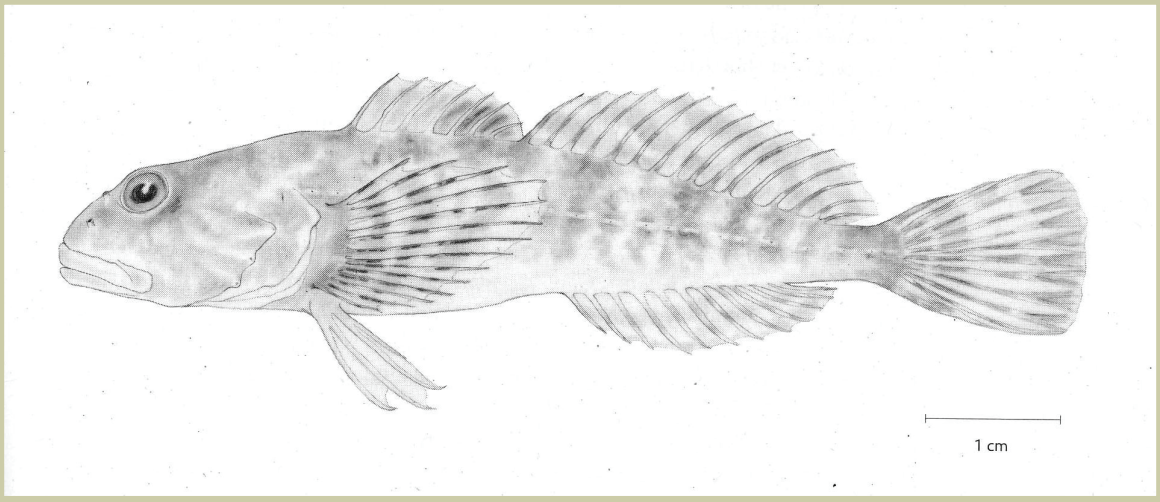
FINAL

Species at Risk Act
Management Plan Series

Management Plan for the Columbia Sculpin (*Cottus hubbsi*) in Canada

Columbia Sculpin



2012

Fisheries and Oceans Canada
Pêches et Océans Canada
Canada

About the *Species at Risk Act* Management Plan Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is "*to manage species of special concern to prevent them from becoming endangered or threatened*."

What is a species of special concern?

Under SARA, a species of special concern is a wildlife species that could become threatened or endangered because of a combination of biological characteristics and identified threats. Species of special concern are included in the SARA List of Wildlife Species at Risk.

What is a management plan?

Under SARA, a management plan is an action-oriented planning document that identifies the conservation activities and land use measures needed to ensure, at a minimum, that a species of special concern does not become threatened or endangered. For many species, the ultimate aim of the management plan will be to alleviate human threats and remove the species from the List of Wildlife Species at Risk. The plan sets goals and objectives, identifies threats, and indicates the main areas of activities to be undertaken to address those threats.

Management plan development is mandated under Sections 65–72 of SARA (http://www.sararegistry.gc.ca/approach/act/default_e.cfm).

A management plan has to be developed within three years after the species is added to the List of Wildlife Species at Risk. Five years is allowed for those species that were initially listed when SARA came into force.

What's next?

Directions set in the management plan will enable jurisdictions, communities, land users, and conservationists to implement conservation activities that will have preventative or restorative benefits. Cost-effective measures to prevent the species from becoming further at risk should not be postponed for lack of full scientific certainty and may, in fact, result in significant cost savings in the future.

The series

This series presents the management plans prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as plans are updated.

To learn more

To learn more about the *Species at Risk Act* and conservation initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the Web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

Management Plan for the Columbia Sculpin (*Cottus hubbsi*) in Canada [Final]

2012

Recommended citation:

Fisheries and Oceans Canada. 2012. Management Plan for the Columbia Sculpin (*Cottus hubbsi*) in Canada [Final]. *Species at Risk Act* Management Plan Series. Fisheries and Oceans Canada, Ottawa. 18 + iv pp.

Additional copies:

Additional copies can be downloaded from the SARA Public Registry (http://www.sararegistry.gc.ca/).

Cover illustration: Columbia sculpin, *Cottus hubbsi*, by Diana McPhail. Reproduced courtesy of the artist.

Également disponible en français sous le titre
« Plan de gestion du chabot du Columbia (Cottus hubbsi) au Canada»

ISBN 978-1-100-18847-8
Catalogue no. En3-5/19-2011E-PDF

DECLARATION

This proposed management plan has been prepared by Fisheries and Oceans Canada (DFO) and the British Columbia Ministry of Environment (B.C. MoE). DFO has reviewed and accepts this proposed document as its management plan for the Columbia Sculpin, as required under the *Species at Risk Act*. The B.C. MoE has reviewed and accepts this document as scientific advice.

This document identifies the strategies that are deemed necessary, based on the best available scientific and biological information, to manage Columbia Sculpin populations in Canada. 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 DFO or any other jurisdiction alone. In the spirit of the Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all responsible jurisdictions and Canadians to join DFO in supporting and implementing this plan for the benefit of the Columbia Sculpin and Canadian society as a whole. The Minister will report on progress within five years as required under SARA.

RESPONSIBLE JURISDICTIONS

The responsible jurisdiction for the Columbia Sculpin under the *Species at Risk Act* is DFO.

AUTHORS

DFO and the Province of B.C. cooperated in the development of this management plan. A recovery team was assembled to provide science-based recommendations to government with respect to the management of Columbia Sculpin. Members of the Columbia Sculpin Recovery Team are listed below:

Jordan Rosenfeld, B.C. Ministry of Environment, (co-chair)
Heather Stalberg, Fisheries and Oceans Canada, (co-chair)
Todd Hatfield, Solander Ecological Research, (coordinator)
Don McPhail, University of British Columbia (UBC)
John Richardson, UBC
Dolph Schluter, UBC
Eric Taylor, UBC
Paul Wood, UBC

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. 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.

Recovery 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 on 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 clearly benefit the environment by promoting the conservation of the Columbia Sculpin. The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to the following sections of the document in particular: description of the species' habitat and biological needs, ecological role, and limiting factors; effects on other species; and the implementation actions.

PREFACE

The responsible jurisdiction for the Columbia Sculpin under the *Species at Risk Act* (SARA) is DFO. The Columbia Sculpin was listed as a species of special concern under SARA in June 2003. SARA (Section 65) requires the Minister of Fisheries and Oceans to prepare management plans for aquatic species listed as special concern, including the Columbia Sculpin. The proposed strategy meets SARA requirements in terms of content and process (Sections 39-41).

