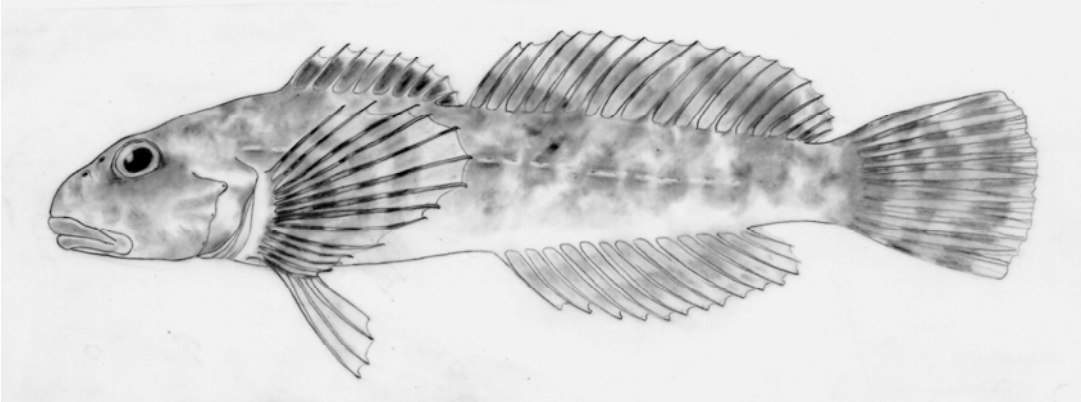
COSEWIC
Assessment and Status Report

on the

Shorthead Sculpin
Cottus confusus

in Canada



SPECIAL CONCERN
2010

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous report(s):

Production note:
COSEWIC acknowledges Don McPhail for writing the provisional status report on the Shorthead Sculpin, *Cottus confusus*, prepared under contract with Environment Canada. The contractor's involvement with the writing of the status report ended with the acceptance of the provisional report. Any modifications to the status report during the subsequent preparation of the 6-month interim status and 2-month interim status reports were overseen by Eric Taylor, COSEWIC Freshwater Fishes Specialist Subcommittee Co-chair.

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COSEWIC
Assessment Summary

Assessment Summary – November 2010

Common name
Shorthead Sculpin

Scientific name
Cottus confusus

Status
Special Concern

Reason for designation
In Canada, this small freshwater fish is endemic to the Columbia River basin where it has a very small geographic distribution. It is sedentary as an adult, making it particularly susceptible to habitat loss and degradation from water flow alteration, drought, and pollution. It occurs at a small number of locations and there is a continuing decline in habitat quality. A change from Threatened (2001) to Special Concern reflects an increase (13) in the estimation of the number of locations.

Occurrence
British Columbia

Status history
Designated Threatened in April 1984. Status re-examined and confirmed Threatened in May 2001. Status re-examined and designated Special Concern in November 2010.

COSEWIC
Executive Summary

Shorthead Sculpin
Cottus confusus

Wildlife species information

The Shorthead Sculpin is a small (maximum of 105 mm total length) bottom-dwelling freshwater fish endemic to the Columbia River basin. It has a large head and the body tapers to a narrower shape towards the caudal (tail) fin. The Shorthead Sculpin may be confused with several other co-occurring sculpins. The Shorthead Sculpin has two median chin pores and 11-13 anal rays, while the Prickly Sculpin has a single median chin pore and 16 to 18 anal rays. The Shorthead Sculpin differs from the Torrent Sculpin in prickle pattern and the length of the lateral line: there is a single dense patch of prickles behind the pectoral fin in the Shorthead Sculpin, whereas the entire flanks of the Torrent Sculpin usually are covered in prickles. Also, the lateral line in the Shorthead Sculpin is incomplete while the lateral line in the Torrent Sculpin is complete. The Columbia and Shorthead sculpins are more difficult to distinguish; however, their caudal peduncles differ in depth (3.1 to 4.5 into the head in the Shorthead Sculpin and 4.8 to 5.7 in the Columbia Sculpin). In addition, the lateral line in the Shorthead Sculpin typically ends before the insertion of the anal fin, whereas the lateral line on the Columbia Sculpin is either complete or ends on the caudal peduncle. The Shorthead Sculpin rarely exceeds 100 mm in total length. There is no evidence for multiple designable units within the Shorthead Sculpin.

Distribution

In Canada, the Shorthead Sculpin occurs only in British Columbia (BC). Its BC distribution extends from just below Keenleyside Dam (near Castlegar, BC) downstream to the United States (US) border, and in the Kootenay River system (including the Slocan River) from below the original site of Bonnington Falls to the confluence of the Kootenay and Columbia rivers. It also occurs in the 5 km of the Kettle River between Cascade Falls and the US border. The BC population in the Kootenay system is isolated from Columbia River populations by Brilliant Dam, and the Kettle River population is isolated from other Columbia River populations by Roosevelt Reservoir in Washington State. In the US, this species occurs in Washington, Oregon, Idaho, and northern Nevada.

Habitat

Like other sculpins, the Shorthead Sculpin usually shelters in riffles and runs during the day. It is associated with moderate to fast water velocities and loose rock substrates. It is active at night, but little is known about either its nocturnal, or winter, habitat use. Although the Shorthead Sculpin is typically a headwater species in the US, in BC it is not associated with headwater streams. It is uncommon in the mainstems of large rivers like the Columbia and Kootenay rivers, but is abundant in the lower reaches of tributaries to these mainstems. Normally, however, it does not ascend more than a few kilometres up these tributaries.

Biology

This species is relatively short-lived. The maximum lifespan is about six years, but most individuals live less than five years. Sexual maturity in females is reached in two to three years, and two years in males. Spawning in Pass Creek near Castlegar occurs from late spring (mid-May) to early summer (mid-July). Males excavate a nest under rocks, court females, and guard the eggs. Most nests contain several separate egg masses. This suggests that the species is polygamous. The eggs are large (eyed eggs in Pass Creek averaged 3.2 mm in diameter), and take about 3 to 4 weeks to hatch at temperatures above 10.0ºC. Shorthead sculpins forage on the larvae and nymphs of aquatic insects (especially caddisflies and stoneflies). Like other freshwater sculpins, as an adult this species is sedentary and individuals rarely move more than 50 to 100 m.

Population sizes and trends

No quantitative data are available on the numbers of Shorthead Sculpins in BC; however, the populations appear to be stable. This stability is inferred from casual collections made over the years — they are still found at all the sites where they were collected in the past, including the 5 km of the Kettle River where they were first collected more than 60 years ago.

Threats and limiting factors

The absence of Shorthead Sculpins from the high-gradient portions of Columbia River tributaries in Canada suggests that they are sensitive to either water velocity or temperature (or a combination of these factors). They also appear to be sensitive to changes in velocity because they are no longer present in the ponded areas of the Kootenay River above Brilliant Dam, but are still present in the free flowing portion of the river and in tributaries to the ponded areas. Hydroelectric dams and associated reservoirs fragment the distribution and disturb the habitat of this species in both BC and the US, and private power projects on small rivers and mid-sized streams are proliferating in BC including the Kootenay Region. The Kettle River population appears to have the numerically smallest population in Canada and appears to be negatively impacted by a combination of high temperatures and low water conditions during the summer irrigation season.

Special significance

The Shorthead Sculpin is endemic to the Columbia River drainage system of western North America. Within this system, it has a limited and fragmented distribution. Consequently, the Shorthead Sculpin has a relatively small global distribution and, in Canada, it only occurs in south-central British Columbia. This limited Canadian distribution makes it an important component of Canada's biological heritage. In addition, there are unresolved taxonomic problems with this species and sculpins are of scientific interest in investigations to understand how such morphologically and behaviourally similar species coexist and remain reproductively isolated in small streams.

Existing protection, status, and ranks

The federal *Fisheries Act* provides Fisheries and Oceans Canada (DFO) with powers to conserve and protect fish and fish habitat (as defined in the *Fisheries Act*) essential to sustaining commercial, recreational and Aboriginal fisheries. Environment Canada has been delegated administrative responsibilities for the provisions dealing with regulating the pollution of fish-bearing waters while the other provisions are administered by DFO. An earlier COSEWIC assessment of Shorthead Sculpin assigned an Endangered status in November 1983; however, that status report included the Rocky Mountain Sculpin in the Flathead River as well as the Shorthead Sculpin. These two sculpins are now recognized as distinct species. A more recent review (May 2001) assessed the species as Threatened and the federal *Species at Risk Act* (SARA) listed the Shorthead Sculpin as Threatened (Schedule 1). The status was re-examined by COSEWIC and designated Special Concern in November 2010. The BC Conservation Data Centre ranks this species S2S3 (a species of special concern). Globally, its NatureServe rank is G5T4Q (globally secure, of concern locally, and of questionable taxonomy).

TECHNICAL SUMMARY

Cottus confusus
Shorthead Sculpin Chabot à tête courte

Range of occurrence in Canada (south-central BC): The Canadian range of the Shorthead Sculpin consists of three populations separated by barriers (dams and reservoirs): the Columbia, Kootenay/Slocan and Kettle populations.

The Columbia River population: This population encompasses the 41 km of the mainstem Columbia River between Keenleyside Dam and the US border, plus 3 km of Norns (Pass) Creek between the Columbia River and Norns Falls, 0.5 km of Blueberry Creek, 0.5 km of Champion Creek, and 4.5 km of Beaver Creek between the Columbia River and Beaver Falls (Figure 2).

