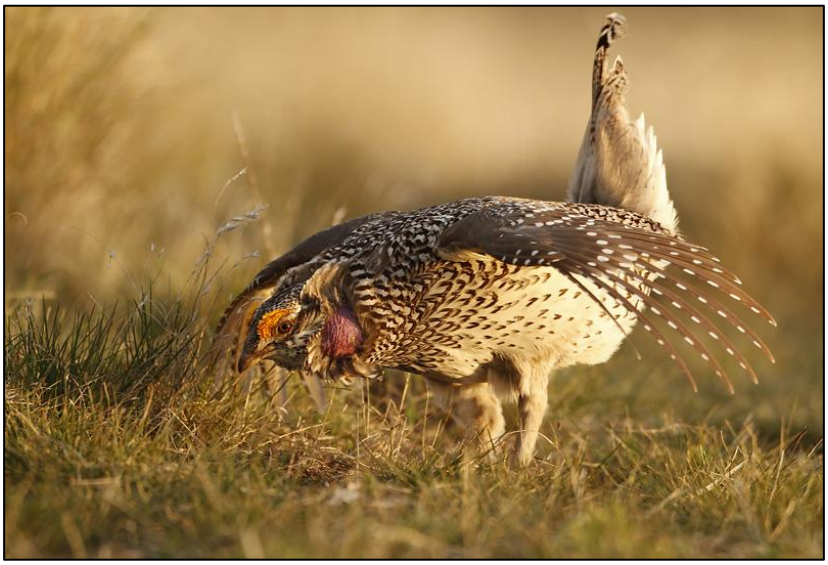
Species-at-risk Recovery in BC



Case Study

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Foreword

This report reveals fascinating insights into the ecology of the endangered wildlife in BC and hopefully provides a more enlightened view of the landscapes from the wildlife's perspective. BC has been divided into three areas, or regions, for the report: 1) coastal rainforests (Coast and Mountains ecoprovince), 2) boreal forested ecosystems (Taiga Plains, Northern Boreal Mountains and Sub-Boreal Interior ecoprovinces) and 3) southern interior forest and grassland habitats (Central and Southern Interior ecoprovinces). Readers will be guided through each of these three regions, using representative species to illustrate the unique biota, conditions and challenges of each life zone. For example: we will examine how the coastal temperate rainforests, and dry cool interior forests have been changed by forestry; how the grassland ecosystems have deteriorated from increased urban and rural development activities; and how the once expansive northern (boreal) forests have been shrunken and fragmented by cumulative impacts from forestry, hydro-electric and oil and gas resource development. The implications on our rapidly changing climate will also be considered.

This approach illuminates the landscape in BC from the perspective of some of the most endangered species by viewing the current landscape "through their eyes". This allows an insightful perspective of what has been lost, what remains, and what we must work hard to restore and protect.

In summary this report aims to:

- ✧ Provide an expert evaluation, using case studies, to profile conservation of species-at-risk across the province.

To accomplish this objective, case studies are provided for six species within three geographic regions of BC (Coastal, Southern and Northern areas). Species or species groups selected for case studies have been strategically selected to profile the eleven widely recognized threat classification schemas, following a process developed by the International Union for Conservation of Nature (IUCN) and adopted, for conservation assessment processes, by NatureServe. The case studies provide a full breadth of consideration to each recognized threat category.

This report uses illustrative case studies to demonstrate the range of threats experienced by species in general, by profiling six species to show achievements and deficiencies realized under the current management regime. Species were selected from three broad geographic areas to ensure representation of a broad geographic range and a diversity of resource development sectors. These case studies are not intended to be exhaustive; they are instead illustrative of the conservation challenges faced by species-at-risk in the province to bring attention to management needs.

Acknowledgments

First, Sierra Club BC and Wilderness Committee would like to acknowledge the species, for telling their story through their own declines as they struggle with the changes we have wreaked upon their habitats in BC. We hope their message is heard.

We would also like to acknowledge Jared Hobbs (Director: J Hobbs Ecological Consulting ltd.) and his work leading to this case study assessing wildlife decline in BC and the legal gaps responsible that allow these declines to continue across geographic regions of the province (coastal, southern and northern areas). This case study focuses on Caribou (southern mountain and boreal), Spotted Owls, reptiles (Western Rattlesnake and Great Basin Gopher Snake) and amphibians (Great Basin Spadefoot and Tiger Salamander), species, whose stories represent a range of diverse threats leading to their decline.

Of equal importance, Wilderness Committee (WC) and Sierra Club BC (SCBC) would like to acknowledge the contribution and insights provided by Indigenous Peoples for sharing their perspectives, their knowledge, and their understanding of the many changes brought about to both species and the ecosystems these species depend upon. The anticipated current and ongoing contribution of Indigenous knowledge holders towards species-at-risk management will afford perspective, and hopefully inform a more holistic understanding of a pre-colonial context – this important perspective allows us to better understand our anthropogenic influence on biodiversity in British Columbia and to envision a more inclusive and forward-thinking approach. This will inform us, as we move forward, to ensure the message imparted by the declines evident for so many species-at-risk are not lost in our understanding of what we need to do.

Case Studies: An Ecosystem-Based Approach

To ensure representation of the diversity of ecosystems in BC, the province was divided into three broad regions consistent with the approach used by the then referred to provincial Ministry of Forests, Lands, Natural Resource Operations and Rural Development's "Develop with Care" program (MFLNRORD 2014). It was not feasible, or warranted, to detail threats to all Schedule 1 listed species in this report. Instead, case studies were strategically selected to profile each of the most commonly occurring, or widespread, threats within each of the three broad geographic regions of the province (**Figure 7**).

Figure 7: Map illustrating three broad geographic regions (Coast, South and North areas) of the province. These logical geographic divisions were used to ensure a provincial scope was provided in consideration of threats and recovery planning. Each MFLNRORD region is delineated within each of the three broad regions of the province (Map taken from MFLNRORD Develop with Care program document).

Within these broad geographic regions seven species were strategically selected for individual case study to ensure representation and consideration of all eleven IUCN threats. These species include:

Caribou – This case study was primarily focused on the North Area, with some consideration extending into the Kootenay Boundary and Thompson-Okanagan regions for more southerly populations. This

species has been impacted most severely by biological resource use (i.e., commercial forestry [IUCN Threat 5]) and by energy production and mining (i.e., oil and gas resource development activities [IUCN Threat 4]).

Spotted Owl – This case study focuses on a species that occurs entirely within the Coast Area, specifically within the South Coast MFLNRORD Region. Since the advent of mechanized commercial forest practices Spotted Owls have been heavily impacted by commercial forestry operations (under IUCN Threat 5). Today Spotted Owls are functionally extirpated from BC as a lasting and disappointing legacy of the provincial government's mismanagement of old-growth forest resources.

Blotched Tiger Salamander, Great Basin Spadefoot, Great Basin Gopher Snake and **Western Rattlesnake** – consideration of four listed species of southern interior herptiles (South Area) provides insight into threats that are particularly pronounced for these herptile species; specifically, loss of habitat to residential and commercial development (IUCN Threat 1), agriculture and aquaculture (IUCN Threat 2), and direct mortality associated with transportation and service corridors (IUCN Threat 4). Additional less impactful stressors also include human intrusions and disturbance (IUCN Threat 6), invasive and other problematic species and genes (IUCN Threat 8), and pollution (IUCN Threat 9).

The intent of the following case studies was not to provide an exhaustive consideration of threats faced by each and every one of the imperiled species in BC, but instead to provide a representative perspective to illustrate how each IUCN threat may affect a given species, and to profile existing legislation (including the lack thereof) that is available to promote species persistence and, optimistically, recovery, in the face of cumulative effects from these activities.

Evaluation Methods – The IUCN Threat Classification System

Each recovery strategy is required to identify Critical Habitat for the focal species where Critical Habitat is defined as "*the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species*". Each recovery strategy also recognizes and describes activities likely to destroy Critical Habitat for each species during this assessment process. As such, there is a documented recognition of pertinent stressors, for each species, under each IUCN threat category.

For recovery planning purposes the federal and provincial governments have adopted a threat classification system developed by the IUCN (**Table 1**). This system recognizes 11 categories of threat that may be faced by a given species. Within each conforming federal recovery strategy each IUCN threat is collaboratively assessed with appropriate engagement from recognized species experts. This assessment is used to inform conservation and management, and to anticipate trends under current management scenarios. Used prudently, this understanding can be used to encourage adaptive management to meet the stated intent of the federal *Species-at-risk Act* (SARA): to promote species recovery and to prevent species from becoming threatened, endangered, or extirpated.

Georgina Mace (1953-2020) developed an evidence-based, objective, and repeatable system to allow evaluation of criteria that was subsequently adopted by the International Union for Conservation of Nature's (IUCN) to classify threats to species at risk globally. As a result of her vision this is now the most used and trusted source for assessing trends in global biodiversity.

To evaluate previous impacts, and potential for future impact based on an assumption of ongoing or continued threat, IUCN threat evaluation criteria were used to ensure a consistent, repeatable, logical, and accepted framework to describe challenges to recovery for each species.

Determination of expert-based rankings for each IUCN threat category presented in this assessment were informed by, and incorporate, expert-based government led assessment of each IUCN threat category for each species-specific case study. Threat ratings follow the IUCN Threat Rating Classification Scheme Ver. 3.2. In the case-studies section of this report, available information from posted recovery strategies, current online and published primary literature, and available policy and management guidance documents were each considered. Assignations were developed, for each species-specific case study, in the context of the entire range of the species, in consideration of both ongoing and future threats AND with consideration afforded to previous and current threats. These assignations were recorded under two criteria (scope and severity) using defined values. The definitions and examples used to describe each of the IUCN threats (**Table 7**) are taken directly from guidance in federal recovery planning documents.

Table 7: IUCN threat classification category definitions

IUCN Threat Category	Definition	Examples
1. Residential & commercial development	Human settlements or other non-agricultural land uses with a substantial footprint.	Campgrounds, golf courses, shopping areas, offices, and vacation homes
2. Agriculture & aquaculture	Threats from farming and ranching from agricultural expansion and intensification, including silviculture, mariculture, and aquaculture.	Farms, orchards, cattle ranching, and hatchery salmon
3. Energy production & mining	Threats from production of nonbiological resources.	Rock quarries, oil wells, geothermal power production, and solar farms
4. Transportation & service corridors	Threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality.	Logging roads, fencing associated with roads, electrical and phone wires, railroads, and oil and gas pipelines
5. Biological resource use & harm	Threats from consumptive use of "wild" biological resources including deliberate and unintentional harvesting effects; also, persecution or control of specific species.	Fuel wood collection, pest and predator control, fur trapping, and control of host plants to combat timber diseases

6. Human intrusions & disturbance	Threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources.	Motorboats, mountain bikes, pets in rec areas, hikers, temporary campsites, rock-climbing
7. Natural system modifications	Threats from actions that convert or degrade habitat in service of "managing" natural or seminatural systems, often to improve human welfare.	Inappropriate fire management, tree thinning in parks, dam operations and groundwater pumping
8. Invasive & other problematic species & genes.	Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance.	Household pets, Chytrid fungus, overabundant native deer, and genetically modified insects for biocontrol
9. Pollution	Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources.	Oil or sediment from roads, road salt, litter from cars, fertilizers and pesticides from lawns and golf-courses and soil erosion
10. Geological events	Threats from catastrophic geological events.	Avalanches, landslides, and mudslides
11. Climate change & severe weather	Long-term climatic changes that may be linked to global warming and other severe climatic or weather events outside the natural range of variation that could wipe out a vulnerable species or habitat.	Severe lack of rain, loss of surface water sources, heat waves, thunderstorms, and hailstorms

For each IUCN threat assignation in compliant published Recovery Strategy documents, a scientific expert-led process is followed to evaluate each IUCN threat, and to assign scores to each threat to describe the anticipated impact upon a species in the area of interests. These considerations are time-bound within the lesser of:

1) a 10-year forecasted timeframe; or,
2) within three generations.

