Species at Risk Act
Management Plan Series

Management Plan for the Shorthead Sculpin (*Cottus confusus*) in Canada

Shorthead Sculpin

2019

Canada

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Cover illustration:
Photo of Shorthead Sculpin courtesy of Wydoski and Whitney.

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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for species listed as special concern and are required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Fisheries and Oceans is the competent minister under SARA for the Shorthead Sculpin and has prepared this management plan, as per section 65 of SARA. To the extent possible, this management plan has been prepared in cooperation with the Province of British Columbia as per section 66(1) of SARA.

As stated in the preamble to SARA, success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Shorthead Sculpin and Canadian society as a whole.

Under SARA, a management plan includes conservation measures to ensure that a species of special concern does not become threatened or endangered. The plan outlines conservation measures to be taken by Fisheries and Oceans Canada and other jurisdictions and/or organizations to help achieve the management objectives identified in the management plan. Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of participating jurisdictions and organizations.

Acknowledgments

Fisheries and Oceans Canada (DFO) wishes to acknowledge the contributions of those who supported the development of the management plan for Shorthead Sculpin. DFO acknowledges the efforts of the members of the former Non-Game Freshwater Fish Recovery Team (NGFWRT) for preparing an early draft of a recovery strategy that was later substantially revised to generate this management plan. These former NGFWRT members are: Jordan Rosenfeld (British Columbia Ministry of Environment [B.C. MOE]), Dan Sneep (DFO), Todd Hatfield (Solander Ecological Research), Don McPhail (University of British Columbia [UBC]), John Richardson (UBC), Dolph Schluter (UBC), Eric Taylor (UBC), and Paul Wood (UBC). Erin Gertzen (DFO) and Heather Stalberg (DFO) drafted the management plan. Erin Gertzen, Martin Nantel (DFO), Sean MacConnachie (DFO), Greg Wilson (B.C. MOE), Guy Martel (BC Hydro), Rachel Keeler (Amec Foster Wheeler), Crystal Lawrence (Amec Foster Wheeler), and Louise Porto (Amec Foster Wheeler) participated in a technical workshop and contributed expertise on the content of the management plan. The input provided will be used to help guide the implementation of conservation measures where possible.

Executive summary

The Shorthead Sculpin (*Cottus confusus*) is a small riverine fish found west of the Continental Divide, primarily in the Columbia River watershed in the western states of Washington, Idaho, Oregon and Montana, and in tributaries to Puget Sound in Washington State. The northern range limit of the species extends into southern British Columbia in the Columbia River watershed. In Canada, Shorthead Sculpin are found in the mainstem and tributaries of the Columbia River, Kootenay/Slocan River, and Kettle River. The Shorthead Sculpin was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as special concern in 2010, and listed under Schedule 1 of the *Species at Risk Act* as a species of special concern in 2013.

Shorthead Sculpin are benthic, sedentary and nocturnal. They inhabit cold and cool water streams in riffles and runs with unembedded cobble, boulder and gravel substrates. Young-of-the-year and juveniles also use seasonally flooded stream margins. Characteristics and needs of the species are described in section 3.

There have been few empirical population estimates of Shorthead Sculpin within Canada. Available data support the species being locally abundant when present throughout most parts of the Canadian range, with populations considered stable. The environmental factors that affect abundance of Shorthead Sculpin have not been well studied.

A threat assessment of historical, current and anticipated threats to Shorthead Sculpin was conducted and took into account uncertainty. Threats include: increased periods of low flow resulting from water extraction (current and anticipated threat); sudden significant alteration of hydrograph from flow regulation (current threat); increased maximum summer water temperature (current and anticipated threat); sedimentation from agriculture, forestry and urbanization (historical and current threat); eutrophication from agriculture and urbanization (current and anticipated threat); harmful substances from mining and industrial activities (historical and unknown threat); and, aquatic invasive species (current and anticipated threat). Details on threats are presented in section 4.

The management objective for Shorthead Sculpin is to maintain self-sustaining populations of Shorthead Sculpin throughout their current distribution to ensure the species' long-term viability in the wild. To support the management objective, broad strategies including monitoring, research, management and coordination, and stewardship and outreach were developed. Specific conservation measures under each broad strategy were outlined. Conservation measures are described in section 6.

The approach to implementing new conservation measures is to focus on addressing knowledge gaps related to Shorthead Sculpin through monitoring and research, thereby strengthening the foundation for any future management actions.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

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1. COSEWIC[1] species assessment information

Date of assessment: November 2010

Species' common name (population): Shorthead Sculpin

Scientific name: *Cottus confusus*

COSEWIC status: special concern

SARA status: special concern

Reason(s) 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 (to 13) in the estimation of the number of locations.

Canadian occurrence: British Columbia

COSEWIC 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.

2. Species status information

The International Union for Conservation of Nature lists Shorthead Sculpin as LC (Least Concern) and NatureServe ranks them as G5 (Globally Secure) (NatureServe 2014). Shorthead Sculpin are blue-listed and ranked as S2S3 (S2=imperiled, S3=special concern, vulnerable to extirpation or extinction) by the Province of British Columbia (B.C.) (British Columbia Conservation Data Centre 2014).

The Canadian population of Shorthead Sculpin was designated threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1984, and re-examined and designated threatened in 2001 (COSEWIC 2010). Shorthead Sculpin was listed as threatened when the *Species at Risk Act* (SARA) came into force in 2003. In 2010, COSEWIC reassessed the Shorthead Sculpin as special concern (COSEWIC 2010), and in 2013 the Shorthead Sculpin was listed as a species of special concern under Schedule 1 of SARA.