The Kootenay/Slocan rivers population: This population consists of 41 km of the Kootenay River from its confluence with the Columbia River upstream to South Slocan Dam, plus the Slocan River from its confluence with the Kootenay River upstream to Slocan Lake (about 45 km) and about 2.5 km of Lemon Creek and approximately 10 km of the Little Slocan River and its tributary, Koch Creek (Figure 3).

Kettle River population: This population occurs in the five km of the Kettle River between Cascade Falls and the US border (Figure 4).

Demographic Information

Generation time (average age of parents in the population)	3 to 4 yrs
Is there an observed continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations.	No decline
Inferred percent reduction in total number of mature individuals over the last 3 generations.	No decline
Projected or suspected percent reduction in total number of mature individuals over the next 3 generations.	Unknown
Inferred percent reduction in total number of mature individuals over any 10 year period, over a time period including both the past and the future. Kootenay/Slocan population	Columbia and Kettle populations apparently stable for last 60 years. No quantitative evidence for a decline in this population over the last 10 years.
Are the causes of the decline clearly reversible and understood and ceased?	Mo decline
Are there extreme fluctuations in number of mature individuals?	No, apparently stable

Extent and Occupancy Information

Estimated extent of occurrence. Columbia population Kootenay/Slocan population Kettle population Total in Canada (individual EOs do not necessarily sum to total because of use of convex polygons)	 380 km² 628 km² 3.4 km² 2,572 km²
Index of area of occupancy (IAO) IAO Columbia population IAO Kootenay/Slocan population IAO Kettle population Total IAO in Canada	 2X2= 176 km² 2X2= 216 km² 2X2= 24 km² 2X2= 556 km²
Is the total population severely fragmented (*sensu* IUCN)?	No

Number of locations (total) Columbia population Kootenay/Slocan population Kettle population	Approximately 13 locations in Canada One in the Columbia River and five in tributaries Three locations in the mainstem Slocan River and three in tributaries (Lemon Ck., Little Slocan R, and Koch Ck). One location in the Kettle R.
Is there an inferred continuing decline in extent of occurrence?	No
Is there an inferred continuing decline in index of area of occupancy?	Unknown
Is there an observed continuing decline in number of populations?	Unknown, possible loss of Blueberry and Champion creeks populations.
Is there an observed continuing decline in number of locations?	Unknown, possible loss of Blueberry and Champion creeks populations.
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Probably, owing to ongoing hydroelectric operations; also possible declines given increased pressure for water extraction and climate warming trends.
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations∗?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	**N Mature Individuals**
	unknown
Total	unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	No quantitative analysis (necessary data not available)

Threats (actual or imminent, to populations or habitats)

Actual
Columbia population: Pollution and introduced species in the mainstem Columbia River.

Kootenay/Slocan population: Minor pollution threats in the Slocan River.

Kettle population: The major threat to this cool-water species in the Kettle River is an increase in the maximum summer temperature and periods of low flow that result from agricultural water extraction.

Potential:
All populations: Scientific oversampling

Columbia population: excessive eutrophication in Beaver Creek

Kootenay/Slocan population: The impact of the proposed hydroelectric project on Koch Creek is unclear.

Kettle population: The impact of the proposed hydroelectric project at Cascade Falls is unclear.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)

Columbia population: Secure in the Columbia River: there is a population in Sheep Creek, Washington (40 km downstream), that might act as a source for recolonization.

Kootenay/Slocan population: Brilliant Dam on the Kootenay River prevents recolonization from any source outside the Slocan River.

Kettle population: Downstream of the US border there are potential recolonization sources in the Kettle River, but only down to Roosevelt Reservoir in the US.

Is immigration known or possible?	Possible for Columbia and Kettle populations but not for Kootenay/Slocan population
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	No, if the BC populations remain stable. Yes, if the BC populations decline.
Is rescue from outside populations likely?	Possible for Columbia and Kettle populations but not for Kootenay/Slocan population

Current Status

COSEWIC: Assessed as Special Concern in 2010.
SARA: Threatened (Schedule 1)

Additional Sources of Information:

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	NA
Reason for Designation: In Canada, this small freshwater fish is endemic to the Columbia River basin where it has a small geographic distribution. It is sedentary as an adult, making it particularly susceptible to habitat loss and degradation from water flow alteration, drought, and pollution. It occurs at a small number of locations and there is a continuing decline in habitat quality. A change from Threatened (2001) to Special Concern reflects an increase (to 13) in the estimated number of locations.	

Applicability of Criteria

Criterion A: Does not meet any criteria.
Criterion B: Meets Endangered B1 (EO < 5,000 km²); close to meeting Endangered for B2 (IAO = 556km²) and meets Threatened for B2(b) as the IAO is < 2,000 km² and there is evidence of past and continuing loss of habitat quality, but not for sub-criterion (a) as there are more than 10 locations (~13), nor (c).
Criterion C: Does not meet any of the criteria. No population size estimates are available.
Criterion D: Does not meet any of the criteria.
Criterion E: Not conducted (required data unavailable).

PREFACE

The Shorthead Sculpin (*Cottus confusus*) is a small, freshwater sculpin (Cottidae). In Canada, it only occurs in the Columbia River and its tributaries in south-central British Columbia (BC). The Shorthead Sculpin was last reviewed in 2001 (COSEWIC 2001) and is included in the *SARA* Schedule 1 list as Threatened. The report that follows is the second assessment under the revised criteria as required for all species assessed by COSEWIC before 1999. Since the 2001 assessment, the relationship between the Shorthead Sculpin and the Mottled Sculpin (*Cottus bairdii*) has been clarified, and the Shorthead Sculpin is no longer considered a close relative of, or even a member of the same clade (a group of related species that share a common ancestor), as *Cottus bairdii*. Still, there are unresolved taxonomic issues with the Shorthead Sculpin that involve some of the isolated disjunct populations found west of the Cascade Mountains. Since the last review, the geographic distribution of the species has remained unchanged in Canada, and there is no evidence of a decline in numbers at any of the known Canadian sites; however, existing data on abundance are scarce and mostly anecdotal. There is some new information on the species' reproductive biology and a few new site-specific estimates of abundance. In terms of threats, there has been an increase in proposals for private run-of-the-river hydroelectric projects in the Kootenay region of BC since the last review. Although in streams that contain Shorthead Sculpins most of these projects are upstream of barriers (waterfalls), the downstream effects of such projects are unknown. The Kettle River population of Shorthead Sculpins is of some concern. The Canadian range of this population is restricted to 5 km of the river below Cascade Falls. The Kettle River is subject to low water and high temperatures during the irrigation season (summer), and fish kills (at least six in the last 20 years) are relatively common. If warming trends in this region continue, the Kettle River population may be in danger of extirpation. The Shorthead Sculpin Recovery Team was established after the species was listed as Threatened under Schedule 1 of *SARA* and a recovery plan has been completed, but no specific actions have been undertaken to facilitate recovery (Shorthead Sculpin Recovery Team 2008).

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2010)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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

COSEWIC Status Report

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2010

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WILDLIFE SPECIES INFORMATION

Name and classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Actinopterygii
Order:	Scorpaeniformes
Family:	Cottidae
Scientific name:	*Cottus confusus*
Common name:	English: Shorthead Sculpin.
	French: Chabot à tête courte

Taxonomic history

Common name

Cottus confusus was described by Bailey and Bond (1963) and the common name, Shorthead Sculpin, was applied to this new species. In subsequent editions of the *American Fisheries Society List of Common and Scientific Names*, the common name Shorthead Sculpin was used for *Cottus confusus*. Thus, there is no confusion about the common name of *Cottus confusus.*

Scientific name

Originally, the Shorthead Sculpin was thought to be a western member of the Uranidea clade of related sculpins — what Bailey and Bond (1963) called the "*Cottus bairdii* species group". Recent morphological and molecular data (Kinziger *et al*. 2005), however, indicate that *Cottus confusus* may belong to a different (as yet unnamed) clade of western North American sculpins that includes *Cottus beldingii*, *Cottus greenei*, and *Cottus leiopomus*. In the past, the Shorthead Sculpin was also confused with the Rocky Mountain Sculpin, *Cottus* sp. (McAllister and Lindsey 1961; Bailey and Bond 1963; Peden and Hughes 1984; Nelson and Paetz 1992).

Morphological description

Diagnosis

At some sites in Canada three other *Cottus* species are sympatric or parapatric with the Shorthead Sculpin: the Prickly Sculpin (*Cottus asper*), the Columbia Sculpin (*Cottus hubbsi*), and the Torrent Sculpin (*Cottus rhotheus*). The Shorthead Sculpin has two median chin pores and 11 to 13 anal rays, whereas the Prickly Sculpin has a single median chin pore and 16 to 18 anal rays. Shorthead Sculpins have a maximum recorded size of 105 mm total length (Scott and Crossman 1973) and differ from the Torrent Sculpin in prickle pattern and the length of the lateral line. There is a single dense patch of prickles behind the pectoral fin in the Shorthead Sculpin, whereas the

entire flanks of the Torrent Sculpin usually are covered in prickles. Also, the lateral line in the Shorthead Sculpin is incomplete while the lateral line in the Torrent Sculpin is complete. Sometimes, Shorthead and Columbia sculpins are difficult to distinguish; however, their caudal peduncles differ in depth (3.1 to 4.5 into the head length in the Shorthead Sculpin and 4.8 to 5.7 in the Columbia Sculpin). In addition, the lateral line in the Shorthead Sculpin typically ends before the insertion of the anal fin, whereas the lateral line on the Columbia Sculpin is either complete or ends on the caudal peduncle.

