ";" for today's date):	1/24/2019			
Assessor(s):	John Post (co-chair), Dwayne Lepitzki (moderator), Tyana Rudolfsen (writer), Doug Watkinson (co-writer), Freshwater Fishes SSC members (Pete Cott, James Grant, Julien April, Doug Watkinson, Constance O'Connor), External Experts (Jeff Burrows, Shane Petry, Ken Miller), DFO (Karine Robert)			
References:	Draft calculator and draft report provided by report writers, December 5, 2018; teleconference Feb 14, 2019			

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	1	0
C	Medium	0	0
D	Low	2	3
Calculated Overall Threat Impact:		High	Low
Assigned Overall Threat Impact:		**CD = Medium - Low**	
Impact Adjustment Reasons:		High range is from uncertainty. Medium to low concluded as overall impact.	
Overall Threat Comments		Generation time = 4 years therefore time frame for severity & timing = 12 years into the future; Saskatchewan - Nelson River DU (St. Mary + Lee Cr): no abundance estimates within range to help score scope although CPUE higher in upper reaches, 2 locations proposed (St. Mary River, Lee Creek).	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Portions of the watershed are expected to be developed for residential purposes in the next 10 years, and infilling of Lee Creek at some locations is likely to occur.
1.2	Commercial & industrial areas						NA. Very small portions of Rocky Mountain Sculpin distribution is developed and there are no known commercial or industrial projects that will directly affect their habitat.
1.3	Tourism & recreation areas						NA. There are some parks and protected areas. Lee Creek is being infilled in locations to develop a golf course and these activities are projected to continue. Water intakes and concrete banks are expected as part of this project and 1 to 3 acre lots are in development. There are no plans for new boat launches.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2	Agriculture & aquaculture		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
2.1	Annual & perennial non-timber crops						NA. A portion of the watershed is cropland, but there are no known negative impacts to Rocky Mountain Sculpin.
2.2	Wood & pulp plantations						NA. No known wood or pulp plantations within the watersheds.
2.3	Livestock farming & ranching		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Livestock have access to the St. Mary River and Lee Creek, but management practices are in place to mitigate crossings. In general, however, cattle are unrestricted and encounters with RMS are likely to be broad and widespread. Negative impacts resulting from these encounters are projected to be minimal.
2.4	Marine & freshwater aquaculture						NA. No known aquaculture activities impacting RMS.
3	Energy production & mining		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3.1	Oil & gas drilling		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Drilling exists in the watershed. The main concern is water withdrawal for fracking. Many abandoned wells are left uncapped. Older pipes and wells associated with drilling might still be an issue because they are more likely to fail and/or negatively impact the environment. New drilling technology minimizes many of these negative impacts.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Aggregate quarrying occurs near St. Mary River within the floodplain.
3.3	Renewable energy						NA. No known renewable energy activities in the watershed.
4	Transportation & service corridors		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	The watershed has only a few road accesses across the river and very little new development.
4.2	Utility & service lines		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Utility lines are present and often cross over the rivers. There is a risk of falling lines, but no immediate direct effect. Horizontal drilling under streams is a mitigation technique. There is no knowledge of significant upcoming development. Older development might be a present concern (orphan wells and older lines under the river). Replacement of the aging infrastructure will likely be required.
4.3	Shipping lanes						NA. No known shipping lanes or dredging activity in any of the relevant watersheds.
4.4	Flight paths						NA. No impact on aquatic species.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						NA. Hunting is common in all watersheds, but does not impact Rocky Mountain Sculpin.
5.2	Gathering terrestrial plants						NA. This activity is terrestrial and unlikely to impact Rocky Mountain Sculpin.
5.3	Logging & wood harvesting						NA. There is no known logging or wood harvesting within the range.
5.4	Fishing & harvesting aquatic resources						NA. Recreational fishing is unlikely to affect RMS. Bycatch is minimal and baitfish collection is not allowed.
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Sedimentation and habitat alteration due to recreational activities is a minor concern, as recreational impacts in the watershed are minimal. Upper Lee Creek is public land and recreational activity such as ATV use is permitted; however, impacts are considered small as there are very few incidences of trail intersections with Lee Creek. Additionally, random camping in the area has been reduced due to local concern.
6.2	War, civil unrest & military exercises						NA. No war, civil unrest or military activity present.
6.3	Work & other activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Scientific research as part of SARA and non-targeted sampling may occur, but is not likely to impact populations significantly. Permit systems are in place to mitigate direct impacts as the result of scientific sampling.
