

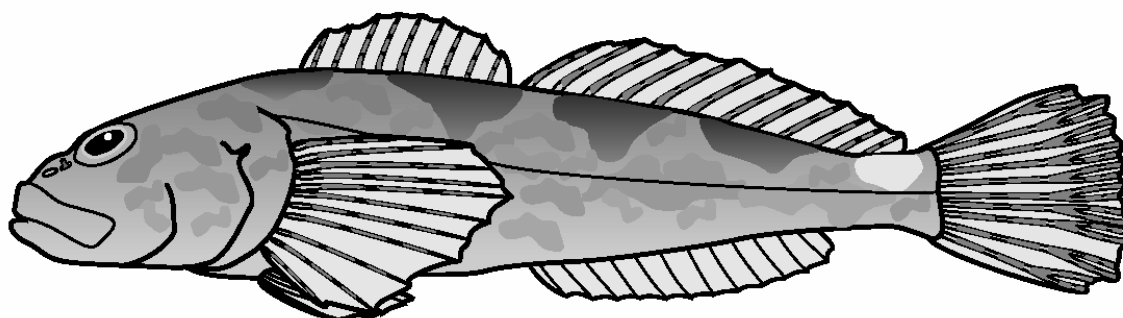
COSEWIC
Assessment and Status Report

on the

Coastrange Sculpin
Cottus aleuticus

Cultus Population

in Canada



THREATENED
2010

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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Previous report(s):

COSEWIC 2000. COSEWIC assessment and status report on the Cultus pygmy sculpin *Cottus* sp. in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 9 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Coffie, P.A. 1997. COSEWIC status report on the Cultus pygmy sculpin *Cottus* sp. in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-9 pp.

Production note:

COSEWIC acknowledges Josh Taylor for writing the provisional status report on the Coastrange Sculpin (Cultus Population), prepared under contract with Environment Canada. The contractor's involvement with the writing of the status report ended with the acceptance of the provisional report. Any modifications to the status report during the subsequent preparation of the 6-month interim and 2-month interim status reports were overseen by Robert Campbell and Eric Taylor, COSEWIC Freshwater Fishes Specialist Subcommittee Co-chairs.

Please note: The Coastrange Sculpin (Cultus Population), *Cottus aleuticus*, is also referred to as the Cultus Pygmy Sculpin.

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COSEWIC Assessment Summary

Assessment Summary – April 2010

Common name

Coastrange Sculpin - Cultus Population

Scientific name

Cottus aleuticus

Status

Threatened

Reason for designation

This species is a small Canadian endemic freshwater fish found in a single lake in the lower mainland region of southwestern British Columbia, an area undergoing sustained and rapid urbanization. The lake is heavily used by recreationists and drains into the lower Fraser River area where many invasive species are well-established. Trends in indices of abundance suggest a persistent decline and the single location makes the species particularly vulnerable should either habitat quality decline or vertebrate invasive species become established in the lake.

Occurrence

British Columbia

Status history

Designated Special Concern in April 1997. Status re-examined and designated Threatened in November 2000 and in April 2010.



COSEWIC
Executive Summary

Coastrange Sculpin
Cottus aleuticus

Cultus Population

Wildlife species information

The Coastrange Sculpin (Cultus Population) is a population of vertically migrating, pygmy Coastrange Sculpin that inhabits the offshore habitat of Cultus Lake, southwestern British Columbia. Their general appearance is typical of Coastrange Sculpin; the head is broad and flat and the body tapers gradually to a moderately deep, laterally compressed tail section. There are two dorsal fins and the pectoral fins are large and fan-like. The Coastrange Sculpin (Cultus Population) differ from typical Coastrange Sculpin in several traits including a smaller maximum size, the nighttime use of surface water habitat into adulthood, a longer spawning period, and several differences in morphology. While other populations of Coastrange Sculpin commonly grow to over 80 mm in length, the Coastrange Sculpin (Cultus Population) only grow to a maximum length of about 52 mm. Coastrange Sculpin (Cultus Population) also have larger head pores, more pectoral fin rays and shorter pelvic fins than typical Coastrange Sculpin, which may be advantageous for living in surface waters. The Coastrange Sculpin (Cultus Population) is an important component of the food web of Cultus Lake and is of great scientific interest as a case of postglacial evolution. Similar forms of pygmy, pelagic Coastrange Sculpin appear to have evolved independently in two interconnected lakes in Washington State, but in general the occurrence of adult pelagic sculpins is extremely rare.

Distribution

Coastrange Sculpin occur in lakes and streams along the Pacific Coast of North America, from California to the Aleutian Islands. Coastrange Sculpin (Cultus Population) are confined to Cultus Lake (49°03' N, 122°59' W) in the Fraser River watershed of southwestern British Columbia. Their area of occupancy is about 5.5 km². Similar pygmy populations of Coastrange Sculpin have been described from the Lake Sammamish/Lake Washington system in Washington State.

Habitat

Coastrange Sculpin mostly inhabit streams but also occur in lakes. The Coastrange Sculpin (Cultus Population) are believed to be restricted to the offshore habitat of Cultus Lake. Coastrange Sculpin normally undergo a switch from a surface water-oriented larval life stage to a bottom-oriented juvenile lifestyle at about 32-35 days after hatching. Hydroacoustic and mid-water trawl surveys conducted to enumerate juvenile Sockeye Salmon in Cultus Lake have demonstrated that adult Coastrange Sculpin (Cultus Population) continue to migrate vertically into surface waters of the lake at night. The Cultus Lake watershed is heavily developed for recreation, residential and agricultural uses, resulting in significant impacts to tributary and outlet streams and lake foreshore habitats. Cultus Lake's limnetic habitat, however, is believed to have changed relatively little over the past 70 years

Biology

Generation times are about 2 to 5 years for Coastrange Sculpin and 3 years for Coastrange Sculpin (Cultus Population). While Coastrange Sculpin normally spawn between February and July, Coastrange Sculpin (Cultus Population) are believed to spawn from late May or early June until August or even September. The diet of Coastrange Sculpin typically switches from zooplankton to aquatic insects and benthic invertebrates after the larval life stage. The diet of Coastrange Sculpin (Cultus Population), however, continues to be dominated by zooplankton into adulthood. In a survey of the diet compositions of Cultus Lake's piscivorous fish in the 1960s, Coastrange Sculpin (Cultus Population) occurred regularly in the diet of Bull Trout, but only rarely in the diet of Coastal Cutthroat Trout and Coho Salmon, and not at all in the stomachs of Northern Pikeminnow. There is the potential for competition between Coastrange Sculpin (Cultus Population) and juvenile Sockeye Salmon for zooplankton prey.

Population sizes and trends

The abundance of Coastrange Sculpin (Cultus Population) is unknown. Although trawl surveys conducted to assess the abundance of juvenile Sockeye Salmon in Cultus Lake from 1975 to 2004 suggest a trend of total population declines of Coastrange Sculpin (Cultus Population) of between 2.5 and 4%.

Limiting factors and threats

The major threat to Coastrange Sculpin (Cultus Population) is its limited distribution and susceptibility to ecological changes to Cultus Lake resulting from the decline of the Sockeye Salmon population, the potential introduction of invasive species, and the impacts of development on water quality.

Existing protection

NatureServe assigned Coastrange Sculpin (Cultus Population) global, national and provincial status rankings of critically imperiled. The current COSEWIC status for Coastrange Sculpin (Cultus Population) is Threatened and it is listed as Threatened on Schedule 1 of the Canadian *Species at Risk Act*. The BC Conservation Data Centre gives Coastrange Sculpin (Cultus Population) its highest provincial rank of red. The provincial parkland surrounding much of Cultus Lake is protected by the *Provincial Park Act* (1996) that sets management guidelines and restricts resources extraction. Additionally, the federal *Fisheries Act* (1985) regulates activities that impact fish and fish habitat in all waters of Canada and must be applied by all levels of government.

