COSEWIC
Assessment and Status Report

on the

Coeur d'Alene Salamander
Plethodon idahoensis

in Canada

SPECIAL CONCERN
2021

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. 2007. COSEWIC assessment and update status report on the Coeur d'Alene Salamander *Plethodon idahoensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 21 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC. 2001. COSEWIC assessment and update status report on the Coeur d'Alene Salamander *Plethodon idahoensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 18 pp. (www.sararegistry.gc.ca/status/status_e.cfm)

Dupuis, L.A. and P. Ohanjanian. 1998. COSEWIC assessment and status report on the Coeur d'Alene Salamander *Plethodon idahoensis* in Canada, *in* COSEWIC assessment and status report on the Coeur d'Alene Salamander *Plethodon idahoensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-18 pp.

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Coeur d'Alene Salamander — Plethodon idahoensis, Mt. Revelstoke, 7 Sept 2010 (photo by K. Ovaska).

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COSEWIC
Assessment Summary

Assessment Summary – April 2021

Common name
Coeur d'Alene Salamander

Scientific name
Plethodon idahoensis

Status
Special Concern

Reason for designation
This terrestrial salamander has a restricted Canadian range in southeastern British Columbia, which represents about 40% of the species' global distribution. It is highly dependent on moist, shaded, rocky habitats, often along fast-flowing streams and seepages scattered across the otherwise dry landscape. Specialized habitat requirements and life history, including low reproductive rate, increase the salamanders' vulnerability to habitat disturbance. New information includes increased knowledge of distribution, establishment of Wildlife Habitat Areas to mitigate logging impacts, and clarification of threats. Climate change vulnerability analyses indicate that it is highly vulnerable to increased frequency and intensity of droughts. Population trends remain unknown. The species may become Threatened if threats from various sources, including road traffic, development and maintenance, are not adequately monitored and mitigated.

Occurrence
British Columbia

Status history
Designated Special Concern in April 1998. Status re-examined and confirmed in November 2001, November 2007 and May 2021.

COSEWIC
Executive Summary

Coeur d’Alene Salamander
Plethodon idahoensis

Wildlife Species Description and Significance

Coeur d'Alene Salamander (*Plethodon idahoensis*) is a terrestrial-breeding, lungless salamander (family Plethodontidae). It is dark brown to black, with light flecking on the sides and legs with an orange, yellow, or occasionally red dorsal stripe. Terrestrial salamanders can be locally abundant and are an integral part of the food web, both as invertebrate predators and as prey.

Distribution

Coeur d'Alene Salamander is restricted to a small portion of the western Cordillera of North America, largely within the northeast portion of the Columbia River drainage, including southeastern British Columbia, Canada, and Montana and Idaho, United States. Approximately 40% of the global range is in Canada, restricted to the southern Columbia Mountains (in the Monashee, Selkirk, and Purcell mountain ranges), in the lower Columbia River drainage (east of the lower Kettle River), and in the eastern edge of the South Thompson River drainage. Increased search effort has more than doubled the known range since the previous assessment; undocumented occurrences probably still exist.

Habitat

Coeur d’Alene Salamander requires moisture to facilitate respiration and protection from desiccation. In British Columbia, the salamanders are associated with incised and fractured bedrock or wet talus near water. Such rocky features appear to be an essential habitat characteristic. There has been an unknown amount of habitat lost to industry and road construction activities; however, the species does not appear to be limited by habitat at this time.

Biology

Coeur d’Alene Salamanders are relatively long-lived, up to 12 years in captivity, with an estimated generation time of 5 to 7 years. Several factors contribute to a low reproductive rate: late age of first reproduction (at 4th summer), breeding in alternate years by individual females, and small (4 to12 eggs) clutch size. There is no aquatic larval stage, and eggs develop directly into small versions of adults. Coeur d’Alene Salamanders spend much of their life in fractured bedrock retreats, an adaptation that, presumably, has allowed them to survive in a climatically harsh mountainous region. Lack of lungs and reliance on moist retreats limit their adaptability to alterations in hydrology and physical structure of their environment.

Population Sizes and Trends

No attempt has been made to determine Coeur d'Alene Salamander population size or fluctuations through sampling. Most watercourses supporting the species either have not been surveyed or cannot be completely sampled due to difficult topography. The subpopulation size at a portion of one of the 42 occurrences was estimated at 278 individuals; however, several challenges were identified that may affect the accuracy of this estimate. The Canadian population is probably greater than 14,000 mature individuals. The available data suggest that population densities, sex ratios, and age distributions may be relatively stable over time, as with other plethodontid salamanders.

Threats and Limiting Factors

The two most significant threats to the species are climate change and transportation corridors. Drying of streams and bedrock refuges, shifting climate zones, and the direct effects of increased ambient temperature on this cold-adapted species may pose significant risks in the long term. More than half of the known occurrences are adjacent to highways or other roads and at risk of disturbance from road traffic, and road maintenance and upgrades. Although the apparent proximity to transportation corridors is at least partially due to sampling bias, road-related mortality remains a significant threat to more than half of the known occurrences.

Other threats to the species that are considered to have a low or unknown impact include: mining and quarrying, renewable energy in the form of micro-hydroelectric development, logging, geological events, pollution, and emerging diseases.

Protection, Status and Ranks

In Canada, Coeur d'Alene Salamander is listed as Special Concern under Schedule 1 (Part 4) of the *Species at Risk Act* and is an Identified Wildlife Species associated with the *Forest and Range Practices Act* of British Columbia. Its NatureServe global rank is Apparently Secure. In Idaho and Montana, the ranks for the species are Special Concern and Imperilled, respectively. In British Columbia, it has been ranked as Apparently Secure since 2008.

TECHNICAL SUMMARY

Plethodon idahoensis

Coeur d'Alene Salamander

Salamandre de Coeur d'Alène

Range of occurrence in Canada (province/territory/ocean): British Columbia

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	5 to 7 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, projected based on threats.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations, whichever is longer up to a maximum of 100 years]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations, whichever is longer up to a maximum of 100 years].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations, whichever is longer up to a maximum of 100 years].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any period [10 years, or 3 generations, whichever is longer up to a maximum of 100 years], including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No; b. Partially; c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	35,843 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	212 km², based on known occurrences; additional occurrences are likely to exist
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No; although movements of individuals are short, habitat connectivity exists along stream sides

Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	7 to 65, based on threat from climate change and other more localized threats; the most likely number is probably >10
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, projected decline in area, extent, and quality, due to habitat shifting and alteration from increased droughts and from other threats.
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Total number of adults cannot be reliably estimated based on current information.	
Total	Unknown but probably at least 14,000

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations whichever is longer up to a maximum of 100 years, or 10% within 100 years]?	N/A

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

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

Was a threats calculator completed for this species?
 	
i. IUCN-CMP Threat 11. Climate change & severe weather, medium to low
    a. The threat assessment period is relatively short compared to the temporal scale of climate change and there is uncertainty around the magnitude and extent of effects of climate change and habitat thresholds leading to uncertainty around the severity within the assessment period.
ii. IUCN-CMP Threat 4. Transportation & service corridors, medium to low
    a. There remains uncertainty around the severity of this threat because there are insufficient data to assess the probability of recolonization from sites up- or downstream of road disturbance.
iii. IUCN-CMP Threat 7. Natural system modifications, low
iv. IUCN-CMP Threat 3. Energy production & mining, low
v. IUCN-CMP Threat 5. Biological resource use, low
vi. IUCN-CMP Threat 10. Geological events, low
vii. IUCN-CMP Threat 8. Invasive & other problematic species & genes, unknown
viii. IUCN-CMP Threat 9. Pollution, unknown
 	
What additional limiting factors are relevant?
 	
The moist microenvironments required by the species are naturally fragmented, and the physiological constraints limit dispersal.
 	
Low reproductive potential limits the ability of subpopulations to recover from disturbances and stochastic events.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Idaho, S3; Montana S2
Is immigration known or possible?	Not known, unlikely
Would immigrants be adapted to survive in Canada?	Possibly
Is there sufficient habitat for immigrants in Canada?	Likely
Are conditions deteriorating in Canada?†	Yes, projected due to climate change
Are conditions for the source (i.e., outside) population deteriorating?	Yes, projected due to climate change
Is the Canadian population considered to be a sink?	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

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

Status History:

COSEWIC: Designated Special Concern in April 1998. Status re-examined and confirmed in November 2001, November 2007 and May 2021.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons for designation: This terrestrial salamander has a restricted Canadian range in southeastern British Columbia, which represents about 40% of the species' global distribution. It is highly dependent on moist, shaded, rocky habitats, often along fast-flowing streams and seepages scattered across the otherwise dry landscape. Specialized habitat requirements and life history, including low reproductive rate, increase the salamanders' vulnerability to habitat disturbance. New information includes increased knowledge of distribution, establishment of Wildlife Habitat Areas to mitigate logging impacts, and clarification of threats. Climate change vulnerability analyses indicate that it is highly vulnerable to increased frequency and intensity of droughts. Population trends remain unknown. The species may become Threatened if threats from various sources, including road traffic, development and maintenance, are not adequately monitored and mitigated.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Insufficient data to reliably infer, project, or suspect population trends.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. IAO of 212 km^2 is within the range for Endangered, but population is not severely fragmented, occurs at >10 locations, and does not experience extreme fluctuations although the area, extent, and quality of habitat are projected to continue to decline.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Number of mature individuals is at least 14,000, exceeding thresholds.
Criterion D (Very Small or Restricted Population): Not applicable. The population is not very small or restricted.
Criterion E (Quantitative Analysis): Not applicable. Analysis not conducted.

PREFACE

Since the previous status assessment (COSEWIC 2007), inventory work has resulted in 13 additional occurrences for Coeur d'Alene Salamander, bringing the total number of known occurrences in British Columbia to 42, doubling both the extent of occurrence and index of area of occupancy. Three occurrences have been documented outside the Columbia River drainage in the Fraser River drainage (South Thompson watershed), which has been subjected to relatively little search effort. Abundance has not been estimated at any of the occurrences, or for the population as a whole, but a mark-recapture study was able to estimate the number of individuals utilizing one habitat area (Ohanjanian and Beaucher 2000). A Management Plan for Coeur d'Alene Salamander (*Plethodon idahoensis*) in Canada was published in 2017 (ECCC 2017).

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
(2021)

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

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

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

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

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
Service canadien de la faune
Canada

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

COSEWIC Status Report

on the

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Plethodon idahoensis

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2021

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Amphibia
Order: Caudata
Family: Plethodontidae
Genus: *Plethodon*
Species: *P. idahoensis*

English common name: Coeur d'Alene Salamander

French common name: Salamandre de Coeur d'Alène

First described by Slater and Slipp (1940), Coeur d'Alene Salamander was subsequently considered to be a subspecies of Van Dyke's Salamander (*Plethodon vandykei idahoensis*) (Lowe 1950), or an unnamed geographic group of *P. vandykei* (Brodie 1970). Subsequent genetic evidence (Wallace 1986; Howard *et al.* 1993; Carstens *et al.* 2004, 2005) and morphometric analysis (Wilson and Larsen 1999) corroborated its status as a full species, and it is now recognized as a valid species (Crother 2017). Literature prior to 1990 refers to the species as *P. idahoensis, P. vandykei idahoensis, or P. vandykei*.

Morphological Description

Background body colour is dark brown to black, with light flecking on the sides and legs (Wilson and Ohanjanian 2002). In Canada, dorsal stripe is primarily orange, yellow, or occasionally red (Ohanjanian and Beaucher 2001; Ohanjanian 2004; Larson 2009). The stripe does not extend to the tip of the tail, has irregular edges, and may be interrupted. A yellow throat patch is usually present on the underside of the head. Juveniles are similar to adults in appearance. Females are larger than males (Nussbaum *et al.* 1983), with a maximum snout-vent length (SVL) of 69 mm recorded from a female north of Creston, British Columbia (Ohanjanian and Beaucher 2001). Recently hatched juveniles average 18 mm SVL (Wilson and Ohanjanian 2002).

Webbed toes, parotoid glands (poison glands on the sides of the head), costal grooves on body, and yellow throat patch distinguish the species from all western *Plethodon* except *P. vandykei.* Compared to *P. vandykei*, *P. idahoensis* has a broader head, darker pigmentation, broader dorsal stripe, yellow limb bases, and a larger throat patch.

Population Spatial Structure and Variability

Coeur d'Alene Salamander occurs most often along streams, and dispersal along streams is likely to be relatively frequent, but there is potential for spatial population structuring between streams or groups of streams. Plethodontid salamanders seldom disperse across habitats that expose them to heat or dryness and typically exhibit high site fidelity with small home ranges; such ecologically constrained species often exhibit high rates of population divergence, including speciation (Pelletier 2015 and references therein).

Genetic work indicated that Coeur d'Alene Salamander dispersed north into Canada from Pleistocene refugia at a rate averaging around 50 m/year (Carstens *et al.* 2004). This movement was possible due to the salamanders' ability to exploit ephemeral habitats of glacial moraines created during glacial retreat. While occurrences have become more isolated in the absence of postglacial landscape features, individuals are capable of dispersing both up- and downstream, and the majority of the population is connected by watercourses within the same watershed; however, the extent to which these connections facilitate dispersal among streams is unknown. Overland dispersal is possible during periods of extended rainfall. Occupied habitat patches are often clustered relatively close together and may be more densely distributed than currently documented, all of which facilitates at least occasional gene transfer. However, further study is required as several studies in Idaho and Montana have found indications of north to south population structure (Carstens and Richards 2007; Carstens *et al.* 2009; Shafer *et al.* 2010; Pelletier and Carstens 2014; Pelletier *et al.* 2015). Lack of gene flow between occurrences as close as 40 km may result in genetic divergence among the *P. vandykei / idahoensis* species complex (Wallace 1986). No genetic studies have been conducted in British Columbia's portion of the range.

Designatable Units

The Canadian population of Coeur d'Alene Salamander is considered a single designatable unit: there are no recognized varieties or subspecies in Canada, and no evidence for discreteness or evolutionary significance of subpopulations, which are poorly defined.

Special Significance

Salamanders are recognized as regulators of food webs and contribute to ecosystem stability: as mid-level vertebrate predators they contribute to species diversity and ecosystem processes and to soil dynamics, and supply stores of energy and nutrients for higher level predators (Davic and Welsh 2004). The significance of Coeur d'Alene Salamander's contributions has not been specifically studied. This species is part of Canadian ecosystems that are important to Indigenous people, who recognize the interconnectedness of all species within the ecosystem. No specific information for this species was available.