7	Natural system modifications	BD	High - Low	Pervasive (71-100%)	Serious - Slight (1-70%)	High (Continuing)	
7.1	Fire & fire suppression						NA. Fire suppression is active and grass fires are possible but not likely to have significant impacts. Aerial spraying for fire suppression addressed under pollution. Possible firefighting activities occur in the Lee Creek region but these activities are not considered detrimental to aquatic systems.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.2	Dams & water management/ use	BD	High - Low	Pervasive (71-100%)	Serious - Slight (1-70%)	High (Continuing)	The St. Mary Reservoir has led to the local extirpation of the species due to alteration of a portion of the river from lotic to lentic. No RMS are found in the reservoir. Temporary Water Diversion Licences (TDL's) can be issued at any time to withdraw water for well injection, watering roads, etc. Therefore, water withdrawal is considered to be broad and widespread. If TDL's are issued during low flow and drought periods, this activity could negatively affect RMS habitat availability. While TDL's are not typically issued in such circumstances, it is legal to do so. There are also current negotiations to increase flow from the upper St. Mary River water diversion into Milk River.
7.3	Other ecosystem modifications		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	There are possible human modifications for recreational use, but they are largely negligible. Rip-rapping, removal of riparian vegetation, invasive species, impacts of fire on vegetation and siltation may be possible. Didymo is naturally occurring but human activities are exacerbating its impacts on aquatic habitat in the area. Quagga Mussels and New Zealand Mud Snail are not present, but could contribute to habitat modifications in the near future.
8	Invasive & other problematic species & genes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Introduction of predatory species including trout, Northern Pike, Walleye, and Yellow Perch could impact populations. There is no scientific evidence of Milk River genetic hybridization, but there is some possibility.
8.2	Problematic native species/diseases						NA. Rocky Mountain Sculpin are susceptible to predation by trout, Burbot, and Sauger in their river systems. Any activity that favours these species like the flow augmentation has the likelihood of increasing predation pressure on Rocky Mountain Sculpin.
8.3	Introduced genetic material						NA. No stocking of Rocky Mountain Sculpin occurs.
8.4	Problematic species/diseases of unknown origin						NA. No known problematic species/diseases of unknown origin affecting Rocky Mountain Sculpin.
8.5	Viral/prion-induced diseases						NA. No known viral/prion-induced diseases affecting Rocky Mountain Sculpin.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.6	Diseases of unknown cause						NA. No known diseases affecting Rocky Mountain Sculpin.
9	Pollution		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.1	Domestic & urban waste water		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	Urban waste water into the systems is rare, and highly unlikely. There is the possibility of some human effluent/leakage into the rivers, but this is unlikely to be significant enough to impact populations. Road salt is minimal, as there are only a small number of paved roads.
9.2	Industrial & military effluents		Unknown	Unknown	Unknown	High (Continuing)	There is very little industrial and military activity where Rocky Mountain Sculpin are distributed. In Alberta, there is the potential for oil drilling and wells to threaten the species, but the overall potential impact is unknown. Pipe bursts and load spills are possible on highways. Older pipelines that are still active could rupture and contaminate rivers. These events are closely monitored and would be cleaned up quickly, therefore it is not considered a significant problem.
9.3	Agricultural & forestry effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Agricultural fertilizer and livestock feces are known to enter the river system. These inputs as well as irrigation demands could have an increasing impact in the future, but the overall impact on RMS is considered insignificant.
9.4	Garbage & solid waste						NA. No known directed solid waste deposits in the river system.
9.5	Air-borne pollutants						NA. Air pollutants are minimal as there is limited industrial activity within the Rocky Mountain Sculpin range. There is the potential for smoke inputs due to wildfires, but impact likely to be insignificant to RMS.
9.6	Excess energy						NA. There is some potential for light and noise pollution from traffic crossings, but these are extremely limited and unlikely to impact RMS.
10	Geological events						
10.1	Volcanoes						NA. No volcanoes nearby.
10.2	Earthquakes/tsunamis						NA. Earthquakes and tsunamis do not occur in the area.
10.3	Avalanches/landslides						NA. Avalanches and landslides do not occur within the area.
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration						NA. Changes with regard to seasons may have an impact on spawning and overall reproductive success due to timing of runoff, but generally, potential impacts are unknown.
11.2	Droughts	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Drought is common and could lead to reduced habitat availability. Decreased snowmelt inputs into the rivers and increased water demand (e.g. for irrigation) could exacerbate these events.
11.3	Temperature extremes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Rocky Mountain Sculpin are known to persist in seasonal temperature extremes throughout their range. Prolonged heat waves, however, may impact species survival, as they are sedentary and unable to move long distances to find cooler water.
11.4	Storms & flooding		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Storms and blizzards are common throughout the range, but increased flows as a result are likely to be minor. Moreover, Rocky Mountain Sculpin have been observed to move near the banks and margins of the rivers where the flow is less severe during spring runoff and rain-induced high water.