TECHNICAL SUMMARY

Cottus aleuticus

Coastrange Sculpin (Cultus Population)

Chabot de la chaîne côtière (population cultus)

Range of occurrence in Canada: BC

Cultus Lake, Lower Fraser River, Southwestern British Columbia (Pacific National Freshwater

Biogeographic Zone)

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2008) is being used)	3 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Seasonally replicated abundance trends are negative, but significant at probability levels greater than 0.05 and assume total catch is an index of abundance in mature adults	Probably
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. The last survey period indicated an average decline of 2.5% inferred from seasonally replicated trawl surveys conducted between 1993 to 2004, but was not statistically significant (P = 0.8) and assumes total catch is an index of abundance in mature adults	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. An average decline of 4% was inferred from seasonally replicated trawl surveys conducted between 1975-2004 (P = 0.07). From 1993-2004, the trend suggested a decline of 2.5%. Both estimates assume total catch is an index of abundance in mature adults.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	Unknown, but probably not
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence Coastrange Sculpin (Cultus Population) only occur in the offshore habitat of Cultus Lake. The offshore surface area of Cultus Lake is about 88% of the lake's total surface area (6.3 km ²).	5.5 km ²
Index of area of occupancy (IAO) (Always report 2x2 grid value; other values may also be listed if they are clearly indicated (e.g., 1x1 grid, biological AO)).	2x2 = 24 km ² 1x1 = 14 km ²

Is the total population severely fragmented?	No
Number of "locations"	1
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] continuing decline in number of populations?	No
Is there an [observed, inferred, or projected] continuing decline in number of locations?	No
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? Declines in habitat quality could occur if further exotic species enter the lake and become established (milfoil plant is established)	No
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Population structure unknown, but appears to be a single population (inferred from genetic data) in the lake.	Unknown
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not conducted
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Threats (actual or imminent, to population or habitats)

Actual: The ongoing decline of the Cultus Lake Sockeye Salmon population could affect the lake's ecology via altering potential competitive interactions or lake productivity in ways that reduce Coastrange Sculpin (Cultus Population) survival.
Potential: Increased predation or competition from the introduction of invasive species of various fishes and bullfrogs, which are well established in some adjacent watersheds.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? NA, endemic to Cultus Lake	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	NA
Is there sufficient habitat for immigrants in Canada?	NA
Is rescue from outside populations likely?	NA

* See definition of location in O&P manual.

Current Status

SARA Threatened, Schedule 1 COSEWIC: Threatened (2010) NatureServe: Critically imperiled BC Conservation Data Centre: Red
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Status and Reasons for Designation

Status: Threatened	Alpha-numeric code: D2
Reasons for designation: This species is a small Canadian endemic freshwater fish found in a single lake in the lower mainland region of southwestern British Columbia, an area undergoing sustained and rapid urbanization. The lake is heavily used by recreationists and drains into the lower Fraser River area where many invasive species are well-established. Trends in indices of abundance suggest a modest decline and the single location makes the species particularly vulnerable should either habitat quality decline or vertebrate invasive species become established in the lake.	

Applicability of Criteria

Criterion A: Not applicable. Suggestions of declines are modest, uncertain, and exceed criteria.
Criterion B: Not applicable. Although EO is << 5,000 km ² , IAO << 500 km ² and there is only 1 location, there is no strong evidence of past or continuing declines or fluctuations in any indices relevant to sub-criteria b(i-v) or c(1-iv), respectively.
Criterion C: Not applicable. No estimates of past or present population sizes available.
Criterion D: Meets Threatened D2. IAO < 20 km ² and the species exists at one location such that it is prone to the effects of human activities that could cause a decline in habitat quality or exotic species introductions.
Criterion E: Not available.

PREFACE

The Coastrange Sculpin (Cultus Population) is a small fish endemic to a single lake (Cultus Lake) in southwestern British Columbia. The Coastrange Sculpin (Cultus Population) was first assessed by COSEWIC in 1997 as Special Concern and was re-examined and assessed as Threatened in 2000. The major threat to the population is its restriction to a single, small lake located in a geographic area that is undergoing extensive and rapid residential and commercial development. Since the 2000 assessment, a recovery strategy was initiated and completed in 2007 under the leadership of Fisheries and Oceans Canada (Pacific Region) and the British Columbia Ministry of Environment. The recovery strategy identified several important information gaps that are required to be addressed to effect recovery of the species (i.e., long-term persistence of the species). These included information on habitat use across life stages and the identification of critical habitat, habitat availability, population abundance, population genetic and taxonomic studies and development of a stewardship group and long-term monitoring program. Co-ordination of efforts to recover the Cultus Lake Sockeye Salmon population (assessed as endangered by COSEWIC in 2003) was also listed as a priority. As of this writing, only some compilation of yearly abundance estimates from trawl surveys and the studies of population genetics and taxonomy are known to have been completed.



COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS (2010)

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

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

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

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



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

COSEWIC Status Report

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Cottus aleuticus

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in Canada

2010

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WILDLIFE SPECIES INFORMATION

Name and classification

Class:	Actinopterygii
Order	Scorpaeniformes
Family	Cottidae
Genus:	<i>Cottus</i>
Scientific Name:	<i>Cottus aleuticus</i>
English Names:	Coastrange Sculpin (Cultus population) 2004)
French Name:	Chabot de la chaîne côtière (population cultus)

The genus *Cottus* is a member of the sculpin family (Cottidae). The Coastrange Sculpin, *Cottus aleuticus*, was originally described from Kodiak Island by Lockington (1880) as *Uranidea microstoma*. Gilbert (1895), however, placed this species in the genus *Cottus*, and because the species name *microstomus* was already assigned in this genus the name was changed to *Cottus aleuticus*. The only synonym is *Cottus protrustus* described by Schultz and Spoor (1933) from Unalaska Island, Alaska.

Coastrange Sculpin are common in coastal streams along the Pacific coast. The Coastrange Sculpin (Cultus Population) is a population derived from Coastrange Sculpin; they are morphologically similar to each other (relative to other freshwater *Cottus* species, McPhail 2007) and a mitochondrial DNA phylogeny is consistent with a postglacial divergence between Coastrange Sculpin (Cultus Population) and Coastrange Sculpin (see **Spatial population structure and variability** and Woodruff 2010).

While Coastrange Sculpin commonly grow to over 80 mm in total length, Coastrange Sculpin (Cultus Population) only grow to maximum length of about 52 mm. Coastrange Sculpins normally undergo a switch from a pelagic larval life stage to a benthic juvenile life stage about 32-35 days after hatching (Scott and Crossman 1973). By contrast, mid-water trawl surveys conducted to enumerate juvenile Sockeye Salmon (*Oncorhynchus nerka*) in Cultus Lake have demonstrated that post-larval Coastrange Sculpin (Cultus Population) (i.e., up to 52 mm in length) continue to migrate into surface waters at night (J. Hume, pers. comm. 2006). Hydroacoustic surveys also conducted to enumerate juvenile Sockeye Salmon in Cultus Lake show much lower densities of sculpin-sized targets in the water column during the day than at night, indicating that Coastrange Sculpin (Cultus Population) migrate toward the surface at night (J. Hume pers. comm. 2006). The planktivorous diet of adult Coastrange Sculpin (Cultus Population) (Ricker 1960)—i.e., rather than the typical diet of benthic invertebrates for adult Coastrange Sculpin—supports the inference of a limnetic life history. The state of retention of a larval life history characteristic into adulthood (i.e., limnetic habitat use) is termed neoteny. While Coastrange Sculpin normally spawn from about February through June (McPhail and Lindsey 1970, Scott and Crossman 1973), Coastrange Sculpin (Cultus Population) spawn from late May or early June until August or even September (Ricker 1960).

The pygmy form of the Coastrange Sculpin inhabiting the offshore habitat of Cultus Lake, within the lower Fraser River Valley in southwestern British Columbia, was first described by Ricker (1960). Another common name for this form, Cultus Lake Pygmy Sculpin, was first used by Coffie (1997). Similar pygmy populations of Coastrange Sculpin have been described from Lake Sammamish and Lake Washington (connected by the Sammamish River) in Washington State (Larson and Brown 1975). Given that Cultus Lake is spatially isolated from the Lake Washington system and both systems have distinct freshwater connections to the sea, the Coastrange Sculpin (Cultus Population) probably evolved independently from these other pelagic sculpins.

Morphological description

The general appearance of the Coastrange Sculpin (Cultus Population) is very similar to that of the Coastrange Sculpin and typical of the genus *Cottus* (Figure 1, McPhail 2007). The head is broad and flat and the body tapers gradually to a moderately deep laterally compressed tail section. There are two dorsal fins, the first with spines and the second with soft rays. The pelvic fins are shorter in the Coastrange Sculpin (Cultus Population) (Table 1) and thoracic in position. The pectoral fins are large and fan-like with a greater number of rays than in typical Coastrange Sculpin (Table 2). The anal fin is about the same length as the head. The caudal fin is slightly rounded. There is a simple well developed preopercular spine (i.e. on the posterior edge of the cheek) and the lateral line is complete. The preoperculo-mandibular pore canal (i.e., an extension of the lateral line system located along the bottom edge of the lower jaw) typically has pore counts of 10 on either side of a single pore on the tip of the chin. There are no scales anywhere on the body, but a patch of hair-like “prickles” is present behind each pectoral fin. Colouration is brown to grey with darker blotches, being lighter on the side and nearly white ventrally. There are usually two to four dark saddle-like markings on the sides under the dorsal fins and a light mark on the back just in front of the caudal fin.