3. Species information

3.1 Species description

Sculpins are members of Cottidae, which consists of more than 300 freshwater and marine species (Scott and Crossman 1973). Historically, the taxonomy of sculpins was unclear.

[1] COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

However, recent genetics work has helped clarify the taxonomy, characteristics and distribution of freshwater sculpins in western North America (for more information see Neely 2004, COSEWIC 2010, Young et al. 2013, and Lemoine et al. 2014). Sculpins lack a swim bladder and are usually benthic (Heard 1965; Scott and Crossman 1973). Shorthead Sculpin, like other sculpins, have a large head and heavy body; the body tapers from head to a relatively narrow caudal peduncle (COSEWIC 2010) (see cover image). Though challenging, Shorthead Sculpin can be distinguished from co-existing sculpins through a combination of: head size, colouration, number of chin and postmaxillary pores, dorsal fin structure and number of rays, lateral line length, and palatine teeth (see COSEWIC 2010 for details). Males in spawning condition exhibit dark body colouration, often with an orange stripe on the tip of the dorsal fin (Amec 2014).

Shorthead Sculpin are benthic, relatively sedentary, and primarily invertivores.[2] Maximum life span is thought to be six years (Lee et al. 1980) but most individuals live less than five years (COSEWIC 2010). Maximum size is 111 mm (Amec 2014). Females mature at approximately two to three years of age, and males at two years of age (COSEWIC 2010). Spawning occurs in the spring on the underside of shallow cobble and boulders at water temperatures of 8-15 degrees Celsius (°C) (Amec 2014). Young-of-the-year inhabit stream margins (Amec 2014). Additional details on life history and habitat requirements can be found in Needs of the Species (Section 3.3), COSEWIC (2010) and Amec (2014).

3.2 Population and distribution

Shorthead Sculpin are restricted to the Columbia drainage and adjacent drainages that contain fish faunas derived from the Columbia River (see map of global range in COSEWIC 2010). In the United States (U.S.), Shorthead Sculpin are found in Washington, Idaho, Oregon, and northern Nevada within the Columbia drainage, and in tributaries to Puget Sound and the Olympic Peninsula in Washington State. The northern range limit of the species extends into southern B.C., in the Columbia River watershed (Figures 1 and 2).

In Canada, there are three main populations of Shorthead Sculpin: Columbia River, Kootenay/Slocan River, and Kettle River. Shorthead Sculpin are found in the mainstem Columbia River between Keenleyside Dam (near Castlegar, B.C.) and the U.S. border, and in tributaries of the Columbia River, including Blueberry, Beaver, Champion, and Norns (Pass) creeks. The Kootenay/Slocan basin Shorthead Sculpin population extends in the Kootenay River from the South Slocan Dam to the confluence with the Columbia River, in the Slocan River from south of Slocan Lake to the confluence with the Kootenay River, and in three tributaries of the Kootenay and Slocan rivers: Little Slocan River, Lemon Creek and Koch Creek.[3] The Kettle River population extends from Cascade Falls to the U.S. border (COSEWIC 2010) (Figures 1 and 2).

Population estimates in 2015 were 2,093 individuals in Norns Creek and 309 in Beaver Creek (Amec 2016). No Shorthead Sculpin were found in Champion Creek during the same survey (Amec 2016). There are no quantitative data available on the numbers of Shorthead Sculpin in other B.C. locations but the populations appear to be stable (COSEWIC 2010). In addition to Norns and Beaver creeks, the species has relatively high densities in the Slocan and Little Slocan rivers (COSEWIC 2010; Amec 2014). Shorthead Sculpin are uncommon in the mainstem of large rivers like the Columbia and Kootenay (COSEWIC 2010). In the Kettle River, the species is rare relative to other sculpin species. Several surveys have been completed to

[2] Invertivore: feeds on invertebrates, including insects, molluscs and crustaceans
[3] There is an unverified report of Shorthead Sculpin in Springer Creek (tributary of Slocan Lake) in 2016

better define the distribution of the species (e.g., Hughes and Peden 1984; Peden and Hughes 1984; Peden et al. 1989; McPhail 2001; Amec 2014). In most of the surveys, individuals were locally abundant when present. Individuals have small home ranges. While Shorthead Sculpin are found in headwaters in the U.S., in B.C. they are found in valley bottoms. Natural (e.g., lakes, steep gradients, or falls) and man-made barriers (e.g., dams, reservoirs) appear to limit further upstream dispersal beyond their current distribution (COSEWIC 2010).