EXECUTIVE SUMMARY

Columbia sculpin are endemic to the Columbia River mainstem and tributaries downstream of Arrow Lakes. In B.C. they have been captured in the Similkameen, Tulameen, Kettle, Columbia, and Kootenay Rivers. In the United States (USA), the Columbia sculpin inhabits most of the Columbia River drainage downstream of the Montana – Idaho border, including the Snake River drainage downstream of Shoshone Falls, Idaho. Abundance and distribution trends in Canada are not known.

Columbia sculpin appear to have broad habitat requirements. They occur in rocky, riffle habitats in streams less than 5 m wide up to rivers the size of the Columbia mainstem. Rearing habitats are riffle areas of clear, cool streams, with cobble substrates. Male sculpins build nests or use existing cavities under rocks or other debris. Individuals do not undertake large migrations or movements, and home ranges appear to be very small, based on studies in similar species.

Columbia sculpin have a restricted distribution in Canada, and thus can be considered vulnerable to a variety of threats. However, much information is lacking on the general biology of the species, which makes a detailed threats assessment and prioritization difficult. General threats include flow regulation, consumptive water uses, point and non-point pollution, introduction of non-native species, and climate change.

There are no habitat protection provisions specifically for this species. Sculpin studies have been mandated under the Columbia Water Use Plan and results will be included in decisions around water management. Aside from this, very few species-specific recovery-related or management-related actions have been completed or initiated for Columbia sculpin.

The management goal for Columbia sculpin is to ensure long-term viability of this species across its extant distribution in the wild. A variety of approaches are presented to help meet this goal. It is likely that this species will always remain at risk due to its limited distribution in Canada.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. SPECIES INFORMATION

1.1. Species Assessment Information from COSEWIC

Date of Assessment: May 2000

Common Name (population): Columbia Sculpin

Scientific Name: *Cottus hubbsi*

COSEWIC Status: Special Concern

Reason for Designation: This subspecies of the mottled sculpin[1] occurs in southern British Columbia, and is impacted by habitat loss. The risk of extirpation is reduced by the possibility of rescue from nearby populations in the USA.

Canadian Occurrence: British Columbia

COSEWIC Status History: Designated Special Concern in May 2000. Assessment based on a new status report.

1.2. Description of the Species

Sculpins are bottom-living, primarily marine fishes of arctic and temperate waters of the Northern Hemisphere (Scott and Crossman 1973). They are distinguished by a large head and a heavy body that tapers to a relatively narrow caudal peduncle (Scott and Crossman 1973). The genus *Cottus* is widely distributed in freshwater (Scott and Crossman 1973). Species of freshwater sculpin are generally less than 18 cm in length, lack a swim bladder and are usually benthic (Heard 1965, Scott and Crossman 1973).

Columbia sculpin were once classified as mottled sculpin, *Cottus bairdii*, a broadly distributed species in eastern North America, which originally included a disjunct western range. "Mottled sculpin" in western North America are now known to be made up of several cryptic species and subspecies, based on detailed morphological and genetic studies (Bailey and Dimick 1949, Neely 2004, McPhail 2007). There continues to be some debate about how best to address the taxonomy of some of these western populations (Peden 2000), but Columbia sculpin are treated here as a bona fide species, following the work of Bailey and Dimick (1949), Neely (2004), and McPhail (2007).

Columbia sculpin occur sympatrically or within the range of other sculpin species (Prickly sculpin *C. asper*, Torrent sculpin *C. rhotheus*, and Shorthead sculpin *C. confusus*) and in some areas are contiguous or overlapping with *C. bendirei*, a closely-related species (McPhail pers.

[1] COSEWIC describes the Columbia sculpin as a "subspecies of the mottled sculpin." Recent evidence suggests Columbia sculpin are a bona fide species (see text for appropriate references and additional description of the species).

comm. 2007). Columbia sculpin can be difficult to distinguish in the field, even by trained biologists and ichthyologists (Roberts 1988, McPhail 2007). Several characters are typically required to confidently identify *C. hubbsi*, including fin ray counts, tooth pattern, lateral line development, presence of prickles, head length, and body coloration (Peden et al. 1989, McPhail 2007). Columbia sculpin usually have three distinct bars or "saddles," which extend from under the soft dorsal fin to about halfway down the body, and there is some coloration on the anal fin (Wydoski and Whitney 2003, McPhail 2007). Other useful characters for identification in the field and laboratory are discussed in McPhail (2007). Several molecular genetic markers are also diagnostic (McPhail 2001). Adding to the difficulty of proper identification, Columbia sculpin hybridize with *C. bendirei*, where the two co-occur (McPhail pers. comm. 2007). *C. bendirei* appears to be a small stream, headwater species, whereas *C. hubbsi* is associated with larger systems, such as the mainstem Similkameen River (McPhail pers. comm. 2007).

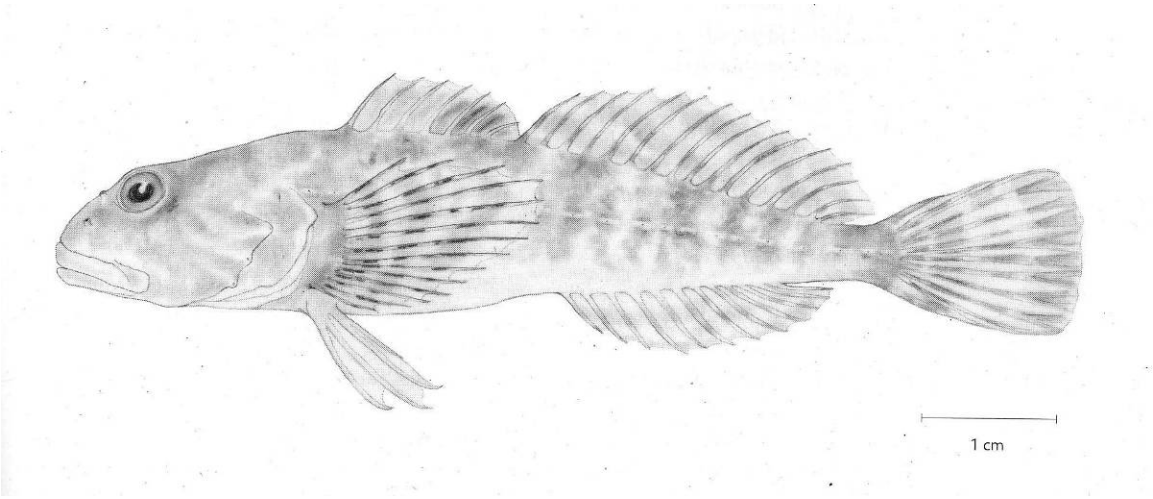


Figure 1. Illustration of Columbia sculpin, *Cottus hubbsi*, by Diana McPhail.