DISTRIBUTION

Global Range

Coeur d'Alene Salamander is restricted to areas west of the Rocky Mountains of North America, largely within the northeast portion of the Columbia River drainage including southeastern British Columbia, northwestern Montana, and northern Idaho (Figure 1). In Montana, the southern limits of its range are in the Bitterroot River drainage (MNHP 2019). In Idaho, it is found south to the Selway River drainage (IDFG 2019).

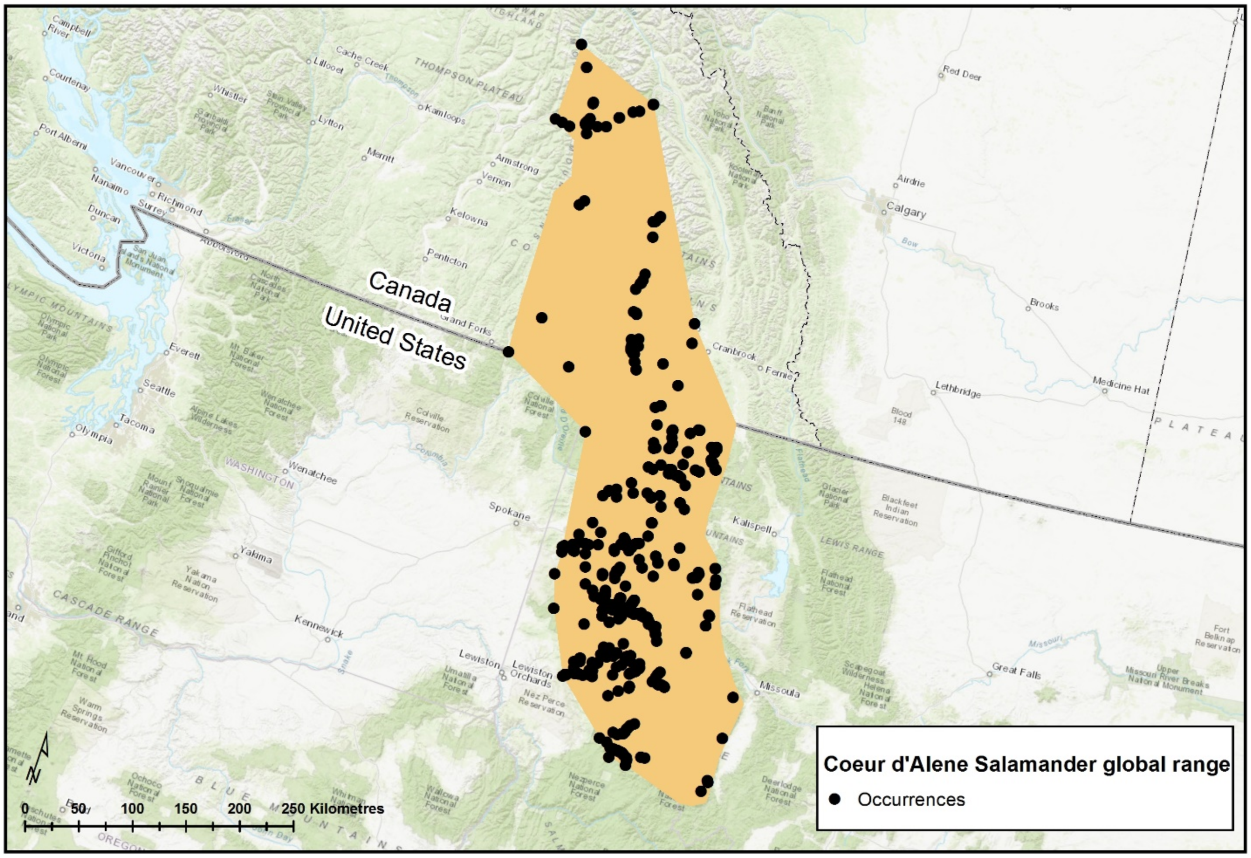

Figure 1. Approximate global distribution of Coeur d'Alene Salamander (based on known occurrences as of 2019). Prepared by Sydney Allen (COSEWIC Secretariat).

Canadian Range

Approximately 40% of the global range of Coeur d'Alene Salamander is in Canada, where it has been found within the southern Columbia Mountains (in the Monashee, Selkirk, and Purcell mountain ranges), spread throughout the Columbia River drainage (east of the Kettle River), and in the eastern edge of the South Thompson River drainage (Figure 2; ECCC, 2017; B.C. CDC 2019a). Within Canada, the species is predominantly found in the Interior Cedar–Hemlock biogeoclimatic zone (very dry to very wet and warm to cool subzones) with a few occurrences in the Montane Spruce (dry warm) zone and one in Interior Douglas-fir (very dry hot) zone.

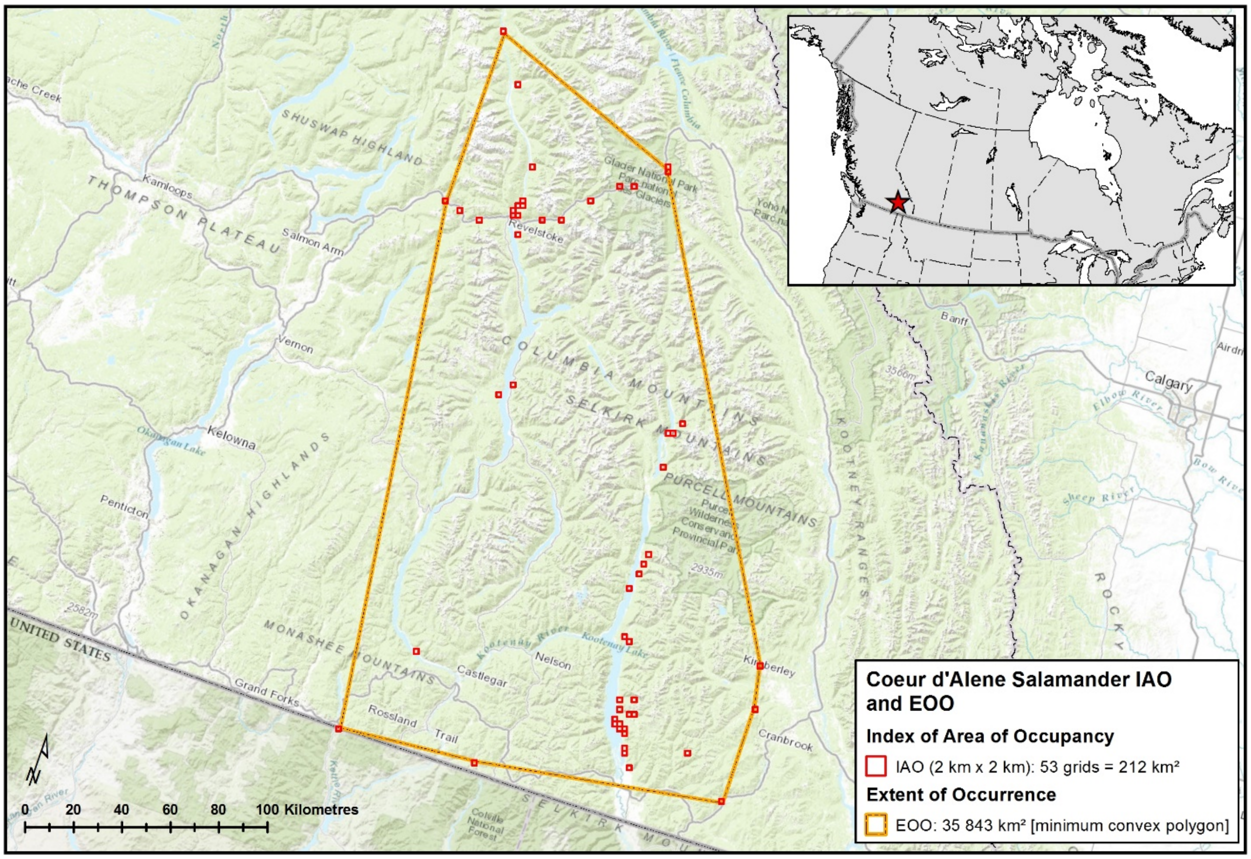

Figure 2. Distribution of occurrences of Coeur d’Alene Salamander in Canada (data from 1981 to 2018), showing extent of occurrence and index of area of occupancy. Prepared by Sydney Allen (COSEWIC Secretariat).

Records exist from 42 occurrences (representing 76 sites, see Table 1) within 7 watersheds: Lower Kootenay (along Kootenay Lake, and the Duncan Reservoir); Central Kootenay (Goat River, Moyie River, and St. Mary River drainages); Kettle (Pend d’Oreille River); Central Columbia and Upper Columbia (Upper and Lower Arrow Lake), Revelstoke (the east shore of Columbia River north and south of Revelstoke, along the Illecillewaet River), McNaughton Lake-Columbia Reach (Glacier National Park, Beaver River tributary) and the South Thompson (Eagle River) (ECCC 2017). An occurrence includes all records of the species within 1 km and may contain several sites. The largest concentration of occurrences is along on the eastern shore of Kootenay Lake, continuing north along the east shore of the Duncan Reservoir and around Revelstoke extending north, east and west.

Table 1. Summary of search effort for Coeur d'Alene Salamander in southern British Columbia. General searches that did not explicitly include Coeur d'Alene Salamander and were not able to detect the species have not been included as they generally targeted unsuitable habitat. PLID = *Plethodon idahoensis*; NR = not reported. Due to inconsistencies in reporting among the studies the number of sites and person-hours should be considered approximations.

Study	Spp. focus	Study area	No. sites surveyed	No. sites w/ detect.	Pers. hrs.
Larson and Rand 2018	PLID	Mount Revelstoke National Park.	2	1	3.3
Parks Canada Agency 2013	PLID	Mount Revelstoke National Park.	Linear road surveys	Detected	26.0
Gunson and Larson 2012	PLID	Mount Revelstoke National Park.	Linear road surveys	Detected	28.7
Hawkes and Tuttle 2010	Amphibian	Kinbasket and Arrow Lakes Reservoirs.	NR	1	91.8
Iredale 2009	PLID	Three Valley Gap, Griffin Lake, Eagle River, and Perry Creek drainages.	8	3	6.3
Larson 2009	PLID	Mount Revelstoke National Park.	26	12 (2 previously known)	10.8
Adama and Ohanjanian 2005	Amphibian	Mount Revelstoke and Glacier National Parks.	NR	3	10.2
D'Eon and Larson 2007a,b	PLID	Frost Hall Creek and Glacier Creek.	NR	2	NR
Dykstra 2004	Amphibian (Western Toad + others)	Mount Revelstoke and Glacier National Parks.	50	3	NR
Ohanjanian 2003a	PLID	Nine study areas: Revelstoke (to the north and south along the Columbia River), Golden and the southwest shore of the Kinbasket Reservoir, the East Kootenay, the west shore of Kootenay Lake to Nelson and south to Ymir, two areas on the east shore of Kootenay Lake, the Duncan River, the Pend d'Oreille, and the east shores of the Upper and Lower Arrow Lakes.	47	6 (2 previously known)	34.2
Ohanjanian and Beaucher 2003	PLID	From Duck Creek north to Clute Creek on eastern side of Kootenay lake, only on crown land within Wynndel Box and Lumber Co. operating area north of Creston.	16	3	19.8
Ohanjanian 2002	PLID	Kootenay Lake (east shore), Pilot Point, Kootenay Lake (west shore), Lower Arrow Lake (east shore), the area west of Nelson and south to Ymir, north and south of Revelstoke along the Columbia River, and in the St. Mary's River drainage near Kimberley (East Kootenay).	36	12	27.4

Study	Spp. focus	Study area	No. sites surveyed	No. sites w/ detect.	Pers. hrs.
Ohanjanian and Beaucher 2001	PLID	From Duck Creek north to Clute Creek on eastern side of Kootenay lake, only on crown land within Wynndel Box and Lumber Co. operating area north of Creston.	12	2	24.3
Ohanjanian 2001a	PLID	Survey Area 1: the east side of Lower Arrow Lake from Castlegar north to Gladstone Creek, Survey Area 2: the east side of Upper Arrow Lake from Octopus Creek north to Galena Bay and east to Beaton, Survey Area 3: the east shore of the Duncan Reservoir and the Duncan River north to Hume Creek, and Survey Area 4: the west side of Kootenay Lake, from Ymir north to Meadow Creek	37	10	38.9
Ohanjanian and Beaucher 2000	PLID	From Duck Creek at Wynndel, north to Murphy Creek on the east side of Kootenay Lake, only on crown lands within Wynndel Box and Lumber Co. operating area.	16 - possible sites identified but not searched due to dry weather	2	16.7
Ohanjanian 2000	PLID	From Duck Creek at Wynndel, north to Murphy Creek on the east side of Kootenay Lake, only on crown lands within Wynndel Box and Lumber Co. operating area.	10	1	11
Ohanjanian 1998	PLID	From Duck Creek at Wynndel, north to Murphy Creek on the east side of Kootenay Lake, only on crown lands that occur within the operating area of Wynndel Box and Lumber Co.	11	3	18.1
Ohanjanian 1997	PLID	From south of Creston to north of Riondel along the east side of Kootenay Lake and in the Moyie and Goat River drainages from Kitchener to the U.S. border and north from Yahk along the Moyie River. Some reconnaissance work was carried out along the Kootenay River.	16	15	15.5
Ohanjanian and Teske 1996	PLID	Report could not be obtained for review.	-	-	-
Charland 1992	PLID	Report could not be obtained for review.	-	-	-
Orchard 1991	PLID	Report could not be obtained for review.	-	-	-
Holmberg *et al.* 1984	Arachnid	Various caves in B.C. and Alberta. 3 within the range of Coeur d'Alene Salamander.	3	1	Incident al obs.
Total			**290**	**76**	**384**

The northernmost limit of the species' range is along a small tributary of the Columbia River, ca. 80 km north of Revelstoke (Ohanjanian 2003a). The most southerly occurrence is south of Christina Lake, near the United States border (map in ECCC 2017)[1]. The distance between these two points is approximately 300 km. The most easterly occurrence is 16 km south of Kimberley on a tributary of the Kootenay River (Ohanjanian 2003a). The most westerly occurrence is in Eagle River Provincial Park, ca. 30 km west of Revelstoke.