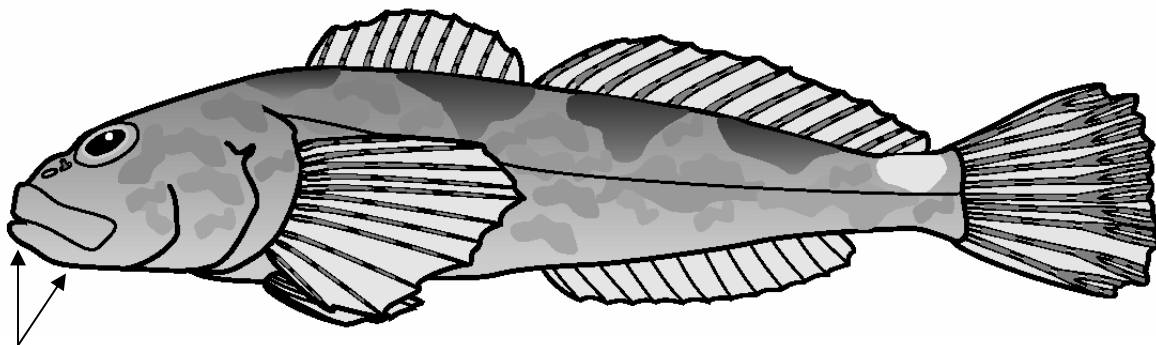


Figure 1. Drawing of the Coastrange Sculpin (Cultus Population) ~ 50 mm total length (Illustrated by Diana McPhail). Arrows indicate approximate location of preoperculo-mandibular pore canal.

Table 1. Comparison of morphometric measurements between Coastrange Sculpin (Cultus Population) (N = 20) and Coastrange Sculpin (N = 20).

Measurement type	Mean ± SD (mm) ¹	
	Coastrange Sculpin	Coastrange Sculpin (Cultus Population)
Anal fin length	10.6±0.45	10.8±0.54
Body depth	6.1±0.26	6.2±0.34
Height of longest dorsal ray	4.6±0.30	4.6±0.26
Head depth	6.7±0.30	6.4±0.29
Head length	9.7±0.45	10.1±0.52
Interorbital width	1.2±0.14	1.1±0.14
Orbit length	2.3±0.16	2.36±0.13
Caudal peduncle depth	2.3±0.10	2.3±0.18
Length of pelvic fin	6.1±0.27	5.7±0.46
Caudal peduncle length	6.8±0.46	6.9±0.59
Snout length	2.4±0.18	2.3±0.17
Length of the 4 th preoperculo-mandibular pore	0.12±0.02	0.22±0.07
Length of the 5 th infraorbital pore	0.21±0.04	0.34±0.06

¹ Prior to estimating means and standard deviations for each fish type, the measurements of individual fish were size-adjusted to the overall mean standard length of 34.7 mm using allometric regression equations.

Table 2. Comparison of anal and pectoral fin ray counts between Coastrange Sculpin (Cultus Population) (CLS, N = 20) and Coastrange Sculpin (CS, N = 20).

Fin type	Sculpin type	Fin ray counts			
		13	14	15	16
Anal fin	CS	1	14	5	0
	CLS	2	15	2	1
Pectoral fin	CS	0	1	19	0
	CLS	0	0	14	6

Coastrange Sculpin can grow as large as 145 mm in total length (Wydoski and Whitney 2003), with adults usually averaging at least 76 mm (Scott and Crossman 1973). In Frosst Creek, a tributary of Cultus Lake, Coastrange Sculpin commonly grow to 80 to 100 mm in total length (J. Taylor, pers. obs., Woodruff 2010). The vertically migrating pygmy form of Coastrange Sculpin found in Lake Washington reaches a maximum total length of about 67 mm (58 mm standard length, Larson and Brown 1975). Data on the size of Coastrange Sculpin (Cultus Population) come from examination of the stomach contents of Dolly Varden and/or Bull Trout (*Salvelinus malma*/S. *confluentus*, collectively referred to as “char” below) caught from Cultus Lake (Ricker 1960) and the length frequency distribution of sculpins caught in mid-water trawl surveys (J. Hume, unpublished data). The maximum length of Coastrange Sculpin (Cultus Population) found in the stomach contents of char was about 50 mm total length (Ricker 1960). Since these char were also eating much larger prey, including some Prickly Sculpin (*Cottus asper*) in the 100 to 200 mm range, it is unlikely that they would have been avoiding larger Coastrange Sculpin (Cultus Population) if they were present

(Ricker 1960). The vast majority of the sculpin caught in mid-water trawl surveys conducted in Cultus Lake (i.e., 98%) have been in the size range 9 to 52 mm total length. A few larger sculpins (i.e., 60 to 132 mm) are caught less frequently (2% of total catch, J. Hume, unpublished data). The species identification of the trawl caught sculpins from Cultus Lake began in 1999. Since 1999, the sculpins caught have ranged from 9 to 52 mm in length and were all identified as Coastrange Sculpin (Cultus Population). It is believed that the few larger sculpins caught in trawl samples prior to 1999 were Prickly Sculpin caught when the net occasionally touched bottom (J. Hume, pers. comm. 2006). The species identity of these larger sculpins, however, should be confirmed by examining the preserved catch samples stored at the Fisheries and Oceans Canada Cultus Lake laboratory.

The Coastrange Sculpin (Cultus Population) differs from typical Coastrange Sculpin in a number morphological and meristic traits (Tables 1, 2), most predominantly in the length of the pelvic fin (shorter) and the size of various cephalic pores (larger, J. Taylor, unpublished data). When summarized by principal component analysis, plotting of scores along principal component (PC) axes 1 and 2 indicates the presence of two morphotypes of fish (Figure 2). The variable explaining the most variation in Component 2 was cephalic pore length. Additional variables making smaller but still notable contributions to Component 2 included pelvic fin length, interorbital width, head depth and head length. The average value of Component 2 was significantly greater for Coastrange Sculpin (Cultus Population) compared to Coastrange Sculpin (t -test, $P < 0.0001$) implying that the two fish types have different average body shapes. Compared to the Coastrange Sculpin, the average Coastrange Sculpin (Cultus Population) had a larger average cephalic pore length (by 73%), a narrower interorbital length (8%), shorter pelvic fins (8%), and a head that was longer (5%) and less deep (4%, Table 1).

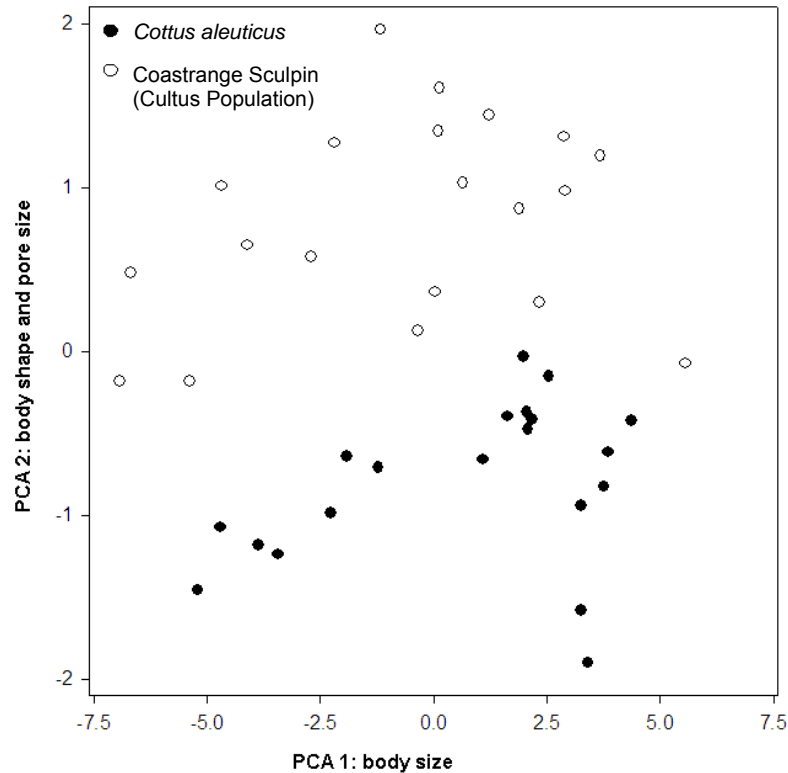


Figure 2. The results of a principal component analysis (PCA) comparing morphology between Coastrange Sculpin (Cultus Population) and Coastrange Sculpin (J. Taylor, unpublished data).

Coastrange Sculpin (Cultus Population) tend to have higher pectoral fin ray counts; although both fish types had a modal pelvic ray count of 15, 30% of Coastrange Sculpin (Cultus Population) had a pectoral fin ray count of 16 while none of the Coastrange Sculpins had a pectoral fin ray count greater than 15 (Table 2, chi-square test, $P = 0.02$). Anal fin ray count frequencies did not differ significantly between the two sculpins (Table 2, chi-square test, $P = 0.4$).