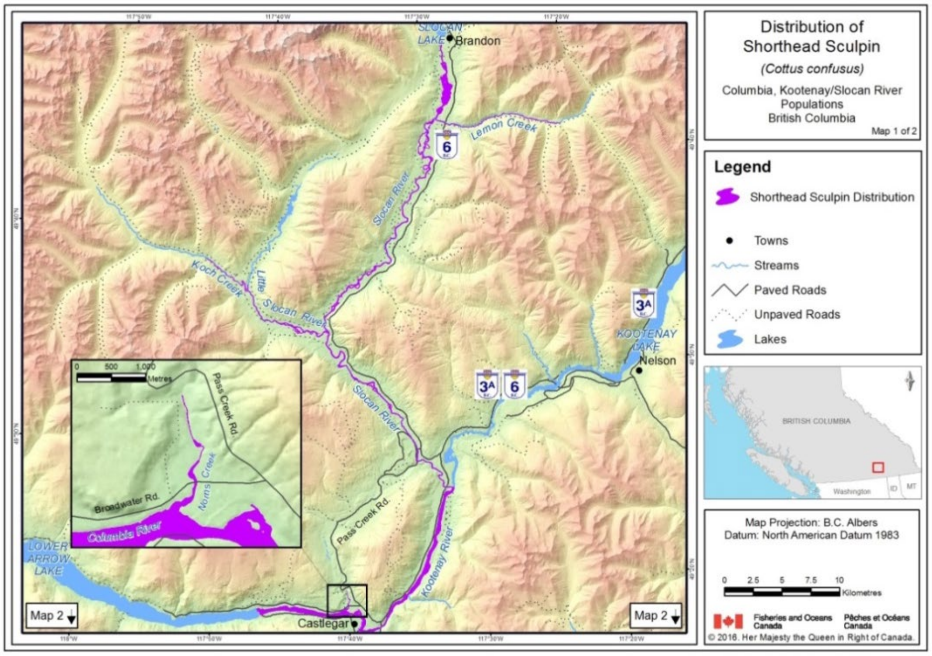

Figure 1. Northern portion of Shorthead Sculpin distribution in Canada.

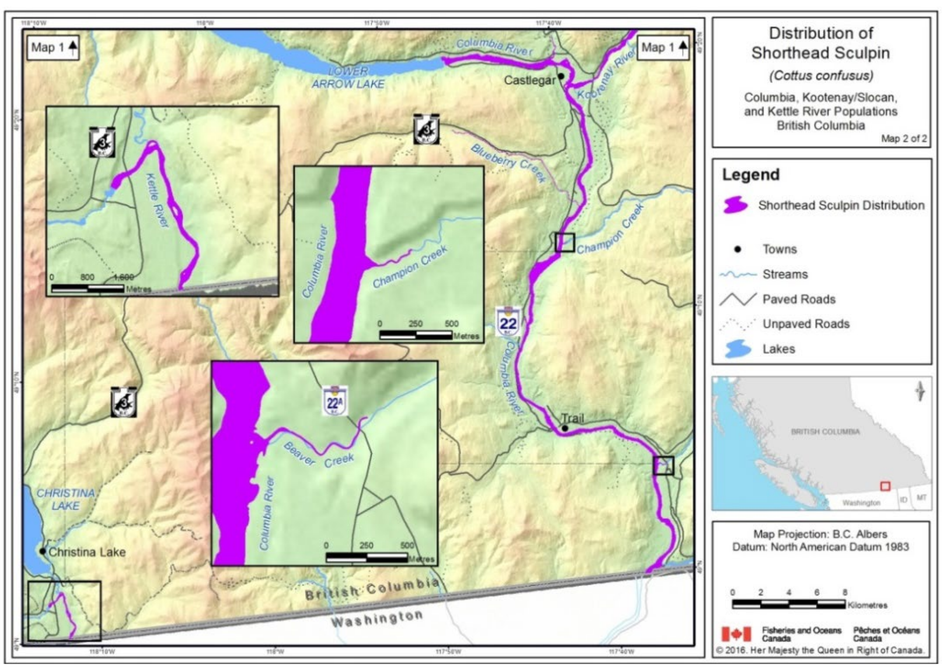

Figure 2. Southern portion of Shorthead Sculpin distribution in Canada.

3.3 **Needs of the Shorthead Sculpin**

Generally, Shorthead Sculpin are found in cold or cool, shallow and flowing water. They are most abundant in riffle and run habitats that contain unembedded large gravel, cobble and boulder substrates (COSEWIC 2010; Amec 2014). Recent monitoring has helped address several knowledge gaps in Shorthead Sculpin habitat needs and habitat suitability indices have been developed (Amec 2014; Golder 2015). Additional details on life history and habitat requirements can be found in COSEWIC (2010) and Amec (2014).

Wydoski and Whitney (2003) suggested that Shorthead Sculpin's preferred current velocity is 0.9 metres/second (m/s) or greater. McPhail (unpubl. data in COSEWIC 2010) found Shorthead Sculpin in riffles and runs with surface velocity ranges of 0.03-0.09 m/s. Amec (2014) observed Shorthead Sculpin in velocities of 0.05-0.9 m/s. Adults reside at depths less than 70 cm and are rare in pools. Young-of-the-year (10-12 mm long) are found along stream margins in shallow, quiet water (COSEWIC 2010).

Shorthead Sculpin reproduce in the spring from April or May to mid-July when water temperatures reach 8-15°C (McPhail 2001; Amec 2014). They spawn in waters less than 1.3 m deep with flows less than 0.5 m/s in crevices under boulder or cobble that is 5-10% embedded (COSEWIC 2010; Amec 2014). In Norns Creek, nests were found on large, irregularly shaped rocks 30-45 cm in diameter and at depths of less than 30 cm, with surface velocities of 0.05-0.1 m/s (McPhail unpubl. data in COSEWIC 2010). Further, in Norns Creek, *Cottus sp.* nest stranding was observed following receding water levels (Amec 2014; Golder 2015). Multiple females lay eggs on the roof of the nest cavity in discrete clusters. The eggs are fertilized, fanned and guarded by a polygynous[4] male until the embryos hatch about three to four weeks later (COSEWIC 2010). Newly hatched larvae typically stay in the interstitial space in the substrate until they emerge as fry. Fry move to shallow stream margins (<4 m from shore) with vegetation on soft substrates or cobble/boulder habitat and little flow (COSEWIC 2010; Amec 2014). The young likely do not move far once they have settled; however, as they grow they move laterally into deeper and faster water (COSEWIC 2010). Once settled in the adult habitat, Shorthead Sculpin have small home ranges, rarely moving more than 50-100 m (COSEWIC 2010; Amec 2014). While Shorthead Sculpin are nocturnal, a recent study found no diel[5] differences in catch rates (Amec 2014).