Coeur d'Alene Salamander was first discovered in British Columbia in 1984 and has since been documented at an increasing number of occurrences: 10 by 1998, 29 by 2007, and 42 by 2020 (Figure 3; Holmberg *et al*. 1984 *in* Ohanjanian 2003a; Dupuis and Ohanjanian 1998; COSEWIC 2007; ECCC 2017). This increase represents expanded search effort and awareness of the species and not a range expansion.

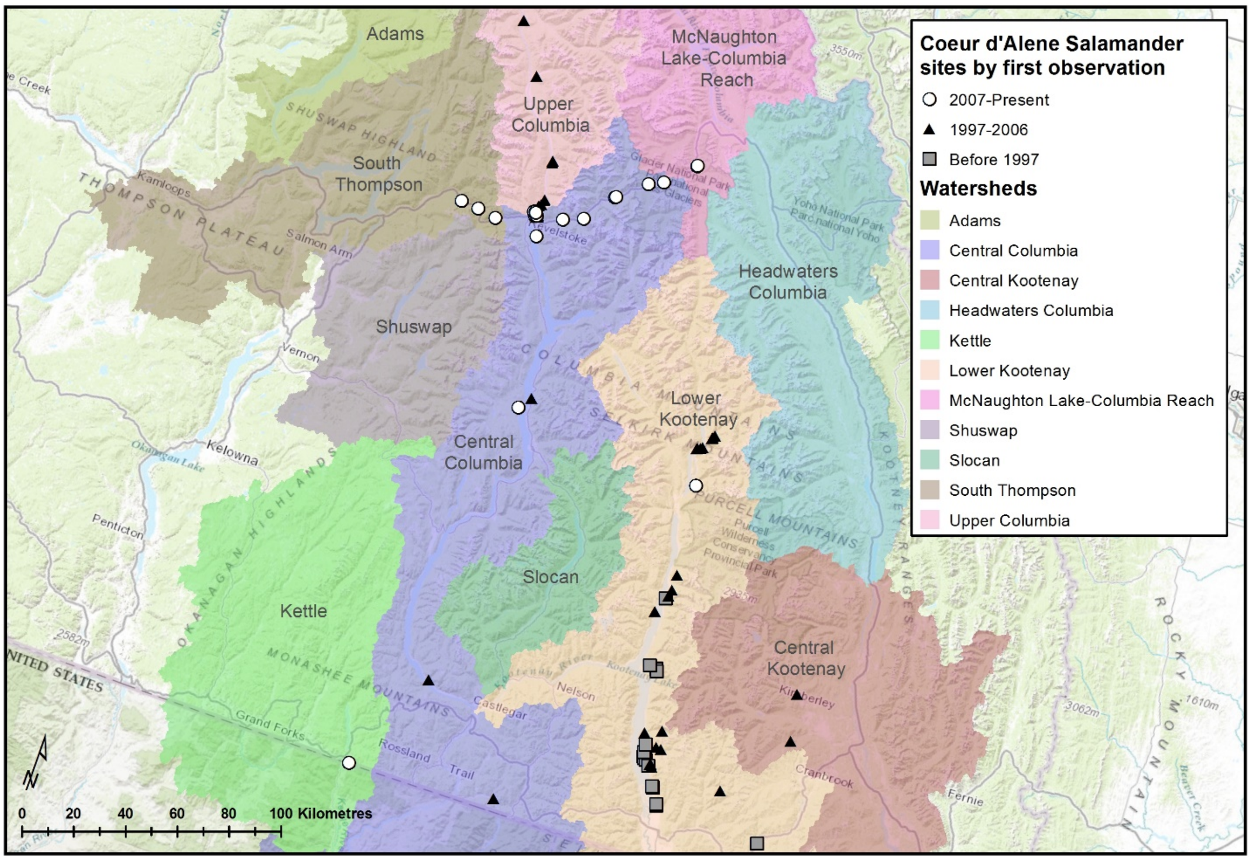

Figure 3. Sites where Coeur d'Alene Salamander has been found in Canada, identified by first year of detection, showing an increase in the known range and drainages where the species has been detected over time. McNaughton Lake-Columbia Reach and Kettle watersheds are in the Columbia drainage; South Thompson watershed is in the Fraser River drainage. Prepared by Sydney Allen (COSEWIC Secretariat).

[1] The original report for this site could not be located.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) for Coeur d'Alene Salamander in British Columbia, calculated using the minimum convex polygon method and encompassing all known occurrences as of 2020, is 35,843 km^2 (Figure 2). The index of area of occupancy (IAO), calculated based on 2 km x 2 km grid cells, is 212 km^2 (Figure 2). COSEWIC (2007) reported an EOO of 17,000 km^2 and IAO of 100 km^2. The known EOO and IAO have increased 111% and 112%, respectively, due to increased search effort. The IAO value, in particular, is an underestimate and is expected to increase with expanded survey efforts.

Search Effort

Coeur d'Alene Salamander has been the subject of numerous directed surveys since 1995 and has been included in several general amphibian surveys (Table 1). While the specific details vary from study to study, surveys generally consisted of non-destructive, visual scanning of the ground at night in wet areas around waterfalls, seepages and stream banks, and along roads. British Columbia Species Inventory Web Explorer (2019) includes several other general amphibian surveys from the Thompson, Okanagan, and Kootenay regions; however, these inventories generally focused on wetlands where the potential for detection of Coeur d'Alene Salamander is lower than directed surveys in suitable habitat (e.g., several years of general amphibian inventory in Kinbasket and Arrow Lakes reservoirs produced one detection compared to several new occupied sites discovered annually by targeted inventory; Hawkes and Tuttle 2010).

More than 384 person-hours have been spent conducting nocturnal surveys at over 290 survey sites with detections at 76 survey sites. The vast majority of occurrences are within several hundred metres of a roadway which reflects a strong bias towards surveys near roads and trails due to access difficulties. Throughout the species' range, dozens of additional watercourses with potential Coeur d'Alene Salamander habitat have not been surveyed due to the steep topography and difficulty of access. Coeur d'Alene Salamander has frequently been found on surveys upstream or downstream of known occurrences (Ohanjanian 2001a, 2003a; Larson 2009). These data suggest that the total number of known occurrences is an underestimate of the true abundance. Since the previous status report, the species has been discovered in two additional watersheds within the Columbia drainage (McNaughton Lake-Columbia Reach and Kettle) and within the Fraser River drainage (South Thompson watershed), which has been subjected to little or no survey effort targeting this species.

A B.C. Conservation Data Centre report (B.C. CDC 2016) suggested that less than 10% of the suitable habitat has been searched for the species, based on personal communication from P. Ohanjanian in 2007. However, no habitat suitability mapping is available to accurately quantify the proportion of unsurveyed habitat.

HABITAT

Habitat Requirements

Coeur d'Alene Salamander is a lungless salamander that requires moisture to facilitate respiration and for protection from desiccation (Spotila 1972). In British Columbia, the species is associated with seeps, rock walls with water flowing over them, waterfall splash zones, streamside habitats with exposed bedrock, caves, avalanche paths, and wet talus (layers of rock) (Ohanjanian 2003a; Larson 2009). These habitats often occur in steep terrain where the bedrock is near the surface and/or the talus has fallen down a slope.

Fractured bedrock or talus in conjunction with water appears to be an essential habitat characteristic (Wilson and Larsen 1988; Nussbaum *et al.* 1993; Ohanjanian 1998, 2003a; Larson 2009). Coeur d'Alene Salamanders may spend up to seven months of the year inactive underground in moist interstitial spaces between rocks (Cassirer *et al.* 1994). These underground refugia provide protection from freezing in winter and from desiccation in summer. Interstitial spaces, conduits of moisture below the surface, and portals from this subterranean environment to the surface are all important and potentially limiting features of the habitat, but the specific structure and extent of underground retreats remain unknown. No egg masses have been found in the wild; however, it is likely that these are deposited in underground crevices.

Coeur d'Alene Salamander does not appear to exhibit a specific or strong preference regarding the character of surrounding habitats as vegetation at occurrences ranges from sparse (at rock walls with limited vegetation) to dense deciduous shrubs (e.g., in avalanche paths) to mixed coniferous forest of varying ages (ECCC 2017). However, while a lack of vegetation does not necessarily restrict the species, Larson (2009) demonstrated that occupancy along streams and in terrestrial habitat is positively associated with the presence of shrub, grass, and forb cover of the stream bank, as well as with litter, moss, and boulders and cobbles. Forested land adjacent to specific habitat features such as caves and rock walls may be used for foraging, mating, and travel.

Habitat Trends

Moist habitats containing suitable refugia for Coeur d'Alene Salamanders are naturally confined to distinct areas or patches within the surrounding landscape. Further, there have likely been past declines in habitat due to industrial activity and the building, improvement, and maintenance of roads. Some occurrences are partly in highway rights-of-ways, and the species occupies some streams that are suitable for run-of-river micro-hydroelectric generation (see Figure 4 for potential run-of-river hydro sites and major highways). Other resource extraction activities such as mining and logging are also likely to affect habitat availability. The species has shown some ability to survive in, and recolonize disturbed habitat including road rights-of-ways, dam sites, and, rarely, old mines (ECCC 2017; NatureServe 2019). The magnitude of previous losses is unknown; however, the species does not appear to be limited by habitat at this time as abundant potential habitat remains among known occurrences (ECCC 2017). The expected effects of climate change are likely to reduce habitat availability within the current range of the species (Appendix 1; see **Threats and Limiting Factors**).

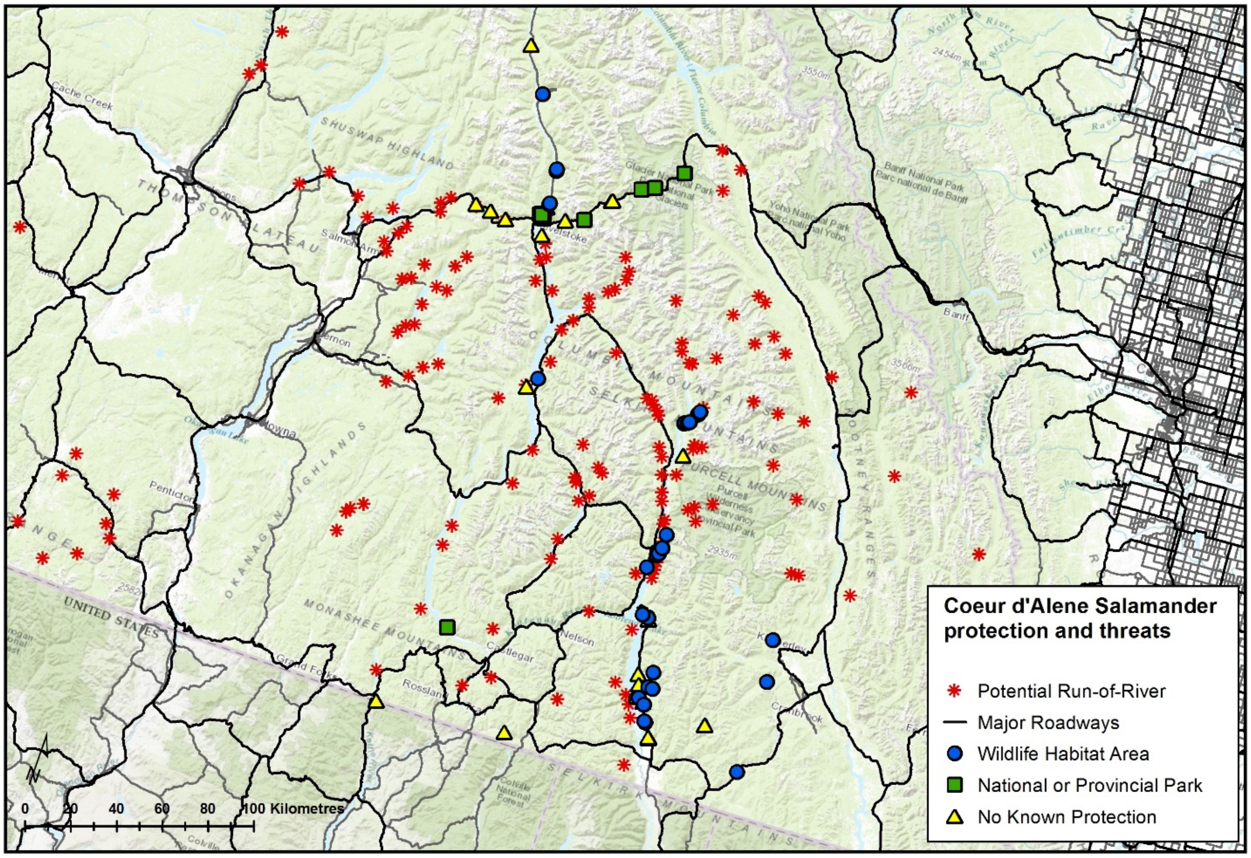

Figure 4. Coeur d'Alene Salamander occurrences within Wildlife Habitat Areas, parks, and on other lands in relation to major roads and potential run-of-river hydro projects. "No known protection" refers to sites outside protected areas and WHAs; management and planning specific to this species may be required under Government Actions Regulations. Approximately 60% of occurrences are within 30 m of a highway or road. Of 160 potential run-of-river sites, 12 are on or within 3 km from watercourses that are known to support the salamander. Map prepared by Sydney Allen (COSEWIC Secretariat).

BIOLOGY

Little is known about the biology of Coeur d'Alene Salamander, and information from a variety of sources including those from the United States is summarized below. Wilson and Ohanjanian (2002) provided an overview of literature regarding the species.

Life Cycle and Reproduction

Coeur d'Alene Salamander is relatively long-lived, up to 12 years in captivity (A. Wilson pers. comm. cited *in* ECCC 2017). Several factors contribute to a low reproductive rate of the species: sexual maturity occurs relatively late, in the fourth summer of life at SVL >44 mm for males and >46 mm for females (Lynch 1984; Cassirer *et al.* 1994; Wilson and Ohanjanian 2002); females probably breed in alternate years (Nussbaum *et al.* 1983); and clutch sizes are small (mean: 6.7 ovarian eggs/female; range: 4 to12 in northern Idaho)

(Nussbaum *et al.* 1983). Larson *et al.* (1998) described an egg mass, consisting of seven eggs, laid in captivity. Females are highly secretive during egg-laying, and no nests have been found in the wild. It is thought that the female attends the nest and broods the eggs as in other plethodontids (Nussbaum *et al.* 1983; Truath *et al.* 2006). There is no aquatic larval stage; the development is direct from eggs to juveniles that have a smaller, yet adult-like form. Juveniles probably hatch in fall.