The qualitative differences in morphology identified as distinguishing Coastrange Sculpin (Cultus Population) from Coastrange Sculpin—i.e., larger average cephalic pore length, narrower inter-orbital length, shorter pelvic fins length, and higher pectoral fin ray counts—were also identified as distinguishing the pygmy and normal forms in the Lake Washington study (Larson and Brown 1975). Lake Washington pygmy sculpins also had longer, but shallower heads than normal Coastrange Sculpin (i.e., as in Coastrange Sculpin (Cultus Population) samples), but this difference was not statistically significant. The most substantial difference in morphology between the pygmy forms and Coastrange Sculpin in both systems was larger cephalic pores for the pygmy forms. The relative difference in pore size between the pygmy forms and normal Coastrange Sculpin, however, was much greater in the Lake Washington system (200-300% larger) compared to the Cultus Lake system (73% larger).

Population spatial structure and variability

Woodruff (2010) examined mitochondrial and microsatellite DNA variation in the Coastrange Sculpin (Cultus Population) samples collected using mid-water trawls and from minnow traps suspended mid-water in the lake to samples from a tributary stream (Frosst Creek) and from littoral regions of the lake, and Coastrange Sculpin from several populations outside the Cultus Lake drainage. The mitochondrial DNA data consisted of about 500 base pairs of sequence from the d-loop region. The Coastrange Sculpin (Cultus Population) and Coastrange Sculpin from tributaries of Cultus Lake and from outside the drainage formed a monophyletic lineage relative to sequences from the Prickly Sculpin and the difference between the two species was about 4.8%. By contrast, the Coastrange Sculpin (Cultus Population) sequences were intermingled amongst an array of other Coastrange Sculpin samples and average sequence divergence ranged from 0.5 – 0.9%. These data clearly indicate that the Coastrange Sculpin (Cultus Population) has very close genetic affinities to Coastrange Sculpin and suggest that the two types of *C. aleuticus* have diverged only very recently (i.e., post-Wisconsinan glaciation or within the last ~10,000 years, Woodruff 2010).

Although the Coastrange Sculpin (Cultus Population) and the Coastrange Sculpin are clearly closely related phylogenetically, they are not genetically identical. The microsatellite DNA data were summarized by the statistic “ F_{ST} ” which represents the proportion of total genetic variation assayed across the eight loci assayed that is attributable to differences between pairwise comparisons (Hartl and Clark 1989). These data demonstrate that Coastrange Sculpin (Cultus Population) are genetically distinct from Coastrange Sculpin at two of the three other areas within the Cultus Lake drainage (Table 3). In fact, although the F_{ST} values are low (but typical for sculpins collected from adjacent freshwater habitats—see Taylor and Gow 2008; Whiteley *et al.* 2009), the difference between Coastrange Sculpin (Cultus Population) and the stream-resident samples from Frosst Creek (0.011) is comparable to the difference between two samples (Norrish Creek and the Squamish River) that are from two systems located some 70 km apart.

Table 3. Comparisons of pairwise F_{ST} values between samples of Coastrange Sculpin (Cultus Population) and Coastrange Sculpin from Cultus Lake and several localities outside the Cultus Lake drainage.

F_{ST} values are estimated by Weir and Cockerham's (1984) θ and are based on allelic variation across eight microsatellite loci (see Woodruff 2010). Coastrange Sculpin (Cultus Population) represent mid-water trawl and minnow trap samples that were pooled after no significant difference in F_{ST} between them was observed ($P < 0.1$). CLS = Coastrange Sculpin (Cultus Population), FC = Frosst Creek, EB = Entrance Bay, MB = Maple Bay, NC = Norns Creek, SR = Squamish River, MR = Manquam River, CR = Cheakamus River, LW = Lake Washington (Washington State, USA). Boldface comparisons represent those within the Cultus Lake watershed. Sample sizes ranged from 25 (Entrance Bay) to 67 (Squamish River) and those values that are underlined are not significantly greater than 0 (from 500 permutations).

CLS FC EB MB NC SR MR CR LW

CLS -

FC 0.011 -

EB 0.008 0.008 -

MB 0.005 0.004 0.000 -

NC 0.022 0.036 0.041 0.039 -

SR 0.039 0.048 0.050 0.047 0.011

MR 0.028 0.043 0.047 0.042 0.007 0.004

CR 0.045 0.058 0.052 0.049 0.011 0.001 0.003

LW 0.041 0.055 0.063 0.061 0.038 0.043 0.031 0.047 -

Woodruff (2010) also examined the behaviour of Coastrange Sculpin (Cultus Population) in terms of their position in the water column in experimental "depth tanks". The percentage of total time observed that Coastrange Sculpin (Cultus Population) spent swimming off the bottom was compared to Coastrange Sculpin from two "typical" stream-dwelling populations. These tests demonstrated that Coastrange Sculpin (Cultus Population) spent more time swimming off the bottom of the depth tanks ($P < 0.01$) than sculpins from the stream-dwelling populations, but differences were only statistically significant when all populations were tested in the presence of the Prickly Sculpin a larger, sympatric congener that may compete with and prey on Coastrange Sculpin (Cultus Population).

Designatable units

Although clearly related to the Coastrange Sculpin, the Coastrange Sculpin (Cultus Population) is eligible as a designatable unit (DU) within *C. aleuticus* under the "discrete" and "significance" criteria because it is (a) genetically distinct from adjacent populations of *C. aleuticus* in the Cultus Lake watershed (as discussed above within the **Morphological description, spatial population structure and variability** sections) and (b) it is a unique part of the evolutionary and ecological legacy of *C. aleuticus* in Canada given its very unusual life history (occupancy of limnetic zone of the lake and planktivory) as expanded upon below within the **Special significance** section.

Special significance

The Coastrange Sculpin (Cultus Population) is probably a postglacially derived form of the Coastrange Sculpin (*Cottus aleuticus*). This is suggested by the glacial history of the area (Cultus Lake only became accessible after the retreat of the Wisconsin ice sheets some 8-10,000 years ago) and by mitochondrial DNA data that clearly show that Coastrange Sculpin (Cultus Population) and Coastrange Sculpin exhibit widespread sharing of mtDNA sequence haplotypes (Woodruff 2010). Thus, they represent examples of rapid, and possibly ongoing, evolution. While the Coastrange Sculpin (Cultus Population) is endemic to Cultus Lake, similar forms of pelagic pygmy Coastrange Sculpins appear to have evolved independently in two Washington State lakes (Larson and Brown 1975). This apparent example of parallel evolution is scientifically topical and interesting (e.g., Colosimo *et al.* 2005). Coastrange Sculpin (Cultus Population) are morphologically and behaviourally distinct from adjacent stream samples; they are characterized by significantly larger cephalic pore size, significantly more pectoral fin rays, mature at a significantly smaller size, and inhabit the pelagic zone of the lake where they are planktivorous. Although the genetic bases for these latter indicators of discreteness are not established, the larger cephalic pore size, larger pectoral fins, shorter pelvic fins and smaller size at maturity are plausibly interpreted as adaptations for a limnetic (open-water), planktivorous lifestyle given the probable role of cephalic pores in sensory perception, and the larger pectoral fins and smaller overall body size in maintaining position in the open water in a group of fishes (all Cottidae) that lack a swim bladder (Bailey and Bond 1953).

Consequently, the Coastrange Sculpin (Cultus Population) occupies an ecological setting (pelagic zone of a lake) that is highly unusual if not unique for *C. aleuticus* in Canada and is generally very rare in sculpins. Except for two highly divergent species in Lake Baikal, Russia (family Comephoridae), cottoid fishes are benthic as adults (Hunt *et al.* 1997). As summarized by Woodruff (2010), extensive open-water trawling surveys designed to help enumerate limnetic populations of Sockeye Salmon and Kokanee (*Oncorhynchus nerka*) in 100 British Columbia lakes since 1975 rarely, if ever, capture *C. aleuticus* in the pelagic zones of these lakes and Cultus Lake is the only location where mature *C. aleuticus* are captured in mid-water by trawling or by minnow traps suspended in the open water (Woodruff 2010). Taken together, the genetic distinctiveness of Coastrange Sculpin (Cultus Population), their occupancy of an unusual ecological setting and associated phenotype represent an important component of the evolutionary legacy of *C. aleuticus* as a whole.

DISTRIBUTION

Global range

The Coastrange Sculpin (Cultus Population) is endemic to a single lake in Canada. Its presumed ancestor, the Coastrange Sculpin, occurs in lakes and streams along the Pacific Coast of North America (Figure 3) and is distributed continuously from San Luis Obispo County California, north to the Bristol Bay region, Alaska, and westward in the Aleutian Island chain as far as Kiska. There is apparently an isolated population that occurs in the Kobuk River, just north of the Arctic Circle, in the Chukchi Sea drainage, 800 km north of the Bristol Bay population in Southern Alaska (Scott and Crossman 1973).