Shorthead Sculpin may be influenced by co-occurring species (e.g., Columbia and Torrent sculpins) competing for resources and the presence of predators (COSEWIC 2010). Shorthead Sculpin may be preyed upon by Bull Trout (*Salvelinus confluentus*), non-native piscivores (Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*Micropterus dolomieu*), Walleye (*Sander vitreus*) and Yellow Perch (*Perca flavescens*)), and Mergansers (*Mergus* spp.) (COSEWIC 2010). Adult Shorthead Sculpin forage mainly on benthic invertebrates, including caddis nymphs, stonefly nymphs and Chironomidae larvae, while young-of-the-year forage primarily on Chironomid larvae (COSEWIC 2010). Occasionally, Shorthead Sculpin feed on small fishes, sculpins, and sculpin eggs (Lee et al. 1980; Johnson et al. 1983).

The environmental variables that limit the population abundance and distribution of Shorthead Sculpin (limiting factors[6]) have not been well-defined. COSEWIC (2010) suggests the species is

[4] Polygynous: a male that mates with multiple females in a single spawning season
[5] Diel: a daily cycle
[6] Limiting factor: a non-anthropogenic factor that, within a range of natural variation, limits the abundance and distribution of a wildlife species or a population (DFO 2014)

mainly limited by habitat needs such as temperature and velocity, and biotic interactions with competitors and predators. Uncertainty associated with limiting factors represents a main knowledge gap. Inferring from field observations, Shorthead Sculpin may be sensitive to climate change and high temperatures because their distribution within their global range is restricted to reaches with cooler temperatures (e.g., they are restricted to the headwater streams in the mountains of Idaho and absent from the arid Snake River plain in the central Columbia Basin) (COSEWIC 2010). Shorthead Sculpin are most abundant in streams with cool summer temperatures; preferred temperatures tend to be cooler than for other sculpin species (Hendricks 1997; Wydoski and Whitney 2003). In Washington, they are typically found in streams with maximum summer temperatures of 16˚C, but they have been observed in areas with temperatures up to 21˚C (Wydoski and Whitney 2003 in COSEWIC 2010). In Canada, the warmest site where they occur is the Kettle River, where water temperatures can reach 22˚C or occasionally higher (COSEWIC 2010). Climate change projections for Kootenay-Boundary include warmer annual average temperatures, less snow, less summer rainfall, increased winter flows and reduced summer flows (S.E.C. Inc. 2012). Limiting factors are important considerations in the management objectives for Shorthead Sculpin populations.

4. Threats

4.1 Threat assessment

An assessment of threats to Shorthead Sculpin was undertaken (Table 1). Background information on the threats can be found in the COSEWIC (2010) status report. A 2016 Shorthead Sculpin technical workshop helped inform the threat assessment. Several threats are population and watershed-specific; the extent in the Threat Assessment Table reflects this. For more details on the threat assessment process, refer to the Guidance on Assessing Threats, Ecological Risk and Ecological Impacts for Species at Risk (DFO 2014).

Table 1. Threat classification for Shorthead Sculpin

Threat category	Threat	Level of concern[7]	Extent[8]	Occurrence[9]	Frequency[10]	Severity[11]	Causal certainty[12]
Loss of habitat quality and quantity	Increased periods of low flow resulting from water extraction	Medium	Localized (Kettle, Columbia tributaries)	Current / anticipated	Seasonal	Unknown	Low
Loss of habitat quality and quantity	Increased maximum summer water temperature	Medium (Kettle), low (other)	Widespread	Current / anticipated	Seasonal	Unknown	Low
Loss of habitat quality and quantity	Sudden significant alteration of hydrograph from flow regulation	Low	Localized (Columbia, Kootenay)	Current	Seasonal	Unknown	Low
Water pollution	Sedimentation from agriculture, forestry and urbanization	Low	Widespread	Historical / current	Recurrent	High	Medium
Water pollution	Eutrophication from agriculture and urbanization	Low	Widespread	Current / anticipated	Continuous	Unknown	Low
Water pollution	Harmful substances from mining and industrial activities	Low	Widespread	Historical / unknown	Recurrent	Unknown	Low
Aquatic invasive species	Displacement and predation by invasive species	Low	Widespread	Current/ anticipated	Continuous	Unknown	Low

7 Level of concern: signifies that managing the threat is of (high, medium or low) concern for the conservation of the species, consistent with the management objective. This criterion considers the assessment of all the information in the table.
8 Extent: proportion of the species affected by the threat.
9 Occurrence: timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipated.
10 Frequency: temporal extent of the threat (one-time, seasonal, recurrent, continuous or unknown).
11 Severity: magnitude of impact caused by the threat and level to which it affects species conservation.
12 Causal certainty: strength of evidence linking the threat to the conservation of the species.

4.2 Description of threats

There are substantial differences between the Kettle River and the Columbia/Kootenay/Slocan watersheds, and the presence and level of concern of threats likely differ between these locations and populations (Table 1). Generally, there is high uncertainty associated with all threats to Shorthead Sculpin because the species' habitat needs and factors affecting vital rates and populations are poorly understood.