The final step in the evaluation process is to assign a summary level assignation to describe the anticipated impact of each threat based on consideration of scope, severity and timing. **In contrast, the process used in this assessment also incorporated expert-based assessment of each threat category for a specific species however assignations of scores were only made for two (of five) IUCN criteria (Scope and Severity), under each IUCN threat category. Most significantly, assignations in the case studies in this report were made with due consideration of previous impacts, current threats AND future potential threats**.

With the above-noted deviation (bold text), the criteria used in this assessment still follow accepted (existing IUCN) definitions and scores as defined below. These definitions and scores are taken directly from IUCN threat assessment guidance processes that are used in all SARA Schedule 1 recovery planning documents.

As described, for each IUCN threat assignation in Recovery Strategy documents a scientifically led process was followed to allow evaluation of each IUCN threat category and assign scores to each threat category where threat is defined as the proximate human activities or processes that have caused, are

causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets. Assignations used in this process are defined as follows:

1. **Scope** – Proportion of the species (population) that can reasonably be expected to be affected by the threat within ten years. Usually measured as a proportion of the species' population in BC:
    a. Pervasive = Affects all or most (71–100%) of the total population.
    b. Large = Affects much (31–70%) of the total population.
    c. Restricted = Affects some (11–30%) of the total population.
    d. Small = Affects a small (1–10%) proportion of the total population.

2. **Severity** – Within the scope, the level of damage to the species (*population*) from the threat that can reasonably be expected to be affected by the threat within a ten-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population:
    a. Extreme = within the scope, the threat is likely to reduce the species population by 71–100%.
    b. Serious = within the scope, the threat is likely to seriously degrade or reduce the species population by 31–70%.
    c. Moderate = within the scope the threat is likely to moderately degrade or reduce the species population by 11–30%.
    d. Slight = within the scope the threat is likely to only slightly degrade or reduce the species population by 1–10%.

Based on these assignations' each species being evaluated was then collectively scored using a risk-matrix (**Figure 8**) to generate a value that describes the overall ongoing threat level for each IUCN category (for each of the seven species of focus). These rolled-up scores are presented for each IUCN threat category in each detailed case study. The numerical values presented under each IUCN summary threat score reflect anticipated (continued) decline based on current existing legal protection in place for each species.

Figure 8: Risk matrix for assignation of overall IUCN threat rank.

		Scope (% decline)				
		Pervasive	Large	Restricted	Small	Overall Rank
Severity	Extreme	50-100	22-70	8-30	1-10	Low
	Serious	22-70	10-49	3-21	1-7	Medium
	Moderate	8-30	3-21	1-9	1-3	High
	Slight	1-10	0-7	1-3	<1	Very High

Coast Area

The coast of BC stretches for 25,725 kilometres, and includes deep, mountainous fjords and thousands of mostly uninhabited marine islands. Pristine bays and coastal mountain slopes and valleys, with remnant fragments of old-growth northern temperate rainforest, cloak the coastline and BC's extensive archipelago of islands and islets. These coastal areas are the ancestral home of many First Nations, where Indigenous people have lived for generations in harmony with natural systems. From a provincial management perspective the area includes three MFLNRORD regions, the Skeena Region in the north, the West Coast Region in the central portion, and the South Coast Region in the mainland portion of the Pacific Northwest (including the Fraser Valley and Sunshine Coast). All three regions are maritime influenced with milder wetter winters relative to the rest of BC, and warm temperate summers. As such, BC's coast is often aptly referred to as the Rain Coast, with a legion of conservation ambassadors that advocate mitigation of ongoing and extensive impacts from commercial forestry, tourism and recreation operators (including the interests of guided trophy hunters) and the salmon farming industry.

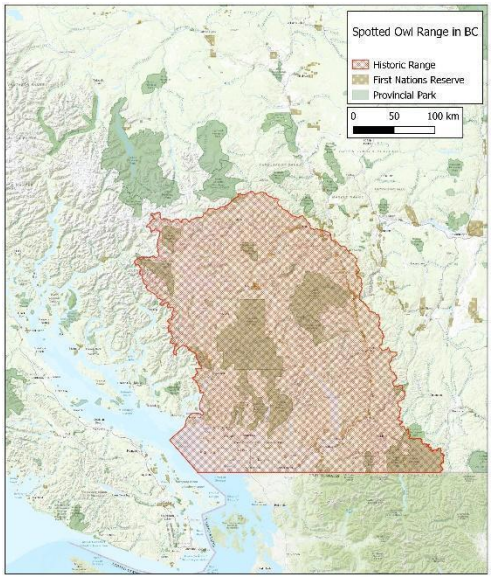
The coast area includes three ecoprovinces: the Southern Alaska Mountains, the Coast and Mountains, and the Georgia Depression. This area also spans seven BEC zones (Coastal Western Hemlock, Interior Cedar Hemlock, Mountain Hemlock, Engelmann Spruce-Subalpine Fir, Coastal Mountain Heather Alpine, Boreal Altai Fescue Alpine and). Elevations along the coast range from sea level to 4,019 m (Mount Waddington is in the coast mountain range and is BC's highest mountain peak).

Western system influence is highest in the southern portions of the Coast Area, in particular Vancouver Island, the Fraser Valley, and the Sunshine Coast. Indigenous communities have existed since time immemorial within the traditional and unceded territories of the Squamish, Musqueam and Tsleil-Waututh people. Since colonization, Vancouver has grown to be the third largest city in Canada. Since Vancouver's incorporation as a city in 1886 resource development accelerated rapidly, to the detriment of the rich natural and Indigenous history that formerly existed throughout the South Coast region. Unfortunately, the southern portion of the Coast Area has a long history of continued exploitation by commercial forestry that is motivated by profit, short-term economic gain, and the demands of residential and urban sprawl development within the Fraser Valley. Today there are several large metropolitan communities in the lower mainland, with a population in the Metro Vancouver area of 2.6 million

To better understand IUCN threat impacts in BC's coastal areas, Northern Spotted Owl was selected as a case study to exemplify existing legal and non-legal habitat management, and to better understand conservation needs, coastwide. As an old-growth forest dependent species the Northern Spotted Owl is an indicator species whose decline signals a worrisome trend for old-growth forested ecosystems along the entire coast of BC. Indeed, today, the Northern Spotted Owl has been functionally extirpated from BC due to commercial forestry, sanctioned, promoted and permitted by the provincial government. Although the former range of Spotted Owl occurs within a relatively small proportion of the Coast Area its consideration in this report is warranted as its decline is symptomatic of, and mirrored by, less severe declines witnessed in other wide ranging coastal old-growth forest dependent species (e.g., Marbled Murrelet and Northern Goshawk (*A.g.laingi*)).

Spotted Owl

The Northern Spotted Owl was first designated as Endangered in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1986 (Chutter et al. 2004). This status was reconfirmed in 1999 and again in 2002. Spotted Owl was listed on Schedule 1 of the federal *Species-at-risk Act* in 2003. By the mid 1980's concern over noted declines within the US, and suspected in BC, motivated increased conservation attention in Canada. In 1984, protection for the species was recommended to COSEWIC (Campbell 2014) and by 2000 the owl's status was confirmed as endangered based on an updated report by Kirk (1999) (as cited in Campbell 2014).



The historic distribution of Spotted Owl in BC is from the international border, from Vancouver continuing east to Manning Park (Hobbs 2019) and continuing north along the Cascades and Coastal ranges north to Carpenter Lake, northwest of Lillooet. The first written records of Spotted Owl detected in BC was recorded in 1903 by Delbert Grovnor Boyd Ryder at Mount Lehman; this was closely followed by a specimen record from Chilliwack in 1909 (Campbell 2014). Between 1909 and 1965, Spotted Owls were reliably recorded at 18 additional locations (including four nest records) between Bute Inlet and Powell River along the west coast and as far east as Lightning Lake in Manning Park in the Cascades (Campbell 2014). There are no confirmed records on Vancouver Island; however, Clark reported repeated observations of Spotted Owl south of Courtenay in 1910 (as described in Campbell 2014). Regardless of these unconfirmed observations the western extent of the species' range in BC was never well defined as no formal surveys were conducted within large portions of the species' former range within the Sunshine Coast NRD (despite several confirmed records near Bute Inlet as documented by Campbell 2014). The current 2020 extant population is restricted to only one remaining extant site near Boston Bar (Cox 2020).

Ecology

Spotted Owls are upper trophic level avian specialists that rely on forest characteristics typically associated with old-growth forests (Forsman et al. 2002). Forest age class is an important attribute; however, several other forest attributes are also required. These include appropriate stand (tree) height, appropriate canopy closure, low stem density (approximately 240 stems/hectare), vertical structural heterogeneity, a healthy understory and presence of course woody debris (Gutiérrez et al. 1995). These structural attributes provide security habitat (i.e., protection from predators and the environment [e.g., inclement weather]), nesting and roosting structures; relatively high prey availability and accessibility; and suitable foraging conditions that permit flight within and beneath the forest canopy. The specific

structural attributes that influence habitat quality varies between ecosystems and topography but, generally speaking, suitable Spotted Owl foraging habitat is comprised of mature forest at ≥ age class 6 (at least 100 - 120 years old) and below 1,200m elevation (Hobbs 2019). Spotted Owl nesting habitat is typically associated with old-growth forested habitat ≥ age class 8 (141-250 years of age) or age class 9 (>251 years of age) (COSEWIC 2008; Manley et al. 2003).

Forest structure is also critical to ensure that Spotted Owls have sufficient access to prey. Spotted Owls depend on specific forest characteristics to locate and capture their prey, and as specialists, feeding predominantly on northern flying squirrel (*Glaucomys sabrinus*) and bushy-tailed woodrat (*Neotoma cinereous*).They require a high abundance of prey species (Horoupian et al. 2004). Flying squirrel and bushy-tailed woodrat occur in higher densities in forested areas with diverse shrub cover, coarse woody debris, or nearby rocky talus (Gutiérrez et al. 1995). As such, mature forested areas with these characteristics are required for persistence of Spotted Owls on the landscape.

Population Trend in BC:
Forest resource management continues to impose a deleterious competing interest (i.e., revenue generation from forest harvest) upon available remaining suitable spotted owl habitat. Previous and continued harvest of old-growth forest has resulted in dramatically diminished availability of suitable habitat on the landscape, with remaining suitable habitat becoming increasingly rare and fragmented rendering remaining small 'patches' of habitat un-usable (Anderson and Mahato 1995; Lamberson et al. 1994). This has a concomitant and directly proportionate negative effect on recovery and survival of spotted owl

- Long-term Trend (1903-1991): Trend data is not available prior to 1991. Historic population estimates (pre-European contact) estimated as many as 500 pairs of northern spotted owl in BC (Blackburn et al. 2002). Large declines from historic population levels have occurred in BC over the past 50-100 years.
- Short-term Trend (1991-2002): Evaluation of short-term trends between 1992 and 2001 confirmed at least 64 occupied sites in British Columbia within the Sea-to-Sky, Chilliwack, and Cascades NRD. Analysis of the occupancy of owls at 40 of these sites in the Chilliwack and Sea-to-Sky forest districts between 1992 and 2001 confirmed a population decline of about 49% at an average annual rate of 7.2% (Blackburn et al. 2002). In 2002, Chutter et al. (2004) suggested a similar sharp population decline in BC (35%) resulting in an overall decline of 67% between 1992 and 2002 at an average rate of 10.4% per year (Chutter et al. 2004).
- Overall Trend (1903-2018): Regardless of subtle differences in reported rates of population decline, based on the historic population estimate of about 500 potential breeding pairs of owls (Blackburn et al. 2002), the current population estimate suggests that the population may have declined by as much as 99% since European settlement (Hobbs 2019).