1.3. Populations and Distribution

Columbia sculpin are endemic to the Columbia River mainstem and tributaries downstream of Arrow Lakes (Neely 2004, McPhail 2007). In B.C. they have been captured in the Similkameen River below Similkameen Falls, Tulameen River as far upstream as Lawless Creek, Kettle River below Cascade Falls, Columbia River mainstem and tributaries below Arrow Lakes, and Kootenay River and tributaries (including the Slocan River) below Bonnington Falls (Peden et al. 1989, Peden 2000, McPhail 2007) (Figure 2). In the USA, the Columbia sculpin inhabits most of the Columbia River drainage downstream of the Montana – Idaho border, including the Snake River drainage downstream of Shoshone Falls, Idaho (Neely 2004).

Abundance and distribution trends are not known in Canada. The historic distribution in Canada is assumed to be similar to its present-day distribution, but habitat alterations from flow regulation have been significant in the Columbia and Kootenay Rivers, and it is possible that historic distribution differed. The historic distribution also included several lakes in the Similkameen system that were poisoned as part of fisheries enhancement projects in the 1950s

(McPhail 2007). The species has a global rank of G4Q[2] (apparently secure) and a provincial rank of S3 (special concern, vulnerable to extirpation or extinction; B.C. Conservation Data Centre 2010).

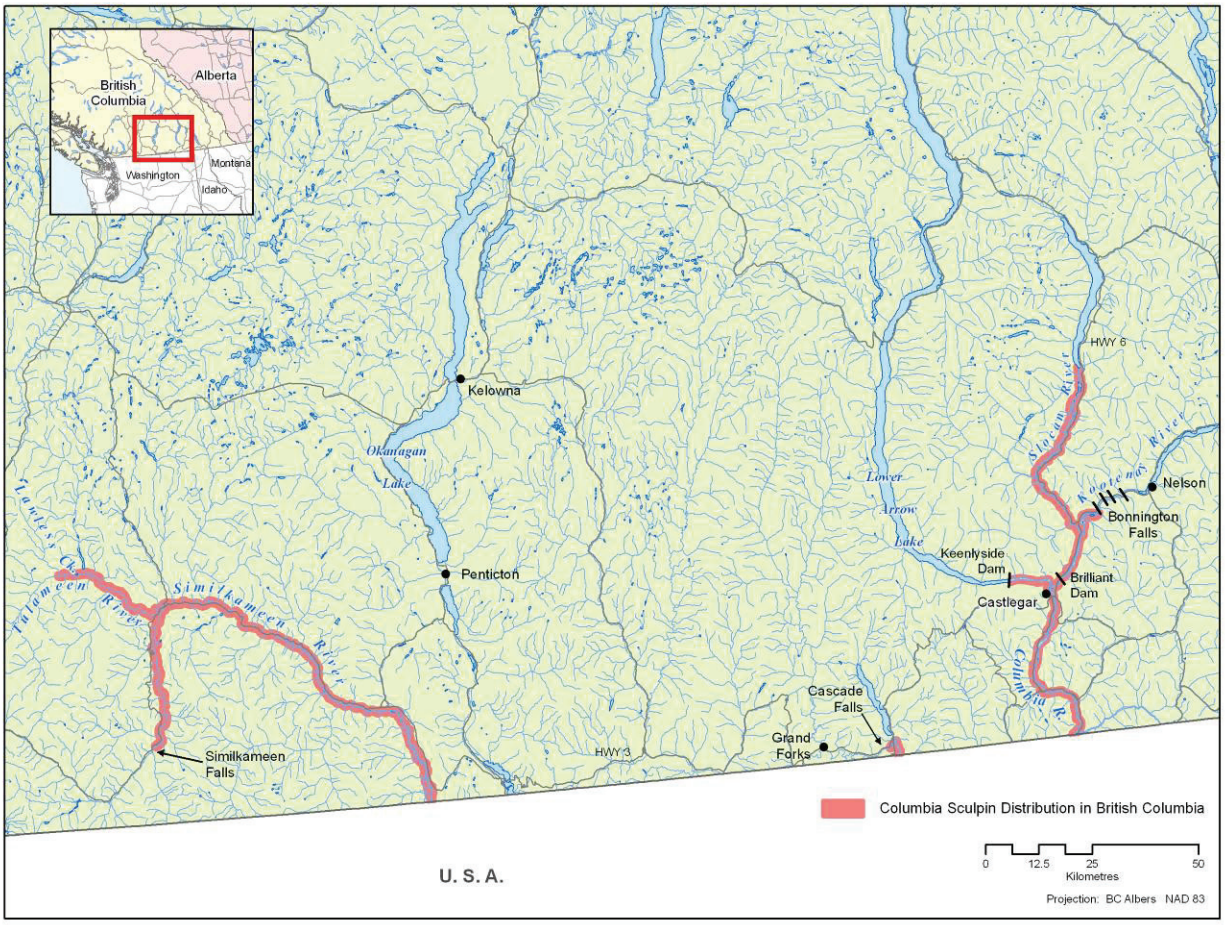


Figure 2. Distribution of Columbia sculpin in Canada.

1.4. Needs of the Columbia Sculpin

1.4.1. Habitat and biological needs

Habitat and life history of the Columbia sculpin have not been studied in detail in Canada, so most information comes from studies in the USA, or from studies on closely-related species.

Columbia sculpin appear to have broad habitat requirements. They occur in rocky, riffle habitats in streams less than 5 m wide up to rivers the size of the Columbia mainstem (Peden 2000, McPhail 2007). They occur primarily in streams, although they occurred at one time in lakes in the Similkameen system before they were eradicated as part of fisheries enhancement programs in the 1950s (Peden 2000, McPhail 2007). They co-exist with Prickly, Torrent and Shorthead

[2] The "Q" is a rank qualifier that notes "questionable taxonomy." Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority (NatureServe 2009).

sculpins, and there is some evidence of microhabitat partitioning among species and among life stages (McPhail 2007). Rearing habitats are riffle areas of clear, cool streams, with cobble substrates. Adults are associated with moderate currents (0.3 – 0.6 m sec^{-1}) and depths of 40 to 100 cm (McPhail 2007). Juveniles typically occur in shallower, slower water than adults. In July and August young of the year occur in quiet, shallow water along stream margins, sometimes in association with submerged vegetation (McPhail 2007). Columbia sculpin are most active at night, and can be difficult to observe in the day (McPhail 2007).