Specific threats described under the loss of habitat quality and quantity threat category are related to habitat loss due to water use, increased maximum summer water temperature, and alteration of hydrograph. Changes to habitat resulting from land use and pollution are discussed under the water pollution threat category. Aquatic invasive species represent their own threat category.

Threat category: loss of habitat quality and quantity

Specific threat: increased periods of low flow resulting from water extraction

Water extraction occurs throughout Shorthead Sculpin's range for agricultural, residential and commercial purposes. It is of greatest concern in the Kettle River. In the Kettle River, approximately 80% of water extractions are for agricultural purposes. The majority of these extractions occur in the summer, which is naturally a low water season in rivers (COSEWIC 2006). The river currently has 224 water use licences allocated (B.C. Ministry of Environment 2016). In the past, unregulated groundwater withdrawals acted as another significant source of water use (COSEWIC 2006), however, on February 29, 2016, new groundwater licensing requirements under the *Water Sustainability Act* came into effect in B.C. (B.C. Ministry of Environment 2016).

In the Columbia watershed, the tributaries of the Columbia River have a variable number of water licences but the associated water extractions can total significant amounts in some instances. For example, Norns Creek has 109 recorded licences for domestic, irrigation and local waterworks (B.C. Ministry of Environment 2016). Together the licences total more than 1 m^3/s, an amount that is roughly equivalent to historic flows recorded during August and September and higher than the total discharge observed in September 2015 (Amec 2016). Blueberry Creek has four recorded licences with total extractions of less than 0.001 m^3/s, and Beaver Creek has 22 recorded licences (B.C. Ministry of Environment 2016). In the Kootenay/Slocan watershed, Slocan Lake is large enough to regulate riverine water flows naturally and water use is not a significant concern at this time (COSEWIC 2010).

In general, water extraction can result in low water levels and flows, and increased maximum summer water temperatures (discussed under the threat "increased maximum summer water temperature" with other temperature-related factors). Because Shorthead Sculpin inhabit riffles and runs, low water levels and flows that are outside the range of natural variability could directly reduce the total availability of shallow water habitat for all life stages. Direct risk of death due to stranding of eggs in nests and males guarding those nests during spawning may be low because most spawning occurs in May and June and the majority of water extractions for agriculture occur in July and August; however, the risk of death may be higher for young-of-the year sculpins inhabiting stream margins during the summer after emergence (Shorthead Sculpin technical workshop 2016).

The future demand for water is difficult to predict but may increase with increased human population and development pressures, and due to climate-related changes (e.g., reduced rainfall). The level of concern of this threat may increase as a result.

Specific threat: increased maximum summer water temperature

Increased maximum summer water temperature poses a threat to Shorthead Sculpin across their range and in particular in the Kettle River, where temperatures already exceed Shorthead Sculpin's preferred range on occasion. Mechanisms that may increase summer temperatures in Kettle River include: water extraction (discussed above), removal of riparian vegetation leading to reduced shading, and proposed run-of-the river hydroelectric projects.[13]

Increased temperatures during the summer and during low water level and flow events could reduce suitable habitat availability, fitness and survival of this cold water species. Across Shorthead Sculpin's range, removal of riparian vegetation for agriculture, forestry or urbanization without leaving a riparian buffer strip along the shore can reduce stream cover and shading, resulting in an increase in stream temperatures. In the Kettle River, when flows are low in the summer months, air and water temperatures are closely correlated; in contrast, when flows are higher, the influence of air temperature on water temperature is suppressed (Epp and Andrusak 2012). Over a twenty year period, at least six fish kills due to low water and high temperature conditions were observed in the Kettle River (COSEWIC 2010). While no mortality to Shorthead Sculpin was observed (sculpins lack swim bladders and do not float), the species is likely susceptible to these events because of their preference for colder water (COSEWIC 2010).

Cumulative effects from stable or increased demands for water (e.g., van der Gulik et al. 2013), ponding, changing land use, climate change (Parmesan and Yohe 2003) and drought may exacerbate high summer temperature conditions in the Kettle River and other areas in the future. Climate change projections for Kootenay-Boundary include warmer annual average temperatures, less snow, less summer rainfall, increased winter flows and reduced summer flows (S.E.C. Inc. 2012). Cold water conditions supplied by snowmelt and cool groundwater are likely to be altered under most climate change scenarios (Leith and Whitfield 1998; Morrison et al. 2002; British Columbia Ministry of Environment 2015).

Specific threat: sudden significant alteration of hydrograph from flow regulation

The Columbia River basin has been altered by river impoundment and regulation for the purpose of flood control and hydropower on both sides of the Canadian-U.S. border. Numerous dams have inundated riverine, lake and foreshore habitats, and altered aquatic habitats and flow regimes. It is unclear whether this historic habitat change has had a significant influence on Shorthead Sculpin habitats and populations because the historic range of the species is unknown. Much of the current Columbia River population is found in tributaries rather than in the

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[13] COSEWIC (2010) included proposed hydroelectric projects on Koch Creek and Kettle River as anticipated threats; however, the Koch Creek project was withdrawn (Canadian Environment Assessment Agency 2012) and the Environmental Assessment Certificate for Cascade Heritage Power Project in Kettle River expired in August 2016 (B.C. Environmental Assessment Office 2017). The effects of the projects on Shorthead Sculpin are unknown but COSEWIC (2010) suggested that water temperatures could increase downstream of the Cascade Falls project due to ponding above the dam.

mainstem river. These tributaries have not been directly impacted by river regulation and impoundment. The major threat related to flow regulation is sudden alterations to the hydrograph from Hugh L. Keenleyside (HLK) Dam on the Columbia River, which regulates discharge according to B.C.'s obligations under the Columbia River Treaty, and Brilliant Dam and Expansion on the lower Kootenay River, which regulates discharge according to local power needs and includes more frequent changes in flows than HLK Dam (Irvine et al. 2014a; Shorthead Sculpin technical workshop 2016).