Pre-European contact, there was an estimated 939,800 ha of Spotted Owl habitat (Chutter et al. 2004) within the Chilliwack and Sea-to-Sky NRD's. Of this, 477,300 ha (51%) is considered as "contributing" to the Timber Harvesting Land Base (THLB) upon which timber resource extractions may occur. Today the amount of currently suitable Spotted Owl habitat is greatly reduced, mostly existing as isolated patches within Provincial Parks and within Greater Vancouver Regional District (GVRD) lands. Commercial forest harvest practices, as managed by the province, have resulted in a patchily distributed mosaic of forest age classes on the landscape; these conditions favor Barred Owls (competitors) and Great Horned Owls

(predators), disfavour Spotted Owl survival and recruitment and have contributed to the species becoming dangerously close to extirpation from BC by 2018.

IUCN Threat Ratings -Spotted Owl

An understanding of current threats, for each IUCN threat category, is necessary to inform subsequent assessment of available conservation and planning tools (or legislation) to facilitate recovery. This understanding is also required to evaluate challenges facing recovery (**Table 8**).

In the treatment of "Threats to the Species" (P.12) of the Spotted Owl Recovery Strategy the authors distinguished primary factors from secondary factors based on the duration of the effect and assigned threat priority as follows: "*The original population decline is believed due to the loss and fragmentation of old-growth habitat to urban and rural development, and forestry activities. This loss of habitat resulted in diminished quantity and quality of habitat, reduced connectivity of owl sites across the landscape, increased isolation from the larger population in the United States, and likely heightened negative effects of stochastic events associated with very small populations. Current known and potential threats include further loss and fragmentation of habitat, competition from barred owls, predation, climate change, disease, and negative effects from environmental and genetic factors."* (From Chutter et al. (2007)).

Table 8: Summary of current conditions and conservation options (for Spotted Owl) for each IUCN Threat classification category.

IUCN Threat Category	Scope	Severity Rating	Overall Threat Rank
1. Residential & commercial development	Small	Extreme	Low
2. Agriculture & aquaculture	Small	Extreme	Low
3. Energy production & mining	Small	Moderate	Low
4. Transportation and Service Corridors	Restricted	Slight	Low
5. Biological resource use & harm	Pervasive	Extreme	Very High
6. Human intrusions & disturbance	Small	Slight	Low
7. Natural system modifications	Large	Serious	High
8. Invasive & other problematic species (i.e., Barred Owl) & genes.	Pervasive	Extreme	Very High
9. Pollution	Large	Slight	Low
10. Geological events	Small	Slight	Low
11. Climate change & severe weather	Pervasive	Slight	Low

Description of Threats and Conservation Tools – Spotted Owl

Key threats to Spotted Owl survival and recovery include further loss and fragmentation of old-growth habitat, competition from the Northern Barred Owl (*Strix varia varia*), predation, climate change, disease, and negative effects from environmental and genetic factors. Of these, the primary threat is loss of habitat. Spotted Owl prey abundance and availability is influenced by available suitable forested habitat; thus, Spotted Owl reproduction and survival are directly influenced by habitat loss. Commercial forest management practices create fragmented landscapes and exacerbate a secondary threat in the form of Barred Owl competition and depredation, and a tertiary threat of depredation by Great Horned

Owl and Northern Goshawk. Natural environmental disturbances are considered quaternary threats but are still significant given the small population size of Spotted Owls.

The summary of current threats, as summarized below, includes a fulsome consideration of available literature for Spotted Owl and considered the previous (2018) threat assessment. The author of this report was a key participant in this threat assessment and, as such, text has been informed by the previous threat assessment with modifications to reflect any changes that may have occurred since.

The overall province-wide office-based assignations for anticipated threats to Spotted Owl were rated as "very high" (ECCC 2018). Both the federal and provincial assessments (e.g., IWMS 2004a and ECCC 2018) considered multiple threats that commonly result in cumulative impacts. Threats, and relevant legal and non-legal conservation mechanisms, are noted for Spotted Owl as determined in this assessment.

IUCN Threat 1 – Residential and Commercial Development

(Overall Threat = Low Risk; <1% decline anticipated*)

**% decline was modified as the scope (small) was the lowest possible assignation but negligible is more appropriate.*

Land clearing activities associated with both residential and commercial development activities results in complete habitat loss as all key biophysical attributes are typically compromised or eliminated. Although it is recognized that development will continue within urbanized centres, particularly Squamish, Pemberton, the Fraser Canyon, and the Lower Mainland, given the restricted range of the species and its propensity to occupy wilderness habitats, this threat is anticipated to be negligible. In that context, this threat has already resulted in extensive habitat loss in past decades throughout the Lower Mainland, Squamish Valley, and Fraser Valley but these effects are irreversible under present circumstances.

Legal Conservation Mechanisms:

- Not applicable due to low threat level.

Non-Legal Conservation Mechanisms:

- To inform and mitigate development on private land the province has developed and promoted best management practices: *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (*2013*)*

IUCN Threat 2 – Agriculture

(Overall Threat = Low Risk; <1% decline anticipated*)

Threats from agricultural activities are similarly anticipated to be negligible. Although these activities result in complete loss of key biophysical attributes agricultural expansion into new wilderness areas, to any significant degree, is not anticipated. Again, in that context within the past 100 years this threat has likely significantly impacted Spotted Owls but occupancy data prior to the now extensively developed agricultural areas of the Fraser valley are not available as formal surveys were not conducted prior to 1987.

Legal Conservation Mechanisms:

- Not applicable due to low threat level.

Non-Legal Conservation Mechanisms:

- ✧ To inform and mitigate development on private land the province has developed and promoted best management practices: *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (*2013*)*

IUCN Threat 3 – Energy Production and Mining

(Overall Threat = Low Risk; <1% decline anticipated*)

As for IUCN Threat 1 and Threat 2 impacts from IUCN Threat 3 are also likely negligible. Development of independent power producing projects (IPP's) are ongoing or anticipated but their footprint is relatively small (relative to the average annual home range size of Spotted Owls and relative to impacts from IUCN Threat 5 associated with commercial forest resource development activities). Connectivity with existing service corridors will likely compromise Spotted Owl habitat along these linear features due to increased fragmentation and edge effect but that impact is addressed separately under IUCN Threat 4.

Legal Conservation Mechanisms:

✧The Environmental Protection and Management Regulation, under the Oil and Gas Activities Act specifies conformance with regulatory objectives for WHAs, UWRs, and OGMAs.

✧Where Provincial Parks, Ecological Reserves, and Protected Areas overlap with Spotted Owl range these designations protect Spotted Owls and Spotted Owl habitat from most resource development activities. These designations are normally used to protect a suite of environmental values and are not instruments used specifically to protect Spotted Owl habitat.

Non-Legal Conservation Mechanisms:

- ✧ To inform and mitigate development on private land the province has developed and promoted best management practices: *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (*2013*)*

IUCN Threat 4 – Transportation and Service Corridors

(Overall Threat = Low Risk; <1% decline anticipated*)

Linear features, such as those created for forest resource development roads and for service corridors associated with construction and maintenance of rights-of-way for pipelines (e.g., Trans Mountain) and powerlines (e.g., BC Hydro, and IPP's), impact habitat quality for Spotted Owl by increasing edge to interior ratios within forested habitats. Increased edge favors increased competition and depredation by two other owl species: Great Horned Owl and Barred Owl, as (unlike Spotted Owl) these species are generalists and tend to forage along openings and edge habitats.

Impacts associated with transportation are also pronounced via direct mortality. Owls frequently suffer from collisions with vehicles and trains but given the current population size of Spotted Owls in BC the probability of collision with vehicles is currently negligible.

Legal Conservation Mechanisms:

- ✧ The Forest and Range Practices Act (FRPA) ensures consideration during development of resource access roads but does not provide governance for other road development activities.
- ✧ The Ministry of Transportation and Infrastructure is responsible for planning and managing the upkeep of the province's entire public road network but there are no specific provisions for management of impacts to Spotted Owl or Spotted Owl habitat. The Highways Act does not mention wildlife values.

Non-Legal Conservation Mechanisms:

- ✧ To inform and mitigate development on private land the province has developed and promoted best management practices: *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (*2013*)*

IUCN Threat 5 – Biological Resource Use and Harm

(Overall Threat = Very High Risk; <50-100% decline anticipated)

Precise quantification of **direct** effects (i.e., **harm**, or mortality) to Spotted Owl, from commercial timber harvest activities, are unattainable as **there are no requirements to conduct pre-clearing surveys for Spotted Owls** prior to commercial harvest of suitable habitat. Inexplicably the forest industry is not held to compliance with the BC *Wildlife Act*, with provincial government approved non-complaint harvest of forested habitat frequently (and predominantly) occurring during the breeding bird season in BC. This incongruence in the forest resource extraction sector has yet to be addressed by the province, despite compliance expected from all other resource development sectors. Instead, direct effects of logging can be logically inferred based on confirmation, in the US, of direct effects from forest harvest in accordance with documented instances of commercial forestry (tree falling) resulting in death of adults and young Spotted Owls.

This assessment thus instead focuses on **indirect** effects of commercial forestry (i.e., **biological resource use**). Indirect effects to Spotted Owls result from habitat loss when old-growth forest habitat is logged. To understand the implications of this threat an understanding of the species' specialized ecology is required (see preceding account). In summary, Spotted Owls are old growth dependent habitat specialists – they persist by foraging on two key species that they hunt within the canopy of a mature forest. The Spotted Owl occupies large home ranges (2,800 – 3,400 ha) within suitable forested habitats. Reproduction and survival are strongly affected by fluctuations in prey abundance and availability; both attributes are negatively affected by loss of old-growth forest habitat.

As a result of the species specialized ecology, commercial forest harvest practices (i.e., clearcutting) is identified as a primary threat to Spotted Owl (Chutter et al. 2004; Chutter et al. 2007). There is an obvious immediate and lasting effect upon the amount, distribution, and abundance of available suitable Spotted Owl habitat with a concomitant reduction in Spotted Owl abundance on the landscape. In that context, the history of provincial (mis)management affords an understanding of the plight of Spotted Owls in Canada. The following points outline the chronology of Spotted Owl management in BC:

- 1990: Canadian Spotted Owl Recovery Team (CSORT) was established to develop a national recovery plan in response to 1986 COSEWIC designation. In 1991 the province initiated surveys to assess population trend, and in 1997 the BC government implemented a management plan address the species' rapid range wide decline. This initial plan was called the Spotted Owl Management Plan Option 1 (SOMP1). Unfortunately, the option (SOMP1) that was adopted had the lowest probability of success, in favor of the lowest associated socio-economic impact.
- 1997: Implementation of the first Spotted Owl Management Plan (SOMP1) began within the Squamish and Chilliwack Forest Districts. The Lillooet FD (now identified as the Merritt-Cascades NRD) was not excluded from management under SOMP1 as Spotted Owls had not yet been confirmed to breed in this area (despite repeated detection at three sites along Cayoosh Creek). SOMP1 was predicated on an area-based 'cap' to mitigate impact to the forest industry with a THLB impact of no greater than 4.5% to the THLB. SOMP1 was in effect from 1997 through to

2007 and was adopted by the provincial government with the recognized shortcoming to accommodate socio-economic considerations; SOMP1 had only a predicted 60% probability of halting the species' decline.