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

Appendix 3. Threats Assessment for Rocky Mountain Sculpin – Missouri River populations.

Species or Ecosystem Scientific Name	*Cottus* sp. – Rocky Mountain Sculpin - Missouri River populations		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	1/24/2019		
Assessor(s):	John Post (co-chair), Dwayne Lepitzki (moderator), Tyana Rudolfsen (writer), Doug Watkinson (co-writer), Freshwater Fishes SSC members (Pete Cott, James Grant, Julien April, Doug Watkinson, Constance O'Connor), External Experts (Jeff Burrows, Shane Petry, Ken Miller), DFO (Karine Robert)		
References:	Draft calculator and draft report provided by report writers, December 5, 2018		

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	1	0
C	Medium	0	0
D	Low	2	3
Calculated Overall Threat Impact:		High	Low
Assigned Overall Threat Impact:		**CD = Medium - Low**	
Impact Adjustment Reasons:		High range is from uncertainty. Medium to low concluded as overall impact.	
Overall Threat Comments		Generation time = 4 years therefore time frame for severity & timing = 12 years into the future; Missouri River DU: no abundance estimates within range to help score scope although CPUE higher in upper reaches, 2 locations proposed (Milk and North Milk river)	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						NA. Very small portions of development and there are no known major projects that will directly affect their habitat.
1.2	Commercial & industrial areas						NA. Very small portions of Rocky Mountain Sculpin distribution is developed and there are no known major projects that will directly affect their habitat.
1.3	Tourism & recreation areas						NA. There are some parks and protected areas. There are no known future impacts.
2	Agriculture & aquaculture		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
2.1	Annual & perennial non-timber crops						NA. A large portion is cropland/grassland. There are no known negative impacts to Rocky Mountain Sculpin.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.2	Wood & pulp plantations						NA. No known wood or pulp plantations within the watershed.
2.3	Livestock farming & ranching		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	In general, cattle are unrestricted on the Milk River. While encounters are expected, overall trampling events are expected to have an insignificant impact on RMS populations.
2.4	Marine & freshwater aquaculture						NA. No known aquaculture activities.
3	Energy production & mining		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3.1	Oil & gas drilling		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Drilling exists in the watershed. The main concern is water withdrawal for fracking. Many abandoned wells are left uncapped. Older pipes and wells associated with drilling might still be an issue because they are more likely to fail and/or negatively impact the environment. New drilling technology minimizes many of these negative impacts.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Aggregate quarrying occurs near Milk River within the floodplain.
3.3	Renewable energy						NA. No known renewable or energy activities in any of the relevant watersheds.
4	Transportation & service corridors		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Milk River has only a few road crossings and very little new development.
4.2	Utility & service lines		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Utility lines are present in the watershed and often cross over the rivers. There is a risk of falling lines, but no immediate direct effect. Horizontal drilling under streams is a mitigation. There is no knowledge of significant upcoming development. Older development might be a present concern (orphan wells and older lines under the river). Replacement of the aging infrastructure will likely be required.
4.3	Shipping lanes						NA. No known shipping lanes or dredging activity in any of the relevant watersheds.
4.4	Flight paths						NA. No impact on aquatic species.
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						NA. Hunting is common, but does not impact Rocky Mountain Sculpin.
5.2	Gathering terrestrial plants						NA. This activity is terrestrial and unlikely to impact Rocky Mountain Sculpin.
5.3	Logging & wood harvesting						NA. There is no known logging or wood harvesting.
5.4	Fishing & harvesting aquatic resources						NA. Recreational fishing is unlikely to affect RMS. Bycatch is minimal and baitfish collection is not allowed.
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Sedimentation and habitat alteration due to recreational activities is a minor concern, as recreational impacts are minimal.
6.2	War, civil unrest & military exercises						NA. No war, civil unrest or military activity present.
6.3	Work & other activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Scientific research as part of SARA and non-targeted sampling may occur, but is not likely to impact populations significantly. Permit systems are in place to mitigate direct impacts as the result of scientific sampling.
7	Natural system modifications	BD	High - Low	Pervasive (71-100%)	Serious - Slight (1-70%)	High (Continuing)	
7.1	Fire & fire suppression						Fire suppression is active. Grass fires are possible but not likely to have significant impacts.