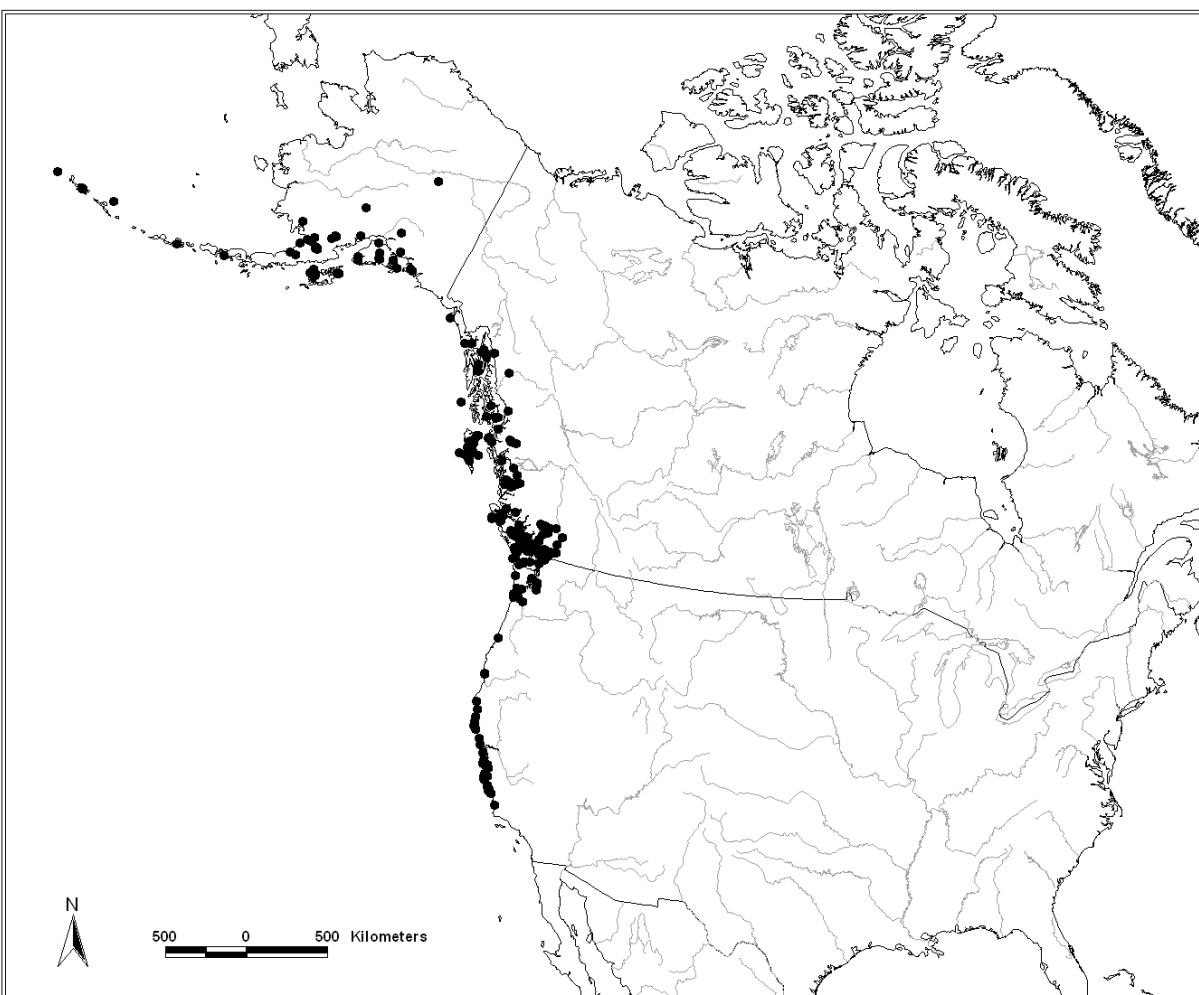


Figure 3. Global distribution of the Coastrange Sculpin based on 262 occurrence records obtained from the WFC (2006) and GBIF (2006).

Canadian range

In Canada, Coastrange Sculpin occur in streams and lakes along the Pacific Coast of British Columbia (Figure 3). Watersheds in which Coastrange Sculpin occur include the Fraser River in the south; north in such rivers as the Skeena, Nass, and Stikine; and on Vancouver and Queen Charlotte Islands. Coastrange Sculpin (Cultus Population) are endemic to the offshore habitat of Cultus Lake (49°03' N, 122°59' W) in southwestern British Columbia (Figure 4). Cultus Lake is located within the Chilliwack River drainage of the lower Fraser River watershed. Since about 12% of Cultus Lake is considered littoral (i.e., the zone where light penetrates to the bottom), 88% could be defined as offshore habitat (COSEWIC 2003). Therefore, the area of occupancy for the Coastrange Sculpin (Cultus Population) is at least 5.5 km² (i.e., 88% of 6.3 km²). The index of area of occupancy (IAO) is 24 km² based on a 2 x 2 km grid and 14 km² based on a 1 x 1 km grid.

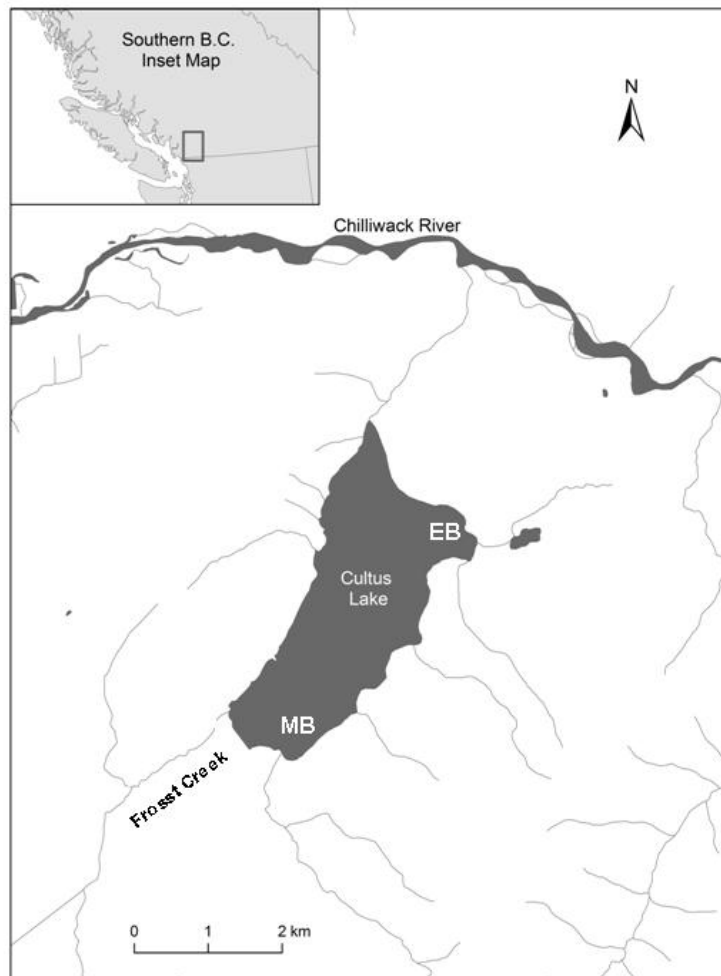


Figure 4. Location map for Cultus Lake. The acronyms EB and MB represent the locations of Entrance Bay and Maple Bay, respectively (see text).

HABITAT

Habitat requirements

Coastrange Sculpin generally inhabit medium- or large-sized streams with a moderate to rapid current, but may also occur in lakes (Wydoski and Whitney 2003). They are usually found on gravel or cobble substrates in streams but, in lakes, are often found on sand or even mud substrates (McPhail and Lindsey 1970). They may move downstream to estuaries and are tolerant of brackish water (McPhail and Lindsey 1970). Coastrange Sculpin are known to spawn in stream habitats with rocky substrate.

Coastrange Sculpin (Cultus Population) are believed to be restricted to the offshore habitat of Cultus Lake based on their common capture in mid-water Sockeye Salmon trawl surveys (J. Hume, unpublished data) and their presence in the stomach contents of piscivorous fish caught from Cultus Lake (Ricker 1960). Neither Coastrange Sculpin (Cultus Population) nor Coastrange Sculpin were caught during extensive seining of shoreline habitats in Cultus Lake, although the larger Prickly Sculpin was captured regularly (Ricker 1960). Minnow trapping of benthic offshore habitats of Cultus Lake have resulted in the capture both of Coastrange Sculpin (Cultus Population) and Prickly Sculpin, but only Coastrange Sculpin (Cultus Population) were captured in mid-water minnow traps (Woodruff 2010). Direct evidence of spawning has not been observed for Coastrange Sculpin (Cultus Population), but breeding is believed to occur in the deeper waters of the lake (Ricker 1960) or on shoals off the mouths of inlet creeks (Woodruff 2010).

Coastrange Sculpin normally undergo a switch from a pelagic larval life stage to a benthic juvenile lifestyle at about 32-35 days after hatching (Scott and Crossman 1973). Hydroacoustic and mid-water trawl surveys in Cultus Lake have demonstrated that post-larval Coastrange Sculpin (Cultus Population) (i.e., up to 52 mm in length) continue to migrate vertically into mid- and surface waters of the lake at night (Jeremy Hume, unpublished data). The Lake Sammamish and Lake Washington forms of pygmy Coastrange Sculpin also migrate vertically into mid- and surface waters of the lake at night (Ikusemiju 1967).