- 2002: Spotted Owl listed as endangered by the GIC on SARA Schedule 1 prompting formation of a new Canadian Spotted Owl Recovery Team (CSORT). A review of SOMP1 began with re-establishment of CSORT. The primary challenge of SOMP1 was recognized (i.e., the area based 'cap' to mitigate impact to forest sector at no greater than 4.5% to the THLB). It was also recognized that Spotted Owl habitat had been mapped too optimistically, over-characterizing available habitat. Logging was permitted within managed areas and logging companies targeted low elevation productive forests the owls needed, relegating the required 'reserves' to marginal high-elevation areas that lacked the key biophysical attributes for Spotted Owl use.
- 2002: Under SARA, there was a requirement for CH to be mapped in a publicly available recovery strategy within one year. To date (2022), this legal requirement has still not been met and appears indeterminably stalled by the provincial government. A legally compliant recovery strategy is now two decades overdue for Canada's most endangered bird.
- 2004: To promote compliance with SARA, Ecojustice (formerly Sierra Legal Defense) filed a petition to the federal government to invoke Section 80 (the 'safety net') under SARA. The request was declined by the federal Minister of the Environment (Min. Rona Ambrose) on the now (and then) obviously erroneous assertion that the province was exercising appropriate recovery planning and management.
- 2006: The release of the 2006 Recovery Strategy resulted in a prolonged three-year process of revisions to SOMP1 SRMZ habitat management areas in the Chilliwack and Sea-to-Sky NRD. In 2009, the province released a document recommending Best Management Practices (BMP) to provide voluntary compliance with prescriptive guidance for licensees harvesting within spotted owl management areas. The province also approved six WHAs in the Cascades NRD as part of an independent planning process.
- 2006-2009: Development of SOMP2, with the initial focus placed on captive breeding of Spotted Owl, and on control of Barred Owl at active Spotted Owl territories. Habitat was not the initial focus of SOMP2 despite CSORT's recommendation to provide immediate protection to occupied Spotted Owl habitat. In 2006 the province released a Recovery Action Plan recommending revised habitat management guidance, but habitat conservation was not implemented until 2009. SOMP2 was (and still is) recognized to be non-complaint with explicit SARA requirements as CH is not formally identified. SOMP2 also fails to comply with the Provincial-Federal bilateral agreement as it does not meet the test of providing effective legal protection for Spotted Owl CH.
- 2009: SRMZ boundary revisions were finally completed. Non-legally required Best Management Practices (BMPs) were released by the province. Unfortunately, the 4.5% THLB limit (or 'cap') from SOMP1 was carried forward and applied again, at the province's mandate, during development of SOMP2. There was a slight change in the area of managed habitat under SOMP1 (363,000 ha) versus SOMP2 (396,247ha); however, of the 396,247 ha purportedly being *managed* for Spotted owl 208,025 ha (52.5%) was co-located within Parks, conservancies, eco-reserves, protected areas and already protected watersheds within the Greater Vancouver

Regional District (GVRD). The remaining 188,222 ha currently still purportedly being managed by the province (for Spotted Owl recovery) is comprised of a large proportion of previously logged former Spotted Owl habitat – only 95,117 ha (51 %) is currently suitable – and within that commercial logging of suitable owl habitat is permitted in 28,198 ha as these habitats occur within MFHAs. In short, there was no additional reduction in the Annual Allowable Cut under SOMP2 (relative to SOMP1) and thus no gain afforded to Spotted Owl habitat conservation – SOMP2 amounted to little more than boundary re-adjustments.

- 2011: SOMP2 was enabled with the designation of Wildlife Habitat Areas (WHAs) within the Chilliwack NRD to provide legal management directive for forest management to support Spotted Owl recovery in BC, but logging was still permitted within these 'reserves'.
- 2013: SOMP2 was enabled with the designation of Wildlife Habitat Areas (WHAs) within the Sea-to-Sky NRD to provide legal management directive for forest management to support spotted owl recovery in BC, but, as before, logging was still permitted within these 'reserves'. Not surprisingly, under SOMP2 the owl continued to decline.
- 2019: Ecojustice again petitioned the federal government to map CH for Spotted Owl (https://www.ecojustice.ca/pressrelease/demand-feds-act-to-save-the-critically-endangered-spotted-owl/). To date (2022) this request has still not been addressed by CWS or by the Province.
- 2021: Draft CH was finally mapped by CWS as the province was reticent to map CH in a manner compliant with the requirements under SARA. The draft CH mapping has passed expert-based external peer review and Director Level review (and approval) by CWS but is now stalled awaiting acceptance by the province. The province is exercising the right to defer acceptance of the proposed (draft) CH identification claiming that more study is required. This claim, by the province, is made despite the well-founded scientific understanding of Spotted Owl habitat requirements. Unfortunately this disingenuous 'stall' tactic is not time-bound under SARA - additional legal petition will likely be required to promote provincial compliance to meet commitments under SARA and under the Provincial-Federal bilateral agreement.
- 2023: The draft critical habitat maps were amended in the 2023 amended proposed recovery strategy. The Proposed Recovery Strategy has adopted a scientifically indefensible identification of critical habitat. It is lacking what SARA requires for a recovery strategy. In comparison to the draft amended recovery strategy produced in October 2021 the Minister has significantly reduced the quantity and quality of identified critical habitat to such an extent that it no longer supports the population and distribution objectives to recover the Spotted Owl. The 2023 Proposed Recovery Strategy inexplicably defers to a provincial management strategy (i.e., SOMP2) that is expressly fettered by socioeconomic factors and has demonstrably failed to halt the precipitous decline of Spotted Owl since its adoption in 2009.

Sadly, 36 years after the 1986 designation by COSEWIC, and over two decades since the Northern Spotted Owl was listed, by the GIC, on Schedule 1 of SARA, this federally endangered species has continued to decline in BC to near extirpation in 2023. The few remaining areas of suitable habitat are still being eroded by provincially approved commercial logging operations, even today, despite repeated legal petitions to the federal government to intervene.

Legal Conservation Mechanisms:

- SOMP2 is legally enabled under the Government Actions Regulation (GAR) of the Forest and Range Practices Act (FRPA); designations for focused owl habitat management was spatially designated and legally approved (as orders) within mapped Wildlife Habitat Areas (WHAs). General Wildlife Measures (GWMs) were set, for each order/WHA, to guide forest management activities within each area. Forest management guidance was developed and formalized under SOMP2 in 2009.
- Under the current Spotted Owl Management Plan (SOMP2) habitat is managed within WHAs, Provincial Parks and within the Greater Vancouver Regional District (GVRD) watersheds (Coquitlam, Capilano and Seymour). All other non-designated crown land within the BC Spotted Owl range is not currently considered for Spotted Owl habitat management and is currently treated as productive forest land within the Timber Harvesting Land Base (THLB).
- Under SOMP2, there are two prescriptive approaches that are applied differentially based on two spatial designations. The SOMP2 spatial designations include Long-term Owl Habitat Areas (LTOHAs) and Managed Future Habitat Areas (MFHAs). MFHA's are intended to provide replacement habitat in the event of catastrophic loss (i.e., fire) within a LTOHA (Blackburn et al. 2009).
    1. Habitat Enhancement Practices (HEPs) are to be applied within LTOHAs (replaced Light Volume Removal (LVR) applied under SOMP1 within SRMZs). HEP prescriptions are now set under GWMs within LTOHAs with the mandate to maintain a 100%[1] of the forested area as suitable owl habitat. LWR prescriptions are intended/purported to "*retain stand integrity and enhance stand structure through accelerated development of stand attributes associated with owl habitat*." (D 'Anjou et al. 2015).
    2. Harvest with Retention (HWR): This prescription replaced the HVR (i.e., clearcutting) prescription under SOMP1 by prescribing retention of 'seed tree' patches within harvest areas. HWR is prescribed, under GWMs, within Managed Forest Habitat Areas (MFHAs) and theoretically allows for retention of 'green (live)' trees, Course Woody Debris (CWD) and wildlife (veteran) trees to create structural diversity for Spotted Owl and their prey.

<u>Non-Legal Conservation Mechanisms:</u>

- To inform and mitigate commercial forestry within Spotted Owl habitat the province developed and promoted best management practices: <u>Guidance and some components of action planning for the Northern Spotted Owl (*Strix occidentalis caurina*) in British Columbia</u> (Chutter et al. 2007). This guidance document was prepared by CSORT to identify reasonable actions required to protect and recover the Northern Spotted Owl in Canada and to provide further guidance to the province during the development of SOMP2.
- It is a companion document to the previously submitted CSORT recovery strategy (Chutter et al. 2004) but it was recognized that this is not a SARA compliant recovery action plan. It was also noted, in the companion document that "implementation of advice and recommendations in the guidance document will be subject to appropriations, priorities, and budgetary constraints imposed by participating jurisdictions and organizations" (i.e., compliance was voluntary and not a legal requirement).

[1] Note: Many of the SRMZs were well below this designation target when they were mapped under SOMP1. Under SOMP2 Ian and I mapped the LTOHAs to meet this requirement based on existing conditions.

IUCN Threat 6 – Human Intrusion and Disturbance

(Overall Threat = Low Risk; <1% decline anticipated*)

Given the status and rarity of Spotted Owls in BC the potential for interaction with this threat is negligible to non-existent. In addition, effects from this threat to Spotted Owls, are also negligible with little to no effect demonstrated in published literature. In the United States active Spotted Owl territories occur, throughout the species range, in areas frequented by rock-climbers, mountain bikers and hikers with seemingly no deleterious affect to reproduction and survival. One published study considered the effects of low-flying military jets on several Spotted Owls and any behavioural changes to disturbance was short-lived with no lasting effects.

Legal Conservation Mechanisms:

- ✧ The BC Wildlife Act prohibits disturbance to Spotted Owls, including their nests and eggs, while the nest is active.

Non-Legal Conservation Mechanisms:

- ✧ Relevant best management practices and guidelines relating to recreational activities within the Spotted Owl's former range in BC include:
  - A Strategy to Manage Backcountry Recreation in Relation to Wildlife and Habitats
  - Wildlife Guidelines for Backcountry Tourism/Commercial Recreation in B.C.
- ✧ To inform and mitigate development on private land the province has developed and promoted best management practices: Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (2013)

IUCN Threat 7 – Natural System Modifications

(Overall Threat = High Risk; 10-49% decline anticipated)

Unfortunately, decades of fire suppression have altered the tree species composition, structure, and spatial distribution of conifer forests in at the drier (Cascades) and transition (Sea-to-Sky) Natural Resource District (NRD). Literature from Washington suggests increased canopy cover and fuel loading on the forest floor has continued to intensify and expand risk from catastrophic wildfire events (Buchanan 2016). Consequently, fires in these altered conditions are more intense and often remove substantial areas of forest resulting in landscape conditions that are unsuitable (or less suitable) for use by Spotted Owls. In summary, fire suppression has served to conserve Spotted Owl habitat in some areas but has altered forest attributes towards an unstable condition; in these modified forests large fires and impacts of insects and disease are more likely to degrade or destroy portions of these forests (Buchanan 2016). The U.S. Fish and Wildlife Service acknowledged the need to address this risk by proactively managing dry forest landscapes (Buchanan 2016).

Given past anthropogenic influence fire is listed in the Recovery Strategy (Chutter et al. 2004) as a significant potential threat to Spotted Owls, since more habitat has been lost in Washington State to fires than timber harvest, and ongoing fire suppression in BC has resulted in increasing incidence of wildfires over the past 15 years. As a result, the scope is uncertain and potentially large with serious severity and challenging if not impossible to mitigate.