Columbia sculpin reproduce in the spring from February to June, depending on location, when water temperatures are between 4º and 11º, and possibly as high as 15º C (Wydoski and Whitney 2003). In Otter Creek, nests with eggs were found from late May to mid- June (McPhail 2007). Male sculpins are polygynous, and build nests or use existing cavities under rocks or other debris (Roberts 1988, Neely 2004). Males entice females with courtship displays and vocalizations (Neely 2004). Eggs are laid on the roof of the cavity in discrete clusters, each cluster comprised of a single clutch, and are guarded and fanned by the male until the embryos hatch, and sometimes until the yolk sac is absorbed completely (Wydoski and Whitney 2003, Neely 2004). Length of incubation depends on temperature, but ranges from 20 to 30 days at 10º to 15.5º C (Wydoski and Whitney 2003, McPhail 2007). Newly hatched larvae remain in the gravel until their egg sac is absorbed, at which time they emerge and begin exogenous feeding (McPhail 2007).

Individuals do not undertake large migrations or movements, and home ranges appear to be very small, based on studies in similar species. For example, a study of summer movements by adult Mottled sculpin in Montana found a mean movement between successive recaptures within a two-week period of 1.2 m, with 14.3 m being the greatest recorded movement (Brown and Downhower 1982). A mark-recapture study of adult Mottled sculpin in North Carolina measured average movement distances of 12.9 m over a period of 128 days (average period between captures; Hill and Grossman 1987). Dispersal patterns of juveniles are not known.

Diets of Columbia sculpin are mostly benthic invertebrates: small chironomid larvae are important when the fish are young; nymphs of caddis flies, mayflies, stone flies and Diptera are most important in older fish (Peden 2000, Wydoski and Whitney 2003, McPhail 2007). Gammarids, snails and fish eggs, including those of nesting sculpins, are also eaten (Wydoski and Whitney 2003).

1.4.2. Ecological role

In most instances Columbia sculpin are part of a simple fish community. As a carnivore, Columbia sculpin play a role in limiting abundance of their prey, which are predominantly aquatic insects. Columbia sculpin are probably eaten by predatory fish, birds and mammals, but the extent to which Columbia sculpin are a significant component of some fish and wildlife diets is not known.

1.4.3. Limiting factors

The environmental factors that limit abundance of Columbia sculpin have not been well-studied. We assume that populations are affected by competition, predation, habitat quantity and quality, and food availability, though the relative effect of each is not known. It is evident that to persist over the long term, all species require sufficient rearing and spawning habitat, a healthy food base, and replacement rates that exceed predation and exploitation rates.

Several factors that may be considered important when discussing limiting factors are the limited dispersal of Columbia sculpin, general habitat preferences, and low fecundity. Added to this are natural and anthropogenic dispersal barriers, such as falls and dams. The relatively short dispersal range of this species may make it difficult to colonize new areas or recolonize areas that become depopulated (Peden 2000). The Canadian portion of this species' distribution is at its northern range limit, and it is not known what is currently limiting the geographic distribution. The species' habitat preference is for riffle habitats in cool, clear streams. These habitats may be somewhat scarce or vulnerable to disturbance (Peden 2000). Fecundity of Columbia sculpin varies with female body size, but clutches have relatively few eggs (50 – 100) and are likely produced only once per year (Wydoski and Whitney 2003, McPhail 2007).

1.5. Threats

1.5.1. Threat classification

Table 1. Threat classification table.

1	**Flow Regulation**	**Threat Attributes**		
Threat Category	Water Use	**Extent**	Widespread (Columbia River and Kootenay River mainstems)	
			Local	**Range-wide**
General Threat	Flow regulation downstream of dams, Fluctuating water levels	**Occurrence**	Current	
		Frequency	Continuous	
Specific Threat	Habitat instability and stranding	**Causal Certainty**	Medium	
		Severity	Moderate	
Stress	Lower individual and population growth rates, Lower carrying capacity	**Level of Concern**	Medium	
2	**Exotic Species**	**Threat Attributes**		
Threat Category	Exotic Species	**Extent**	Widespread	
			Local	**Range-wide**
General Threat	Introduction or range expansion of non-native species	**Occurrence**	Current	
		Frequency	Continuous	
Specific Threat	Competitive exclusion or predation	**Causal Certainty**	Medium	
		Severity	Unknown	
Stress	Recruitment decline or failure	**Level of Concern**	Medium	

3	Consumptive Water Use	Threat Attributes		
Threat Category	Water Use	**Extent**	Localized (primarily Similkameen River and tributaries)	
			Local	**Range-wide**
General Threat	Water extraction, Fluctuating water levels	**Occurrence**	Current	
		Frequency	Seasonal	
Specific Threat	Habitat instability	**Causal Certainty**	Medium	
		Severity	Low	
Stress	Lower individual and population growth rates, Lower carrying capacity	**Level of Concern**	Low to Medium	

4	Water Quality	Threat Attributes		
Threat Category	Water Quality	**Extent**	Localized	
			Local	**Range-wide**
General Threat	Pollution from mining, industry and agriculture	**Occurrence**	Historic / Current	
		Frequency	Continuous	
Specific Threat	Metal and nutrient concentrations	**Causal Certainty**	Medium	
		Severity	Unknown	
Stress	Acute and chronic toxicity	**Level of Concern**	Low	

5	Land Use	Threat Attributes		
Threat Category	Land Use	**Extent**	Widespread	
			Local	**Range-wide**
General Threat	Habitat alteration and destruction, Riparian removal and sedimentation of instream habitat	**Occurrence**	Current	
		Frequency	Continuous	
Specific Threat	Water temperature increases and habitat destruction	**Causal Certainty**	Medium	
		Severity	Unknown	
Stress	lower individual and population growth rates, Lower carrying capacity	**Level of Concern**	Low	

6	Hybridization	Threat Attributes		
Threat Category	Hybridization	**Extent**	Widespread	
			Local	**Range-wide**
General Threat	Changes in interactions with closely related species	**Occurrence**	Current	
		Frequency	Continuous	
Specific Threat	Changing habitat conditions lead to changes in distribution of species	**Causal Certainty**	Medium	
		Severity	Unknown	

	with which Columbia sculpin may hybridize			
Stress	Genetic introgression and collapse of genetically distinct populations	**Level of Concern**	Low	
7	**Climate Change**	**Threat Attributes**		
Threat Category	Climate change	**Extent**	Widespread	
			Local	**Range-wide**
General Threat	Habitat changes, Altered habitat conditions	**Occurrence**	Anticipated (Probable)	
		Frequency	Ongoing	
Specific Threat	Habitat alteration, Changes in species distribution	**Causal Certainty**	Medium	
		Severity	Unknown	
Stress	Lower individual and population growth rates, Lower carrying capacity, Changes in species interactions	**Level of Concern**	Low at present	

1.5.2. Description of threats

Columbia sculpin have a restricted distribution in Canada, and thus can be considered vulnerable to a variety of threats. However, much information is lacking on the general biology of the species, which makes a detailed threats assessment and prioritization difficult. It is possible to identify general threats, and these are discussed below, but quantifying these threats is not possible until more is known about the species' biology, including its specific habitat requirements.