Description

The following description of the Shorthead Sculpin is based on specimens from the three British Columbia populations. In general body shape, Shorthead Sculpins resemble most other sculpins in the genus *Cottus* (see cover illustration). The size of body parts in fishes is often expressed as a percentage of length in order to compare fish of different lengths. In the Shorthead Sculpin, the head is short (usually < 31% of standard length, SL); standard length is measured as the distance from the tip of mouth to the hinge point of the tail. The maximum body depth immediately behind the head is 18 to 20% of SL, the mouth length is 14 to 20% of SL, and the caudal peduncle depth is 7 to 9% of SL. There are two median chin pores, and a single postmaxillary pore is present on more than half the specimens. The first and second dorsal fins usually are weakly conjoined, with 7 to 9 spines in the first dorsal fin and 15 to 18 rays in the second dorsal fin. There are 12 to 13 anal rays and 12 to 15 pectoral rays. Pelvic fins have 1 spine and 4 rays. The lateral line is incomplete (22 to 33 pores) and typically terminates before the last ray of the second dorsal fin. Usually, there is a patch of prickles in the pectoral axial. Palatine teeth are present, and usually well developed but arranged in a narrow row. The preopercular spines are reduced and usually only two sharp spines are obvious but sometimes there is a blunt third spine.

Colouration is variable but, typically, the back is light brown or olive with slightly darker, indistinct saddles under the soft dorsal fin and small, irregular dark marks on the upper flanks. The top of the head and nape are often peppered with small, dark spots. In non-breeding adults there are usually two dark blotches on the first dorsal fin: the anterior blotch is often indistinct but normally the posterior blotch is obvious. In breeding males the first dorsal fin is black with a yellow or orange edge.

Population spatial structure and variability

Allozymes

An allozyme data set (attributed to Ruth Withler (Fisheries and Oceans Canada, DFO) and Alex Peden (Royal British Columbia Museum, RBCM)) includes Shorthead Sculpins from the Columbia, Kootenay (Slocan River), and Kettle rivers' populations (COSEWIC 2001). These data indicate that Nei's genetic distances among the uppermost Columbia River site (Norns Creek) and the Slocan and Kettle rivers are minor (e.g., genetic distances of <0.01). Curiously, the genetic distance between the Norns Creek population and the Beaver Creek population was much higher, 0.05, but

the river distance between Norns and Beaver creeks is only about 39 km. Similarly, the genetic distance between Beaver Creek and Sheep Creek (a Columbia River tributary stream about 40 km south of Beaver Creek in Washington State) is 0.10. By contrast, the river distance between Norns Creek and the Kettle River site is about 200 km yet the genetic differences are much smaller (< 0.01).

Mitochondrial DNA

Genetic distances among mitochondrial sequences were obtained from the six *Cottus* species that occur in the Canadian portion of the Columbia drainage system (Table 1). In addition, information on the Staghorn Sculpin, *Leptocottus armatus,* a marine species was included. *Leptocottus* is used for comparison because this genus is thought to be the sister taxon of *Cottus* (Yabe 1985; Smith and Wheeler 2004). Because of the history of confusion about the possible existence of *Cottus bairdii* in western North America, a "real" *C. bairdii* from Ontario has been included in the analyses (Table 1). Typically, genetic distances among *Cottus* species (based on mitochondrial DNA) range from 2.5 to 5% (Yokoyama and Goto 2005; Yokoyama *et al.* 2008). The genetic distances among the six BC *Cottus* species range from 0.024 to 0.068 (2.4 – 6.8%). *Cottus asper* is the most divergent of these six freshwater species and Kinziger *et al.* (2005) placed the Prickly Sculpin in the Cottopsis sculpin clade. Except for *C. confusus*, the rest of the *Cottus* species in Table 1 are in the Uranidea sculpin clade; however, *Cottus confusus* does not appear to belong in either of the two clades mentioned above. Instead, it groups with the Paiute Sculpin *C. beldingii*, the Shoshone Sculpin, *C. greenei*, and the Wood River Sculpin, *C. leiopomus*. Together, these species appear to form a separate and distinct clade of western North American sculpins (Kinziger *et al.* 2005).

Table 1. Genetic distances among the six species of sculpins found in the Canadian portion of the Columbia River system plus the eastern North American species, *Cottus bairdii*. The distances are uncorrected and based on 1,140 base pairs of cytochrome b sequence.

	1)	2)	3)	4)	5)	6)	7)	
1) *C. bairdii*	-----							
2) Slimy	0.035	-----						
3) RMS	0.039	0.024	-----					
4) Columbia	0.040	0.029	0.026	-----				
5) Shorthead	0.048	0.036	0.033	0.033	-----			
6) Torrent	0.050	0.033	0.033	0.040	0.045	-----		
7) Prickly	0.065	0.060	0.063	0.063	0.068	0.067	-----	
8) *Leptocottus*	0.082	0.081	0.080	0.080	0.082	0.089	0.093	-----

Cottus bairdii is the "real" mottled sculpin from Ontario; RMS is the Rocky Mountain Sculpin from Sage Creek (Flathead River); Slimy is the Columbia form of *Cottus cognatus* from above the barriers on Koch Creek (Slocan system); Shorthead is *C. confusus* from Beaver Creek near Trail, BC; Columbia is *C. hubbsi* from Koch Creek near Slocan; Torrent is *C. rhotheus* from the Similkameen River, BC, and Prickly is *C. asper* from the Kootenay River near Castlegar, BC. McPhail (unpublished data, 2009).

Complete (1,140 bp) cytochrome *b* sequences obtained from Shorthead Sculpins in Beaver Creek, a small tributary of the Columbia River near Trail, BC, and the Slocan River near Vallican, BC, closely match each other (< 0.02% difference) and a sequence from a specimen from the Salmon River, Blaine County, Idaho (Genbank AY833343, Neely 2002 and pers. comm., 2010). The BC and Idaho specimens are undoubtedly the same species.

Summary of genetic evidence

With one exception, the allozyme data indicate only minor (interpopulation) differences among the Columbia, Kootenay, and Kettle rivers' populations of Shorthead Sculpins. The exception is Beaver Creek near Trail, BC. The genetic distance between this population and the other BC sites is about five times larger (0.05) than what was found among the other sites; however, it is important to put these allozyme data in perspective. First, these genetic distances are based on differences in allele frequencies and not on locality-specific alleles. Thus, although all the localities share the same alleles, the frequencies of the alleles can, and do, differ among populations. Second, Nei's genetic distance assumes allozymes are selectively neutral; however, the frequency of alleles at any locality may reflect founder effects, genetic drift, or responses to local selection. In particular, population bottlenecks and founder events can dramatically influence allele frequencies and resultant genetic distances (i.e., use of Nei's genetic distances assumes, among other things, that the effective population sizes of all populations have been stable through time, Nei 1972). Third, in the Shorthead Sculpin the differences in allele frequencies among the Canadian populations make no phylogeographic sense — populations in creeks (e.g., Beaver and Sheep creeks) that are separated by no barrier other than 40 km of the Columbia River differ by 0.10, whereas populations (e.g., the Kettle River and Norns Creek) that are separated by 200 km of river plus a natural barrier (Kettle Falls) are almost identical. Relative to salmonids, and presumably other freshwater fishes, the depth of allozyme divergences found among Canadian populations of Shorthead Sculpins are typical of those found among populations within a geographic region (Avise 1994). Consequently, although allele frequencies in the Beaver Creek population are different from other BC populations of *C. confusus*, they do not necessarily indicate a phyletic divergence.

In contrast, differences in mitochondrial sequences probably better reflect phyletic divergence, and the mitochondrial differences among BC populations of *C. confusus* (including the Beaver Creek population) and the specimens from Idaho are small (0.01%) and typical of postglacial interpopulation divergences.

Designatable units

Although physical barriers restrict gene flow among populations within the Canadian range of the Shorthead Sculpin, these river segments (the Columbia River, the Kootenay/Slocan drainage system below Bonnington Falls, and the Kettle River) constitute a single designatable unit. All localities are within a single National Freshwater Biogeographic Zone (Pacific) and there are no genetic data that can be used to statistically assess discreteness amongst all Canadian populations. Still, the river segments differ in their size, the threats they face and, perhaps, in their probabilities of extinction. Consequently, aspects of the biology of Shorthead Sculpins and the threats they face will be discussed, when possible, for three recognized population groups: a Columbia population, a Kootenay/Slocan population, and a Kettle River population.

Special significance

Taxonomically, the Shorthead Sculpin, *Cottus confusus*, is an enigmatic species that appears to belong to a unique sculpin clade endemic to northwestern North America (Kinziger *et al*. 2005) and is the only sculpin in Canada that belongs in this clade. Not only is the Shorthead Sculpin's distribution in Canada limited but also it has no place to go — its Canadian distribution is constrained by physical barriers (dams, large lakes, and water falls). Thus, if climate changes or invasive species negatively modify their environment, Shorthead Sculpins cannot disperse farther into Canada and we will lose a unique part of our biological heritage. Additionally, sculpins of the genus *Cottus* are of unusual scientific interest. The presence of up to five morphologically and ecologically similar species in the streams of south-central BC provide unique opportunities to study the phenomena of resource partitioning and reproductive isolation.