Legal Conservation Mechanisms:

✧The *Wildfire Act* allows regulations to be developed for fire control and protection of forest resources.

✧There is currently no legislation to *require* potentially beneficial prescribed burning practices.

Non-Legal Conservation Mechanisms:

✧The B.C. Wildland Fire Management Strategy outlines the importance of including fire regimes in land management plans and can be used to support reduction of long-term detrimental fire suppression activities.

IUCN Threat 8 – Invasive and Other Problematic Species and Genes

(Overall Threat = Very High Risk; <50-100% decline anticipated)

In addition to direct loss of habitat, forest harvest promotes and exacerbates a more recent secondary threat, competition, and to a lesser extent, depredation, from the Northern Barred Owl. Barred Owls have expanded throughout most of the historic range of the Spotted Owl in BC, competing for prey, displacing Spotted Owls from breeding territories and depredating young Spotted Owls. Unlike Spotted Owls, Barred Owls forage along the edge of a forest, hunting prey in forest openings. Barred Owls are regarded as a "generalist" species in ecology (i.e., a species with general foraging requirements that can capitalize on a wider variety of prey) (Livezey and Fleming 2009). By converse, Spotted Owls are regarded as a "specialist" species (i.e., a species with specific foraging requirements that specialize on feeding on a relatively limited number of key prey items). As forest harvest increases the area of 'edge' habitat, relative to the area of available interior forested habitat[2], foraging conditions are optimized for Barred Owl. These distinct ecologies are apparent when considering diet, home range size, fecundity, and survivorship in response to environmental perturbation.

Barred Owls are now considered a Primary Threat to Spotted Owls by the province although an inherent conflict of interest likely biases this perspective as commercial forest harvest resource development, by the same government, likely underscores the provincial government's position. Decades of research, conservation and management suggest clearcutting practices are the primary threat in BC as clearcut harvest practices, approved by the province, continue to deleteriously impact Spotted Owl habitats in BC. It is biologically more defensible to classify forestry as the Primary Threat and Barred Owl as a Secondary Threat.

In a 2019 article in Narwhal magazine Sarah Cox posited that "*substantial amounts of money are being spent on increasingly complex efforts to recover endangered species while governments quietly sanction destruction of their habitat. The B.C. government, for instance, has approved clear-cut logging in areas it set aside for Spotted Owl recovery*…" These efforts and expenditures were committed while sinking over $1.5 million into provincial programs for experimental captive breeding efforts and into Barred Owl control.

Legal Conservation Mechanisms:

- ✧ There are no legal requirements to address threats from Barred Owl (and Great Horned Owl) upon Spotted Owl.

Non-Legal Conservation Mechanisms:

- ✧ The province has, since 2006, implemented Barred Owl control using both lethal and non-lethal methods with emphasis afforded to removal of Barred Owls from active (or recently active) Spotted Owl territories. Between 2009 and 2019 the B.C. government removed 189 barred owls;

[2] Edge-effect is an ecological term used to describe the influence of increased edge-to-interior ratios in mature (primary, or old growth) forests. As mature forest is harvested and replaced by cleared openings the ratio of interior to edge habitat is reduced.

138 were captured and relocated and 51 were shot at active or recently occupied Spotted Owl sites (Cox 2019).

IUCN Threat 9 – Pollution

(Overall Threat = Low Risk; <1% decline anticipated*)

Threats from pollution may be largely in the past given that Spotted Owls are now functionally extirpated in BC. More recently, air-borne pollutants from wildfires are having increasingly pronounced effects upon air quality with effects extending throughout most of the owl's range in BC but the severity of this threat is unclear and likely negligible relative to effects from previous and ongoing commercial forest harvest approved by the provincial government.

In the United States illegal cannabis growing operations, within wilderness areas, likely disturb Spotted Owls through increased atmospheric pollution (noise and light) and through illegal or non-compliant use of pesticides. This activity was identified as a threat by US Spotted Owl researchers.

Legal Conservation Mechanisms:

✧Several pieces of legislation in BC prohibit or regulate the release of deleterious substances into the environment, including the *Waste Management Act*, the *Environmental Management Act*, and the *Water Act*.

Non-Legal Conservation Mechanisms:

✧In addition to environmental acts, regulations related to human health and safety, such as Worker Hazardous Materials Information System (WHMIS) and Transportation of Dangerous Goods (TDG), provide standards for storing and transporting deleterious substances that minimize potential for their release into the environment. In that context illegal (non-licensed) cannabis growing operations are unlikely to comply with either legal or non-legal mechanisms.

IUCN Threat 10 –Geological Events

(Overall Threat = Low Risk; <1% decline anticipated*)

Natural stochastic events also affect owl survival and recovery. Typically, these include natural environmental disturbances including fire, landslides, and unusual weather patterns as a result of climate change (Dulc 2018). These threats become more serious, and more likely to result in extirpation, when population sizes are small as these populations have reduced resilience to cope with change.

In that context, the current Canadian Spotted Owl population is now so reduced that the statistical probability of influence from a random geological event, including avalanches and landslides, upon Spotted Owls and their habitat is likely low in BC. In addition, snow avalanches typically occur at high elevations, away from typical owl habitat.

Legal Conservation Mechanisms:

This thought is thought to be negligible, and beyond any available mitigation. No legal tools exist for protecting Spotted Owl from geological events.

Non-Legal Conservation Mechanisms:

This thought is thought to be negligible, and beyond any available mitigation. No non-legal tools exist for protecting Spotted Owl from geological events.

IUCN Threat 11 – Climate Change

(Overall Threat = Low Risk; <1% decline anticipated*)

Although forest health consequences that can result from climate change effects are likely potentially severe in the long-term, the immediate cause of forest health issues is likely fire suppression and this threat has already been assessed above.

Specifically, the effects of climate change (e.g., seasonal temperature extremes, increased frequency of stochastic storm events, drought) will likely exacerbate ongoing forest and ecosystem health issues. Impacts from habitat shifting and alteration may be most apparent in coastal-interior transition or drier habitat types where soil moisture is already limiting; foraging habitat may change if temperatures increase and moisture declines which could affect prey habitat.

Legal Conservation Mechanisms:

✧There are many acts that strive to reduce emissions to slow climate change (e.g., Greenhouse Gas Reduction Act, Zero-Emission Vehicles Act, Clean Energy Act); however, there is no legal legislation that directly addresses the effects of climate change on Spotted Owl.

Non-Legal Conservation Mechanisms:

✧There are government programs affording attention to reduction of carbon emissions to slow climate change (e.g., Carbon Neutral Government Program, Clean BC Roadmap to 2030) but, again, nothing that is specific to Spotted Owl.

Threat Assessment Summary

Forest resource management continues to impose a deleterious competing interest (i.e., revenue generation from forest harvest) upon available remaining suitable Spotted Owl habitat. Previous and continued harvest of old-growth forest has resulted in dramatically diminished availability of suitable habitat on the landscape, with remaining suitable habitat becoming increasingly rare and fragmented rendering remaining small 'patches' of habitat un-usable (Hobbs 2019). This has a concomitant and directly proportionate negative effect on recovery and survival of Spotted Owls (Lamberson et al. 1994; Anderson and Mahato 1995).

Competition with Barred Owl and depredation from Great Horned Owl are secondary threats. Initial recovery efforts under SOMP2 emphasized captive breeding of Spotted Owls, and Barred Owl control, with priority and urgency afforded to these threats *instead* of habitat conservation and management. After an unsuccessful Spotted Owl translocation effort in 2002, and attempted supplemental feeding programs from 2003-2004, a 12-year long effort to manage juvenile recruitment via captive breeding has resulted in a net-negative impact to the wild Spotted Owl population in BC (Cox 2019). The captive breeding program is ongoing despite no realized net benefit and despite very limited breeding success (based on review of Gillis 2016). The Barred Owl control program is also ongoing and has been purported to have resulted in some (potential/unmeasurable) benefit to Spotted Owls at previously known occupied sites (Gillis 2016), but scientific, moral, and logistical considerations warrant attention.

Understanding the effect of BC's management upon all key threats affecting Spotted Owl recovery requires consideration of five key life-history attributes that influence Spotted Owl survival. These key ecological attributes, exacerbated by the species 'specialist behavior, include:

1. Habitat dilution (loss of suitable forested habitat primarily from commercial forest harvest),

2. Reduced prey accessibility (due to an increase in stem density during post-harvest forest succession),
3. Reduced prey abundance (due to reduction in prey abundance in post-harvest landscapes), increased competition for diminishing prey resources (due to an increasing Barred Owl population),
4. Increased predation risk (particularly upon dispersing juvenile Spotted Owls),
5. The Allee effect (i.e., decline of a species' population below a critical population threshold to facilitate reproduction and persistence).

Continued loss of suitable old-growth forested habitat continues to compromise survival and recovery of Spotted Owls in BC by negatively influencing productivity and survivorship via each of these aforementioned ecological stressors.

The designation of WHAs as Spotted Owl habitat management areas still allows ongoing forest harvest and does not constitute identification or effective legal protection (of CH) as required by SARA. In addition, the province imposed a constraint on the impact to the THLB (under both SOMP1 and SOMP2) to accommodate competing interests from revenue generation from commercial forestry activities. Under SARA, ecological considerations should not be influenced by socio-economic considerations when designating CH, so this approach also fails a second requirement of CH identification under SARA. In summary, an appropriate process for mapping CH requires a more fulsome suite of considerations that accommodates all ecological needs of the species and recognizes and protects breeding, foraging and dispersal habitats required for effective species recovery throughout the species' entire (former) range. This action is still required (and over two decades overdue) for provincial compliance with SARA. While habitat provisions under the current SOMP2 promotes considerate management of some suitable Spotted Owl habitat, it does not define or manage CH as required by the SARA and current provincial management, under the BC Timber Sales program, still permits activities identified as likely to damage or destroy CH (i.e., logging). **Under SARA these activities must not be permitted within mapped CH to meet the test of effective legal protection required under SARA, and under the Provincial-Federal bilateral agreement.**