Sudden reductions in water levels during spawning season can result in the dewatering of nests and stranding of adult males guarding nests. Amec (2014) observed tagged sculpins moving away from areas that became dewatered. However, during spawning season, they observed risk stranding to be higher; during this time, nests and male sculpins guarding those nests were stranded following declines in flow. A probability of stranding model for the Lower Columbia River found that the probability of stranding one or more sculpins increased with the magnitude of reduction in discharge, with risk increasing from 5 to 20% when discharge decreased from 1,000 to 500 m^3/s (Amec 2014). HLK Dam operates under a Rainbow Trout Spawning Protection Flows regime that aims to maintain stable or increasing flows between April and June to protect Rainbow Trout (*Oncorhynchus mykiss*) redds (Irvine et al. 2014b). This operation should also provide some protection to Shorthead Sculpin nests in areas influenced by HLK flows (Shorthead Sculpin technical workshop 2016).

Threat category: water pollution

Specific threat: sedimentation from agriculture, forestry and urbanization

Land-based activities including forest harvest, agriculture, urban and rural development, and clearing of riparian trees and shrubs have the capacity to alter riparian and aquatic habitats through increasing sedimentation. Of primary importance is loss of riparian vegetation, which offers streambank stability. Land clearing and associated bank instability and erosion can lead to increased inputs of fine sediments into streams and fill in interstitial spaces in gravel and cobble habitats, thereby reducing their suitability (e.g., siltation can lead to a reduction in benthic invertebrate prey, potential impacts on egg survival, and less physical space for refuge from predators) (Haas 1998; Bateman and Li 2001; Amec 2010; Amec 2014). Further, dams and instream obstructions can alter sediment transport and sedimentation rates. Increased sedimentation has likely occurred at a small scale throughout Shorthead Sculpin's range but the specific effects on Shorthead Sculpin and their habitat are poorly understood (Shorthead Sculpin technical workshop 2016).

Specific threat: eutrophication from agriculture and urbanization

Point source and non-point source pollution from agriculture and urban land uses have the capacity to affect water quality and degrade aquatic habitats. Inputs from agriculture and domestic fertilizers, poor groundwater quality, poorly-performing septic systems, and effluents from primary and secondary sewage treatment systems have the potential to degrade water quality. It is unclear if existing levels of pollution negatively affect Shorthead Sculpin across their range. COSEWIC (2010) suggests excessive eutrophication may be a concern in the future in Beaver Creek, a tributary of the Columbia River containing abundant Shorthead Sculpin populations and flow through two municipalities (Montrose and Fruitvale); however, more recent advice suggests that eutrophication would not become a major concern (Shorthead Sculpin technical workshop 2016). While Shorthead Sculpin have been identified as sensitive to changes in water quality (Maret and MacCoy 2002; Mebane et al. 2003), at this time water quality is not identified as a substantial concern.

Specific threat: harmful substances from mining and industrial activities

Historically, the Slocan Valley was heavily mined. Today, limited silver mining, mineral exploration, metal finishing, and pulp and paper operations occur across Shorthead Sculpin's Canadian range (MapPlace 2017). The effects of historical and present day mining and industrial activities on Shorthead Sculpin are unknown, however, in Idaho, the species was absent from sites downstream of hard-rock mining areas (Maret and MacCoy 2002; Peden and Hughes 1984). Recent toxicity studies found liver abnormalities in Shorthead Sculpin exposed to high concentrations of selenium (Rhea et al. 2013), and that the species was more sensitive to cadmium than to zinc (Mebane et al. 2012).

Threat category: aquatic invasive species

Specific threat: displacement and predation by invasive species

Non-native species are a leading driver of biotic change in freshwater systems globally (Sala et al. 2000). While specific invasive species and their effects on Shorthead Sculpin have not been identified, invasive species may threaten Shorthead Sculpin populations through predation and competition. Risk assessments found that six non-native piscivorous fish species (Largemouth Bass, Northern Pike (*Esox lucius*), Pumpkinseed (*Lepomis gibbosus*), Smallmouth Bass, Walleye and Yellow Perch) pose a moderate to very high ecological risk to the Columbia Basin in B.C. (Bradford et al. 2008a; Bradford et al. 2008b; Tovey et al. 2008). The risk assessments for Largemouth Bass and Yellow Perch specified sculpin species as prey sources. In addition, there could be a competition threat from ecologically similar benthic fishes, including gobies, which have been implicated in the severe decline of Mottled Sculpin (*Cottus bairdii*) in the St. Clair and Detroit rivers in the Great Lakes basin (Jude et al. 1992; MacInnis and Corkum 2000; Lauer et al. 2004)

5. Management objectives

Management objectives are ideally stated as quantitative targets (e.g., for population abundance or habitat quantity and quality). Insufficient information is available about current population abundance, habitat requirements and habitat availability to develop scientifically defensible quantitative targets for Shorthead Sculpin. Therefore, the management objective for Shorthead Sculpin is to maintain self-sustaining populations of Shorthead Sculpin throughout their distribution in the Columbia River, Kootenay/Slocan River, and Kettle River systems to ensure the species' long-term viability in the wild.