No information is available on annual survivorship, and thus generation time cannot be calculated accurately. Based on age at first reproduction and maximum longevity, generation time is approximately between 5 and 7 years (COSEWIC 2007; ECCC 2017).

Physiology and Adaptability

Details of Coeur d'Alene Salamander's physiological requirements have not been studied, but like other plethodontids it requires moist microenvironments to facilitate exchange of respiratory gases through the skin and is prone to water loss through evaporation (Spotila 1972; Grover 1998). The species is active on the surface at temperatures lower than other species of plethodontids, one individual was observed near Kimberley at air temperature of 3.8°C (Ohanjanian 2003b). In the mountainous regions of southeastern British Columbia, northwestern Montana, and northern Idaho, ambient temperatures are generally low at the times of year when rains provide adequate moisture for surface activities. The species has been consistently observed on the surface in summer during rainy weather and at waterfalls that maintain a moist environment (Nussbaum *et al.* 1983; Ohanjanian 2001a).

Use of rocky retreats, where Coeur d'Alene Salamander spend much of their life, is an adaptation that, presumably, has allowed it to survive in a climatically harsh mountainous region subjected to recurrent wildfires. Due to the physiological constraints described above, Coeur d'Alene Salamander is sensitive to alterations in hydrology and the physical structure of its environment.

Movements, Dispersal, and Migration

Coeur d'Alene Salamanders are relatively sedentary, but small-scale annual movements away from summer/fall habitat have been documented, including movements up to 52.8 m away from a capture point and then back again over several years (Ohanjanian 2001b in COSEWIC 2007; Ohanjanian and Beaucher 2001, 2003). Ohanjanian and Beaucher (2001) noted that 12 of 15 recaptures (of 79 individuals) were in the same area with greatest distance between capture sites of 8.1 m; two individuals had moved more than 20 m to nearby habitat areas. In 2003, eight individuals were recaptured with a mean movement of 6.6 m between capture sites; the maximum movement was 21.7 m (Ohanjanian and Beaucher 2003).

Information on dispersal by Coeur d'Alene Salamander along and among tributaries is limited. The mechanisms for dispersal may be passive, for example individuals being carried downstream by runoff or flood events, or active, with individuals walking upstream, downstream, or laterally away from one watercourse to another. The species has been detected at multiple points on the same watercourse (Ohanjanian 2001a, 2003a; Larson 2009), indicating dispersal up and downstream. The requirement for moisture constrains the timing and distances travelled laterally between watercourses.

Interspecific Interactions

No studies of the food habits of Coeur d'Alene Salamander have been carried out in British Columbia. COSEWIC (2007) provided a review of food habits from other parts of the range, where the species feeds on an array of invertebrates including adult insects, aquatic larval insects, spiders, worms, and slugs.

Predation by American Robin (*Turdus migratorius*) has been recorded (Wilson and Simon 1985). Other, potential predators of salamanders include small mammals, such as Bushy-tailed Woodrat (*Neotoma cinerea*), garter snakes (*Thamnophis* species), and various large invertebrates (COSEWIC 2007).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

No attempt has been made to determine Coeur d'Alene Salamander population size or trends. Detection rates can be extremely variable between surveys (e.g., see Appendix 2, no./10 min of search for occurrences 2, 19a, 22, and 35), which makes calculating any estimate of abundance difficult. Two attempts to determine subpopulation size by mark-recapture are discussed below.

Abundance

Mark-recapture studies have met with mixed results. Larson (2009) could not estimate subpopulation size due to low recapture rates (10 recaptures of 253 tagged salamanders in 2006). Ohanjanian and Beaucher (2000) were able to calculate an estimate of 278 (SE = 36.5, CI = 221 to 362) individuals at one site (a portion of one occurrence), based on captures of 79 individuals of which 67% were adults. However, a very low recapture rate and various unknowns about Coeur d'Alene Salamander's behaviour were challenges. In all models, the lower confidence interval was over 100 and the upper well under 1000 individuals (Ohanjanian and Beaucher 2000). Assuming an average of 278 individuals at each of 76 occupied survey sites (Table 1) provides an estimate of roughly 21,000 individuals, of which 14,000 (67%) are adults. Such an estimate should be used with extreme caution because it is based on a single study that identified several potential biases. For comparison, a population estimate adjusted to the presumed percentage of the population near the surface and available for capture at any one time (21% as used in

COSEWIC 2007) yields 3,400 individuals[2] compared to 2,800 in 2007. Considering the number of additional occurrences and the mark-recapture analysis, the Canadian population is probably greater than 14,000 mature individuals.

Fluctuations and Trends

Population trends and fluctuations of Coeur d'Alene Salamander in Canada are unknown. Population densities, sex ratios, and age distributions of other plethodontid species are relatively stable over time, unlike those of many aquatic-breeding amphibians (Hairston 1987; Grover 1998). Several measures suggest that this may also be true for Coeur d'Alene Salamander. Frequency histograms of size classes at three monitored sites revealed that all size classes were present, and size distribution was stable over a 3-year period, suggesting stability (Ohanjanian and Beaucher 2001, 2002, 2003; Ohanjanian 2001a). Adults and juveniles are consistently encountered (Appendix 2).

The population may have been stable in the recent past in undisturbed habitats, but climate change and other threats could cause widespread habitat-related population declines in the future (see **Threats and Limiting Factors**). Climate change will likely make some current habitat uninhabitable, especially in the south. Additional habitat may become suitable at higher altitudes and north of the current range; however, higher altitude habitat will be less extensive, and the species' limited dispersal ability will hinder northward dispersal.

Population Fragmentation

The possibility of dispersal of the salamanders among streams and stream systems is unstudied. There is no information on the viability of occurrences, and thus whether the population is severely fragmented as per COSEWIC definition (i.e., ≥50% of the population is in habitat fragments smaller than required for long-term population viability) cannot be assessed with any degree of confidence. However, it seems unlikely that severe fragmentation would apply due to habitat connectivity along stream corridors, nor was it implied in the previous status assessment (COSEWIC 2007).

[2] To avoid double counting individuals where multiple surveys have been undertaken for a given habitat patch the number of observed salamanders at each site has been averaged. The total number of salamanders observed across all habitat patches is then 1053. Where recorded, the proportion of juveniles detected in the data is 32%. Applying this to the total to account for studies that did not distinguish age estimates yields 716 mature individuals. Applying the 21% detection rate used in COSEWIC (2007) provides an estimate of 3,410 individuals.

Rescue Effect

Given the species' physiological constraints and low dispersal ability, rescue from the closest United States populations is unlikely. The species is not believed to be habitat limited in Canada, and salamanders from the United States would presumably be able to survive if they were to arrive. The northernmost occurrence in Idaho is within the same drainage basin and 24 km from the nearest Canadian occurrence. Habitat suitability between these occurrences is unknown. Considering the species' poor dispersal ability, cross-border dispersal with sufficient frequency to establish a breeding population is unlikely.

THREATS AND LIMITING FACTORS

An assessment of threats and limiting factors was undertaken during the production of the Management Plan for Coeur d'Alene Salamander (*Plethodon idahoensis*) in Canada (ECCC 2017) and was used as the basis of a follow-up assessment conducted in winter 2020 for the development of this status report.

Threats

Coeur d'Alene Salamander is vulnerable to the cumulative effects of various threats, especially Climate change & severe weather, and Transportation & service corridors (Table 2). Threats were assessed following the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system (see Salafsky *et al*. 2008 for definitions and Master *et al*. 2012 for guidelines). The process consists of assessing impacts for each of 11 main categories of threats and their subcategories, based on the scope (proportion of population exposed to the threat over the next 10-year period), severity (predicted population decline within the scope during the next 10 years or 3 generations, whichever is longer), and timing of each threat. The overall threat impact is calculated by taking into account the separate impacts of all threat categories and can be adjusted by the species experts participating in the evaluation. The overall threat impact for Coeur d'Alene Salamander is considered to be "high to medium", corresponding to an anticipated decline of between 70% and 3% over the next three generation period; the suspected decline is probably closer to the lower end of the range. The wide range reflects lack of data and resulting uncertainties associated with many of the assigned scores.

Table 2. Threat classification table for Coeur d'Alene Salamander in Canada.