DISTRIBUTION

Global range

The Shorthead Sculpin is endemic to northwestern North America. It is restricted to the Columbia drainage system and adjacent drainages that contain fish faunas derived from the Columbia River. *Cottus confusus* occurs in parts of the Columbia system in BC; in the Columbia, Snake, Puget Sound, and Olympic Peninsula drainages in Washington; in the Columbia, Willamette, and lower Snake drainages in Oregon; in the lower Snake (Clearwater, Boise, and Salmon rivers) and Sinks rivers, and Bruneau River in Idaho, and in the Jarbidge River in northern Nevada. The Shorthead Sculpin's distribution within this range is highly fragmented (Figure 1). Most of these isolated fragments are natural, but hydroelectric and storage dams now exacerbate this fragmentation.

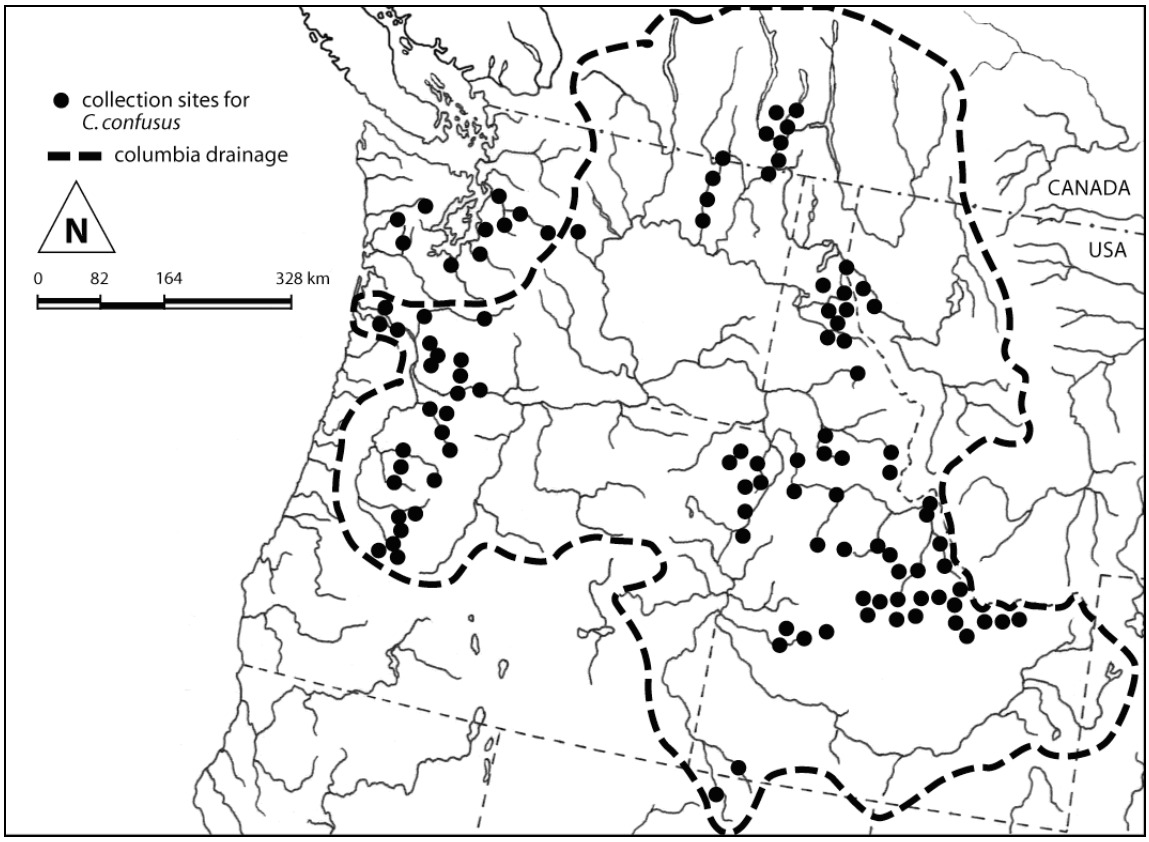

Figure 1. Global distribution of the Shorthead Sculpin, *Cottus confusus*. Note the absence of this coolwater species from the arid central Columbia Basin. Data from Bond (1963), Simpson and Wallace (1978), Wydoski and Whitney (2003), COSEWIC 2001, and McPhail (2007).

Canadian range

The Canadian range of the Shorthead Sculpin consists of three populations separated by natural and man-made barriers and includes areas within the Okanagan First Nation. The Columbia River population consists of the 41 km of the mainstem Columbia River between Keenleyside Dam on the Columbia River and the US border, plus 2.8 km of the Kootenay River between Brilliant Dam and its confluence with the Columbia River, 3 km of Norns (Pass) Creek between the Columbia River and Norns Falls, 0.5 km of Blueberry Creek, 0.5 km of Champion Creek, and 4.5 km of Beaver Creek between the Columbia River and Beaver Falls (Figure 2). The Kootenay/Slocan population extends from Brilliant Dam upstream to the original site of Bonnington Falls (a distance of about 41 km), plus the Slocan River from its confluence with the Kootenay River upstream to Slocan Lake (about 45 km), about 2.5 km of Lemon Creek, and approximately 10 km of the Little Slocan River and its tributary, Koch Creek (Figure 3). Virtually all (> 95%) of the Kootenay River above Brilliant Dam is ponded and is now inappropriate habitat for *C. confusus*; however, Shorthead Sculpins are modestly abundant in the Slocan River and the lower reaches of the Little Slocan River (including lower Koch Creek) and Lemon Creek. This species has not been found above Slocan Lake. The Kettle population is restricted to the 5 km stretch of the Kettle River between

Cascade Falls and the US border (Figure 4). Using the polygon method (COSEWIC 2009b), the total EO (extent of occurrence) in Canada is estimated to be 2,572 km^2. Based on the lengths of rivers and creeks known to contain this species and overlaying 2 x 2 km grids, the IAO (index of the area of occupancy) in Canada is estimated to be 556 km^2. Employing a 1 x 1 km grid results in an IAO of 245 km^2.

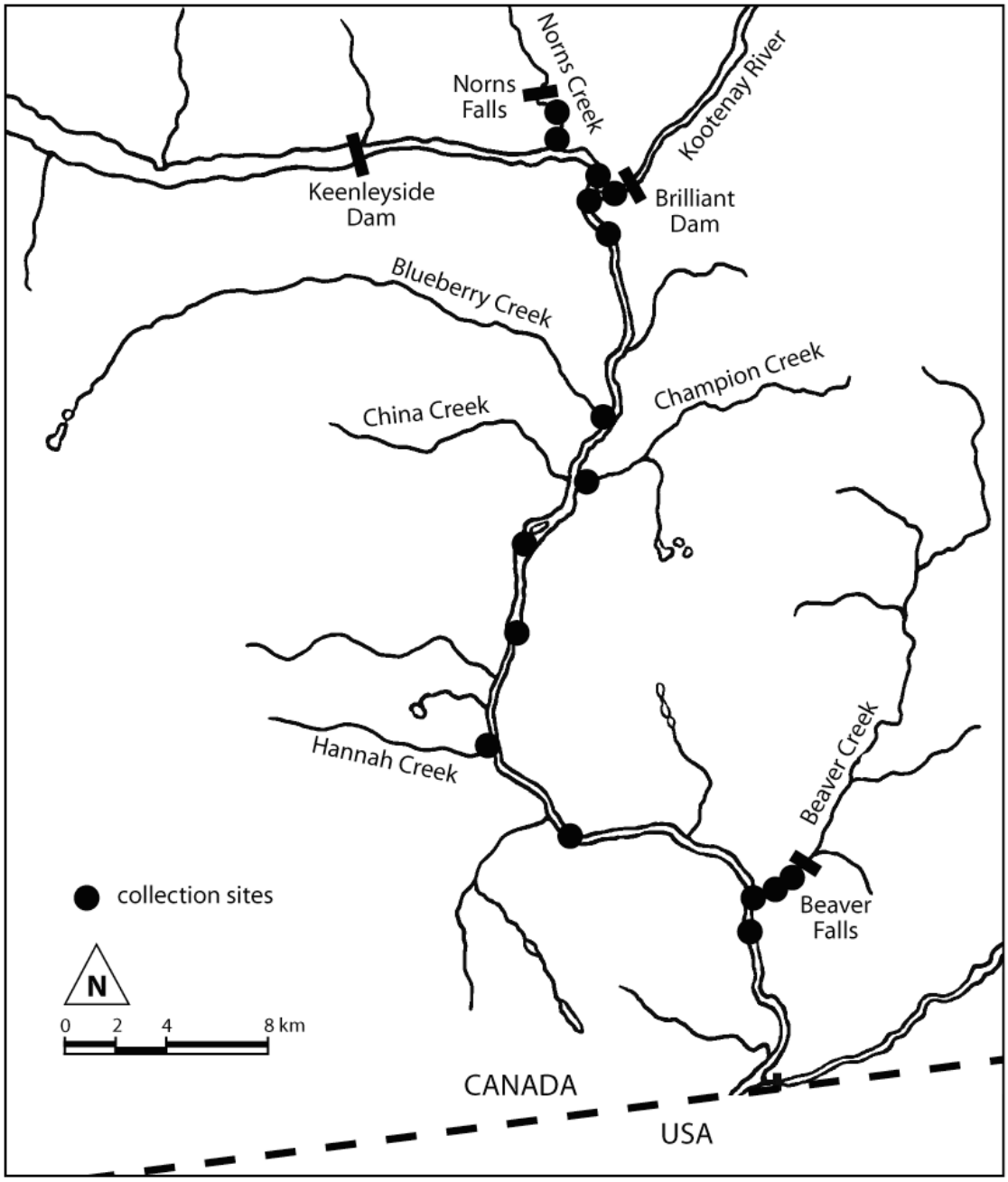

Figure 2. Distribution of the Columbia population of Shorthead Sculpins. Black bars represent named migration barriers. Source: University of British Columbia and Royal British Columbia Collections databases.