6. Broad strategies and conservation measures

6.1 Actions already completed or currently underway

Several actions to increase understanding of Shorthead Sculpin life history, population and distribution and to fill knowledge gaps have been completed, including studies on:

1. Taxonomy including some molecular genetics work (COSEWIC 2010; Lemoine et al. 2014)

2. Distribution of the Columbia River population as part of the Columbia Water Use Plan (Amec 2014)
3. Abundance in Norns and Beaver creeks (tributaries of the Columbia River) (Amec 2016)
4. Life history information in an unregulated tributary and the regulated lower Columbia River as part of the Columbia Water Use Plan (Amec 2014)

In addition, the B.C. Ministry of Forestry, Lands and Natural Resource Operations is in the process of collecting detailed hydrology and occupancy data to support the development of a water reserve in Norns Creek. The water reserve will moderate the number and volume of water licences in Norns Creek with the goal of minimizing periods of low flow, particularly in the summer, and providing habitat benefits to native fish species, including Shorthead Sculpin (L. Anderson, pers. comm).

6.2 Broad strategies

The following broad strategies support the management objective outlined in Section 5. Broad strategies and conservation measures are summarized and prioritized in Tables 2-4.

1. Inventory and monitoring
2. Research
3. Management and coordination
4. Stewardship and outreach

6.3 Conservation measures

Success in the management of this species is dependent on the actions of many different jurisdictions; it requires the commitment and cooperation of the constituencies that will be involved in implementing the directions and measures set out in this management plan.

This management plan provides a description of the measures that provide the best chance of achieving the management objectives for the Shorthead Sculpin, including measures to be taken to address threats to the species and monitor their management, and to guide not only activities to be undertaken by Fisheries and Oceans Canada, but those for which other jurisdictions, organizations and individuals have a role to play. As new information becomes available, these measures and the priority of these measures may change. Fisheries and Oceans Canada strongly encourages all Canadians to participate in the conservation of the Shorthead Sculpin through undertaking conservation measures outlined in this management plan.

Table 2 identifies the measures to be undertaken by Fisheries and Oceans Canada to support the management of Shorthead Sculpin. Table 3 identifies the measures to be undertaken collaboratively between Fisheries and Oceans Canada and its partners, other agencies, organizations or individuals. Implementation of these measures will be dependent on a collaborative approach, in which Fisheries and Oceans Canada is a partner in conservation efforts, but cannot implement the measure alone. As all Canadians are invited to join in supporting and implementing this management plan, Table 4 identifies remaining measures that represent opportunities for other jurisdictions, organizations or individuals to lead for the management of the species. If your organization is interested in participating in one of these measures, please contact the Species at Risk Pacific Region office at sara@pac.dfo-mpo.gc.ca.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Table 2. Conservation measures to be undertaken by Fisheries and Oceans Canada

#	Conservation measure	Broad strategy	Priority[14]	Threats addressed	Timeline
1	Develop a sufficiently robust monitoring plan to provide a clear indication of the progress towards achieving the management objective to “maintain self-sustaining populations of Shorthead Sculpin throughout their current distribution to ensure the species’ long-term viability in the wild.” Monitoring efforts may include: • Population abundance monitoring over time to establish quantitative population estimates, including variability, at index sites for the three populations throughout Shorthead Sculpin’s known and potential range.	Inventory and monitoring	H	All	2020

[14] “Priority” reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species:

- "High" priority measures are considered likely to have an immediate and/or direct influence on the conservation of the species.
- "Medium" priority measures are important but considered to have an indirect or less immediate influence on the conservation of the species.
- "Low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats.

Table 3. Conservation measures to be undertaken collaboratively between Fisheries and Oceans Canada and its partners, other agencies, organizations or individuals

#	Conservation measure	Broad strategy	Priority	Threats addressed	Timeline	Collaborators
2	Implement the long-term population abundance monitoring program for the three populations of Shorthead Sculpin.	Inventory and monitoring	H	All	Ongoing	Consultants, industry, researchers, provincial government
3	Increase the understanding of threats to Shorthead Sculpin. Research on threats may include: • Monitoring water quality parameters (e.g., temperature, nutrients, contaminants), especially in areas where pollution, harmful substances and increased maximum summer water temperatures are a concern, in relation to Shorthead Sculpin distribution and abundance. • Examining the relationship between water use, flow regulation, hydrographic regime (i.e., water level, flow, abrupt changes in discharge), and Shorthead Sculpin habitats and populations. Research should include examining the relationship between flow management in the Columbia[15] and Kootenay rivers and Shorthead Sculpin distribution.	Research	H	Water use, water temperature, sedimentation, water pollution	Ongoing	Stewardship groups, researchers (e.g., academic institutions, consultants), industry, provincial government

[15] Within the Columbia River, Shorthead Sculpin are currently found mainly in unregulated tributaries of the mainstem river and the influence of flow management on their distribution is unclear.