THREATS ASSESSMENT WORKSHEET				
Species or Ecosystem Scientific Name	*Plethodon idahoensis* (Coeur d'Alene Salamander)			
Element ID			**Elcode**	
Date:	2020-01-20			
Assessor(s):	Kristiina Ovaska, Tom Herman, Rosana Soares, Conan Webb, Christopher Edge, Sara Ashpole, Nicholas Cairns, Lea Gelling, Jared Maida, Stephen Ben, Lindsay Anderson, Karen Stefanyk			
References:	COSEWIC draft status report (Nov 2019); Management Plan (ECCC 2017)			
Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	2	0
	D	Low	4	6
Calculated Overall Threat Impact:			High	Medium
Assigned Overall Threat Impact:			**BC = High - Medium**	
Impact Adjustment Reasons:				
Overall Threat Comments			Generation time: 5-7 years (3 generations: 15-21 years); EOO: 35,843 km² IAO: 212 km².	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	
3.1	Oil & gas drilling						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.2	Mining & quarrying	D	Low	Small (1-10%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Hard rock operations: Bedrock and talus retreats could be blasted destroying habitat and individuals. Extraction of gravel for road building or re-activation of previous such sites could disturb habitat and kill salamanders during operation of machinery. Placer mining operations: Spoils piled at the site could alter habitat structure and bury salamanders. Scope: Some mining exploration occurred historically in the Creston area, and a small exploration cave with seepage now provides Coeur d'Alene Salamander habitat. The group was not aware of any plans for mining, but this is possible in the future. The area affected is deemed small. Severity: Population level impacts depend on the size of the disturbed area, type of operation, and opportunity to recolonize from surrounding areas.
3.3	Renewable energy						Micro-hydro developments considered under threat 7.2
4	Transportation & service corridors	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	
4.1	Roads & railroads	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	Includes construction of new roads, roadkill on existing roads, and road maintenance activities. Intensely disruptive activities, including rock-scaling, ditch-cleaning, culvert repair and replacement, road widening, and blasting, are associated with transportation construction and maintenance. All of these will directly kill Coeur d'Alene Salamanders and/or disrupt their habitat. Rock scaling and other maintenance activities for public safety are likely at all sites where Coeur d'Alene Salamanders and roads intersect (see 9, Pollution, for salt application). Rip-rapping or armoring stream banks to control erosion around bridges and culverts could negatively affect the species' ability to enter underground retreats, but could also enhance habitat complexity for salamanders. Scope: ~60% of known occurrences are within 30 m of a highway or road, many occurrences are near roads at intersection with streams (Ohanjanian 2002a). However, safety and access issues have created a strong bias towards surveying near HWYs. Severity: Substantial proportion of the salamanders inhabiting intersection of streams and seepages with roads could be at risk of roadkill, especially on mild wet nights when they tend to linger on roads. Additional source occurrences up or downstream from problem sites may provide recolonization within 3 generations (estimated 20 years), but there is no documentation.
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						Illegal collecting for the pet trade is theoretically possible, but it is unknown whether this occurs in British Columbia. There is no evidence that this species is sought after by collectors; therefore, this category was not scored.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	Logging and wood harvesting alter habitat and may also result in direct mortality during operations. Ephemeral streams and rocky seepages may go unnoticed during logging, and crucial subsurface water may be diverted by blasting, leading to desiccation of downslope habitats. Heavy equipment may cause direct mortality of salamanders and soil compaction, decreasing habitat quality (Moorman *et al*. 2011). Slumping and soil compaction can clog interstitial spaces thus smothering and/or preventing movement of salamanders. The species depends on moist substrates and high humidity, which makes it vulnerable to tree canopy opening that increases temperatures and altered moisture regimes on the forest floor. Scope: The species occurs within Arrow Boundary, Kootenay Lake, and Columbia Forest Districts and has recently been found in Okanagan-Shuswap Forest District (Ireland 2009). Logging has been and will continue to be discontinuous in both time and space, and numerous tree farm licences are in effect and under application. Any fish-bearing creeks are to receive best management practices under *Forest and Range Practices Act* (FRPA; Province of British Columbia 2002), but small non–fish-bearing streams remain vulnerable. Most known salamander sites are in parks or within Wildlife Habitat Areas (WHA), where logging activities are modified to protect them (Province of British Columbia 2004). 40 of 65 occurrences have some protection (31 by WHAs, 9 by parks, 1 by Wildlife Compensation Program, as of 2019). However, the protection by WHAs applies only to known sites; sites within occupied streams outside these areas remain vulnerable. Scope was scored as small based on the possibility of occurrences outside protected areas being subjected to logging over the next 10 years. Severity: *P. idahoensis* is listed under section 7 of the FRPA and is designated an Identified Wildlife species subject to management guidelines. Forest Stewardship Plans exist for portions of the range and include protection measures for this species (Canfor 2018; BC Timber Sales 2017-2022). Logging is prohibited within WHA core area, but selective logging is permitted within the surrounding management zone. Given the mitigation measures afforded to the species within WHAs and requirements to report occurrences outside these areas in the Forest Stewardship Plans prior to harvesting, the severity is considered slight. There is uncertainty how effective the mitigation measures are and how diligently they will be applied by the various forestry companies operating in the area; hence residual population effects remain.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Disturbance can occur at recreational sites at the base of waterfalls, where trail modification and trampling of vegetation alter habitat and remove cover. Piling of rocks and construction of inukshuks can also cause habitat disturbance. Scope: Because much of the habitat is on steep terrain, direct disturbance from human activities is limited. Severity: Due to the salamander's nocturnal habits, crushing of individuals from human traffic is unlikely but may occur occasionally, especially if the activities involve rock climbing. Habitat disturbance also contributes to the score.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Work-related activities, such as surveying of riparian areas, staking mining claims, or other land surveys, have the potential to crush salamanders. However, because of the species' nocturnal habits, this is highly unlikely.
7	Natural system modifications	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	Wildfires and controlled burns may have a negative effect on habitat, especially if they result in reduction of coarse woody debris used for refuges by salamanders. Direct mortality is unlikely unless the burn is deep, because the salamanders can retreat to deep rock retreats; they are not at the surface during the prescribed burning window in winter. Removal of vegetation during a burn can result in increased erosion which could bury and infill bedrock refuges. Scope: A mixed fire-regime existed historically through the Coeur d'Alene Salamander range (Chavardès 2019; Davis *et al*. 2018; Klenner *et al*. 2008). Drought is strongly related to fire probability, and the length and severity of drought is expected to increase under climate chance scenarios leading to increased frequency and severity of fire (Chavardès 2019; Davis *et al*. 2018; Wang *et al*. 2016). Further, due to fire suppression over the last century there has been a change in forest structure leading to increase in canopy closure and ladder fuels and increased fire severity is expected (Chavardès 2019). Changes in forest structure and severity of drought may cause areas historically protected in wetter gullies to be vulnerable during more severe summer droughts. Severity: Population effects are expected because a fire could modify habitat over relatively large areas, but their severity is uncertain. Occasionally, a massive wildfire could occur, which would modify the natural system for some time and eliminate the species at that site.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.2	Dams & water management/use	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	Impact is mostly from micro-hydroelectric development. Diverting water from the stream, water levels are lowered, thus potentially leading to desiccation of interstitial spaces and seep habitats. Riparian vegetation and cover are removed during the construction phase resulting in habitat loss. During the operational phase, salamanders can be flushed into turbines. Large dams have had past impacts on habitat. Alteration of stream flow by small dams or diversions for rural domestic water supply may drown salamanders in interstitial spaces that get flooded. Alternatively, salamander habitat downstream of such diversions could dry out, leading to habitat loss (Cassirer *et al.* 1994). Because of this species' affinity for steep terrain, a potential threat exists from tourism and recreational development, if water is diverted to make snow on ski hills. Scope: Nearly half of the 572 streams that have been identified as having the potential for small micro hydro development (<5 MW) are located within the species' range (BC Hydro 2000). Within the range of the Coeur d'Alene Salamander 7 run-of-river projects have been developed since 2001, none known to harbour Coeur d'Alene Salamanders. Development of future projects is on hold as BC Hydro's standing offer program has been suspended indefinitely since 2018 (BC Hydro website 2020) Small dams or stream diversions are likely in some areas of the Kootenay region, but the group did not know of any plans at or near salamander occurrences. Diversion of water for ski hills is possible but would be a highly localized. Severity: Continuous, long-term reduction of water flow over a given reach from micro-hydro developments could lead to drying of the riparian habitat used by the salamanders and reduced abundance at the site. Uninterrupted lowered flows could prevent recolonization.
7.3	Other ecosystem modifications						No significant ecosystem modifications are known to be implemented in the steep, remote, terrain occupied by the species. Rip-rapping is considered in section 4.1 as part of road maintenance.
8	Invasive & other problematic species & genes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species/diseases		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	As for other amphibians, chytridiomycosis is a potential threat but has not been reported in Coeur d'Alene Salamanders. Although the species lacks an aquatic stage, these salamanders forage in small pools where they could, in theory, pick up *Batrachochytrium dendrobatidis* spores.
8.2	Problematic native species/diseases						
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.6	Diseases of unknown cause						
9	Pollution		Unknown	Large - Restricted (11-70%)	Unknown	High (Continuing)	
9.1	Domestic & urban waste water						
9.2	Industrial & military effluents		Unknown	Large - Restricted (11-70%)	Unknown	High (Continuing)	In winter, salt (or other chemical de-icers) is regularly applied on all major routes. Increased salinity of ponds from road salt application can alter embryonic development of amphibians (e.g., Spotted Salamander, *Ambystoma maculatum*) and acute toxicity from de-icers has been shown in experiments with Wood Frogs (*Lithobates sylvatica*) (Turtle 2000; Harless *et al*. 2009). Coeur d'Alene Salamanders could be affected through run-off from roads that enters occupied streams and interstitial spaces among talus where the salamanders shelter. Increased salinity could also negatively affect their aquatic prey base. Additional pollutants include application of magnesium chloride (MgCl) to desiccate gravel road surfaces for dust abatement during road maintenance. Impacts have been documented for other amphibians (e.g., metamorphs of Long-toed Salamander, *Ambystoma macrodactylum*, leaving a breeding pond died by the thousands trying to cross a recently treated road in the Cariboo region; Packham pers. comm. 2019). This is an emerging threat that is becoming more widespread and requires research. Scope: Scope was set to mirror road density and scope for threat 4.1. Severity: There is no information on exposure and potential effects of pollutant run-off from roads to damage this species; therefore, it was scored as unknown.
9.3	Agricultural & forestry effluents		Unknown	Unknown	Unknown	High (Continuing)	While direct effect of herbicide application on Coeur d'Alene Salamanders has not been studied, they respire through highly permeable skin and theoretically could be vulnerable. In silviculture, herbicides are commonly used to reduce competition from deciduous species and promote growth and release of young conifers (Lautenschlager and Sullivan 2002). Most frequently the herbicide of choice is one of the commercial formulations with glyphosate as the active ingredient. Studies have shown that one formulation (Roundup Regular) is lethal to both larval and juvenile anurans (Relyea 2005; King and Wagner 2010). Current evidence suggests that it is the surfactant used in some formulations of glyphosate that causes the negative impacts on amphibians. More research, however, is needed to establish ecosystem levels of toxicity of this and other formulations. Other compounds with potential toxic effects are not widely used in the species' range.
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10	Geological events	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	More frequent and severe storms predicted to occur as a result of climate change, together with road building and resource extraction, are expected to increase the occurrence of landslides over the next 10-year period. Because of the Coeur d'Alene Salamander's affinity for steep terrain, disturbance by debris flow is an ongoing potential threat in much of its range. Some areas are naturally prone, others are made worse by industrial activity or road building (see Threat 5, Biological Resource Use). Landslides that have a high proportion of very fine-grained materials may prevent reoccupation of a site for many years as rocky retreats become covered. Over the long term, landslides can create habitat. Scope was considered small taking into account the proportion of sites that might be affected by landslides within the next 10-year period. Severity depends on the area of habitat affected, size of the landslide, and site-specific considerations, which generate much uncertainty. However, average impact for the entire population was deemed slight.
11	Climate change & severe weather	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	Climate change is not expected to cause a pervasive transformation in the next 10 years. However, because change happens incrementally over time, its impacts will become significant over the long term. In drier areas, such as near Creston, the consequences may appear sooner than in wetter areas, such as near Revelstoke. Subpopulations along ephemeral or low-flow watercourses will be more at risk. Price and Daust (2016) evaluated climate sensitivity of 63 species of BC vertebrates; Coeur d'Alene Salamander, together with Great Basin Spadefoot, were the only amphibians with a "High" climate change sensitivity rating. A separate analysis using IUCN Climate Change Vulnerability Index resulted in a score of "Extremely vulnerable" (Ashtarieh *et al*. 2020).
11.1	Habitat shifting & alteration	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	Habitat shifts are expected from increased droughts and the drying of seepages and small streams. Modelling by Milanovich *et al*. (2010) suggests that plethodontid salamanders currently distributed at mid- and high elevations would be restricted to only up-slope dispersal due to their inability to move through warmer valley bottoms. As a result, southern populations are at higher risk from a complete loss of their climatic niche (with no climatic "bridge" to enable migration to suitable habitat) and from shrinking of their habitat (with associated effects on population size and genetic diversity). See 11.2 Droughts, below, for notes on scope and severity.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	Impacts are predicted to begin in the 2020s with increasing severity through the 2080s. Predictions at Coeur d'Alene Salamander sites include reduced precipitation as snow and warmer winters (leading to reduced snowpack), and reduced summer rainfall (leading to a decrease in late spring and/or summer water flows and length of dry season) (Wang *et al*. 2016). Drying of subterranean refuges in summer may result in the loss of sites where minimum moisture thresholds are no longer met, and survivorship is reduced. Lungless salamanders are particularly sensitive to desiccation. Scope: Low-flow streams and sites in drier portions of the range are most at risk. However, without further knowledge of surface and sub-surface water flow, stream source, and the extent of bedrock refuges, it is impossible to predict which specific sites may be lost. Severity: A range of scores was used to reflect uncertainty in the population level effects of increased summer droughts.
11.3	Temperature extremes	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Predictions include an increase in temperature and in frost free days within the range of this species (Wang *et al*. 2016; PCIC 2019), resulting in large scope. While warmer winters may extend the activity season, cold-adapted montane plethodontids studied in eastern North America appeared to already live at or near the limit of their physiological tolerances and showed dramatic metabolic depression when they experienced higher temperatures (Bernardo and Spotila 2006). These concerns likely apply to the Coeur d'Alene Salamander, and models are consistent for warmer temperatures across all seasons in the species' range in southern B.C. (Wang *et al.* 2016; PCIC 2019). The salamanders' ability to take refuge in subterranean retreats provides some resilience in the face of increased summer temperatures; however, the species' long-term ability to handle chronically higher temperatures is unknown. While the distribution of this species extends southward to the US, the entire range is in northern areas, and the species is cold-adapted.
11.4	Storms & flooding	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Extreme weather events may cause drowning of salamanders or their eggs due to flooding of interstitial refuges. The frequency and severity of storms is expected to increase with warmer wetter winters, faster spring melt, and higher intensity storm patterns brought about by warmer air masses.
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

<u>IUCN-CMP Threat 11. Climate change & severe weather (threat impact: medium to low)</u>

The threat of climate change is pervasive throughout the range of Coeur d'Alene Salamander. The ability of Coeur d'Alene Salamander to respond to anticipated changes is uncertain: possible responses include alteration of movements, behavioural changes, and physiological adaptation. Plethodontids may be at increased risk as ectotherms with a relatively limited ability to move and dependence on cool, moist conditions.

Climate modelling indicates that the climate in British Columbia will be characterized by wetter winters, drier summers, and higher temperatures overall (Spittlehouse 2008; Pojar 2010; PCIC 2019). Climate modelling based on Wang *et al.* (2016) predicts similar trends across Coeur d'Alene Salamander's Canadian range. In line with Milanovich *et al.* (2010), seasonal predictions at Coeur d'Alene Salamander occurrences in Canada show effects of climate change from the 2020s onward, with increasing severity through the 2080s (Wang *et al.* 2016; PCIC 2019; Appendix 1). Expected effects include less precipitation falling as snow but more as rain, and higher winter temperatures (leading to reduced snowpack) and reduced summer rainfall (leading to a decrease in late spring and/or summer water flows), an increase in temperature and length of dry season, and an increase in frost-free days (Wang *et al.* 2016; PCIC 2019). Overall, the effects of these changes are unknown, but expected to be detrimental to the salamanders.

Habitats are likely to shift both northward and higher in elevation, and it is unknown to what extent Coeur d'Alene Salamanders will be able to track these changes. Modelling by Milanovich *et al.* (2010) suggests that plethodontid salamander species that are currently distributed at mid- and high elevations (such as Coeur d'Alene Salamanders) may be restricted to upslope areas due to inability to disperse through warmer valley bottoms. Such restrictions place more southern occurrences at greater risk from reduced habitat area (with associated effects on population size and genetic diversity) or a complete loss of their climatic zone (with no climatic "bridge" to enable migration to suitable habitat).

Increased drought and drying of streams and/or subterranean refuges may result in the loss of occurrences where the habitat becomes too dry. In drier areas, such as near Creston, the consequences of climate change may appear sooner than in wetter areas, such as near Revelstoke. Coeur d'Alene Salamander occurrences along ephemeral and low-flow watercourses will be more at risk to changes in hydrology than occurrences in watercourses with more flow.

Temperature extremes may also affect the species. Bernardo and Spotila (2005) found that cold-adapted montane plethodontids appeared to already live at, or near, the limit of their physiological tolerances and showed dramatic metabolic depression when they experienced higher temperatures. The distribution of Coeur d'Alene Salamander extends southward into the United States, but the entire range is in northern areas, and the species is cold-adapted. The species' ability to take refuge in subterranean retreats will provide some resilience in the face of increased summer temperatures; however, the species' long-term ability to cope with consistently higher temperatures is uncertain.

Extreme weather events may cause drowning of salamanders or their eggs due to flooding of interstitial refuges. The frequency and severity of storms is expected to increase with warmer, wetter winters, faster spring melt, and higher intensity storm patterns brought about by warmer air masses.

Price and Daust (2016) evaluated the climate sensitivity of 63 species of BC vertebrates. Coeur d'Alene Salamander and Great Basin Spadefoot (*Spea intermontana*) were the only amphibians with a “High” climate change sensitivity rating. Using a different analysis, a group of University of Toronto Master class students applied the IUCN/NatureServe climate vulnerability index to Coeur d’Alene Salamander in Canada (Ashtarieh *et al*. 2020). This analysis incorporates three components related to climate change: A. direct exposure, B. indirect exposure, and C. sensitivity and adaptive capacity. The analysis for this species resulted in the ranking of “Extremely Vulnerable”, the highest category. All of the Canadian range of the species was calculated to be exposed to a 2.54-2.84ºC increase in temperature and a 47.13% moisture deficit (in total), by 2050 (component A). Important contributors to indirect exposure included natural and anthropogenic barriers (component B), and those to sensitivity and adaptive capability included limited dispersal and movement ability, physiological thermal and hydrological niches occupied by the salamanders, and disturbance to and features of their physical habitat (component C).

IUCN-CMP Threat 4. Transportation & service corridors (threat impact: medium to low)

Coeur d’Alene Salamander has been found clinging to rock walls and venturing onto roads and their shoulders on rainy nights along highway and secondary road corridors throughout their range in British Columbia (Ohanjanian 2003a; Gunson and Larson 2012; Parks Canada Agency 2013). The salamanders are subject to road mortality where occupied streams or seepages intersect roads, as well as to disturbance from road maintenance and construction activities, such as rock scaling, ditch cleaning, culvert repair and replacement, road widening, and blasting. Armouring stream banks with large rocks to control erosion around bridges and culverts could negatively affect the species’ ability to enter underground retreats; conversely, this could enhance habitat complexity for salamanders and provide opportunities for cover while they are on the surface.