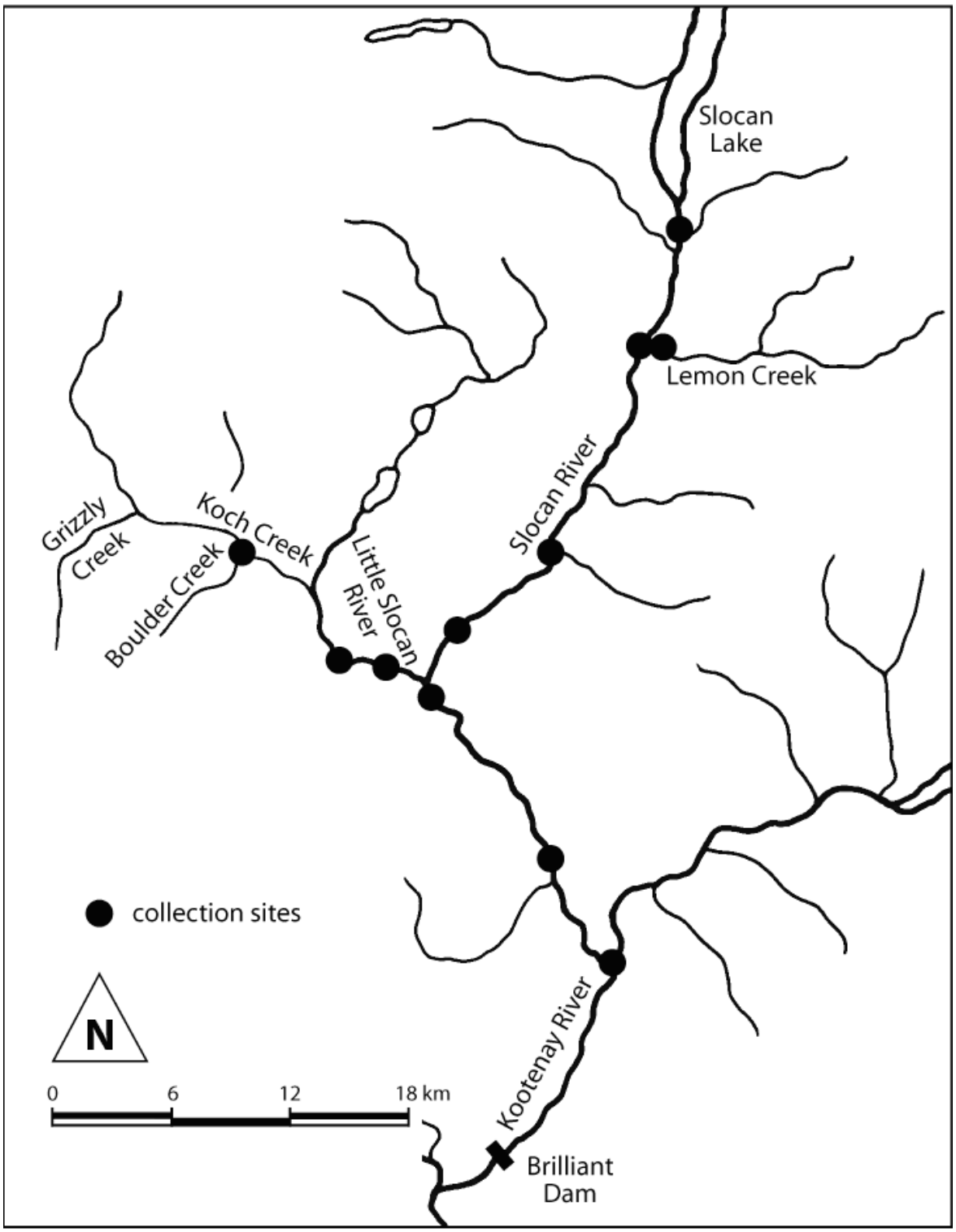

Figure 3. Distribution of the Kootenay/Slocan population of Shorthead Sculpins. Source: University of British Columbia and Royal British Columbia Collections databases.

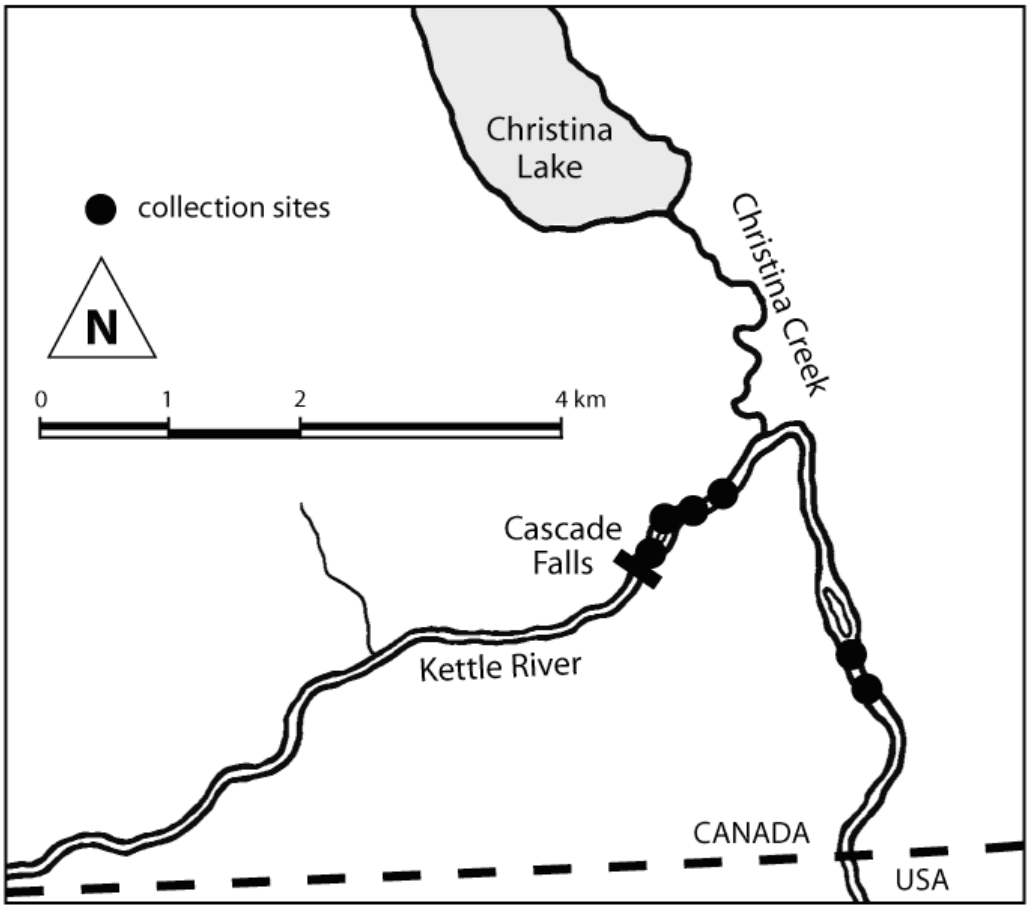

Figure 4. Distribution of the Kettle population of Shorthead Sculpins. Black bars represent named migration barriers. Source: University of British Columbia and Royal British Columbia Collections databases.

Shorthead Sculpins, like all cottids, lack a swim bladder and are lithophilic and relatively sedentary as adults, although some species have been documented to have dispersive larval stages (McCleave 1964; McPhail 2007). Freshwater sculpins may move up to one km, but typically less than 100 m over a season, while amphidromous species may move up to 5 km (reviewed in Schmetterling and Adams 2004). In addition, the most serious threats to Shorthead Sculpin involve largely point source alterations to habitat or habitat quality (e.g., pollution, temperature increases, drought, urbanization in tributary streams and flow regulation in the mainstem Columbia, Kootenay, and Kettle rivers – see **Threats and Limiting Factors** section). Consequently, the determination of the number of locations was guided by considering each tributary separately and counting mainstem river sites (i.e., in the mainstem Columbia, Kootenay, and Kettle Rivers) as single locations given that each river has its flow heavily regulated by dams. Site occurrences in the mainstem Slocan River were counted as distinct locations if separated from each other by 10 km or more given that this river is relatively undisturbed (see **Threats and Limiting Factors** section). Using this rationale, there are an estimated 13 locations for the Shorthead Sculpin in Canada.