Flow Regulation and Consumptive Water Use.— The Columbia River valley has been profoundly altered by river impoundment and regulation for the purpose of flood control and hydropower. Numerous dams, on the Columbia, Kootenay and Pend d'Oreille Rivers have inundated riverine, lake and foreshore habitats and altered flow regimes. It is unclear whether this historic habitat change has had a significant influence on Columbia sculpin abundance, but the habitat in these rivers has clearly been considerably altered. Much of the current population is found in the Columbia River mainstem rather than in tributaries. The Kootenay River has also been profoundly altered by river impoundment and regulation, and no unaffected habitat exists for Columbia sculpin on this river below Bonnington Falls (Peden 2000). A few individuals were captured here though, indicating that a small population continues to persist.

Smaller scale water use occurs throughout the species' range for residential and commercial purposes. Licensed and actual consumption patterns have not been specifically assessed, but based on an overview analysis for Shorthead sculpin in Columbia River tributaries (National Recovery Team for Shorthead Sculpin 2007) consumptive water use may be a concern for Columbia sculpin. Water use often varies considerably among streams, but can be significant in some instances, and exacerbate poor habitat conditions during low flow periods. Since extreme

low flows will reduce habitat availability, there are likely flow thresholds below which habitat availability declines rapidly. Some of the small tributaries of the Similkameen and Tulameen Rivers go completely dry in most summers, yet usually contain Columbia sculpin in the spring, and may be breeding or rearing areas (McPhail pers. comm. 2007). Licensed or unlicensed water extraction may affect habitat in these streams.

The future demand for water is difficult to predict, but will likely increase in the future with increased human population and development pressures and changes to water availability associated with climate change. In addition to licensed users there are likely unlicensed water users throughout the region; the threats to Columbia sculpin posed by unlicensed water users is not known.

Exotic Species.— Sala et al. (2000) suggest that non-native species are the leading driver of biotic change in freshwater systems in general, and there may be some threat to Columbia sculpin from introduced species. The Columbia drainage in B.C. contains 43 species of fish of which 16 species are introduced (McPhail and Carveth 1992). At least one more introduced species (Northern pike, *Esox lucius*) has been added to this list since (DeRosa pers. comm. 2009). Not all of these introductions co-occur with Columbia sculpin, and not all would be considered threats, but the proportion of the total fish population that is introduced (37%) highlights the potential risk.

Walleye, *Sander vitreus*, are now common in the Columbia River as far north as Castlegar. As a dominant piscivore, Walleye are a possible threat to sculpins and other fish species. Other non-native predatory fish such as bass may rely heavily on sculpins in their diets (Summers and Daily 2001, Bonar et al. 2005). Threats from other existing exotic organisms have not been identified, but there may be a threat from ecologically similar benthic fishes. For example, the Round goby, *Neogobius melanostomus*, was introduced to the St. Clair and Detroit Rivers, in the Great Lakes region, and has been implicated in the severe decline of the Mottled sculpin there (Jude et al. 1992, MacInnis and Corkum 2000, Lauer et al. 2004). A related species, the Amur goby, *Rhinogobius brunneus*, has been identified in the East Fork Lewis River in the state of Washington.

Water Quality.— Several species of sculpin have been identified as particularly sensitive to changes in water quality (Maret and MacCoy 2002, Mebane et al. 2003). For example, Maret and MacCoy (2002) noted that Shorthead sculpin and other cottids were absent from sites downstream of hard-rock mining areas in the Coeur d'Alene basin, Idaho, implying that they are sensitive to elevated metals concentrations. Peden and Hughes (1984) raised concerns regarding development of coal mining within portions of the Flathead River basin, believing that this may threaten sculpin populations there. *Cottus bairdi* are among the most sensitive species tested to date for acute and chronic toxicity to zinc (Woodling et al. 2002). It is possible that Columbia sculpin populations in the mainstem Columbia River have been affected by historic slag dumping. Historically there were major copper mines in the Similkameen valley, and there are still a number of active mines (McPhail pers. comm. 2007). The extent to which mine tailings are currently leaching into the river is unknown, but is of concern and may warrant study.

Other point and non-point source pollution has the capacity to affect water quality and to degrade aquatic habitat. Poorly-performing septic systems, inputs from agriculture and domestic fertilizers, sedimentation from land-based activities, and poor groundwater quality are general concerns that have the potential to degrade water quality to some degree. Nitrite (an intermediate in the oxidation of ammonium to nitrate) toxicity was reviewed by Lewis and Morris (1986), and Mottled sculpin (a related sculpin species) were among the least sensitive. It is unclear if existing levels of this form of pollution negatively affect Columbia sculpin within its Canadian range, but overall water quality is not identified as a substantial concern at this time. This threat may require additional assessment in the future as related information becomes available.

Land Use.— Some land-based activities have the capacity to alter aquatic habitat directly (e.g., impacts to riparian habitat, alteration of runoff or water storage capacity in headwaters) or indirectly (e.g., changes to water quality through introduction of pollutants). The Columbia watershed has undergone considerable development associated with residential, agricultural, forestry, and industrial land uses. Land-based activities have the potential to increase sediment and nutrient loads to fish-bearing streams, or directly affect littoral habitat, but the extent and magnitude of specific impacts to Columbia sculpin habitats is unclear. Given the general sensitivity of benthic invertivores to infilling of substrate interstices, and the extensive forestry and other riparian impacts that have occurred throughout the species' range, some habitat degradation through siltation has almost certainly occurred; this generalized threat was identified by Haas (1998) and Peden (2000).