Cultus Lake has a surface area of 6.3 km², a drainage basin of 65 km², and a mean and maximum depth 32 m and 41 m, respectively. It is steep-sided and has a littoral area (i.e., the zone where light penetrates to the bottom) of only 12% of the total surface area. Like most coastal British Columbia lakes, Cultus Lake is a warm monomictic lake (i.e., it is thermally stratified except during the winter overturn) with a strong and prolonged thermocline. Summer temperatures in the surface layer (the epilimnion) exceed 20°C while bottom temperatures in the fall average less than 7°C. Cultus Lake is mesotrophic and has relatively high water clarity (i.e., Secchi disk depths average 10 to 11 m).

Cultus Lake supports a fish community that includes Sockeye Salmon, Chinook Salmon (*O. tshawytscha*), Coho Salmon (*O. kisutch*), Chum Salmon (*O. keta*), Pink

Salmon (*O. gorbuscha*); Coastal Cutthroat Trout (*O. clarkii clarkii*), both Steelhead and Rainbow Trout (*O. mykiss*), Dolly Varden, Bull Trout, Coastrange Sculpin (Cultus Population), Prickly Sculpin, Threespine Stickleback (*Gasterosteus aculeatus*), Largescale Sucker (*Catostomus macrocheilus*), Longnose Dace (*Rhinichthys cataractae*), Mountain Whitefish (*Prosopium williamsoni*), Northern Pikeminnow (*Ptychocheilus oregonensis*), Peamouth Chub (*Mylocheilus caurinus*), Redside Shiner (*Richardsonius balteatus*) and Western Brook Lamprey (*Lampetra richardsoni*).

Habitat trends

Streams and lakes suitable as habitat for Coastrange Sculpin populations are common along the Pacific Coast of North America and there is no reason to believe that the availability of suitable habitat has changed appreciably over time. The Cultus Lake watershed is heavily developed for recreation, residential and agricultural uses, resulting in significant impacts to tributary and outlet streams and lake foreshore habitats (COSEWIC 2003). Water quality, however, was assessed as excellent in 1996 (MWLAP 1996) and comparisons of limnological information from 2001-2007 with data collected in the 1930s and 1960s suggest that Cultus Lake's limnetic habitat has changed relatively little over the past 70 years (COSEWIC 2003; Shortreed 2007). Two notable exceptions, however, are: (i) average monthly water temperatures (both at the surface and at depth) were about 1-2°C warmer in 2001-2002 than between 1927-1937, and (ii) measures of productivity are higher now than in the past (Shortreed 2007).

Habitat protection/Ownership

The aquatic habitat of Cultus Lake (i.e., below the high watermark) is provincial Crown land. Most of Cultus Lake's shoreline (92%), but not the aquatic habitat *per se*, is within either Cultus Lake Provincial Park (2561 ha along the east and west shores) or Cultus Lake Municipal Park (640 ha along the north shore). The federal *Fisheries Act* (1985) regulates activities that impact fish and fish habitat in all waters of Canada and must be applied by all levels of government. The *Provincial Park Act* (1996) provides management guidelines and restricts resource extraction within provincial parks, thereby providing some level of protection against habitat degradation or loss for the adjacent terrestrial habitat. Cultus Lake Municipal Park is managed under a unique provincial statute, the *Cultus Lake Park Act* (1932), which gives the City of Chilliwack tenure over the park, but prohibits the City from selling property. Cultus Lake Municipal Park functions as a resort community with about 930 year-round residents. The small private resort/residential community of Lindell Beach is at the south end of the lake. South of Lindell Beach is the Columbia Valley, a light agricultural area that extends south across the United States border. The number of year-round residents in the Canadian portion of the Columbia Valley, including Lindell Beach, is about 370 people. Frosst Creek, the largest tributary of Cultus Lake, drains this agricultural area (including the United States portion) before entering Cultus Lake at Lindell Beach.

BIOLOGY

Although there are a number of studies available examining the typical biology of Coastrange Sculpin, most of the available information regarding Coastrange Sculpin (Cultus Population) biology comes from the one published study of this population by Ricker (1960). The remaining information available regarding Coastrange Sculpin (Cultus Population) comes from trawl and acoustic surveys conducted in Cultus Lake to enumerate Sockeye Salmon (J. Hume, unpublished data). Studies from Washington State (Ikusemiju 1967; Larson and Brown 1975) provide information about the other two known occurrences of pygmy Coastrange Sculpin.

Life cycle and reproduction

Coastrange Sculpin typically mature at age two to three years (i.e., for females; Bond 1963; Patten 1971) and can live to maximum of age eight (Wydoski and Whitney 2003). Using length frequency distribution data, Ricker (1960) estimated that Coastrange Sculpin (Cultus Population) mature at age three (i.e., females) and live to maximum of age four. Males of both normal Coastrange Sculpin and Coastrange Sculpin (Cultus Population) may begin to spawn a year earlier than females. Generation times are probably about two to five years for Coastrange Sculpin and three years for Coastrange Sculpin (Cultus Population). The minimum size at maturity for females is about 37 mm total length for Coastrange Sculpin (Cultus Population) (Ricker 1960) and ranges from 41 to 49 mm total length for other Coastrange Sculpin populations (Bond 1963, Patten 1971, Wydoski and Whitney 2003). Ricker (1960) recorded mature males of Coastrange Sculpin (Cultus Population) as small as 29 mm.

While Coastrange Sculpin normally spawn between February and July (McPhail and Lindsey 1970, Scott and Crossman 1973, Wydoski and Whitney 2003), Coastrange Sculpin (Cultus Population) are believed to spawn from late May or early June until August or even September (Ricker 1960) although direct evidence of Coastrange Sculpin (Cultus Population) spawning has not been observed. Coastrange Sculpin deposit adhesive egg masses on the undersides of rocks (Scott and Crossman 1973). One male Coastrange Sculpin may spawn with, and guard the eggs from, multiple females (Scott and Crossman 1973). The ripe egg size of Coastrange Sculpin is usually less than 1.5 mm (Scott and Crossman 1973). The average diameter of formalin-hardened ripe Coastrange Sculpin (Cultus Population) eggs is about 0.8 mm (Ricker 1960). The fecundity of Coastrange Sculpin can range from 100 eggs for a 49 mm fish to 1,764 eggs for a 101 mm fish (Patten 1971). Since adult Coastrange Sculpin (Cultus Population) are smaller, their fecundity is probably lower.

Coastrange Sculpin feed largely at night, mainly on aquatic insects and benthic invertebrates (particularly molluscs), but in the autumn they may feed extensively on Pacific salmon and trout (*Oncorhynchus* spp.) eggs (McPhail and Lindsey 1970; Scott and Crossman 1973). Larval Coastrange Sculpin feed on plankton in lakes (Wydoski and Whitney 2003). Adult Coastrange Sculpin (Cultus Population) are also planktivorous, with a diet that includes *Daphnia* sp., chironomid midge larvae and

pupae, *Epipishura*, Ostracoda, *Bosmina*, and *Cyclops* (Ricker 1960). Additionally, one Coastrange Sculpin (Cultus Population) of 37 mm in length consumed a smaller sculpin (*Cottus* sp.) of 14 mm in length (Ricker 1960).

Herbivory/Predation

In a survey of the diet compositions of Cultus Lake's piscivorous fish, Coastrange Sculpin (Cultus Population) occurred regularly in the diet of char (*Salvelinus* spp.), but only rarely in the diet of Coastal Cutthroat Trout and Coho Salmon and not at all in the stomachs of Northern Pikeminnow (Ricker 1960). One potential explanation for the observed difference among fish types in the frequency of Coastrange Sculpin (Cultus Population) occurrence in diet samples could be that char tend to forage more offshore and deeper than the other three species (Ricker 1960). A study of stomach contents for Sockeye Salmon caught in Cultus Lake (Ricker 1937) found that while planktonic crustaceans composed the majority of the food items consumed by juvenile Sockeye Salmon, larval sculpins had been consumed by 8% of age three Sockeye Salmon (i.e., maturing males) that had probably "residualized" within the lake (i.e., never migrated to the sea as is typical for Sockeye Salmon).

Physiology

Although Coastrange Sculpin are primarily a freshwater species, they can also occur in brackish or salt water (Moyle 1967, McPhail and Lindsey 1970, Brown *et al.* 1995). There is no information available regarding the physiological requirements or tolerances of Coastrange Sculpin (Cultus Population).

Dispersal/Migration

In streams, the pelagic larvae of Coastrange Sculpin drift downstream before settling as benthic juveniles in lower stream reaches (Brown *et al.* 1995). Upstream and tributary populations of Coastrange Sculpin are believed to be maintained by the upstream migration of juveniles (Brown *et al.* 1995). Moyle (1967) suggested that the wide coastal distribution of Coastrange Sculpin is related to their having pelagic larvae that are able to disperse through salt water.