Approximately 60% of all known occurrences are within 30 m of a road. However, safety and access issues have created a strong bias towards surveying near roads. Coeur d’Alene Salamander has been found at multiple points on watercourses (Ohanjanian 2001a, 2003a; Larson 2009), and additional occurrences may exist up- or downstream of roads and would provide sources for recolonization, somewhat mitigating road impacts.

IUCN-CMP Threat 7. Natural system modifications (threat impact: low)

Threats accrue from impacts of fire, fire suppression, dams, and water management/use. Prescribed and natural burns may remove wooden cover objects along occupied watercourses and could modify habitat over relatively large areas. A massive wildfire could occasionally extirpate a salamander occurrence. Direct mortality is unlikely because the salamanders can retreat to deep rock retreats and spend relatively little time on the surface. However, removal of vegetation during a burn can result in increased erosion, which could bury and infill bedrock refuges. Occasionally a massive, intense wildfire could occur and modify the natural system for some time, eliminating the species from a patch of habitat. The degree to which fire suppression has increased fuel loads and thus the probability and intensity of wildfires is unknown, but it is likely that some massive wildfires would be directly attributable to human activities.

A mixed fire regime existed historically through Coeur d’Alene Salamander’s range (Klenner *et al*. 2008; Davis *et al.* 2018; Chavardès 2019). Fire is strongly related to drought probability, and the length and severity of drought at Coeur d'Alene Salamander occurrences is expected to increase under climate chance scenarios, leading to increased frequency and severity of fire (Wang *et al.* 2016; Davis *et al.* 2018; Chavardès 2019). Furthermore, increased fire severity is expected due to fire suppression over the last century and an increase in canopy closure and “ladder” fuels (Chavardès 2019). Changes in forest structure and severity of drought may cause historically protected wetter gullies to be vulnerable to fire during more severe summer droughts.

One hundred sixty sites on streams within the Coeur d’Alene Salamander range have been identified as having potential for run-of-river hydroelectric projects to generate power (B.C. Hydro 2000). Twelve potential sites are less than 3 km from known occurrences or near watercourses known to support the species. These projects alter the hydrology by diverting water from the stream and water levels may be lowered, which could lead to desiccation of interstitial spaces and seep habitats. Riparian vegetation and cover can be removed during the construction phase resulting in habitat loss. Salamanders can be flushed into turbines during the operational phase. Further, diminished water flows may also reduce prey items such as aquatic insects. Since 2001, seven run-of-river hydro projects have been developed within the Coeur d’Alene Salamander’s range, none within 10 km of known occurrences (B.C. Hydro 2020). There is currently a moratorium on new applications for the development of run-of-river projects (since August 2018); B.C. Hydro has submitted (March 2019) an application to lift the moratorium (B.C. Hydro 2020). The presence of Coeur d’Alene Salamander has been a major factor in denying approval for at least one run-of-river project (T. Antifeau pers. comm. 2014, cited *in* ECCC 2017). Large dams near Duncan, Revelstoke, and Kimberley likely have negatively affected Coeur d’Alene Salamander habitat in the past, but these are not expected to have ongoing effects.

<u>IUCN-CMP Threat 3. Energy production & mining (threat impact: low)</u>

Hard rock operations could negatively affect Coeur d’Alene Salamanders if their bedrock and talus retreats are destroyed. Although bedrock is not generally disturbed in placer mining operations, spoils could be piled, and this overburden could not only alter habitat structure but also bury salamanders. Extraction of gravel for road building (new sites or reactivation of previous sites) could disturb habitat and kill salamanders during operation of machinery.

Some mining exploration occurred historically in the Creston area, and a small exploration cave with seepage now provides Coeur d’Alene Salamander habitat. There are no known plans for mining near Coeur d’Alene Salamander occurrences, but it remains a possibility in the future. Population level impacts depend on the size of the disturbed area, type of operation, and potential of recolonization from surrounding areas. Recolonization from either above or below on a given watercourse would likely occur over a period of 20 years (or approximately 3 generations) where habitat is continuous and disturbance is relatively small.

IUCN-CMP Threat 5. Biological resource use (threat impact: low)

The impact is primarily due to logging. In addition to the potential of direct mortality during harvesting operations, logging activities modify habitat. Ephemeral streams and rock seepages may go unnoticed, and road building and crucial subsurface water may be diverted by blasting, leading to desiccation of downslope habitats. Any alteration of hydrology in the watershed around streams can affect downstream water quantity or quality. Heavy equipment may cause substrate compaction and direct mortality of salamanders (Moorman *et al.* 2011). Slumping and soil compaction can clog interstitial spaces thus smothering and/or preventing movement of salamanders. The species is vulnerable to vegetation removal that results in higher temperatures and drier moisture regimes as more sunlight reaches the forest floor.

Numerous tree farm licences are in effect and under application within the species' range, and logging has a cumulative impact on the landscape over decades (Appendix 3). Forty percent of occurrences (17 of 42) are currently within 1 km of current or pending harvest authorities (legal areas cleared by the Ministry of Forests, Lands, and Natural Resource Operations and Rural Development for harvesting purposes), nine of those are designated Wildlife Habitat Areas (WHAs), two are partially designated as WHAs, and one is in a national park (analysis performed using Forest Tenure Harvesting Authority Polygons; Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Forest Tenures). Since 1981, 29 occurrences have been within 1 km of cut blocks, and an average of 38% (16 occurrences) per decade have been within 1 km of cut blocks, using a 1 km buffer around occurrences (the number of point occurrences actually within cut blocks is less). In addition, upstream logging may affect water quality and erosion, and 64% (27 occurrences) have cut blocks within their upstream watershed.

Any creeks bearing fish in B.C. are to receive best management practices under the *Forest and Range Practices Act* (FRPA), but small streams without fish are more vulnerable. Most known salamander occurrences are in parks or within WHAs, where logging activities are modified to protect Coeur d'Alene Salamanders (B.C. 2004). Approximately one third of occurrences (27 of 42) have some form of provincial or federal protection (as of 2020, 21 by WHAs, six by national parks, and one additional site has some protection by a Wildlife Compensation Program). However, because of incomplete knowledge of the species' distribution, occurrences outside of these areas remain vulnerable. Coeur d'Alene Salamander is listed under section 7 of the FRPA as an Identified Wildlife species subject to management guidelines. Forest Stewardship Plans exist for portions of the range and include protection measures for this species (Canfor 2018; B.C. Timber Sales 2020). Logging is prohibited within WHA core area, but selective logging is permitted within the surrounding management zone. There is uncertainty as to how effective the mitigation measures are and how diligently they are applied by the various forestry companies operating in the area; hence, residual population effects remain. Furthermore, an interaction with climate change is expected as large portions of the northern range are within designated harvest authorities, and climate change may increase the importance of northern habitat for survival as suitable habitat may be lost in southern portions of the Canadian range (Appendix 3).

IUCN-CMP Threat 10. Geological events (threat impact: low)

Climate change is predicted to bring more frequent and severe storms and, together with road building and resource extraction, storm activity is expected to increase the occurrence of landslides. Disturbance by debris flows is an ongoing possibility over much of Coeur d'Alene Salamander's range because of the salamanders' affinity for steep terrain. Some areas are naturally prone to landslides, while others are made unstable by industrial activity or road building (see Threat 5, Biological Resource Use). Landslides with a high proportion of very fine-grained materials may prevent reoccupation of habitat for many years as rocky retreats become covered. Landslides can create habitat over the long term. The severity of this threat depends on the area of habitat affected, size of the landslide, and site-specific considerations, which generate much uncertainty.

IUCN-CMP Threat 8. Invasive & other problematic species & genes (threat impact: unknown)

Chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis* (Bd), has been responsible for frog declines around the world (Olson *et al.* 2013). Bd was detected in only 0.2% of samples across 12 *Plethodon* species along a 752 km transect in the eastern United States where Bd is known to occur (Muletz *et al.* 2014). A second fungus, *Batrachochytrium salamandrivorans* sp. nov., is responsible for declines of Fire Salamander (*Salamandra salamandra*) in the Netherlands, causing erosive skin disease and rapid mortality (Martel *et al.* 2013). To date, it has not been detected in North America, but its import and spread are of concern to native salamanders.

Coeur d'Alene Salamander forages along streams and small pools where it could, in theory, pick up fungal spores even though it lacks an aquatic larval stage. Eastern Red-backed Salamanders (*Plethodon cinereus*) have bacteria on their skin that produce antifungal metabolites that inhibit Bd (Loudon *et al.* 2014). There are no records of Bd in Coeur d'Alene Salamander, and whether it has similar inhibitors is unknown.

IUCN-CMP Threat 9. Pollution (threat impact: unknown)

Plethodontid salamanders respire through their highly permeable skin and are vulnerable to pollution. In silviculture, herbicides are commonly used to reduce competition from deciduous species and promote growth and release of young conifers (Lautenschlager and Sullivan 2002). Salt (or other chemical de-icers) is regularly applied on all major routes in winter and can be detrimental to amphibians (Turtle 2000; Harless *et al.* 2009). Additional pollutants for consideration include application of magnesium chloride (MgCl) to desiccate gravel road surfaces for dust abatement during road maintenance (Packham pers. comm. 2019).

Limiting Factors

Moist microenvironments required by the species are naturally disjunct, and the physiology of Coeur d'Alene Salamander limits dispersal between suitable habitat patches. Both prolonged wet weather and the presence of adequate cover (i.e., subterranean retreats and/or cover objects on the surface) are required for successful dispersal. In the seasonally drier southern portions of the species' range in British Columbia where the mean summer precipitation is < 200 mm (Braumandl and Curran 1992; ECCC 2020), conditions that typify the landscape between suitable microhabitats limit opportunities for genetic exchange. In the northern portions of the species' range, for example in the Revelstoke area, opportunities for dispersal, colonization of new habitats, and genetic exchange are greater because mean precipitation is higher (up to 400 mm) in summer (Braumandl and Curran 1992; ECCC 2020). Although data are lacking, the degree of risk from isolation of habitat patches may be less significant in the north compared to the south of the species' Canadian range.

Reproductive attributes of the species (i.e., age of first reproduction, clutch size, and alternate breeding years) limit Coeur d'Alene Salamander's overall reproductive capacity and ability for occurrences to recover in response to disturbances and stochastic events.

Number of Threat-based Locations

Climate change and severe weather, including prolonged droughts and drying of foraging habitats and shelter sites, was assessed as the greatest threat facing Coeur d'Alene Salamander over the next 10-year period and beyond. Although climate patterns simultaneously affect large areas, effects on salamanders probably depend on drainage patterns, availability of below-ground refuges, and overall habitat quality at a finer spatial scale. Therefore, the areas where salamanders may be affected within a relatively short period by a single threatening event are difficult to quantify. If major watersheds where the species occurs are each considered a threat location, there would be 7 locations. A more likely scenario, given habitat heterogeneity, is that each major watershed consists of multiple threat locations.

If each occupied stream or group of sites is considered separately and affected similarly by climate changes, there may be as many as 65 threat locations, with some encompassing more than one site. For example, two Coeur d'Alene sites 200 m apart on a small side tributary would likely be similarly affected by reduced water flow and both may be extirpated before a site within the same occurrence 900 m downstream in the main drainage, which is fed by multiple tributaries. Of the 76 occupied sites (Table 1), those in close proximity (< 500 m to nearest neighbour), where no individual watercourses are identified in hydrographic data, were identified as a single location (e.g., southwest slope of Mt. Revelstoke).

A similar analysis for other potential threats, such as transportation corridors, mining and quarrying, and logging results in a similar upper number of threat locations. While some threats (e.g., crushing, blasting, and highway maintenance) are localized, all Coeur d'Alene Salamander occurrences downstream in the same watershed are at risk from other threats (e.g., water diversion, siltation, pollution, climate-related water flow reduction). Due to the potential for water flow to carry pollutants through several occurrences or to be reduced by diversion, damming, or altered climate, a single small stream (including minor tributaries) may be considered a threat location. In larger drainages where many small streams feed a larger watercourse, occurrences on the same major water course separated by several kilometres may be considered as separate locations.

In conclusion, the number of threat-based locations is uncertain but is most likely >10.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In Canada, Coeur d'Alene Salamander is listed as Special Concern under Schedule 1 (Part 4) of the *Species at Risk Act*. A Management Plan for Coeur d'Alene Salamander in Canada has been published (ECCC 2017). The management objectives are to clarify the distribution, to monitor (persistence, relative abundance, and age structure), and to initiate assessment and recovery actions if threats or declines are detected: trend monitoring and inventory are currently incomplete.

Individuals are protected under the British Columbia *Wildlife Act* and cannot be killed, collected, or held in captivity without permit. This act does not protect the species from habitat loss or destruction. Coeur d'Alene Salamander is designated an Identified Wildlife species in British Columbia associated with the provincial *Forest and Range Practices Act*. As such, resource extraction at WHAs for this species must follow guidelines laid out in the Species Account for Coeur d'Alene Salamander (B.C. 2004). General Wildlife Measures that apply within WHAs and other management areas governed by Government Actions Regulations seek to protect the population from physical disturbance and direct mortality, disruptions of natural flow regimes of watercourses, and removal of rock and stream crossings/road building that fail to control silt and sediments. Guidelines to protect Coeur d'Alene Salamander during highway maintenance activities have been developed and provided to the British Columbia Ministry of Environment (ECCC 2017).

Non-Legal Status and Ranks

The Global Rank of Coeur d'Alene Salamander is G4 (Apparently Secure; NatureServe 2019). The state ranks for the species in Idaho and Montana are S3 (Special Concern) and S2 (Imperilled), respectively (IDFG 2019; Montana Field Guide 2019; NatureServe 2019). The provincial rank in British Columbia is S4 (Apparently Secure; B.C. CDC 2016). The BC Conservation Data Centre changed the rank from S3 to S4 in 2008 based on potential occurrences in unsurveyed areas and the establishment of Wildlife

Habitat Areas to minimize logging impacts (B.C. CDC 2019b). However, it was acknowledged that the effectiveness of protection provided by Wildlife Habitat Areas has not been monitored.

Habitat Protection and Ownership

Of the 42 known occurrences, 27 have some form of provincial or federal protection, the remainder are on private land (5), unknown or mixed tenure land (5), or Crown land with no known protection (5), of which at least one has some non-government protection:

- 21 occurrences have been partially or fully designated WHAs under the *British Columbia Forest and Range Practices Act* (B.C. 2019).
- 1 occurrence is in Syringa Creek Provincial Park (Dulisse 1999).
- 5 occurrences are in Mount Revelstoke and Glacier National Parks (Larson 2009; Parks Canada Agency 2014).
- 1 occurrence (tenure unknown) is on property managed by the Columbia Basin Fish and Wildlife Compensation Program (COSEWIC 2007).