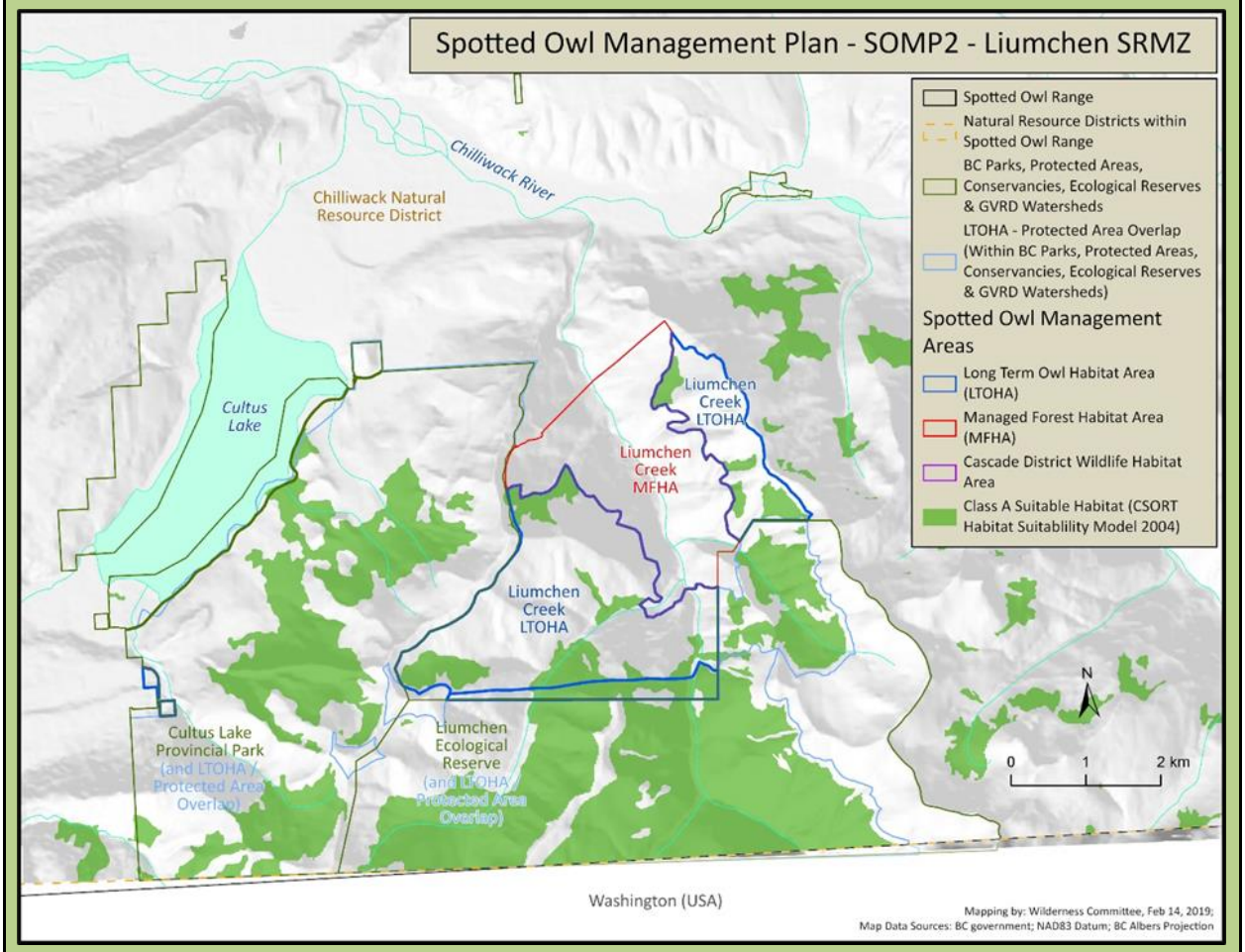
Conservation Conclusion

As a species whose ecological requirements are determined by the availability and distribution of old-growth forest habitat, any measure of recovery action demands the protection of suitable habitat in sufficient quantity. Secondary actions such as captive breeding and control of barred owl populations should be undertaken once sufficient habitat conservation has been achieved.

In describing the areas being managed for Spotted Owl habitat, under SOMP2, the Province is circumspect regarding the distinction between capable (i.e., disturbed or previously harvested areas of immature forest that are not currently suitable for spotted owl but, with the passage of decades, have potential to mature into suitable habitat) and suitable habitat (old-growth forest currently suitable for use by spotted owl). A 2019 analysis of currently suitable habitat available within SOMP2 designations revealed that only 51% of the SOMP2 managed areas are considered currently suitable for use by spotted owl (Hobbs 2019). In addition, these management areas represent only 31% of the available spotted owl Class A (breeding and nesting) habitat (as assessed in 2019).

Overstated Conservation Claims by the Province

An example of misleading accounting is evident in the map depicting current remaining Class A suitable spotted owl habitat (239 ha) within the Liumchen Creek WHA (total area: 1,485 ha). Less than 16% of the area reported by the province as “managed for Spotted Owl” contains currently suitable Spotted Owl habitat[1]. This habitat condition is characteristic within all Spotted Owl WHAs (to varying degrees) and is consistent under SOMP1, and now under SOMP2.



In accordance with SARA all habitat that is essential to the Spotted Owl recovery should be mapped as CH and be afforded immediate effective legal protection, based on the proposed 2021 critical habitat maps. In principle, SOMP2 is aligned with conventional wisdom for Spotted Owl reserve design (i.e., delineate large habitat reserves spaced evenly on the landscape) but the size of the reserves are smaller than that recommended in the literature and clear cut logging practices are still permitted within provincially designated management areas. The omission of protection afforded to currently remaining suitable habitat (i.e., logging is still permitted) suggests that management of CH, as defined and required to ensure compliance with SARA, would be markedly different. It is illogical, contradictory, and

counterintuitive that logging of old-growth Spotted Owl habitat is identified in the provincial recovery strategy as the primary threat to Spotted Owl recovery and yet the province continues to promote and permit clear-cut harvest of the last remaining tracts of old-growth forest within the species' range in BC.

Existing legal management (within WHAs, LTOHAs and MFHA) does not adequately support Spotted Owl survival and recovery. Critical Habitat needs first to be explicitly spatially defined and protected from future harvesting to maximize the likelihood of future Spotted Owl recovery.

Even though the species is essentially functionally extirpated its recovery under SARA is still mandated as long as recovery is deemed technically and biologically feasible. This test is met as long as the species is not extinct (globally) and habitat still exists as re-establishment is feasible (Hobbs 2019). Unfortunately the cost of recovery in BC increases with every old-growth tree that is logged, and the probability of recovery is eroded as habitat is lost, but there is no release of the provincial and the federal government from this legal obligation. To do so would be complicit with, and accepting of, this level of mismanagement and legal non-compliance by our government. Sadly, this legacy is not unique to Spotted Owl, with species likely Caribou, Williamson's Sapsucker and Marbled Murrelet following closely behind. The reality is that BC has already extirpated many species (e.g., Pygmy Short-horned Lizard, White-Tailed Jackrabbit, Sage Grouse, Burrowing Owl, etc.). This long path of mismanagement defies public expectation and provincial and federal legal commitments. Hopefully we can heed the warning that the Spotted Owl is giving us, through its own demise, and finally comply with SARA by affording effective legal protection to habitat essential for species' recovery.

South Area

The southern interior of BC is bound to the south by the international border north to the Cariboo Plateau. The western edge is defined the Cascades Mountain Range and continues east to the Rockies. The southern interior includes three MFLNRORD regions; the Cariboo (8,500 km^2), the Thompson-Okanagan (1,200 km^2) and the Kootenay Boundary Region (8,200 km^2). Given the size of the area the climate is simply described here as variable with lower elevations characterized by warm, dry summers and upper elevations characterized by winters that are drier and colder than those experienced in the Coast Area.

The biodiversity in the southern interior is unmatched anywhere in BC, with 13 of the 16 BEC zones occurring within this area. Three of these BEC zones (IDF, PP and BG zones) support some of the most threatened ecosystems in the province. This area contains the northernmost extent of the Great Basin Dessert (near Osoyoos), transitioning to grasslands at lower elevation areas throughout the Okanagan, Thompson, and Fraser River Valleys. These grassland ecosystems contain some of the most threatened habitats in BC and although they represent only 1.5% of the province's total land area these grasslands provide habitat for >30% or the rare and endangered species in the province (see **Figure 1**).

This area is a biodiversity hotspot, but it is also a popular and populous region of the province, with population growth anticipated to continue throughout the area (see **Table 9**).

Census Region	2020 Census	2032 Census	Projected 10 Year Population Increase	Projected 10 Year % Population Increase (relative to 2020)
Okanagan-Similkameen	90,056	99,873	9,817	10.9%
Central Okanagan	222,748	260,151	37,403	16.8%
North Okanagan	92,183	102,417	10,234	11.1%
Thompson Nicola	147,557	163,887	16,330	11.1%
Cariboo	65,554	68,070	2,516	3.8%
East Kootenay	65,782	69,530	3,748	5.7%
Central Kootenay	63,913	69,457	5,544	8.7%
Kootenay Boundary Region	33,430	32,564	(866)	-2.6%
South Area Average	**781,223**	**865,949**	**84,726**	**10.8%**

The South Area is home to many of the reptile and amphibian species in BC, with most species being recognized as at-risk, and one extirpated species (Pygmy Short-horned Lizard). Other species, like Blotched Tiger Salamander, Great Basin Spadefoot, Great Basin Gopher Snake and Western Rattlesnake still occur but are facing numerous threats, with little effective legal protection in place to ensure their persistence or aid their recovery. These species are profiled in this section. Further east, the Kootenay Boundary Region is home to the (arguably) most imperiled frog; once common in BC, the Northern Leopard Frog (*Rana pipiens*) is now restricted to two very small populations near Creston and Cranbrook. This area is also home to many at-risk invertebrates (e.g., Half-moon Hairstreak, Mormon Metalmark), birds (e.g., White-headed Woodpecker, Williamson's Sapsucker, Yellow-Breasted Chat) and mammals (e.g., American Badger, Pallid Bat) and over 250 federally or provincially listed plants.

These limiting ecosystems provide habitat for some of the rarest species; unfortunately they frequently overlap prime development sites in the region. The rapidly expanding wine industry, intensification of agricultural operations, increased recreational development, sprawling urban development, and introduced species (plants and animals) all threaten natural habitats and the native species-at-risk that inhabit them. The following case studies afford greater insight into these threats.

The Truth About BC's Wine Industry…

There's a less well advertised and much less attractive fact about the famous Okanagan vineyards in BC that is lost on most tourists that visit the area. Every year visitors are attracted by well-advertised wine tours but what most visitors don't realize is that to grow the grapes used to create a luxurious dining experience most of the Okanagan's vineyards were planted on one of the rarest ecosystems in BC; the final remnants of the Great Basin Desert near Osoyoos, BC. The well-drained soils and arid landscapes, once dominated by antelope brush desert habitat, was discovered to provide ideal growing conditions for grapes. The ecosystem once totalled ~4,000 ha in BC, today there's less than a tenth of the original area remaining in a functioning condition. There's almost nowhere left to develop in Osoyoos, where one ironically named popular vineyard displaced the last breeding pairs of Burrowing Owls, but new vineyards continue to be developed in Oliver, Similkameen, Naramata and even xeric habitats in other areas like Lillooet and Midway. Many other SARA listed species have also been impacted including endangered butterflies, snakes, plants, birds and mammals.

One particularly strident example of this litany of loss is a well-known and aptly named popular vineyard where grapes now grow over intensively farmed land that was once home to the last active Burrowing Owl breeding site in BC. The owners have erected a sign, advertising their 'environmental farm plan', and, at least for a while, donated funds to help dig holes nearby in hopes that this endangered species would breed elsewhere, but except for a few re-introduction sites the species is now extirpated from BC.

Amphibians and Reptiles

BC is second only to Ontario in its diversity of amphibians and reptiles (i.e., herpetofauna, or herptiles), and in BC, the south-central interior regions, including Okanagan, Similkameen, Thompson, Kettle and Granby River valleys are unsurpassed for their diversity of herpetofauna. Of the nine species of snakes, seven occur here. Similarly, of 20 native species of amphibian, seven occur here along with both of the two remaining native lizard species in BC, with a third species (Pygmy Short-horned Lizard) now extirpated. The only remaining native freshwater turtle in BC also occurs in this region – sadly, the only other species of freshwater turtle in the province (Western Pond Turtle) is now extirpated from BC.