#	Conservation measure	Broad strategy	Priority	Threats addressed	Timeline	Collaborators
4	Address information gaps on species needs (life history, behaviour and habitat) that inhibit conservation of Shorthead Sculpin. Research on species needs may include: • Researching life history requirements (e.g., spawning behaviour and susceptibility of early life stages to water level, flow, temperature and sedimentation changes). • Developing an inventory of habitat types (e.g., substrate, depth, flow, cover) across Shorthead Sculpin's range and defining key habitat needs (e.g., sediment embeddedness). • Increasing understanding of causes of mortality (e.g., temperature, pollutants, predation from native and non-native species, sedimentation of incubation habitat, etc.). • Researching limiting factors to population growth (e.g., biotic interactions, climate change).	Research	M	All	Ongoing - 2023	Stewardship groups, researchers (e.g., academic institutions, consultants), recreational users, industry, schools, local or provincial government

Table 4. Conservation measures that represent opportunities for other jurisdictions, organizations or individuals

#	Conservation measure	Broad strategy	Priority	Threats addressed	Contributors
5	Share information about Shorthead Sculpin and encourage land owners and relevant levels of government to consider the species in the development, implementation, and updating of land use plans, official community plans, by-laws and management guidelines.	Management and coordination	L	All	Potentially stewardship groups, industry, local and provincial governments
6	Promote best management practices (e.g., riparian planting by private landowners or school groups) through increased cooperation among landowners, stewardship groups and other interested parties.	Stewardship and outreach	M	Water use, water temperature, sedimentation, water pollution	Potentially stewardship groups, recreational users, industry, schools, other agencies, groups or individuals
7	Incorporate Shorthead Sculpin stewardship activities into existing programs. Stewardship groups, local governments and other interested parties could lead and participate in Shorthead Sculpin stewardship activities, including the possibility of combining Shorthead Sculpin and Columbia Sculpin stewardship.	Stewardship and outreach	L	All	Potentially stewardship groups, recreational users, industry, schools, local or provincial governments, other agencies, groups or individuals
8	Develop and distribute educational outreach materials for the general public and landowners to foster awareness of Shorthead Sculpin and general biodiversity values. Outreach materials could include school programs, brochures, web-based materials, and signage to place at targeted locations.	Stewardship and outreach	L	All	Potentially stewardship groups, recreational users, industry, schools, local or provincial governments, other agencies, groups or individuals

7. Measuring progress

The performance indicators presented below provide a way to define and measure progress towards achieving the management objective:

1. Observe a stable or positive trend in Shorthead Sculpin B.C. population abundance by 2022, taking into account natural variation
2. Observe a preservation or expansion of Shorthead Sculpin's B.C. distribution by 2022, taking into account natural variation

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Appendix A: effects on the environment and other species

In accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (2010), SARA recovery planning documents incorporate strategic environmental assessment (SEA) considerations throughout the document. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's goals and targets.

Management planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the plan itself, but are also summarized below.

This management plan will benefit the environment by promoting the conservation of Shorthead Sculpin, thereby contributing to FSDS Goal 4 (Conserving and Restoring Ecosystems, Wildlife and Habitat, and Protecting Canadians). Specifically, it will help to attain the associated Target 4.1 which is to have populations of federally listed species at risk exhibit trends that are consistent with recovery strategies and management plans. In addition, it could help to meet the target associated with 4.6, whereby pathways of invasive alien species introductions are identified, and risk-based intervention or management plans are in place for priority pathways and species.

The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. For information on how the management plan and Shorthead Sculpin potentially link to, or interact with, other species and the ecosystem, refer to the following sections of the document: Species Description, Needs of the Shorthead Sculpin, and Conservation Measures.

More specifically, within the distribution of the Shorthead Sculpin, it is unlikely that the broad strategies to recovery recommended within this document will negatively impact other fish or wildlife species. The broad strategies for conservation suggested in Tables 2-4 will help to address threats to the Shorthead Sculpin and its habitat, such as improving water quality by limiting sediment inputs, which will also benefit other native species. Furthermore, conservation efforts may benefit species downstream of the distribution of Shorthead Sculpin as improvements in water quality could be conveyed to these areas.

Appendix B: record of cooperation and consultation

The Shorthead Sculpin (*Cottus confusus*) is a freshwater fish that was listed as a species of special concern under the *Species at Risk Act* (SARA) in March 2013. The Shorthead Sculpin was downlisted from threatened status to special concern under SARA following the 2010 assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as special concern due to the increased number of locations in which the species is found. The Minister of Fisheries and Oceans (DFO) is the competent minister for the Shorthead Sculpin in Canadian waters and prepared the management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the Province of British Columbia as per section 66(1) of SARA. Processes for coordination and consultation between the federal and British Columbia governments on management and protection of species at risk are outlined in the *Canada-British Columbia Agreement on Species at Risk*.

In July 2016, DFO held a technical workshop with species and local experts to seek input on the draft management plan and to ensure the document incorporated the best technical and scientific information on the species. Participants are identified in the table below.

Name	Affiliation
Erin Gertzen (chair)	Fisheries and Oceans Canada (Species at Risk Program)
Martin Nantel	Fisheries and Oceans Canada (Species at Risk Program)
Sean MacConnachie	Fisheries and Oceans Canada (Science)
Greg Wilson	B.C Ministry of Environment
Guy Martel	BC Hydro
Rachel Keeler	Amec Foster Wheeler
Crystal Lawrence	Amec Foster Wheeler
Louise Porto	Amec Foster Wheeler

In December 2016 the draft management plan was circulated to nine Indigenous organizations and approximately 40 local, regional, and provincial government, consultant, academic, environmental non-government organization and industry representatives for a 35-day external review. Eight sets of comments were received, including one from BC Hydro, one from an Indigenous organization and six from a local streamkeepers group. All feedback was considered in the proposed management plan. Comments resulted in minor revisions to species distribution descriptions and clarification of terminology.

Additional stakeholder, Indigenous, and public input was sought through the publication of the proposed document on the Species at Risk Public Registry for a 60-day public comment period. One comment was received and considered in finalizing the document.