It should be noted that the presence of the species in a protected area does not necessarily protect it from all threats, such as those related to climate change.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Conan Webb has 18 years of experience as a field ecologist in species and ecosystems at risk stewardship and restoration projects in the Coastal Douglas-fir zone. In 2005, he graduated from the University of Victoria with B.Sc. in Biology (focusing on botany and plant ecology). He worked with Parks Canada for 13 years on species and ecosystem at risk restoration projects and on the production of two dozen recovery strategies for species at risk. As a consultant he continues to work with species and ecosystems at risk mapping rare element occurrences, providing assessments and recommendations on developments, and mentoring young people in nature connection activities.

COLLECTIONS EXAMINED

No specimens were examined, but the databases of the following persons and institutions were queried for records of Coeur d’Alene Salamander from British Columbia:

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Appendix 1: Climate Change Modelling.

The latitude and longitude of all Coeur d'Alene Salamander survey sites with detections in Canada were used with the climate model developed by Wang *et al.* (2016) to assess average expected seasonal changes (_wt=winter, _sp=spring, _sm=summer, _at=autumn) in temperature (Tave), precipitation (PPT), and snow pack (PAS) under various climate change scenarios (rcp26, rcp45, and rcp85). The averages below represent the average of 8 different climate models: CanESM2, 13GCM-Ensemble, 15GCM-Ensemble, ACCESS1-0, CCSM4, CESM1-CAM5, CNRM-CM5, and HadGEM2-ES. There is general agreement on overall trends across all models with differences in degree of predicted change.

Temperature average of 8 models under rcp26 scenario.

Period	Average of Tave_wt	Average of Tave_sp	Average of Tave_sm	Average of Tave_at
2025.0	-2.9 ºC	8.0 ºC	18.5 ºC	6.7 ºC
2055.0	-2.4 ºC	8.6 ºC	19.1 ºC	7.3 ºC
2085.0	-2.2 ºC	8.7 ºC	19.0 ºC	7.3 ºC

Precipitation average of 8 models under rcp26 scenario.

Period	Average of PPT_wt	Average of PPT_sp	Average of PPT_sm	Average of PPT_at
2025	368 mm	177 mm	154 mm	267 mm
2055	374 mm	183 mm	155 mm	274 mm
2085	371 mm	183 mm	162 mm	272 mm

Snowpack average of 8 models under rcp26 scenario.

Period	Average of PAS_wt	Average of PAS_sp	Average of PAS_sm	Average of PAS_at
2025	221 mm	16 mm	0 mm	48 mm
2055	204 mm	13 mm	0 mm	41 mm
2085	195 mm	11 mm	0 mm	39 mm

Temperature average of 8 models under rcp45 scenario.

Period	Average of Tave_wt	Average of Tave_sp	Average of Tave_sm	Average of Tave_at
2025	-3.1 ºC	7.9 ºC	18.6 ºC	6.9 ºC
2055	-1.9 ºC	9.1 ºC	19.9 ºC	7.9 ºC
2085	-1.2 ºC	9.8 ºC	20.8 ºC	8.6 ºC

Precipitation average of 8 models under rcp45 scenario.

Period	Average of PPT_wt	Average of PPT_sp	Average of PPT_sm	Average of PPT_at
2025	357 mm	172 mm	146 mm	252 mm
2055	361 mm	182 mm	142 mm	265 mm
2085	380 mm	187 mm	144 mm	272 mm

Snowpack average of 8 models under rcp45 scenario.

Period	Average of PAS_wt	Average of PAS_sp	Average of PAS_sm	Average of PAS_at
2025	218 mm	18 mm	0 mm	45 mm
2055	180 mm	10 mm	0 mm	35 mm
2085	167 mm	7 mm	0 mm	30 mm

Temperature average of 8 models under rcp85 scenario.

Period	Average of Tave_wt	Average of Tave_sp	Average of Tave_sm	Average of Tave_at
2025	-2.8 ºC	8.1 ºC	18.8 ºC	7.0 ºC
2055	-1.2 ºC	9.7 ºC	21.1 ºC	8.9 ºC
2085	0.9 ºC	11.6 ºC	24.0 ºC	10.9 ºC

Precipitation average of 8 models under rcp85 scenario.

Period	Average of PPT_wt	Average of PPT_sp	Average of PPT_sm	Average of PPT_at
2025	358 mm	175 mm	150 mm	256 mm
2055	373 mm	186 mm	141 mm	272 mm
2085	388 mm	192 mm	129 mm	286 mm

Snowpack average of 8 models under rcp85 scenario.

Period	Average of PAS_wt	Average of PAS_sp	Average of PAS_sm	Average of PAS_at
2025	210 mm	16 mm	0 mm	41 mm
2055	161 mm	8 mm	0 mm	28 mm
2085	100 mm	3 mm	0 mm	16 mm

Appendix 2: Survey data from studies targeting Coeur d'Alene Salamander in British Columbia.

Surveys have been assigned to numbered occurrences based on proximity (i.e., surveys within 1 km of each other are considered to be the same occurrence as per the default NatureServe occurrence separation guidelines). Occurrence numbers are assigned based on date of first observation and each occurrence may be divided into one or more sites when separate surveys were undertaken that did not encompass the entire occurrence. Only a subset of data has been included here for occurrence 8 due to the volume and variety of surveys. NR = data not recorded or reported in the sources available. - = no data available or could not be calculated due to missing data. * = report could not be obtained.

Occ.	Site	Reference	Obs. Date	Ad.	Juv.	Unk.	Tot.	Survey Min.	No./10 min	Survey Type
1	a	Ohanjanian 1997	1996-06-24	0	1	2	3	25	1.2	Site Search
1	b	Ohanjanian 1997	1996-06-24	1	2		3	12	2.5	Site Search
1	c	Ohanjanian 1997	1996-10-07	1	0		1	NR	-	Site Search
1	d	Ohanjanian 1997	1996-10-14	1	0		1	13	0.8	Site Search
1	e	Ohanjanian 2002	2001-08-23	1	0	0	1	NR	-	Site Search
2	a	Ohanjanian and Beaucher 2001	2001-10-12	1	0		1	40	0.3	Site Search
2	a	Ohanjanian 2000	1999-10-08	1	0	0	1	40	0.3	Site Search
2	a	Ohanjanian 2000	1999-10-07	1	0	0	1	40	0.3	Site Search
2	a	Ohanjanian 2000	1999-10-05	0	0	0	0	40	0.0	Site Search
2	a	Ohanjanian 2000	1999-09-25	1	0	0	1	40	0.3	Site Search
2	a	Ohanjanian 1998	1998-10-15	0	0		0	20	0.0	Site Search
2	a	Ohanjanian 1998	1998-10-02	5	2		7	20	3.5	Site Search
2	a	Ohanjanian 1998	1998-09-28	1	0		1	40	0.3	Site Search
2	a	Ohanjanian 1998	1998-09-28	1	0		1	40	0.3	Site Search
2	a	Ohanjanian 1997	1996-09-10	4	5		9	96	0.9	Site Search
2	b	Ohanjanian and Beaucher 2003	2003-11-10	6	2	4	12	60	2.0	Site Search
2	b	Ohanjanian and Beaucher 2003	2003-10-28	13	7	0	20	60	3.3	Site Search
2	b	Ohanjanian and Beaucher 2003	2003-10-19	16	3	0	19	60	3.2	Site Search
2	b	Ohanjanian and Beaucher 2003	2003-09-16	7	5	0	12	30	4.0	Site Search

Occ.	Site	Reference	Obs. Date	Ad.	Juv.	Unk.	Tot.	Survey Min.	No./10 min	Survey Type
2	b	WSI Project 2625 data sheet	2002-11-23	7	0	4	11	220	0.5	Site Search
2	b	WSI Project 2625 data sheet	2002-11-22	4	1	0	5	140	0.4	Site Search
2	b	WSI Project 2625 data sheet	2002-11-20	2	2	0	4	200	0.2	Site Search
2	b	WSI Project 2625 data sheet	2002-11-18	2	0	0	2	80	0.3	Site Search
2	b	WSI Project 2625 data sheet	2002-11-16	3	1	0	4	95	0.4	Site Search
2	b	WSI Project 2625 data sheet	2002-11-14	2	0	0	2	60	0.3	Site Search
2	b	WSI Project 2625 data sheet	2002-11-13	0	0	1	1	60	0.2	Site Search
2	b	WSI Project 2625 data sheet	2002-11-09	2	0	0	2	60	0.3	Site Search
2	b	WSI Project 2625 data sheet	2002-11-08	10	2	0	12	185	0.6	Site Search
2	b	WSI Project 2625 data sheet	2002-10-07	2	1	0	3	NR	-	Site Search
2	b	Ohanjanian and Beaucher 2001	2001-10-30	6	1		7	40	1.8	Site Search
2	b	Ohanjanian and Beaucher 2001	2001-10-27	3	0		3	40	0.8	Site Search
2	b	Ohanjanian and Beaucher 2001	2001-10-22	2	1		3	40	0.8	Site Search
2	b	Ohanjanian and Beaucher 2001	2001-10-12	5	2		7	40	1.8	Site Search
2	b	Ohanjanian and Beaucher 2001	2001-10-10	2	1		3	40	0.8	Site Search
2	b	Ohanjanian and Beaucher 2001	2001-06-14	1	1		2	40	0.5	Site Search
2	b	Ohanjanian and Beaucher 2001	2001-06-09	1	0		1	40	0.3	Site Search
2	b	Ohanjanian 2000	1999-10-25	1	1	0	2	40	0.5	Site Search
2	b	Ohanjanian 2000	1999-10-08	5	1	0	5	40	1.3	Site Search
2	b	Ohanjanian 2000	1999-10-07	5	1	0	6	40	1.5	Site Search
2	b	Ohanjanian 2000	1999-10-05	0	1	0	1	40	0.3	Site Search
2	b	Ohanjanian 2000	1999-09-25	5	0	0	5	40	1.3	Site Search
2	b	Ohanjanian 2000	1999-07-07	5	0	0	5	40	1.3	Site Search
2	b	Ohanjanian 1997	13-Oct-96	6	2		8	40	2.0	Site Search

Occ.	Site	Reference	Obs. Date	Ad.	Juv.	Unk.	Tot.	Survey Min.	No./10 min	Survey Type
2	b	Ohanjanian 1997	27-Jun-96	4	0		4	40	1.0	Site Search
2	c	Ohanjanian 2002	2001-08-23	3	0	0	3	NR	-	Site Search
3		Orchard 1991*	-	-	-	-	-	-	-	-
4	a	WSI Project 2625 data sheet	2002-11-19	13	5	0	18	720	0.3	Site Search
4	a	WSI Project 2625 data sheet	2002-11-12	1	0	0	1	NR	-	Site Search
4	a	Ohanjanian 2000	1999-10-11	8	1	0	9	20	4.5	Site Search
4	a	Ohanjanian 2000	1999-09-24	4	4	0	8	20	4.0	Site Search
4	a	Ohanjanian 1997	1996-09-15	1	4		5	20	2.5	Site Search
4	a	Ohanjanian 1997	1996-07-04	2	1		3	20	1.5	Site Search
4	a	Ohanjanian 1997	1996-06-25	6	3		9	20	4.5	Site Search
4	b	Ohanjanian 1997	1996-09-15	1	0		1	20	0.5	Site Search
4	b	Ohanjanian 1997	1996-07-04	0	0		0	40	0.0	Site Search
4	b	Ohanjanian 1997	1996-06-25	0	0		0	20	0.0	Site Search
4	c	Ohanjanian 1997	1996-06-25	1	0		1	8	1.3	Site Search
4	d	Ohanjanian 1997	1996-09-15	1	1		2	28	0.7	Site Search
4	d	Ohanjanian 1997	1996-07-04	1	0		1	48	0.2	Site Search
5	a	Ohanjanian 1997	1996-06-25	0	0	2	2	40	0.5	Site Search
5	b	Ohanjanian 1997	09-Sep-96	2	3		5	158	0.3	Site Search
6	a	Ohanjanian 1997	04-Jul-96	0	0		0	20	0.0	Site Search
6	a	Ohanjanian 1997	25-Jun-96	2	0		2	20	1.0	Site Search
6	b	Ohanjanian 2002	2001-06-27	3	0	0		NR	-	Site Search
7	a	Ohanjanian 1997	05-Oct-96	4	1		5	66	0.8	Site Search
7	b	Ohanjanian 1998	1998-09-20	1	0	0	1	28	0.4	Site Search
8		Ohanjanian 1997	20-Sep-96	11	1		12	>50		Site Search
9	a	Ohanjanian 1997	1996-10-14	1	0	0	1	20	0.5	Site Search
9	b	Ohanjanian 1998	1999-06-24	1	2	0	3	102	0.3	Site Search
9	b	Ohanjanian 1998	1998-09-26	2	0		2	62	0.3	Site Search
9	b	Ohanjanian 1998	1998-09-26	0	1		1	40	0.3	Site Search
9	c	Ohanjanian 2000	1999-06-24	0	1	0	1	20.4	0.5	Site Search