Most SARA Schedule 1 listed reptile and amphibian species, occur in the arid, hot valley bottom habitats, and associated mid-bench grassland and open dry parkland forest habitats. Unfortunately, busy transportation corridors are situated in all of the major valley bottoms (e.g., Highway 1, Highway 97 and Highway 3). Several high-density urban areas (i.e., cities and towns) also compete for this space. Human population estimates, from statistics Canada, predict continued growth, in all of the southern interior regions, with an 8.7-16.8% growth in the human population by 2032. Tourism and recreation (golf courses and wineries) have a massive footprint, with extensive habitat loss in the wake of their development and use. There are also extensive areas used for intensive agriculture (fruit and vineyards) and the intensity of these more commercially motivated enterprises is shifting away from wildlife-tolerant small-business operations, towards more commercial practices motivated by maximizing efficiency and yield, while minimizing costs. In other areas residential areas sprawl over once intact valley bottom habitats, crowding the lakeshores and riparian areas and excluding most of the region's remaining biodiversity to peri-urban areas. Census data anticipate that population growth is expected in each of these areas, and with it the precious remaining intact areas of valley bottom habitat are facing increasing pressure from our influence. As evidence of this trend, we've lost 92% of the Great Basin Desert habitat in the Okanagan Valley (mostly to vineyards as the well-drained soil and hot summer temperatures appeal to the grape-growing industry). Less than 400 hectares of an original 4,000 hectares of endangered antelope brush (desert) habitat remains in a highly fragmented and degraded state. A 2008 estimate of cottonwood-riparian floodplain habitat in the Okanagan and Similkameen concluded that less than 30% of the original area of this habitat type remained (in 2008), and it is much less today.

An assessment of the herpetofauna in BC provides insight and allows a better understanding of the (dominant) anthropogenic influence to these very limited and rapidly diminishing high-biodiversity habitats in BC's southern interior. A look at current conditions, through the eyes of just four of these species (two snakes, a spadefoot, and a salamander) illuminate most of the key conservation concerns. Widespread patterns of decline in species abundance, and pervasive range collapses, for all four species assessed herein, emphasize the lack of effective legal protection that is still direly needed to afford parity with SARA. This was a commitment of BC's federal-provincial (bilateral) agreement and yet by 2022 there are more gaps than gains in the existing legislation to protect these species. Although Recovery Strategies have been posted, and CH has been mapped, for all four species assessed here

there is no effective legal protection in place to address common stressors; CH mapping serves no benefit if land use practices are not amended to reflect species' conservation requirements.

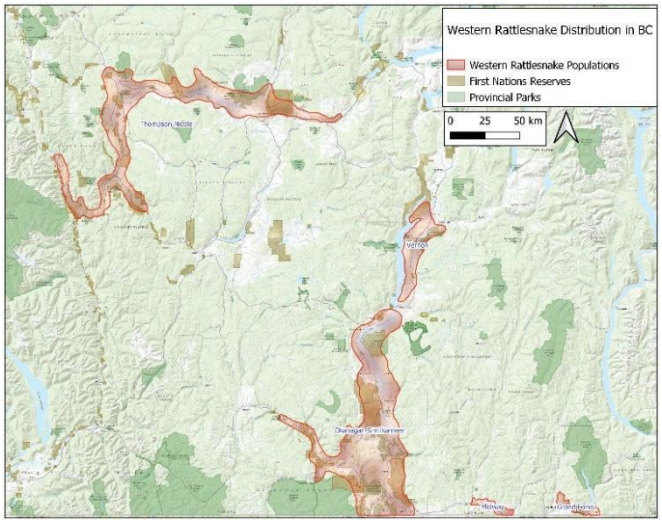
To ameliorate the threats to these species, and to the last remaining habitat they need for recovery, we first have to understand the species ecology, habitat needs and distribution (former and current). Each species is profiled briefly, as follows:

Western Rattlesnake

The northern Pacific rattlesnake (*Crotalus oreganus oreganus*) is BC's only venomous snake species and is the only subspecies of the Western Rattlesnake in BC[3]; hence it is referred to as simply Western Rattlesnake in recovery planning documents (COSEWIC 2015).

In BC's southern interior Western Rattlesnakes are restricted to two habitat types:

1. Grasslands characterized by blue bunch wheatgrass (*Agropyron spicatum*) and big sagebrush (*Artemisia tridentata*); and,
2. Open parkland forests characterized by Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*).



These vegetation types are referred to as the Bunchgrass (BG), Ponderosa Pine (PP), and Interior Douglas-fir (IDF) Biogeoclimatic Zones (BEC); they occur primarily within the Thompson-Okanagan Plateau and Okanagan Highland Eco-regions. Restricted geographic range within BC, threats (habitat loss and persecution), and reported declines in the BC population (due to localized extirpations and habitat loss) motivated listing of Western Rattlesnake as a cause for conservation concern (ECCC 2017a).

Ecology

The active season for Western Rattlesnake begins each spring with emergence from the den (or hibernaculum) in mid through to late March. By mid to late April snakes move away from the den to

3 Within Canada, Northern Pacific rattlesnake is the only extant subspecies of the western rattlesnake clade Two other SARA listed species of rattlesnake occur in Canada – the prairie rattlesnake (*C. viridis viridis*) occurs in Alberta and the eastern Massasauga rattlesnake (*Sistrurus catenatus catenatus)* occurs in Ontario.

summer foraging habitats; males tend to move further than females and gravid females remain proximal to den sites.

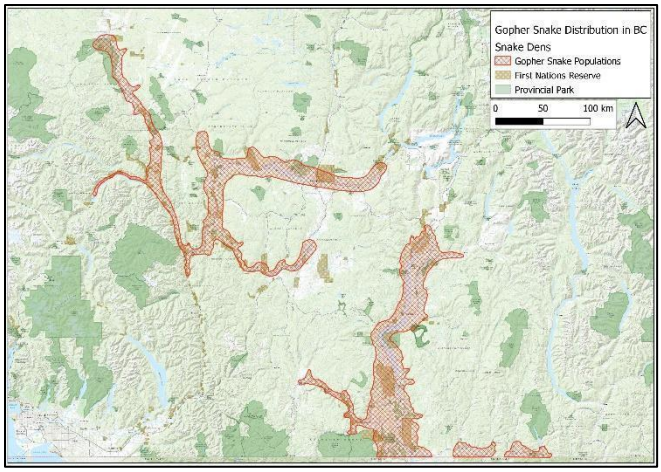
Each fall, starting mid-September, Western Rattlesnakes return to the dens where they spend the remainder of the active season basking at or near the den entrance until mid to late October. In the fall and winter rattlesnakes use hibernacula (or dens) to provide thermal protection during BC's cold interior winters. Within their documented range in southern BC the denning requirements of adult gopher snakes and racers partially overlap with those of Western Rattlesnake (Hobbs 2001, Shewchuk 1996). Dens are typically located in south to southwest aspect rock outcrops or deep talus associated with cliffs. Due to limited availability on the landscape these den features are typically shared by other species - often in large aggregations. In addition, communal use by other species including the Racer (*Coluber constrictor*), Gopher Snake and common Garter Snake (*Thamnophis sirtalis*) is also frequent. Fidelity to these often-limiting habitat features is high particularly for rattlesnakes, consequently these features are important for snake conservation in BC.

Western Rattlesnake has been heavily subjected to direct persecution, by humans, although as snake populations decline, and public education and awareness improves, it is likely that the threat from direct persecution has diminished somewhat in the past decade. Unfortunately, over the same period, the probability of direct mortality from increased road density and increased human use (of roads) in BC's southern interior have greatly increased. Studies in the Okanagan grasslands have documented a loss of 6.6% of the population/year from road mortality (Winton 2015). Winton's mortality estimates provide "*strong evidence that road mortality is and will be a significant contributor to population decline and adds to the growing body of evidence that large populations of long-lived species will face extirpation under low levels of road mortality, even in the absence of other sources of disturbance*".

Great Basin Gopher Snake

The Great Basin Gopher Snake (colloquially may be referred to as bull snake) is the largest snake in BC and can reach a total length of 2.4 m; however, this non-venomous, oviparous (egg-laying) colubrid snake seldom attains lengths over 1.4 metres in BC (IWMS. 1999). Superficially Gopher Snakes may appear similar to Western Rattlesnake as there are prominent rectangular dark brown dorsal patches against a yellow background, but Gopher Snakes lack the prominent rattle, the stout body, and the triangular head of a rattlesnake. There is also a conspicuous diagnostic stripe that extends from the upper labial scales, through the eye and across the dorsal surface of the head (see image above).

The interior grasslands of southern BC are at the northern extent of the range of this species in North America. In BC, it is limited to the warm, dry grassland valleys of the Thompson and Okanagan valleys, the Fraser River Valley (from Lillooet north to the Chilcotin), the Nicola River valley, the Similkameen



River Valley and the Boundary region (Hobbs 2013). Throughout most of its range gopher snake distribution and habitat preferences are sympatric and aligned with Western Rattlesnake.

Ecology

As with all BC snakes, Gopher Snake is active in the summer between April through to mid-October, and then dormant in the winter, seeking shelter from lethal temperatures by retreating to underground den sites. Den site fidelity has been well documented for several snake species including Gopher Snakes. Dens are typically at or near the valley bottom and are typically positioned with a southwest aspect in rocky areas.

Unlike Western Rattlesnake, Gopher Snake reproduces by laying eggs so, in addition to den sites, conservation of egg-laying sites is also important. In BC, egg-laying sites are also sometimes shared with other individuals and, in some cases, other species of snake—most commonly with Racer (*Coluber constrictor)*. These nest sites may be re-used from year to year by the same individuals.

Shewchuk (1996) demonstrated that adult Gopher Snakes typically moved an extensive distance over a short duration when moving between the den and the summer range. In Shewchuk's study adults had a mean dispersal distance of 933.9 +/- 185.1m (n=9) but gravid females often travel even further to reach their egg-laying sites in late June or early July. Where these movements are bisected by roads extensive mortality results.

During the active season small mammals account for 91% of the diet with the remaining 9% comprised of juvenile birds (Shewchuk 1996). Gopher Snakes have also been reported to eat bird eggs, insects, and lizards (IWMS. 1999). More recently, McAllister and Maida (2016) dissected the gastrointestinal tracts of road-killed specimens and identified a total of 11 prey items with a high degree of dietary overlap between gopher snake and Western Rattlesnake. Deer Mouse (*Peromyscus maniculatus*) was the most frequently identified prey item (both species), followed by shrews (*Sorex* spp.); Gopher Snakes had higher prey diversity with higher frequency consumption of both voles (*Microtus* spp.) and birds.

IUCN Threat Ratings – Western Rattlesnake and Great Basin Gopher Snake

An understanding of current threats, for each IUCN threat category, is necessary to inform subsequent assessment of available conservation and planning tools (or legislation) to facilitate recovery (**Table 10**). This understanding is also required to evaluate challenges facing recovery.

The summary of current threats, as summarized below, includes a fulsome consideration of available literature for both Western Rattlesnake and gopher snake. This review considered recent research, including published BC MSc thesis reports from S. Winton (2018), L. Gomez (2007), J. Maida (2014) and J. Hobbs (2007) and incorporated learnings from numerous additional scientific publications on both species. Federal and provincial Recovery Strategy and Recovery Action Plans were reviewed and incorporated, as were COSEWIC accounts for both species. In addition, the author and project leader

had previously completed his masters research on Western Rattlesnake, has been a key member in all BC herptile recovery teams, has supported all previous threat assessments for all herptile species (in BC) and remains very active in applied research and conservation of herptile fauna in the province with over 20 years of field research and snake den inventory. This collective knowledge and expertise informed the following summary of current threats.

Table 10: Summary of threat assessment for Western Rattlesnake and Great Basin Gopher Snake for each IUCN Threat classification category.