Hybridization.— As noted earlier, Columbia sculpin hybridize with *C. bendirei*, where the two species co-occur (McPhail pers. comm. 2007). The two tend to occupy different habitat types (*C. hubbsi* is associated with larger mainstems and *C. bendirei* is associated with smaller headwater streams), but it is conceivable that habitat disturbances, translocations or climate change may bring the two into more frequent contact. At this point, we do not know if introgression is a current or potential threat to either species, but it is identified here as topic warranting additional study.

Climate Change.— Scientific evidence clearly indicates that climate is changing and animal and plant distributions are responding to these changes (Parmesan and Yohe 2003). Since climate affects precipitation, water flow and temperature in many ways, it may also affect Columbia sculpin abundance and distribution. This threat is of particular concern because Columbia sculpin require cool temperatures throughout the year, which are likely supplied by snowmelt and cool groundwater sources, and are likely to be altered under most realistic climate change scenarios (Leith and Whitfield 1998, Morrison et al. 2002, B.C. MoE 2006); the generally poor dispersal ability of this species (Peden 2000) accentuates the concern. At present the topic is considered beyond the scope of this management plan, but the threat may be assessed and addressed at future stages of recovery planning for Columbia sculpin.

1.6. Existing Protection

There are no habitat protection provisions specifically for Columbia sculpin, however, the fish habitat protection provisions of the *Fisheries Act* provide protection for Columbia sculpin, and the *BC Forest and Range Practices Act* has provisions to protect fish habitat from forestry and range activities.

Very little of the land base within the current Canadian range of Columbia sculpin is within protected areas. Within the Similkameen drainage, the species is outside the boundaries of Manning Provincial Park. Small portions of habitat are found within Beaver Creek and Snowy Provincial Parks, but these portions are likely too small to be of significance for long-term population persistence. All other known occurrences of Columbia sculpin are on Crown land or private property.

1.7. Actions Already Completed or Underway

Sculpin studies have been mandated under the Columbia Water Use Plan and results will be included in decisions around water management; these studies have been initiated and are underway. The studies will collect life history information in an unregulated system, to act as a control, and in the regulated lower Columbia River. The information will be collected in support of describing important habitat for this species. Aside from this, very few species-specific, recovery-related or management-related actions have been completed or initiated for Columbia sculpin.

1.8. Knowledge Gaps

Little is known about the ecology of Columbia sculpin, the environmental factors that affect abundance and distribution, and the threats to this species. Meeting conservation goals will require addressing several knowledge gaps. The gaps fall into three main categories, as outlined below.

Basic Biology of Columbia Sculpin

1. Species identification tools (e.g., field keys and other tools to enable better identification and discrimination among related sculpin species),
2. Habitat use and requirements by life stage (e.g., population distribution within each drainage),
3. Which habitats are most likely to be limiting for different life stages,
4. Life history information,
5. Diets, particularly of younger life stages,
6. Factors limiting population growth and geographic distribution (physiological limits, competition and predation),
7. Population connectivity (movements, genetics, dispersal).

Threat Clarification

1. Status of key habitats and potential threats to these habitats,
2. Effect of past, present and future human activities and prioritization of threats,
3. Causes of mortality in relation to threats from human activities (e.g., temperature, pollutants, predation, siltation of incubation habitat, etc.),

4. Potential for increased hybridization with *C. bendirei* under different disturbance regimes or climate change scenarios.

Population Abundance and Dynamics of Columbia Sculpin
1. Current population abundance,
2. Natural population fluctuations,
3. Current and historic trends in abundance.

2. MANAGEMENT

2.1. Management Goal

The management goal for Columbia sculpin is to ensure long-term viability of this species across its extant distribution in the wild. It is likely that this species will always remain at risk due to its limited distribution in Canada.

2.2. Management Objectives

Management objectives are ideally stated as quantitative targets (e.g., for population abundance or habitat quantity and quality). Unfortunately, insufficient information is available about current population abundance, habitat requirements and habitat availability to develop defensible quantitative targets. Management objectives for Columbia sculpin are therefore stated as follows:

1. Maintain self-sustaining populations of Columbia sculpin throughout its natural range in Canada.
2. Maintain, and where possible enhance the ecological integrity of habitat for Columbia sculpin.
3. Increase scientific understanding of Columbia sculpin through additional investigation of its natural history, habitat requirements and threats to its persistence.
4. Foster awareness of Columbia sculpin and its conservation status.

2.3. Actions and Performance Measures

The following approaches are recommended for the conservation of Columbia sculpin:

Broad Strategy: Protection

Approach: Clarify and mitigate threats to Columbia sculpin.
Priority: High
Actions: Undertake appropriate research to clarify and inform protection measures against threats, including:
1. Assess effects of land and water use, changes to water quality, and risks from invasive species.

2. Exercise caution (in favour of conservation) when planning/regulating/enforcing land development, water use and fisheries regulations until threats are better clarified, and resource use implications better understood.
3. Stewardship group should work with stakeholders to ensure that development plans do not impact key habitats.
4. Develop plans to mitigate threats as they become clarified by further work.
5. Stewardship group should work with stakeholders to respond to threats as they are better understood, to ensure that development plans do not impact key habitats.

Performance Measures: Specific performance measures have not yet been devised, but can focus on the following questions: Have threats been clarified and assessed? Are threats being mitigated? Has a plan that recognizes these habitats as important been developed? Have key habitats been effectively protected?

Broad Strategy: Management

Approach: Support establishment of a stewardship group for Columbia sculpin.
Priority: High
Actions:

1. Invite stakeholders and interested parties to participate in a stewardship group.
2. Encourage local governments to have membership or representation on the stewardship group to facilitate Management Plan communication and implementation.
3. Support establishment of the stewardship group leadership (chair, facilitator, etc.), develop terms of reference, and obtain necessary funding to support stewardship and planning activities.
4. Examine the feasibility of combining efforts with a Shorthead Sculpin Recovery Implementation Group if one is developed in the future.

Note: It is desirable to establish species-specific stewardship groups, but this may not be feasible given the limited expertise and interest in the species. Establishing some form of stewardship group is expected to facilitate the recovery actions listed here. It will increase the overall efficacy of recovery actions and should occur simultaneously to other actions listed here.
Performance Measures: Specific performance measures have not yet been devised, but can focus on the following questions: Has a stewardship group been established? Is it adequately supported with funding and technical expertise? Is the stewardship group achieving the goals outlined in the management plan?

Approach: Inform and educate stakeholders and general public about the species and general biodiversity values, with the intent of promoting active stewardship, reducing impacts to habitat and reducing risk of non-native species introductions.
Priority: Low
Actions: Stewardship group to work with government agencies and educators to develop:

1. Educational material (e.g., an educational brochure, web-based material) to explain the general biology of the species, its biodiversity values and threats to its persistence. Consider developing material for project WILD http://wildbc.org/index.php/programs/project-wild/
2. Educational material for use in public schools, particularly schools within the species' range.