Coastrange Sculpin (Cultus Population) are only known to occur in the offshore habitat of Cultus Lake, where they migrate vertically into surface waters of the lake at night. They are unlikely to actively move, or to be passively carried by currents, into the lake's inlet or outlet streams. Indeed, salmon fry traps operated at the outlet of Cultus Lake (Sweltzer Creek) during spring have caught Prickly Sculpin, but not Coastrange Sculpin (Cultus Population) (Ricker 1960). Dispersal to another lake is unlikely since there are no other lakes located within the Cultus Lake watershed and the discharge from Cultus Lake does not pass through any other lakes during its 112 km course to the Pacific Ocean.

Interspecific interactions

Besides being a planktivore that is sometimes preyed on by piscivorous fish (see the **Herbivory/Predation** section), another potentially important interspecific interaction for Coastrange Sculpin (Cultus Population) is their competition with juvenile Sockeye Salmon for planktonic crustacean prey. Both Coastrange Sculpin (Cultus Population) and juvenile Sockeye Salmon in Cultus Lake prey mostly on planktonic crustaceans, with *Daphnia* being the most important prey type by volume (Ricker 1960, COSEWIC 2003). Although Cultus Lake is one of the more productive Sockeye Salmon nursery lakes in British Columbia, with a large *Daphnia* population (Shubert *et al.* 2002), intraspecific competition for planktonic crustacean prey has been shown to reduce juvenile Sockeye Salmon growth in years of large Sockeye Salmon abundance, particularly during late summer (Ricker 1937). It is possible that interspecific competition also occurs between juvenile Sockeye Salmon and Coastrange Sculpin (Cultus Population) in the lake, particularly in years of higher juvenile salmon abundance.

Adaptability

Although Coastrange Sculpin are common in lakes and streams throughout most of the Pacific Coast of North America (Scott and Crossman 1973), vertically migrating pygmy forms of Coastrange Sculpin are only known from Cultus Lake, and Lake Sammamish and Lake Washington in Washington State. It is possible that these three lakes have distinctive environmental characteristics responsible for the evolution and persistence of these unusual Coastrange Sculpin populations.

POPULATION SIZES AND TRENDS

Search effort

The presence of Coastrange Sculpin (Cultus Population) in Cultus Lake is known from their occurrence in both stomach samples taken from piscivorous fish (Ricker 1960) and mid-water trawl sets performed to enumerate juvenile Sockeye Salmon (Jeremy Hume, unpublished data). The trawl surveys have been conducted up to three times per year since 1975. Between 1975 and 2007, the total trawling effort was 138 sets taken over more than 30 hours, and the catch was 481 Coastrange Sculpin (Cultus Population). By way of comparison, up to several hundred juvenile Sockeye Salmon or Threespine Stickleback (juveniles and adults) are often captured in a single, 30 min trawl (J. Hume, unpublished data). Tow net sampling has revealed the presence of similar vertically migrating pygmy forms of Coastrange Sculpin in two Washington State lakes (Larson and Brown 1975).

In the last 30 years, Fisheries and Oceans Canada has conducted acoustic and mid-water trawl surveys to enumerate juvenile Sockeye Salmon in over 100 British Columbia lakes containing anadromous Sockeye Salmon (J. Hume and K. Hyatt, pers. comm. 2006; Woodruff 2010). In most of these lakes, there were virtually no sculpins caught. The majority of the sculpins caught have not been identified to species and they generally reach too large a size to be considered pygmy forms (J. Hume, pers. comm. 2006). Since 1999, larger sculpins caught from lakes of the Fraser River system (i.e., larger than 35 mm in total length) have been identified to species and most of these have been Prickly Sculpin (J. Hume, pers. comm. 2006). There are two lakes in which sculpin catches in mid-water trawl sets suggest the potential for pygmy Coastrange Sculpin occurrence. The first is Seton Lake, of the middle Fraser River system, where 15 immature Coastrange Sculpin ranging from 10 to 35 mm in total length have been caught (J. Hume, pers. comm. 2006). The second is Tuya Lake, of the Stikine River system, where sculpin catch rates in trawls are high. The presence of Coastrange Sculpin in the Tuya Lake is uncertain, however, and a recent survey of the lake using gillnets, minnow traps and electroshocking recorded only Prickly Sculpin and Slimy Sculpin (Beere 2002).

Abundance

Fluctuations and Trends

The mid-water trawl data from Cultus Lake were analyzed to look for time series trends in Coastrange Sculpin (Cultus Population) catch rate (Josh Taylor, unpublished data). It is important to note that the trawling done in Cultus Lake is designed to target age-0 Sockeye Salmon fry in the lake and not sculpins. Trawl depths and duration are targeted on Sockeye Salmon through the use of hydroacoustics and are designed to get a representative sample of fish in the layer that has Sockeye Salmon-sized targets. It is not a representative sample of all fish in the water column and as such may not accurately represent the sculpin population in the lake at the time of sampling.

Model fitting was performed using simple least squares linear regression. The main model terms were year, season and depth. Season and depth were included to account for inter-annual differences in sampling effort across depth and season. The model also included all the possible interactions among these three main terms (i.e., up to and including the 3rd order interaction). Seasons were defined as Spring (March 20 to June 20), Summer (June 21 to September 21), Autumn (September 22 to Dec. 20), and Winter (December 21 to March 19). A final or “best” model was selected using a backwards stepwise removal process with the Akaike Information Criteria (AIC) as the test statistic. Of the 138 trawls sets conducted in Cultus Lake from 1975 to 2004, only 124 could be included in the analysis due to missing duration data for the remaining sets. Prior to analysis, catch rate (fish/h) was log transformed (i.e., $\log_{10}(Y+1)$).

The final selected model retained year ($P = 0.07$) and season ($P = 0.002$) as predictor variables and explained very little of the total variation in sculpin catch rate ($R^2 = 0.14$, Figure 5). Over the entire time series, catch rates declined by about 4% ($P = 0.07$). While this small decline in catch rate over time may not provide strong evidence of a decline in population size it does suggest that future monitoring is warranted. Mean (\pm SD), sculpin catch rate in trawl samples was highest in the summer (55 ± 160 fish/h), decreased through autumn (26 ± 50 fish/h), and was lowest during winter and spring (9 ± 21 fish/h).