HABITAT

Habitat requirements

Most data on the habitat requirements of *Cottus confusus* are the result of casual field observations; however, in the past BC Hydro has commissioned sculpin studies of the Columbia River population (e.g., R.L.&L 1995; AMEC 2003). The R.L.&L. study operated from 1993 to 1994, and in 1994 involved year-round quantitative sampling of multiple habitats. Data were collected for 959 sculpins; however, only 1.7 % (16) of these were Shorthead Sculpins. Unfortunately, the AMEC study did not distinguish between sculpin species. Consequently, the following account is largely anecdotal and based on collections made during taxonomic studies. Still, the descriptions of the habitats used by Shorthead Sculpins throughout the species' geographic range are remarkably consistent. It appears to be a cool-water species that is most abundant in riffle and run habitats containing large gravel and cobble-sized rocks. It is rare in the mainstem Columbia River, and usually associated with the mouths of tributary streams (R.L.&L. 1995; COSEWIC 2001).

In smaller streams, Shorthead Sculpins are associated with shallow (< 50 cm) riffles and runs (surface velocities of 30 to 90 cm/s) with gravel, cobble, or small boulder (> 50 cm in diameter) substrates (McPhail unpub. field notes from the Little Slocan River and Beaver Creek, 2000). Adults are rare in pools and areas with silt or sand substrates; however, small juveniles (10 to 12 mm long) are found along stream margins in shallow, quiet water, and are often associated with seasonally flooded vegetation. In other sculpins, this habitat segregation between adults and young is driven by adult predation on young rather than differences in habitat preferences (Freeman and Stouder 1989).

Although these habitat descriptions are useful in locating Shorthead Sculpins, a few caveats are necessary. First, most fluvial sculpins are nocturnal, and Shorthead Sculpins are no exception. They spend most of the daylight hours sheltering in or on the substrate, and most collections are made during the day. Consequently, typical representations of habitat (e.g., COSEWIC 2001) actually are descriptions of daytime sheltering habitat. In addition, no winter habitat observations are available for this species and suitable overwintering sites may be crucial to survival in streams like the Little Slocan River and Koch Creek. Thus, for this species, there is an almost complete lack of the quantitative field observations, enclosure experiments, and laboratory physiological studies that have been indispensable for establishing the habitat requirements of other stream fishes (e.g., the salmonids).

Habitat trends

Over most of its geographic range the Shorthead Sculpin is viewed as a headwater species (species found in the upper reaches of streams or in lower order streams), but this is not true in Canada. Here, the Shorthead Sculpin is a valley bottom species (McPhail 2007). This difference may be a consequence of the relatively recent glacial

history of the BC portion of the species' range. The Columbia, Kootenay, and Slocan rivers flow through U-shaped valleys. Their smaller tributary streams are either precipitous or have falls within a few kilometres of their confluence with the main river, while unsuitable habitat (large lakes and reservoirs) prevents dispersal upstream in larger rivers. Thus, the amount of suitable habitat in Canada is geographically and ecologically constrained. Also, the productivity of all three populations probably was adversely affected by the closure of Grand Coulee Dam (Washington State) in 1942 (e.g., see review by Gresh *et al*. 2000); however, the only estimate of the impact of the closure on aquatic productivity is for the Slocan River. The annual Chinook Salmon (*Oncorhynchus tshawytscha*) run into the Slocan River was estimated at 9,000 to 18,000 fish (G. Oliver, pers. comm., 2009). The nutrient transported into the river by this run probably amounted to 4.1 to 8.2 kg/km of phosphorus and 37.8 to 75.6 kg/km of nitrogen, and the loss of these nutrients probably had a significant impact on the carrying capacity of the river (G. Oliver, pers. comm., 2009).

In the Columbia River, the maximum upstream penetration of *C. confusus* was probably limited by Lower Arrow Lake even before the construction of Keenleyside Dam (Figure 2). Similarly, the maximum upstream penetration of Shorthead Sculpins in the Slocan River is limited by Slocan Lake and, originally, by Bonnington Falls on the Kootenay River. In the Kettle River, Cascade Falls marks the upstream limit of Shorthead Sculpins. Collections from Norns and Beaver creeks in the Columbia River population consistently yield the largest catches of this species. Both of these streams have impassable falls within a few kilometres of their confluence with the Columbia River (Figure 2). In the Slocan River, the densest population appears to be that in the Little Slocan River and its tributary lower Koch Creek. Lower Little Slocan Lake is probably a barrier to upstream dispersal and there is an impassable falls on Koch Creek at the Grizzly Creek recreation site (Figure 3).

Except for the Kootenay River, these spatially limited habitats still exist. In the Kootenay River, however, there has been a major loss of physical habitat caused by the ponding above Brilliant Dam. This dam, and farther upstream the closely spaced South Slocan and Bonnington dams, flooded more than 95% (41 km) of the original fluvial habitat in the Kootenay River below Bonnington Falls. In addition to the physical habitat, the hydrograph, water quality, and biological communities in these spatially restricted populations have changed dramatically. Dams have modified the natural hydrograph in larger rivers, while urbanization, agriculture, and industrial pollution have changed water quality. Introductions of exotic species (e.g., Smallmouth Bass (*Micropterus dolomieu*) and Walleye ((*Sander vitreus*), see McPhail 2007) probably have modified the biological community in the Columbia mainstem. For now, the Kootenay/Slocan and the Kettle regions still support Shorthead Sculpins; however, private hydroelectric projects are proposed for both these populations (see **Threats and Limiting Factors** section).

Habitat protection/ownership

The Shorthead Sculpin receives protection as a Schedule 1 Threatened species under *SARA* although critical habitat has not yet been identified, biologically or legally. The federal *Fisheries Act* provides Fisheries and Oceans Canada (DFO) with powers to conserve and protect fish and fish habitat (as defined in the *Fisheries Act*). Environment Canada has been delegated administrative responsibilities for regulating the pollution of fish-bearing waters while the other provisions are administered by DFO. Thus, the *Fisheries Act* can provide some general protection for the aquatic habitats occupied by the three Canadian populations of Shorthead Sculpins. Also, as a transboundary river the Columbia River is subject to environmental obligations imposed by the International Joint Commission (IJC) and the Columbia River Treaty. So far, in western North America, these international treaties have focused on water storage, flood control, and power generation issues. Recently, however, the Canadian Inter-tribal Fisheries Commission has raised fish and fisheries issues with the IJC.

Although the Columbia, Kootenay, Slocan, and Kettle rivers are public waters, most of the land adjacent to these rivers is private. For instance, there are 190 water licences for the Kettle River mainstem alone, 95% of which are for irrigation (pers. com. to Sue Pollard from Tara White, BC Ministry of Environment, 2010). There is, however, an 81 ha provincial park (Beaver Creek Provincial Park) at the mouth of Beaver Creek, and an 85 ha Community Park on Norns Creek. These parks provide some protection for two of the three largest known concentrations of Shorthead Sculpins in Canada. In addition, Gladstone Provincial Park (39,387 ha) protects about half of the Christina Lake watershed, and Christina Lake drains directly into the Kettle River below Cascade Falls. There is no evidence that Shorthead Sculpins occur in any of the streams entering Christina Lake; however, Sander and Troy creeks at the north end of the lake have never been sampled and, judging from topographic maps, their lower reaches appear to be appropriate habitat for Shorthead Sculpins. In the Kootenay/Slocan area, Valhalla Provincial Park (49,893 ha) protects the west side of Slocan Lake and includes streams that drain into both the Slocan and Little Slocan rivers. Additionally, part of Kokanee Glacier Provincial Park (32,035 ha) includes the upper reaches of Lemon Creek. This stream has Shorthead Sculpins in its lower reaches.

BIOLOGY

Life cycle and reproduction

Spawning period

Like other species of *Cottus* in western North America, the Shorthead Sculpin spawns in the spring. In the Sinks drainages in Idaho, spawning starts in mid-April (Gasser *et al*. 1981). In BC, eggs were found attached to the underside of rocks in Norns Creek from mid-May to mid-July. This suggests a fairly protracted spawning season. The afternoon water temperature at this site in mid-May was 8ºC and in mid-

July water temperature ranged from 13 to 15ºC. Post-larval juvenile (10 to 12 mm TL) Shorthead Sculpins were collected with fine mesh dip-nets in a flooded backwater at the mouth of Beaver Creek on July 1, 1998, and in the seasonally flooded margins of the Slocan River on July 3 of the same year. Given the incubation time reported (see incubation period below) these Beaver Creek and Slocan fry probably result from matings that occurred in mid-May.

Spawning sites

Generally, freshwater sculpins spawn in crevices under rocks or under other instream debris. Males often excavate, or at least enlarge, these holes. In Norns Creek, about 200 m above the Kokanee viewing station, nests were found under irregularly shaped flat rocks that measured 30 to 45 cm in length. Surface velocities over nests ranged from 0.5 to 1.0 m/s and water depths over the nests were usually < 30 cm (McPhail, unpublished field notes, 2000).

Spawning behaviour

The spawning behaviour of this species has not been recorded; however, spawning behaviour in other *Cottus* species has been documented and, although there are some differences in the details of courtship behaviour, the general pattern of spawning behaviour is similar. Typically, males excavate a nest cavity and court females. The courtship is complex and usually involves rapid changes in male colour, and acoustic and visual signals (Savage 1963; Whang and Jannsen 1994). The female turns upside down and deposits her eggs on the roof of the nest cavity. The male then fertilizes the eggs. Typically, males are polygynous and spawn with several females. This seems to be the case in *Cottus confusus* — the nests found in Norns Creek all contained several egg clumps. Males fan and guard the eggs until they hatch.