Performance Measures: Specific performance measures have not yet been devised, but can focus on the following questions: Have educational materials been produced? Has public perception and awareness been affected? How many classes have received educational presentations?

Approach: Address information gaps that limit conservation of Columbia sculpin.
Priority: High
Actions: Address key information gaps including:

1. improve species identification tools (e.g., field keys for discrimination among related sculpin species)
2. habitat use and requirements
3. life history information
4. causes of mortality (e.g., temperature, pollutants, predation, siltation of incubation habitat, etc.)
5. limiting factors to population growth.

Performance Measures: Specific performance measures have not yet been devised, but can focus on the following questions: Are there key information gaps that inhibit conservation of Columbia sculpin?

Broad Strategy: Research

Approach: Define important habitats for Columbia sculpin through habitat suitability mapping.
Priority: Medium
Actions: Undertake habitat suitability mapping and modeling, and validate results.
Performance Measures: Specific performance measures have not yet been devised, but can focus on the following questions: Have important habitats been defined for Columbia sculpin? Have key areas in the watershed (i.e., those that are disproportionately important for maintaining habitat) been identified?

Approach: Develop and implement a long-term monitoring program.
Priority: Medium
Actions: Recovery Team and stewardship group to develop a monitoring program to assess population trends through time, and to allow measures of response to management activities or threats. Monitoring may include:

1. trends in abundance of Columbia sculpin and its prey species,
2. trends in habitat quantity and quality,
3. water quality,
4. land use, and
5. water use.

Note: some care may be required to ensure that census methods do not impact the population. Monitoring programs may be combined with those of other species (e.g., Shorthead sculpin).
Performance Measures: Specific performance measures have not yet been devised, but can focus on the following questions: Have monitoring programs been implemented? How long has a monitoring program been in place? Is it effective? Is it a benign activity for the population? Is funding secure for the long term?

2.4. Monitoring

Little is known about the ecology of Columbia sculpin, including trends in abundance and distribution. Such information is critical to assessing threats to the species, population status and trends, and understanding the response to management actions. Meeting conservation goals will therefore require monitoring population abundance and distribution. A monitoring program should include, at a minimum, assessing the presence or absence of Columbia sculpin throughout the species' current range, with key geographic locations monitored at least every five years. Details of the monitoring plan should be developed in consultation with individuals having technical expertise with the species. The monitoring program should be used as an opportunity to address other key knowledge gaps, such as habitat associations, life history information, and threats assessments. There may be some opportunity to combine monitoring efforts with those for Shorthead sculpin.

2.5. Proposed Implementation Schedule

DFO encourages other agencies and organizations to participate in the conservation of the Columbia sculpin through the implementation of this management plan. Table 2 summarizes those actions that are recommended to support the management goals and objectives. Activities implemented by DFO will be subject to the availability of funding and other required resources. Where appropriate, DFO will consider supporting actions as part of an ecosystem management approach for species at risk within the species' geographic area and partnering with specific organizations and sectors to provide the necessary expertise and capacity to carry out the listed action, subject to their agency's priorities and budgetary constraints. Future updates of the management plan will capture actions that have been undertaken.

Table 2. Implementation schedule for this management plan.

Action	Obj.	Priority	Threats or concerns addressed	Timeline
Broad Strategy: Protection				
Clarify and mitigate threats to Columbia sculpin.	1, 2	High	Conservation efforts require good scientific understanding of the threats.	2011 on
Broad Strategy: Management				
Establish and support a stewardship group.	1, 2, 3, 4	High	Conservation requires coordination of efforts.	2011 on
Inform and educate stakeholders and general public about the species and general biodiversity values, with the intent of reducing impacts to habitat and reducing risk of non-native species introductions.	1, 4	Low	Conservation efforts require public commitment and participation.	2011 on
Broad Strategy: Research				
Address information gaps limiting conservation.	1,2,3	High	Conservation efforts rely on good scientific understanding of the species.	2011 on
Define important habitats for Columbia sculpin.	1, 2, 3	High	Conservation efforts require identification of key habitats for conservation and stewardship.	2011 – 2015
Develop and implement a long-term monitoring program.	1, 2, 3	Medium	Conservation efforts require good scientific understanding of the trends in species abundance and distribution.	2011 on (at least once every five years)

2.6. Effects on Other Species

It is unlikely that conservation efforts aimed at Columbia sculpin will have a negative effect on other fish or wildlife species. Indeed, protection of Columbia sculpin habitats will likely benefit other species.

Columbia sculpin have a limited distribution within Canada, but their introduction into other areas is not recommended at this time. Conservation efforts therefore are unlikely to affect species outside the current range of Columbia sculpin.

3. REFERENCES

B.C. Conservation Data Centre. 2010. BC Species and Ecosystems Explorer. B.C. Ministry of Environment, Victoria, BC. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed November 1, 2007 and July 2010).

Bailey, R. M. and M. F. Dimick. 1949. *Cottus hubbsi*, a new cottid fish from the Columbia River system in Washington and Idaho. Occasional Papers of the University of Michigan Museum of Zoology **513**:1-18.

Bonar, S. A., B. D. Bolding, M. Divens, and W. Meyer. 2005. Effects of introduced fishes on wild juvenile coho salmon in three shallow Pacific Northwest lakes. Transactions of the American Fisheries Society **134**:641–652.

British Columbia Ministry of Environment. 2006. Indicators of climate change for British Columbia 2002. Available at http://www.eng.gov.bc.ca/air/climate.

Brown, L. and J. F. Downhower. 1982. Summer Movements of Mottled Sculpins, *Cottus bairdi* (Pisces: Cottidae). Copeia **1982**:450-453.

Haas, G. R. 1998. Indigenous fish species potentially at risk in BC, with recommendations and prioritizations for conservation, forestry/resource use, inventory and research. Fisheries Management Report 105. British Columbia Ministry of Fisheries, Victoria, BC.

Heard, W. R. 1965. Limnetic cottid larvae and their utilization as food by juvenile sockeye salmon. Transactions of the American Fisheries Society **94**:191-193.

Hill, J. and G. D. Grossman. 1987. Home range estimates for three North American stream fishes. Copeia **1987**:376-380.

Jude, D. J., R. H. Reider, and G. R. Smith. 1992. Establishment of Gobiidae in the Great Lakes basin. Canadian Journal of Fisheries and Aquatic Science **49**:416-421.