7.2	Dams & water management/use	BD	High - Low	Pervasive (71-100%)	Serious - Slight (1-70%)	High (Continuing)	The entire Milk River population is affected. Extreme fluctuations in flow due to water diversion throughout the year has occurred for over 100 years; however, Rocky Mountain Sculpin still exists in the system. Temporary water diversion licences (TDLs) are prevalent near Milk River and can be issued at any time to withdraw water for well injection, wetting roads, etc. If issued during low flows or drought periods, water withdrawal could have negative effects on habitat availability. While not typically issued under those circumstances, it is still allowed. The upper St. Mary River water diversion into Milk River could possibly be increasing in flow by less than 1%. Augmentation is providing habitat for Sculpin in the Milk River.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.3	Other ecosystem modifications		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Possible human modifications for recreational use, but largely negligible. Removal of riparian vegetation, invasive species, impacts of fire on vegetation and siltation can all modify RMS habitat. Didymo is naturally occurring but human activities are exacerbating its impacts on habitat. Quagga Mussels and New Zealand Mud Snail are not yet present, but could lead to future habitat modifications.
8	Invasive & other problematic species & genes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Introduction of predatory species including trout, Northern Pike, Walleye, and Yellow Perch into the Milk River could impact populations. There is no scientific evidence of St. Mary - Milk River genetic mixing but it is possible at confluence of water diversion from St. Mary to Milk River.
8.2	Problematic native species/diseases						Rocky Mountain Sculpin are prey species, and thus are susceptible to predation by trout, Burbot, and Sauger in their river systems. Any activity that favours these species like the flow augmentation has the likelihood of augmenting predation pressure on Rocky Mountain Sculpin. An example of this is the water diversion to the Milk River. Increased flow provides suitable habitat for Sauger and Burbot.
8.3	Introduced genetic material						NA. No stocking of Rocky Mountain Sculpin occurs.
8.4	Problematic species/diseases of unknown origin						NA. No known problematic species/diseases of unknown origin affecting Rocky Mountain Sculpin.
8.5	Viral/prion-induced diseases						NA. No known viral/prion-induced diseases affecting Rocky Mountain Sculpin.
8.6	Diseases of unknown cause						NA. No known diseases of unknown cause affecting Rocky Mountain Sculpin.
9	Pollution		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Domestic & urban waste water		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	Urban waste water into the system is rare, and highly unlikely. There is the possibility of some human effluent/leakage into the Milk River, but it is unlikely to be significant enough to impact populations. The town of Milk River is the only major effluent source, but effluent diversion from Milk River is underway. Road salt is minimal, as there are only a small number of paved roads in the Missouri River DU.
9.2	Industrial & military effluents		Unknown	Unknown	Unknown	High (Continuing)	There is very little industrial and military activity where Rocky Mountain Sculpin are distributed. In Alberta, there is the potential for oil drilling and wells to threaten the species, but the overall potential impact is unknown. Pipe bursts and load spills are possible on highways. Older pipelines that are still active could rupture and contaminate rivers. These events are closely monitored, however, and would be cleaned up quickly, therefore it is not considered a significant problem.
9.3	Agricultural & forestry effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Agricultural fertilizer and livestock feces are known to enter the river system. These inputs as well as irrigation demands could have an increasing impact in the future, but the overall impact on RMS is considered insignificant.
9.4	Garbage & solid waste						NA. No known directed solid waste deposits in any of the river systems.
9.5	Air-borne pollutants						NA. Air pollutants are minimal as there is limited industrial activity within Rocky Mountain Sculpin range. Potential for smoke due to wildfires, but impact likely to be insignificant to the species.
9.6	Excess energy						NA. Some potential light and noise pollution from traffic crossings, but these are extremely limited and unlikely to impact Rocky Mountain Sculpin.
10	Geological events						
10.1	Volcanoes						NA. No volcanoes nearby.
10.2	Earthquakes/tsunamis						NA. Earthquakes and tsunamis do not occur in the area.
10.3	Avalanches/landslides						NA. Avalanches and landslides do not occur.
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration						NA. Changes with regard to seasons may have an impact on spawning and overall reproductive success due to timing of runoff, but generally, potential impacts are unknown.
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Drought is common and could lead to reduced habitat availability. Historically, droughts have been known to extirpate RMS from locations throughout the Milk River where flows decreased drastically or dried up. This is likely to become more frequent and widespread. Decreased snowmelt runoff into the river and increased water demand (e.g. for irrigation) could exacerbate these events.
11.3	Temperature extremes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Rocky Mountain Sculpin are known to persist in seasonal temperature extremes throughout their range. Prolonged heat waves, however, may impact species survival, as they are sedentary and unable to move long distances to find cooler water.
11.4	Storms & flooding		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Storms and blizzards are common throughout the range, but increased flows as a result are likely to be minimal. Moreover, Rocky Mountain Sculpin have been observed to move near the banks and margins of the rivers where the flow is less severe during spring runoff and rain-induced high water.
11.5	Other impacts						