Fecundity

In sculpins, fecundity varies with female size. In Washington, Patten (1971) found a range of 47 to 217 eggs in a sample of gravid female Shorthead Sculpins that ranged from 61 to 86 mm in length. In contrast, in the Sinks River drainages in Idaho, Gasser *et al.* (1981) found 53 to 71 eggs in females that ranged in length from 53 to 71 mm in length. For a combined group of eight females from Norns, Beaver, and Sheep creeks (Sheep Creek is in Washington), COSEWIC (2001) gives a range in egg number from 102 in a 42 mm (SL) female to 569 in a 99 mm female. The egg counts from single egg clumps in nests in Norns Creek ranged from 52 to 213. Shorthead Sculpin eggs are large, and eyed eggs from nests in Norns Creek averaged 3.5 mm in diameter.

Incubation period

In the laboratory, at a constant water temperature of 10ºC, eggs hatched in 29 days. The newly hatched larvae averaged 7.5 mm in total length. They immediately burrowed into the gravel substrate and remained there for two weeks. When they emerged from the gravel they had metamorphosed and were miniature (about 9 to 10 mm in length) copies of adults, but the pigment pattern was not as well developed as in adults (McPhail 2007).

Age structure

At first, growth is relatively slow. In the Slocan River, fry averaged 25 to 35 mm (SL) by late August. In this lake-fed river, small juveniles may have some growth over winter, and by next summer they averaged 45 mm (SL). Both sexes begin to mature in their third summer, and the smallest mature female was 42 mm and the smallest male 46 mm long. Apparently, the Shorthead Sculpins in Beaver Creek grow more rapidly and reach a larger size than any of the other Canadian populations (COSEWIC 2001). There is considerable agricultural activity in Beaver Creek as well some effluent from the Fruitvale sewage plant, thus the stream is eutrophic.

Predation

The diet of adult Shorthead Sculpins consists mostly of caddis and stonefly nymphs as well as chironomid larvae, while young-of-the-year forage primarily on chironomid larvae (COSEWIC 2001). There are no data on the predators of Shorthead Sculpins in Canada, but potential predators occur in all three populations. The Torrent Sculpin is a large-mouthed sculpin that is known to prey on young Shorthead Sculpins. It is present in the mainstem Columbia and tributaries (Norns Creek and Beaver Creek), as well as in the Kettle River below Cascade Falls, and in the Slocan River, Little Slocan River, and lower Koch Creek. The Columbia Sculpin also occasionally eats young sculpins, although in this region it is mainly confined to the mainstem Columbia and Slocan rivers (there are some in lower Norns Creek and in lower Beaver Creek). Bull Trout (*Salvelinus confluentus*) are present in the mainstem Columbia River and in Slocan Lake but are absent from the Kettle River. Mergansers (*Mergus* spp.) are ubiquitous in the region and are known to feed on sculpins. Introduced Walleye and Smallmouth Bass are also likely predators in the Columbia River.

Physiology

Although there are no data on the physiology of Shorthead Sculpins, their geographic distribution suggests that they are sensitive to temperature. On the arid Snake River Plain (Figure 1), and even in the mountains in Idaho, they are restricted to headwater streams (Maughan and Saul 1979). In Washington, they are usually found in streams with maximum summer temperatures of 16ºC or less but they have been recorded at temperatures as high as 21ºC (Wydoski and Whitney 2003). In Canada, the warmest site where they occur is the Kettle River. Here, the average August water temperature is about 19ºC (range is 17 to 22ºC). Temperatures of 22ºC occur about once every decade and even exceeded 25ºC during the last week of September 2009, when some fish kills were reported (Tara White, pers. comm. 2010, see **Threats and Limiting Factors** section). The maximum temperature recorded in the Kettle River below Cascade Falls is 25ºC (COSEWIC 2001).

Dispersal and migration

There are no quantitative data on migration and dispersal on Shorthead Sculpins in nature; however, they are a fluvial species with large eggs (see the **Life cycle and reproduction** section) and for sculpins this usually means that the newly hatched larvae stay in the gravel until they transform into miniature bottom-dwelling versions of the adults (see also McPhail 2007 for discussion of laboratory studies). After the fry emerge from the gravel, they move to shallow water along stream edges and there may be some downstream dispersal at this time. Once settled, the young probably don't move far; however, as they grow they move laterally into deeper and faster water. Like other stream-dwelling sculpins (McCleave 1964), once settled in the adult habitat, they probably do not migrate far from their relatively small home areas.

Interspecific interactions

Hybridization

There is no direct evidence of hybridization between the Shorthead Sculpin and other sculpins; however, in the Columbia River between Keenleyside Dam and the US border Shorthead Sculpins and the Columbia Sculpin usually are parapatric — Columbia Sculpins in the mainstem and Shorthead Sculpins in tributary streams. At the ecotones where these habitats abut, occasional individuals are encountered that are morphologically intermediate (McPhail 2007). It is possible that some of these individuals are hybrids. A single possible hybrid between a Shorthead and Columbia sculpin was found in the Slocan River during an allozyme study (COSEWIC 2001).

Competitive interactions

There are no data on competitive interactions between *Cottus confusus* and other sculpins; however, the distribution patterns of *C. confusus* and *C. hubbsi* in the Columbia River below Keenleyside Dam suggest an interaction between these species. In this region, Columbia Sculpins typically occur in the main river and Shorthead Sculpins in the lower reaches of tributary streams. Whether this dichotomy in habitat use is due to differences in habitat preferences or to a competitive interaction is unknown. Shorthead Sculpins, however, do not occur in the Similkameen River system where the Columbia Sculpin is common in some headwater streams and tributary creeks. This suggests that it is the presence of Columbia Sculpins, and not the habitat characteristics of tributary streams, that drives the habitat-use dichotomy observed in the mainstem Columbia River. In the Slocan River system, Slimy Sculpins replace Shorthead Sculpins in the upper portions of Koch and Lemon creeks. Again, it is not known if this a competitive interaction mediated through temperature or if physical barriers (e.g., falls) are involved.

Adaptability

No experimental data are available concerning the short-term adaptation limits (thermal, chemical, and velocity) beyond which Shorthead Sculpins are unable to cope. Nonetheless, their highly fragmented geographic distribution (Figure 1) and, in the southern parts of their range, their restriction to headwater habitats suggest that they are temperature-sensitive and not especially adaptable.

POPULATION SIZES AND TRENDS

Sampling effort

So far, the purpose of most of the BC sampling of Shorthead Sculpins has been to collect specimens for taxonomic studies (e.g., McAllister and Lindsey 1961; Peden *et al.* 1989). Consequently, there is a shortage of quantitative data on sampling effort. In the Kettle River, an attempt to collect 50 specimens with an electrofisher obtained only 37 individuals over the 5 km of river between Cascade Falls and the US border (COSEWIC 2001). Unfortunately, there is no information on the elapsed collecting time.

Abundance

In Canada, qualitative estimates of abundance are available for Shorthead Sculpins (COSEWIC 2001) but quantitative estimates are rare. In the Columbia mainstem, Shorthead Sculpins are rare relative to other sculpins; an R.L.&L. (1995) survey found only 16 individuals during the course of a sampling program that spanned a year. In contrast, the populations in two Columbia River tributaries (Norns and Beaver creeks) are the densest known populations. Certainly, they are abundant in Beaver Creek. An 8 by 5 m section of this stream was electro-fished (McPhail, Field notes, July

2000), and 38 Shorthead Sculpins were collected in 3 minutes: a CPUE (catch per unit effort) of about 12 fish per minute. The densest numbers of Shorthead Sculpins in the Kootenay/Slocan population occur in the Slocan and Little Slocan rivers. In this area, an 11 by 5 m riffle was shocked for 9 minutes (McPhail, Field notes, July 2000). Eighteen fish were collected: 14 sculpins and four Longnose Dace (*Rhinichthys cataractae*) for a CPUE of two fish per minute. Five of the sculpins were Torrent Sculpins, one was a Columbia Sculpin, and eight were Shorthead Sculpins. Thus, the CPUE for Shorthead Sculpins at this site was 0.9 per minute. More recent sampling (Rachel Keeler, pers. comm., 2009) indicated that Shorthead Sculpins were concentrated in Pass Creek (95% of all fish caught amongst five sites). Catch per unit effort from electro-fishing ranged from < 0.1 fish per minute (one fish total) at the Kootenay River-Columbia River confluence to 17.0 fish per minute (443 fish total) in Pass Creek (Rachel Keeler, pers. comm. 2009). In the Kettle River, Shorthead Sculpins appear to be rare relative to other sculpins (COSEWIC 2001), a situation that appears to be consistent over the last 10 years. A small side channel was electro-fished for about 0.5 hr in August 2009; of the 18 cottids sampled, 11 were Torrent Sculpins, six were Columbia Sculpins, and one was a Shorthead Sculpin (40 mm TL, E.B. Taylor, unpubl. field data, and UBC Fish Collection un-catalogued record, 2009).

Fluctuations and trends

Without a time series of population estimates or, at a minimum, a comparable set of collections, population fluctuations and trends cannot be quantified. While relatively recent sampling in some areas still finds Shorthead Sculpins (e.g., Columbia River and tributaries — see **Abundance** section), other areas (e.g., Kettle River) have not been systematically surveyed since the late 1990s (COSEWIC 2001). Nonetheless, even in the Kettle River, where the population appears to be the least dense, this species was still present as of 2009 (E.B. Taylor, unpubl. data).