Lauer, T. E., P. J. Allen, and T. S. McComish. 2004. Changes in mottled sculpin and johnny darter trawl catches after the appearance of round gobies in the Indiana waters of Lake Michigan. Transactions of the American Fisheries Society **133**:185-189.

Leith, R. and P. Whitfield. 1998. Evidence of climate change effects on the hydrology of streams in south-central BC. Canadian Water Resources Journal **23**:219-230.

Lewis, W. M. J. and D. P. Morris. 1986. Toxicity of nitrite to fish: A review. Transactions of the American Fisheries Society **115**:183-195.

MacInnis, A. J. and L. D. Corkum. 2000. Fecundity and reproductive season of the round goby *Neogobius melanostomus* in the upper Detroit River. Transactions of the American Fisheries Society **129**:136–144.

Maret, T. R. and D. E. MacCoy. 2002. Fish assemblages and environmental variables associated with hard-rock mining in the Coeur d'Alene river basin, Idaho. Transactions of the American Fisheries Society **131**:865-884.

McPhail, J. D. 2001. Habitat use of vulnerable (Blue-listed) sculpins in the Kootenays. Final report, HCTF project #0-217.

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

McPhail, J. D. and R. Carveth. 1992. A foundation for conservation: the nature and origin of the freshwater fish fauna of British Columbia. Report for BC Ministry of Environment, Victoria, BC.

Mebane, C. A., T. R. Maret, and R. M. Hughes. 2003. An index of biological integrity (IBI) for Pacific Northwest rivers. Transactions of the American Fisheries Society **132**:239-261.

Morrison, J., M. C. Quick, and M. G. G. Foreman. 2002. Climate change in the Fraser River watershed: flow and temperature projections. Journal of Hydrology **263**:230-244.

National Recovery Team for Shorthead Sculpin. 2007. Recovery Strategy for Shorthead Sculpin (*Cottus confusus*) in Canada [Draft]. *In* Species at Risk Act Recovery Strategy Series. Ottawa: Fisheries and Oceans Canada. 18 + ix pp.

NatureServe. 2009. Version 7.1 (2 February 2009) Available: http://www.natureserve.org/explorer/granks.htm (accessed February 12, 2009).

Neely, D. A. 2004. Identification of problematic sculpins from Montana using mtDNA sequence data and morphology. Unpublished report to Montana Fish, Wildlife and Parks, submitted 15 June 2004. 20 pp.

Parmesan, C. and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature **421**:37-42.

Peden, A. E. 2000. COSEWIC status report on the Columbia mottled sculpin *Cottus bairdi hubbsi*.

Peden, A. E. and G. W. Hughes. 1984. Status of shorthead sculpin, *Cottus confusus*, in the Flathead River, British Columbia. Canadian Field-Naturalist **98**:127-133.

Peden, A. E., G. W. Hughes, and W. E. Roberts. 1989. Morphologically distinct populations of the shorthead sculpin, *Cottus confusus*, and mottled sculpin, *Cottus bairdi* (Pisces, Cottidae), near the western border of Canada and the United States. Canadian Journal of Zoology **67**:2711-2720.

Roberts, W. 1988. The sculpins of Alberta. Alberta Naturalist **18**:121-153.

Sala, O. E., F.S. Chapin III, J. J. Armesto, E. Berlow, J. Bloomfield, R. Dirzo, E. Huber-Sanwald, L. F. Huenneke, R. B. Jackson, A. Kinzig, R. Leemans, D. M. Lodge, H. A. Mooney, M. Oesterheld, N. L. Poff, M. T. Sykes, B. H. Walker, M. Walker, and D. H. Wall. 2000. Global biodiversity scenarios for the year 2100. Science **287**:1770-1774.

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Bulletin of the Fisheries Research Board of Canada **184**.

Summers, J. and K. Daily. 2001. Willamette river bass diet study-spring 2000. Information report number 2001-04, Oregon Department of Fish and Wildlife, Portland, Oregon.

Woodling, J., S. Brinkman, and S. Albeke. 2002. Acute and chronic toxicity of zinc to the mottled sculpin Cottus bairdi. Environmental Toxicology and Chemistry **21**:1922–1926.

Wydoski, R. S. and R. R. Whitney. 2003. Inland fishes of Washington. Second edition. American Fisheries Society in association with University of Washington Press.

Personal Communications

DeRosa, D., pers. comm. 2010. *Consultation feedback via e-mail to A. Serena, Fisheries and Oceans Canada*. January 2010. Natural Resource Specialist. B.C. Hydro, Castlegar, B.C.

McPhail, J.D., pers. comm. 2007. *E-mail correspondence with Todd Hatfield*. October to December 2007. Professor Emeritus, Department of Zoology, University of British Columbia, Vancouver, B.C..

APPENDIX I. RECORD OF COOPERATION AND CONSULTATION

The Columbia sculpin is listed as a species of 'special concern' on Schedule 1 of the *Species at Risk Act* (SARA). As an aquatic species, Columbia sculpin fall under federal jurisdiction, and are managed by Fisheries and Oceans Canada (DFO) 200 - 401 Burrard Street, Vancouver, B.C., V6C 3S4.

There are few people in Canada, or elsewhere, with scientific, technical, traditional or local knowledge of Columbia sculpin. As a result, DFO and the Province of B.C. cooperated on the development of this draft document through participation in the Non-Game Freshwater Recovery Team, a working group of technical experts in science, and management formed in early 2003. Most of the species addressed by the Recovery Team have a limited information base and are not widely known. The Recovery Team's role is to provide science-based conservation advice on non-game freshwater fish species in B.C., to develop draft recovery strategies and management plans for species listed under the Species at Risk Act, and to provide science-based recommendations for critical habitat identification. The Recovery Team's mandate is to provide science-related information and advice to the public, First Nations, government and Non-Government Organisations. Processes for coordination and consultation between the federal and B.C.n governments on management and protection of species at risk are outlined in the *Canada-B.C. Agreement on Species at Risk* (2005).

A draft version of the management plan was posted to the DFO Pacific Region website for public comment from December 21, 2009 - January 22, 2010; an initial draft (December 2009) of the management plan along with background information was provided. These consultations were web-based, however mail-outs requesting feedback were also sent to First Nations, hydroelectric facilities, and municipal governments occurring within the distributional range of the species.

Comments on the draft management plan were received from one independent source. No First Nations responded to consultation letters. All feedback has been carefully considered and incorporated into the draft management plan as appropriate.