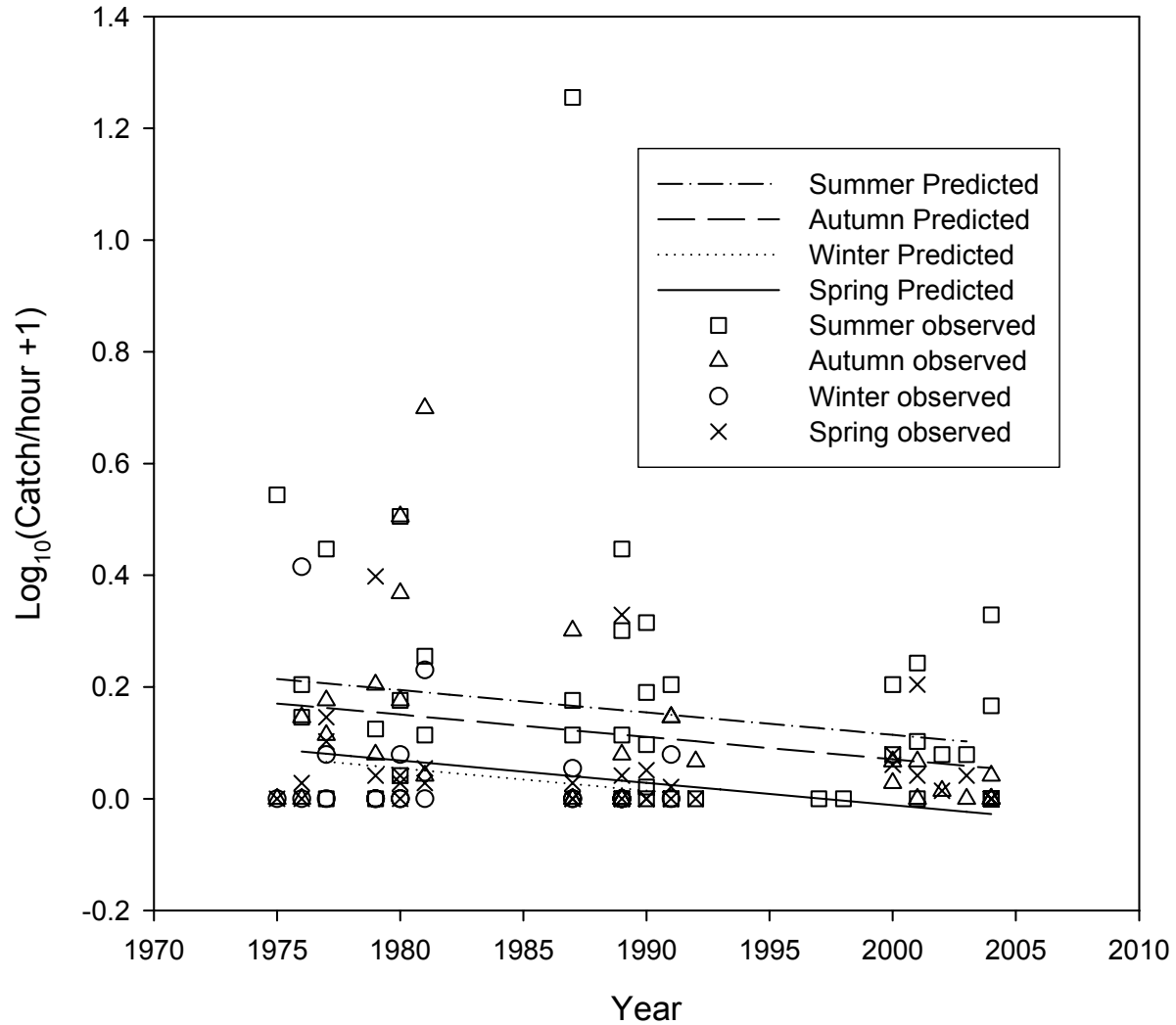


Figure 5. Annual and seasonal trends in the catch rates of Coastrange Sculpin (Cultus Population) (fish/hour) in 124 mid-water trawl samples collected from Cultus Lake from 1975 to 2004. Catch rates are shown on a logarithmic scale for better visualization of patterns. Trend lines show the catch rates predicted by an analysis of covariance (Josh Taylor, unpublished data).

Rescue effect

Since Cultus Lake is located 112 km up the Fraser River system and the Fraser and Sammamish/Lake Washington watersheds are separated by about 190 km of ocean, it is highly unlikely that there would be natural exchange of individuals between the Washington State and British Columbia populations. This inference is consistent with highly significant genetic differences between sculpins from the two areas (Table 2, Woodruff 2010).

LIMITING FACTORS AND THREATS

The recovery strategy for Coastrange Sculpin (Cultus Population) summarized a number of potential threats and generally concluded that quantifying these threats was not possible until more specific information was obtained regarding the biology of Coastrange Sculpin (Cultus Population) (National Recovery Team for Cultus Pygmy Sculpin 2007).

Invasive species

No invasive fish species are known to occur in Cultus Lake. The future introduction of invasive species, however, could significantly increase competition with, or predation on, various life stages of the Coastrange Sculpin (Cultus Population) and there are many invasive species in watersheds adjacent to Cultus Lake in the lower Fraser River (Taylor 2004; Nowosad 2010). Predation from introduced brown Bullhead (*Ameiurus nebulosus*) led to the extinction of the endemic Threespine Stickleback species pair located in Hadley Lake, British Columbia (COSEWIC 2001). Brown Bullhead and the closely related Yellow Bullhead (*A. natalis*) have also been introduced to the lower Fraser River system where they are common in sloughs and creeks closely associated with the main river (Nowosad 2010). There has been recent expansion of introduced Yellow Perch (*Perca flavescens*) and bass species (*Micropterus* spp.) in lakes of southern British Columbia (Dunphy 2006; Koopmans 2006). Furthermore, niche modelling shows generally high environmental suitability of the Lower Mainland region for several centrarchid and percid predators (e.g., Bradford *et al.* 2008). These occurrences and models, coupled with the observation that several invasive fishes and amphibians have been recorded within the Lower Mainland (including the Vedder River into which Cultus Lake drains via Sweltzer Creek) for more than 50 years (Nowosad 2010), suggest that introduction of one or more vertebrate exotic predators or competitors into Cultus Lake is a very real possibility.

Population trends in potential competitors and predators

The demonstrated decline and potential extinction of the Cultus Lake Sockeye Salmon population (COSEWIC 2003) could affect the survival of Coastrange Sculpin (Cultus Population). The number of Sockeye Salmon returning to Cultus Lake has declined since the late 1960s with a particularly drastic decline (92%) during the 1990s (COSEWIC 2003). The primary reasons for this decline are thought to be over-exploitation by fisheries, recent increases in the level of pre-spawn mortality associated with early migration and climate-driven reductions in marine survival (COSEWIC 2003). The potential impact of decreased Sockeye Salmon abundance on the survival of Coastrange Sculpin (Cultus Population) is unclear. Because juvenile Sockeye Salmon and Coastrange Sculpin (Cultus Population) may compete for zooplankton prey, decreases in juvenile Sockeye Salmon abundance could increase the survival of Coastrange Sculpin (Cultus Population). Then again, returning Sockeye Salmon can contribute a large proportion of the available phosphorus and nitrogen in Sockeye Salmon nursery lakes (Gende *et al.* 2002), which may elevate zooplankton densities. Consequently, reduced Sockeye Salmon abundance might decrease the abundance of prey for Coastrange Sculpin (Cultus Population). Comparisons of limnological information collected from Cultus Lake in 2001-2007 with data collected in the 1930s and 1960s suggest, however, that there has been no marked change in either water quality (COSEWIC 2003; Shortreed 2007), or zooplankton abundance and community structure (Schubert *et al.* 2002), over the past 70 years. During years of reduced juvenile Sockeye Salmon abundance, Ricker (1941) noted a shift in diet composition of the predacious fish community in Cultus Lake away from juvenile Sockeye Salmon towards other prey species, including Prickly Sculpin and Coastrange Sculpin (Cultus Population). Therefore, another consequence of reduced Sockeye Salmon abundance could be a switch in the diet of the lake's piscivorous fish community away from juvenile Sockeye Salmon and towards Coastrange Sculpin (Cultus Population), thereby reducing Coastrange Sculpin (Cultus Population) survival.

Northern Pikeminnow numbers in Cultus Lake have increased significantly recently, which may be in part due to the presence of introduced Eurasian Milfoil (*Myriophyllum spicatum*) in the lake's littoral zone which has increased to cover about 73% of the lake's surface littoral area that is < 6 m in depth (Schubert *et al.* 2002; Shortreed 2007). Although adult Northern Pikeminnow in Cultus Lake occupy both limnetic and littoral zones, and prey mostly on fish (Ricker 1941), Coastrange Sculpin (Cultus Population) were not found in the stomach contents of 240 Northern Pikeminnow sampled from Cultus Lake during the 1930s (Ricker 1941, 1960). Recent dramatic reductions in the abundance of juvenile Sockeye Salmon (COSEWIC 2003) could, however, lead to a shift in the diet of Northern Pikeminnow towards Coastrange Sculpin (Cultus Population) (Ricker 1941; National Recovery Team for Cultus Pygmy Sculpin 2007). In addition, given the high abundance of Northern Pikeminnow in Cultus Lake (e.g., about 40,000 in 1991; Hall 1992), even a small increase in the average rate of predation on Coastrange Sculpin (Cultus Population) might have a significant effect on survival.

Urbanization and recreational development

Another potential threat is the impact of recreational, residential and agricultural development on the lake's offshore water quality (see **Habitat trends** section). The lake's parks currently receive about 1.5 million visitors annually, making Cultus Lake one of the most heavily utilized lakes in British Columbia (COSEWIC 2003). Poorly performing septic tanks, inputs from agricultural and domestic fertilizers, sedimentation from land-based activities, and poor groundwater quality have all been identified as concerns and have the potential to degrade the lake to some degree (Schubert *et al.* 2002). Despite these threats from development, water quality was assessed as excellent in 1996 (MWLAP 1996) and examination of limnological data suggests little change over the past 70 years (COSEWIC 2003; Shortreed 2007). Although these data suggest that development has not had a substantial impact on water quality to this point, urbanization of the watershed is expected to increase, and water quality should continue to be monitored. For instance, BC population projections to 2031 predict the Fraser Valley Regional District to increase by more than 60% versus the BC average among the 28 other regional districts of about 35% (BCSTATS 2010).

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

NatureServe (2005) assigned Coastrange Sculpin (Cultus Population) global, national and provincial status rankings of critically imperiled (G1, N1 and S1, respectively). COSEWIC assigned a status of threatened to the Coastrange Sculpin in 2010 and it is currently listed as Threatened under Schedule 1 of the federal *Species at Risk Act*. The BC Conservation Data Centre gives Coastrange Sculpin (Cultus Population) its highest provincial rank (red). The Coastrange Sculpin (Cultus Population) is not listed in the IUCN Red List of Threatened Species (IUCN 2006).

The provincial park land surrounding much of Cultus Lake is protected by the *Provincial Park Act* (1996) of BC, which sets management guidelines and restricts resources extraction. Additionally, the federal *Fisheries Act* (1985) regulates activities that impact fish and fish habitat in all waters of Canada. Cultus Lake Municipal Park is managed under the *Cultus Lake Park Act* (1932), which prohibits private land ownership, but the park functions as a resort community rather than a conservation area.

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COLLECTIONS EXAMINED

Preserved Coastrange Sculpin (Cultus Population) samples stored at the Cultus Lake Salmon Research Laboratory were examined as part of the preparation of this report.