Occ.	Site	Reference	Obs. Date	Ad.	Juv.	Unk.	Tot.	Survey Min.	No./10 min	Survey Type
9	d	Ohanjanian and Beaucher 2003	2003-10-16	0	1	0	1	150	0.1	Site Search
9	e	Ohanjanian and Beaucher 2003	2003-10-16	3	0		3	40	0.8	Site Search
10		Ohanjanian 1998	1998-09-20	2	0	0	2	42	0.5	Site Search
11		Dulisse 1999*	-	-	-	-	-	-	-	-
12		Ohanjanian and Beaucher 2000	2000-09-06	1	0		1	14	0.7	Site Search
13		Ohanjanian and Beaucher 2000	2000-10-19	4	1		5	180	0.3	Site Search
14	a	Ohanjanian 2001a	2000-05-29	1	0	0	1	44	0.2	Site Search
14	b	Ohanjanian 2001a	2000-05-29	1	1	0	2	34	0.6	Site Search
14	c	Ohanjanian 2001a	2000-05-29	0	1	0	1	18	0.6	Site Search
14	d	Ohanjanian 2001a	2000-05-30	4	1	0	5	54	0.9	Site Search
15	a	Ohanjanian 2001a	2000-07-01	2	1	0	3	20	1.5	Site Search
15	a	Ohanjanian 2001a	2000-05-28	2	8	0	10	45	2.2	Site Search
15	b	Ohanjanian 2001a	2000-07-01	0	1	0	1	56	0.2	Site Search
15	c	Ohanjanian 2001a	2000-06-30	4	1	0	5	35	1.4	Site Search
15	d	Ohanjanian 2001a	2000-06-30	0	3	0	3	12	2.5	Site Search
16		Ohanjanian 2001a	2000-06-08	7	2	0	9	56	1.6	Site Search
17		Ohanjanian 2001a	2000-08-27	1	0	0	1	10	1.0	Site Search
18	a	Ohanjanian 2002	2001-08-24			4	4	10	4.0	Site Search
18	a	Ohanjanian 2002	2001-08-21			5	5	43	1.2	Site Search
18	a	Ohanjanian 2002	2001-08-20			20	20	40	5.0	Site Search
18	a	Dykstra 2004	2003	NR	NR	≥1	≥1	NR	-	Site Search
18	b	Larson 2009	2006	NR	NR		≥1	NR	-	Site Search
18	b	Dykstra 2004	2003	NR	NR	≥1	≥1	NR	-	Site Search
18	c	PCA 2014	NR			≥1	≥1	NR	-	Site Search
18	c	Larson 2009	2006	NR	NR	≥1	≥1	~25min ea.	11 of 12 surveys	Site Search
18	d	Larson 2009	2006	NR	NR		≥1	~25min ea.	1 of 2 surveys	Site Search
18	e	Larson 2009	2006	NR	NR		≥1	~25min ea.	5 of 6 surveys	Site Search

Occ.	Site	Reference	Obs. Date	Ad.	Juv.	Unk.	Tot.	Survey Min.	No./10 min	Survey Type
18	f	Larson 2009	2006	NR	NR		≥1	~25min ea.	6 of 6 surveys	Site Search
18	g	Larson 2009	2006	NR	NR		≥1	~25min ea.	5 of 6 surveys	Site Search
18	h	Larson 2009	2006	NR	NR		≥1	~25min ea.	6 of 6 surveys	Site Search
18	i	Larson 2009	2006	NR	NR		≥1	~25min ea.	6 of 6 surveys	Site Search
18	j	Larson 2009	2006	NR	NR		≥1	~25min ea.	12 of 13 surveys	Site Search
18	k	Larson 2009	2006	NR	NR		≥1	~25min ea.	4 of 7 surveys	Site Search
18	l	Larson and Rand 2018	2018-05-18			4	4	75	0.5	Site Search
18	l	Gunson and Larson 2012	2011-09-29	0	0	0	0	20	0.0	Road
18	l	Gunson and Larson 2012	2011-09-22	18	4	0	22	225	1.0	Road
18	l	Gunson and Larson 2012	2011-09-16	11	0	0	11	36	3.1	Road
18	l	Gunson and Larson 2012	2011-09-08	5	0	0	5	66	0.8	Road
18	l	Gunson and Larson 2012	2011-08-30	8	1	0	9	64	1.4	Road
18	l	Gunson and Larson 2012	2011-08-29	0	0	0	0	58	0.0	Road
18	l	Gunson and Larson 2012	2011-08-09	1	0	0	2	74	0.3	Road
18	l	Gunson and Larson 2012	2011-08-06	0	0	0	0	70	0.0	Road
18	l	Gunson and Larson 2012	2011-07-26	10	2	0	12	70	1.7	Road
18	l	Gunson and Larson 2012	2011-07-16	1	3	0	4	150	0.3	Road
18	l	Gunson and Larson 2012	2011-07-13	31	3	0	34	150	2.3	Road
18	m	Gunson and Larson 2012	2011-09-27	8	1	1	10	132	0.8	Road
18	m	Gunson and Larson 2012	2011-09-16	0	1	0	1	72	0.1	Road
18	m	Gunson and Larson 2012	2011-09-05	0	0	0	0	50	0.0	Road
18	m	Gunson and Larson 2012	2011-08-30	0	0	0	0	44	0.0	Road

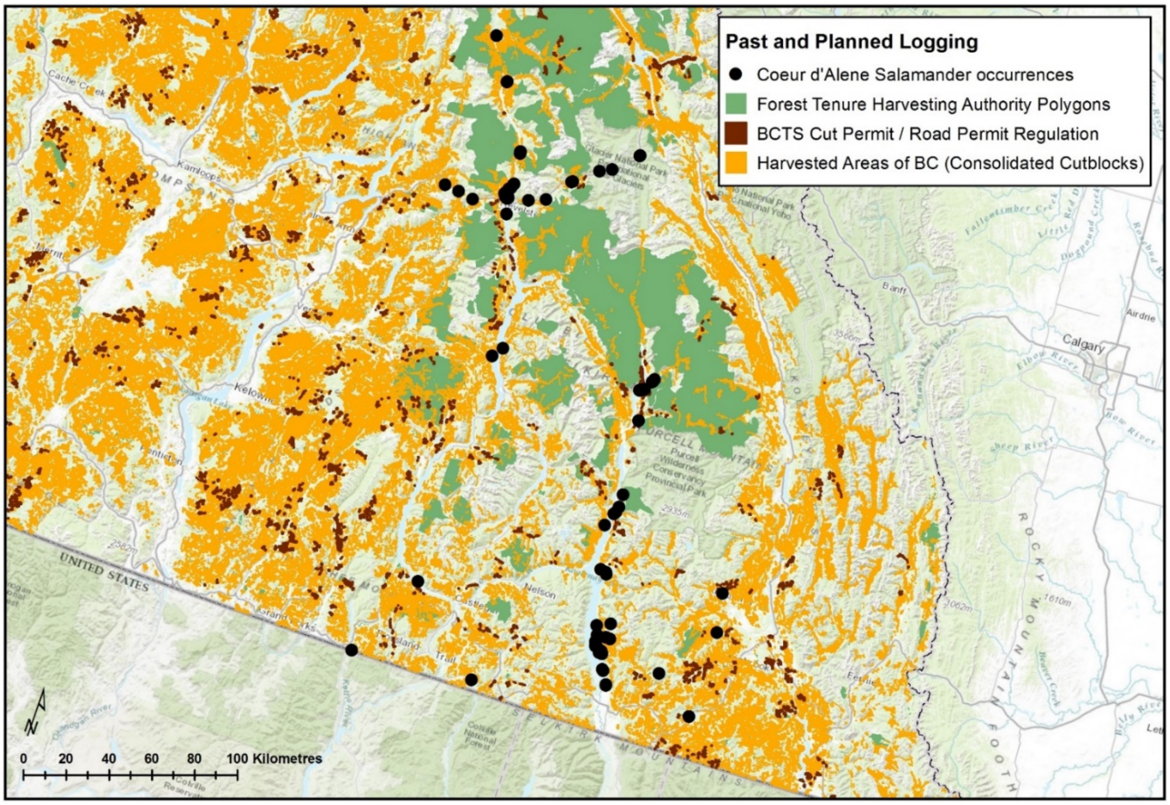
Occ.	Site	Reference	Obs. Date	Ad.	Juv.	Unk.	Tot.	Survey Min.	No./10 min	Survey Type
18	m	Gunson and Larson 2012	2011-08-19	0	0	0	0	60	0.0	Road
18	m	Gunson and Larson 2012	2011-08-10	0	0	0	0	84	0.0	Road
18	m	Gunson and Larson 2012	2011-07-29	0	0	0	0	82	0.0	Road
18	m	Gunson and Larson 2012	2011-07-21	2	0	0	2	63	0.3	Road
18	m	Gunson and Larson 2012	2011-07-21	6	4	0	10	63	1.6	Road
18	m	Gunson and Larson 2012	2011-07-21	3	0	0	3	90	0.3	Road
18	m	Larson 2009	2006	NR	NR	≥1	≥1	~25/survey	1 of 1 surveys	Site Search
18	m	Dykstra 2004	2003	NR	NR	≥1	≥1	-	-	Site Search
18	o	Parks Canada (2013)	2013-08-30			2	2	135	0.1	Road
18	o	Parks Canada (2013)	2013-08-29			43	43	180	2.4	Road
18	o	Parks Canada (2013)	2013-08-28			17	17	135	1.3	Road
18	o	Parks Canada (2013)	2013-08-23			38	38	140	2.7	Road
18	o	Parks Canada (2013)	2013-08-22			2	2	120	0.2	Road
18	o	Parks Canada (2013)	2013-08-18			1	1	75	0.1	Road
18	o	Parks Canada (2013)	2013-08-17			28	28	150	1.9	Road
18	o	Parks Canada (2013)	2013-08-15			57	57	165	3.5	Road
18	o	Parks Canada (2013)	2013-08-14			3	3	105	0.3	Road
18	o	Parks Canada (2013)	2013-08-06			1	1	90	0.1	Road
18	o	Parks Canada (2013)	2013-08-04			4	4	90	0.4	Road
18	o	Parks Canada (2013)	2013-08-02			3	3	120	0.3	Road
19	a	Ohanjanian 2002	2001-08-24			18	18	20	9.0	Site Search
19	a	Ohanjanian 2002	2001-08-21			3	3	9	3.3	Site Search
19	a	Ohanjanian 2002	2001-08-10			16	16	65	2.5	Site Search

Occ.	Site	Reference	Obs. Date	Ad.	Juv.	Unk.	Tot.	Survey Min.	No./10 min	Survey Type
19	a	Ohanjanian 2002	2001-07-18			1	1	25	0.4	Site Search
19	b	Ohanjanian 2002	2001-07-12			2	2	44	0.5	Site Search
19	c	Ohanjanian 2002	2001-07-18			2	2	19	1.1	Site Search
19	c	Ohanjanian 2002	2001-07-12			1	1	24	0.4	Site Search
19	d	Larson 2009	2006	NR	NR		≥1	~25/survey	1 of 1 surveys	Site Search
20	a	Ohanjanian 2002	2001-07-28			7	7	62	1.1	Site Search
20	b	Ohanjanian 2002	2001-08-23			3	3	70	0.4	Site Search
21	a	Ohanjanian 2002	2001-08-09			1	1	20	0.5	Site Search
21	b	Ohanjanian 2002	2001-08-09			8	8	55	1.5	Site Search
22		Ohanjanian 2002	2001-08-23			3	3	10	3.0	Site Search
22		Ohanjanian 2002	2001-08-09			27	27	50	5.4	Site Search
23		Ohanjanian and Beaucher 2001	2001-07-21	1	0	0	1	60	0.2	Site Search
24		Ohanjanian and Beaucher 2001	2001-07-17	1	0	0	1	120	0.1	Site Search
25		Ohanjanian 2003a	2002-09-30	0	1	0	1	216	0.0	Site Search
26		Ohanjanian 2003a	2002-09-17	11	2	0	13	68	1.9	Site Search
27		Ohanjanian 2003a	2002-08-26	2	0	0	2	30	0.7	Site Search
28		Ohanjanian 2003a	2002-09-05	1	0	0	1	35	0.3	Site Search
29		Ohanjanian and Beaucher 2003	2003-10-20	1	0		1	40	0.3	Site Search
29		Ohanjanian and Beaucher 2003	2003-10-17	0	1		1	80	0.1	Site Search
30		D'Eon and Larson 2007	2007-05-19	NR	NR	1	1	NR	-	Site Search
31		D'Eon and Larson 2007	2007-06-18	NR	NR	1	1	NR	-	Site Search
32		ECCC 2017	-	-	-	≥1	≥1	-	-	NR
33		Hawkes and Tuttle 2010	2009-05-05	2	0	0	2	NR	-	Site Search
34		Iredale 2009	2009-09-09	NR	NR	1	2	20	1.0	Site Search
35		Iredale 2009	2009-09-30	NR	NR	192	192	280	6.9	Site Search
35		Iredale 2009	2009-09-09	NR	NR	3	3	20	1.5	Site Search
36		Iredale 2009	2009-09-08	NR	NR	1	1	20	0.5	Site Search

Occ.	Site	Reference	Obs. Date	Ad.	Juv.	Unk.	Tot.	Survey Min.	No./10 min	Survey Type
37		PCA 2014	2011	NR	NR	≥1	≥1	NR	-	Site Search
37		PCA 2014	2011	NR	NR	≥1	≥1	NR	-	Site Search
38		PCA 2014	2011	NR	NR	≥1	≥1	NR	-	Site Search
39		PCA 2014	2011	NR	NR	≥1	≥1	NR	-	Site Search
40		PCA 2014	2011	NR	NR	≥27	≥27	NR	-	Site Search
41		PCA 2014	2011	NR	NR	≥1	≥1	NR	-	Site Search
41		PCA 2014	2011	NR	NR	≥3	≥3	NR	-	Site Search
42		PCA 2014	2011	NR	NR	≥1	≥1	NR	-	Site Search

Appendix 3: Distribution of logging activity in relation to Coeur d'Alene Salamander occurrences.

Extent of previous, current, and planned logging within Coeur d'Alene Salamander range. Harvested areas of BC indicating harvested cut block boundaries on crown land from 1900 to 2020[3], planned harvest blocks[4], and harvesting authority polygons (active and pending legal areas cleared by the Ministry of Forests, Lands, and Natural Resource Operations and Rural Development for harvesting purposes)[5]. NB clearing activities on private land are not included.



Prepared by Sydney Allen (COSEWIC Secretariat).

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[3] Harvested Areas of BC (Consolidated Cutblocks), Ministry of Forests, Lands, Natural Resource Operations and Rural Development - Forest Analysis and Inventory (https://catalogue.data.gov.bc.ca/dataset/b1b647a6-f271-42e0-9cd0-89ec24bce9f7)

[4] BCTS Cut Permit / Road Permit Regulation - Blocks polygons, Ministry of Forests, Lands, Natural Resource Operations and Rural Development, BC Timber Sales (https://catalogue.data.gov.bc.ca/dataset/4723ed1c-9a37-4d13-b2b6-6c7dc4be1882).

[5] Forest Tenure Harvesting Authority Polygons. Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Forest Tenures (https://catalogue.data.gov.bc.ca/dataset/cff7b8f7-6897-444f-8c53-4bb93c7e9f8b)