Rescue effect

Although Shorthead Sculpins probably are relatively sedentary (see section on **Dispersal/Migration**), there are no physical barriers to movement (or gene flow) between the 5 km portion of the Kettle River below Cascade Falls and downstream populations in Washington State such that recolonization from downstream may be possible.

Shorthead Sculpins are rare in the mainstem Columbia River, but are more abundant in some tributary streams. Allozyme data (COSEWIC 2001) showed detectable allele frequency differences between Norns and Beaver creeks (the two densest Columbia River populations). This implies that either there is strong selection on different alleles in the two creeks or that there is little gene flow between the two populations. The other tributary streams where Shorthead Sculpins have been found (Blueberry and Champion creeks) are small and subject to drought. They may not support permanent populations. Potentially, however, these two streams are important. If they support permanent populations, it increases the number of Shorthead Sculpin locations in the Columbia population; however, if they are not permanent populations, their presence in these apparently ephemeral streams argues for some movement of individuals within the Columbia population. About 40 km downstream of Beaver Creek, Sheep Creek in Washington State also supports a permanent population of Shorthead Sculpins (COSEWIC 2001). This creek is the closest known potential recolonization source for the Columbia population. Allozyme data from Sheep Creek (COSEWIC 2001), however, indicated substantial allele frequency differences between Beaver and Sheep creeks, which argues that there is little or no gene exchange between the two creeks. Consequently, in the event of a catastrophe in the Columbia River population the probability of natural recolonization from this downstream population may be low. The sculpins in the Kootenay/Slocan populations are interconnected and, barring a major environmental change, fish lost in any single creek would probably be recolonized from elsewhere within the system but not from any outside source.

THREATS AND LIMITING FACTORS

Threats

Aside from large-scale potential threats like climate change and urbanization, the potential threats to the three Canadian populations of Shorthead Sculpin are different.

Kettle population

The Kettle River population is the most precarious of the populations. First, this area is physically small (about 5 linear km) and has the least dense confirmed population of Shorthead Sculpins in Canada. Second, it has the most extreme (warmest) thermal environment within the Canadian range of this species. Apparently, there have been more than six fish kills in the last 20 years that are attributed to environmental factors (high temperature and low water, Tara White pers. comm. 2010). Although the only fish reported to be affected by these kills were Rainbow Trout, *Oncorhynchus mykiss*, and Mountain Whitefish, *Prosopium williamsoni*, (Tara White, pers. comm. 2010), sculpins are less easily detected because they lack a swim bladder and do not float. Like salmonids, Shorthead Sculpins are cold-water fishes (Wydoski and Whitney 2003) and probably similarly susceptible to such kills induced by high summer water temperatures. Warm ambient temperatures in the Kettle River valley are exacerbated by water extraction for irrigation (e.g., there

are 190 current water extraction licences on the mainstem Kettle River alone — see http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input). Third, there is a proposed hydroelectric project immediately associated with Cascade Falls. This project proposes to construct a rubber barrier immediately above Cascade Falls. This barrier would pond water above the falls. The water would then be passed through an 800 m long tunnel to a power house to be built on the site of the original (1897) power house. This project was approved in 2006 after a combined provincial and federal environmental assessment. Under the terms of this assessment the project is committed to an environmental monitoring and protection program for *SARA*-listed species at risk. Four listed fishes occur below Cascade Falls: Speckled Dace (*Rhinichthys osculus*), Umatilla Dace (*Rhinichthys umatilla*), Shorthead Sculpin, and Columbia Sculpin. The Speckled Dace also occurs above the falls. The other three species do not occur above the falls. So far, there has been a study of the potential impacts of the project on Rainbow Trout and Speckled Dace above the falls, but no studies on non-game fishes below the falls. A specific concern regarding the Shorthead Sculpin is the potential impact of the project on maximum summer water temperatures below the falls should the operation extend year-round. Because the maximum temperature recorded in the Kettle River is 25.2°C, it is possible that post-project maximum temperatures could increase from ponding of water above the proposed dam site. It is not clear how this would affect the probability of continued survival of Shorthead Sculpins in the Kettle River. The Shorthead Sculpin is generally considered to be a cold-water fish that tends to occur in streams with maximum temperatures of about 16^0C, but as high as 21ºC (Wydoski and Whitney 2003).

Columbia population

In BC, the mainstem Columbia River has a regulated hydrograph, and there are no data on the pre-dam distribution of the Shorthead Sculpin in the main river. Consequently, it is not known if the flow regulation procedures used in the operation of Keenleyside Dam adversely affected Shorthead Sculpins in the main river. What is clear, however, is that now *C. confusus* is rare in the main river but abundant in two unregulated tributary creeks (Norns and Beaver creeks). The human population in the Norns Creek watershed is not large and there is limited agricultural activity in the watershed. It is probably the least threatened stream in this area, although even here the creek experiences very low autumn flows (Bruce MacDonald, DFO, pers. comm. 2010). In contrast, the human population in the Beaver Creek watershed is much larger (the towns of Fruitvale and Montrose are in the catchment), there are dairy farms and orchards within the watershed and there are currently 25 licences for water extraction for irrigation and other uses (http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input). In addition, effluent from the Fruitvale and Montrose primary and secondary sewage treatment systems flows into Beaver Creek and agricultural run-off also enters the stream. Consequently, water quality in Beaver Creek is lower than in either the main river or Norns Creek (COSEWIC 2001; Westcott *et al*. 2004). So far, eutrophication in Beaver Creek has not adversely affected Shorthead Sculpins. Indeed, Beaver Creek may have the densest known Canadian population of Shorthead Sculpins. Potentially, however, there is a

tipping point in the fertility of Beaver Creek, and too much organic input into the watershed could become a real threat to the spatially constrained Beaver Creek population. The other two creeks in this region that may support small Shorthead Sculpin populations (Blueberry and Champion creeks) are subject to drought and urban growth. This combination has the potential to eliminate the species from these small streams. Presumably, these stresses on water flow and associated conditions (temperature, available habitat) will increase given that climate change models (using ClimateWNA version 4.51) predict increasing average temperatures and decreasing snowpack (Wang *et al*. 2006), while human population in the area is projected to increase by 2 to 5% over the next 10 years (STATSBC 2010).

Kootenay/Slocan population

The Slocan portion of the Kootenay/Slocan population is probably the least disturbed of the three Canadian populations. In the past there was extensive mining and logging activity in the Slocan Valley but, although the valley is now pastoral, it is not intensively exploited for commercial agriculture. Also, Slocan Lake is large enough that it naturally regulates water temperatures and flow in the Slocan River. Consequently, the Shorthead Sculpins in this system are relatively secure. The only potential threat is a proposed private hydro project on Koch Creek. There are no Shorthead Sculpins in Koch Creek above the falls at Grizzly Creek Recreational Site, and the proposed project is situated above these falls. There are, however, Shorthead (as well as Columbia) Sculpins in Koch Creek below the falls. It is not clear whether this project will influence the downstream hydrographic regime and associated effects of stranding and water temperature and their impacts on Shorthead Sculpins.

Finally, given the apparently low numbers and limited geographic distribution of Shorthead Sculpins across all population groups, it is possible that scientific/monitoring oversampling and disturbance could pose a threat in all populations.

Limiting factors

There are no hard data on the factors that limit the abundance of Shorthead Sculpins in the Columbia, Slocan, and Kettle populations; however, the geographic distribution of this species in the three Canadian populations is limited primarily by physical factors (see the section on **Habitat trends**). The majority of Shorthead Sculpins in the Columbia population are found in two tributary streams (Norns and Beaver creeks). This suggests that either physiological (temperature or velocity preferences?) or ecological (competition with other sculpins or predation?) limit their numbers in the mainstem Columbia River. In the Kettle River, it is possible that competition with (and or predation by) Columbia and Torrent sculpins limits the number of Shorthead Sculpins.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Existing protection

The Fish Habitat section of the *Fisheries Act* can provide some protection for fishes in the Canadian portion of the Columbia River system. In addition, a previous assessment of the Shorthead Sculpin (COSEWIC 2001) assigned a Threatened status, and the Shorthead Sculpin is protected as such under the federal *Species at Risk Act* (*SARA*, Schedule 1). The status was re-examined by COSEWIC and designated Special Concern in November 2010. A recovery strategy was completed in 2008 (Shorthead Sculpin Recovery Team 2008) where the identification of critical habitat and the formation of a Recovery Implementation Group were recommended as actions "necessary" to meet the recovery objectives mandated under SARA. To date, however, neither of these recommendations has been acted upon.

Non legal status and ranks

The BC Conservation Data Centre ranks the Shorthead Sculpin as S2S3. In BC the species is blue-listed as a species of special concern. Globally, its NatureServe (2010) rank is G5T4Q (globally secure, of concern locally, and of questionable taxonomy); in Washington State the rank is S5 (secure). These NatureServe ranks are based on the assumption that the Shorthead Sculpin is a subspecies of *C. bairdii* and, consequently, that it is part of an abundant and widely distributed species. This is not the case and, presumably, these rankings will be reassessed.

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COLLECTIONS EXAMINED

The specimens used in the preparation of this report are housed in the Fish Museum, University of British Columbia, Vancouver (http://www.zoology.ubc.ca/~etaylor/nfrg/fishmuseum.html), and the Royal BC Museum, Victoria (http://www.royalbcmuseum.bc.ca/Collect_Research/default.aspx).