IUCN Threat Category	Scope	Severity Rating	Overall Threat Rank
1. Residential & commercial development	Small	Extreme	Low Risk; 1-10% decline anticipated
2. Agriculture & aquaculture	Restricted	Serious	Medium Risk; 3-21% declines anticipated
3. Energy production & mining	Small	Extreme	Small Risk; 1-10% decline anticipated
4. Transportation and Service Corridors	Pervasive	Serious	High Risk; 22-70% decline anticipated
5. Biological resource use & harm	Small	Slight	Low Risk; <1% decline anticipated
6. Human intrusions & disturbance	Restricted	Moderate	Low Risk; 1-9% decline anticipated
7. Natural system modifications	Small	Slight	Low Risk; <1% decline anticipated
8. Invasive & other problematic species & genes.	Unknown	Unknown	Unknown Risk
9. Pollution	Unknown	Unknown	Unknown Risk
10. Geological events	Unknown	Unknown	Unknown Risk
11. Climate change & severe weather	Unknown	Unknown	Unknown Risk

Description of Threats and Conservation Tools- Western Rattlesnake and Great Basin Gopher Snake

The overall province-wide office-based assignations for anticipated threats to Western Rattlesnake and Gopher Snake were rated as “high” in the Recovery Strategy (ECCC 2019). Both the federal and provincial assessments (e.g., IWMS 2004a and ECCC 2019) considered multiple threats that may commonly result in cumulative impacts. Threats, and relevant legal and non-legal conservation mechanisms, are noted for both snake species as determined by this assessment.

IUCN Threat 1 – Residential and Commercial Development

(Overall Score = Low Risk; 1-10% decline anticipated)

This threat contributes to loss and fragmentation of both foraging and denning habitats (ECCC 2019). Habitat loss and alteration from residential and commercial development is perceived to be the second highest threat (ECCC 2019). Urban development has also resulted in extensive loss of habitat, and with it there is an unquantifiable increase in depredation by pets, persecution by humans and mortality associated with vehicles when snake movements intersect with roads. This threat contributes to loss and fragmentation of both foraging and denning habitats (ECCC 2019). Habitat loss, and the expected detriment, is notably more pronounced in peri-urban areas, particularly in the Okanagan Valley where both species have been extirpated from large areas of their former range.

Legal Conservation Mechanisms:

- ✧None; the Official Community Plans (OCPs) fail to provide any legal requirement, or any non-legal guidance, for developments within snake habitat for most of the communities within the species' range.
- ✧The *Agricultural Land Commission Act* allows designation of Agricultural Land Reserves (ALRs). Within ALRs certain developments are restricted unless a permit is acquired. This affords consideration, but not protection, to some harmful land development activities.

Non-Legal Conservation Mechanisms:

- ✧BMPs advise to leave habitat features such as talus and flat rocks unaffected during development. When possible, restoration of these structures and the creation of artificial refuges and buffers is recommended.
- ✧The BC government published best management practices (non-legal, informative guidance). The Develop with Care document provides region specific advice on environmentally conscious developments; however, snakes are not mentioned in the recommendations.
- ✧Environmental stewardship organizations can prioritize educating the public to promote retaining backyard habitat to enhance connectivity within residential developments, but this is transitory and non-legal.

IUCN Threat 2 – Agriculture

(Overall Score = Medium Risk; 3-21% declines anticipated)

This threat considers effects from cattle grazing operations and considers agricultural activities for food production. The later threat is more severe as it results in large areas of land conversion, and hence habitat loss. Agricultural developments (e.g., vineyards, orchards, hay production or alfalfa farms etc.) alter or destroy habitat, disrupt movement, and cause accidental mortality through interaction with farm machinery. In addition, crops can disrupt movement corridors, and farm machinery causes direct mortality to individual snakes (ECCC 2019). A more recent threat has also been documented resulting from entrapment in plastic mesh used for bank stabilization, or for crop protection from birds (ECCC 2019). By converse, threats from free-range cattle grazing are less severe. Although intensive grazing can reduce cover and affect prey availability (i.e., microtines) (ECCC 2019) light grazing, if well managed, is likely relatively benign to snakes and snake habitat unless activity is concentrated near denning features (unlikely). Within the species' ranges the pervasiveness and scope of land conversion for agricultural purposes is high to extreme.

Range management practices can compromise snake habitat. Both snake species occur within xeric ecosystems that have historically supported native shrub-steppe grassland habitats dominated by

perennial grasses. As grazing intensity increases in these habitats soil compaction typically occurs, ground cover species composition often changes to favour sod-forming grasses with a concomitant reduction in perennial bunchgrasses, soil erosion may also increase, and water retention may be reduced as the cryptogamic crust is disturbed (Holechek et al. 1999). The effects on prey diversity are unquantified but are also likely negative. Deleterious effects related to livestock ranching include reduction in security cover (through reduction in stubble height and reduction in ground cover as sod-forming grasses (particularly cheat grass) succeed over native perennial bunchgrasses. In addition, productive riparian areas associated with relatively limited aquatic features (in xeric habitats) likely further impacts prey availability and abundance in these key foraging areas (for gopher snake and, to a lesser degree, for Western Rattlesnake).

For grazing, in general, range health is reasonable on crown lands within the range of both snake species. Impacts from overgrazing (and thus within all designated CH polygons) are localized. Continued communication with range tenure holders is required to encourage continued effective management for snakes, and snake habitats, within areas where grazing activities occur.

Legal Conservation Mechanisms:

- ✧The Government Actions Regulations (GAR), under FRPA, enables designation of WHAs, UWRs, Old-Growth Management Areas and Wildlife Habitat Features. These designations allow for area (and species) specific grazing and forestry practices regulations to conserve habitat values for identified species of wildlife (as listed on the Category of Species-at-risk or the Category of Ungulates).
- ✧For Gopher Snake and Western Rattlesnake FRPA prohibits concentration of livestock within 200m of den sites during snake dispersal and aggregation seasons within WHAs.
- ✧The *Range Act* enables the suspension of a range use license if non-compliance is found to potentially cause imminent damage to key biophysical attributes in a WHA but there has never been any compliance and enforcement for snakes in BC.
- ✧The Wildlife Act states that the owner of an escaped captive animal (i.e. livestock outside of permitted range land) is liable for any loss or damage to wildlife or habitat but it is very unlikely that this would ever be reported or corrected.
- ✧The *Parks Act* ensures no range activities may be permitted within designated park areas.

Non-Legal Conservation Mechanisms:

- ✧BMPs (PARC 2014) suggest range management to maintain grass height provide refuge from trampling, to provide security habitat and to prevent bank destabilization from livestock passage.
- ✧The BC Grazing Management Guide acknowledges the importance of grassland age-class structure for wildlife but makes no recommendations for maintaining structural diversity in grazed lands.

IUCN Threat 3 – Energy Production and Mining

(Overall Score = Small Risk; 1-10% decline anticipated)

Although footprint effects are localized mining, quarrying, and extraction of road-building material (e.g., riprap) causes direct mortality and can influence limiting denning habitats causing significant mortality to entire local populations.

Mining, quarrying, and extraction of road-building material (e.g., riprap) causes direct mortality and can influence limiting denning habitats causing significant mortality to entire local populations. Threats associated with quarrying activities are severe with complete loss of function to directly affected snake

habitats. Indirect effects from IUCN Threat 3 might also pronounce up to several hundred metres from the area of direct influence as these activities will impact snakes that attempt to move through mined areas.

Legal Conservation Mechanisms:

- ✧The *Mineral Tenure Act* prohibits application, by a recorded mineral tenure holder, for any mining activities within five specified protected designations (e.g., designated parks, ecological reserves, Land Act designations under 93.1, etc.).
- ✧The land use operation policy for aggregate and quarry materials states that quarry activities must have "due regard" for environmental sensitivities and minimize any adverse impacts.

Non-Legal Conservation Mechanisms:

- ✧Provincial best management practices for aggregate extraction require review and suggestion of mitigations for potentially impacted species, **excluding snakes**. Suggestions include proper planning and survey of wildlife prior to mine development, minimizing habitat loss within quarry boundaries, and ensuring adequate remediation. Similar values and mitigations are expressed in the Atlin Placer Miners' Association best management practices.
- ✧BMPs published by the Partners in Amphibian and Reptile Conservation (PARC 2014) suggest avoidance of development that results in habitat degradation and prevention of development of barriers that restrict snake movement.

IUCN Threat 4 – Transportation and Service Corridors

(Overall Score = High Risk; 22-70% decline anticipated)

The highest impact threat to both gopher snake and Western Rattlesnake in BC is direct mortality from collision/interaction with vehicles during snake dispersal (i.e., when seasonal migration movements from the dens intersect with roads) (ECCC 2019). Paved and unpaved roads (through direct mortality from collisions with vehicle traffic) and increased interaction with humans increase potential for direct mortality (Brown and Bomberger Brown 2013; Jochimsen et al. 2014; Rudolph et al. 1999; Winton 2015). Each of these mortality sources also have a secondary effect of reducing gene flow between populations by creating barriers to movement. Indirect effects include reduction of habitat quality, forage supply and direct predation from introduced and invasive species (e.g., weeds spread along roads). As such, habitat evaluation appropriately considered and included proximity to road in scoring criteria as the presence of roads directly effects habitat quality by influencing survivorship within at least a 1km area adjacent to roads (Winton 2020). Winton (2018) concluded that "*road mortality is and will be a significant contributor to population decline and adds to the growing body of evidence that large populations of long-lived species will face extirpation under low levels of road mortality, even in the absence of other sources of disturbance*".

Several recent publications further establish the severity of IUCN Threat 4 to snakes (Jochimsen et al. 2014; Winton 2015). Paved and unpaved roads (through direct mortality because of vehicle traffic) and increased interaction with humans increase potential for direct mortality (Rudolph et al. 1999; Brown and Bomberger Brown 2013; Jochimsen et al. 2014; Winton 2015). Each of these mortality sources also have a secondary effect of reducing gene flow between populations by creating barriers to movement. Indirect effects include reduction of habitat quality, forage supply and direct predation from introduced and invasive species (e.g., weeds spread along roads).

Modelling by Kirk et al. (2021) estimated that approximately 50% of the provincial population of Western Rattlesnake has been lost due to direct mortality associated with transportation corridors. This is likely a conservative estimate, particularly in the Boundary, Okanagan, Thompson and Similkameen Regions, where major Highways bisects most of the mapped snake CH.

Legal Conservation Mechanisms:

- ✧None; the highways act does not mention environmental values within its legislation. The Ministry of Transportation and Infrastructure is responsible for planning and managing the upkeep of the province's entire public road network but there are no specific provisions for management of impacts to wildlife.

Non-Legal Conservation Mechanisms:

- ✧Provincial BMPs (PARC 2014) advise avoidance of roadway development in sensitive areas. When this cannot be achieved, the document recommends providing corridors for wildlife passage (e.g., tunnels, wildlife overpasses, etc.) or installation of fencing to reduce wildlife access.
- ✧Similarly, BMPs also suggest installation of safe passages under roads.
- ✧BMPs provide additional suggestions including increased signage for wildlife crossings in relevant areas and minimizing the use of plastic mesh erosion control in high wildlife trafficked areas (to reduce associated risk of entanglement of snakes).

IUCN Threat 5 – Biological Resource Use and Harm

(Overall Score = Low Risk; <1% decline anticipated)

For forest dependent species this IUCN threat is typically significant (e.g., Williamson's Sapsucker, Spotted Owl and Marbled Murrelet) as it considers affects from commercial forest harvest practices, but for snakes this threat is low with the noted exception of accidental mortality that may result during low elevation access road construction, harvesting, and timber hauling. Impacts from forestry were deemed unknown.

By converse, threats from direct persecution (and, to lesser degree, collection) are also considered within this threat category and these may be relatively high for snakes; hence all den location data is treated as sensitive by the BC CDC. Notwithstanding, persecution continues but it is challenging to quantify the level of threat.

Legal Conservation Mechanisms:

- ✧FRPA allows prescription of regulations to support wildlife objectives. The designation of WHAs under this act can be used as a tool to afford management to snake dens. The act also states that a person must not carry out a forest practice that results in damage to the environment.
- ✧The *Forest Act* states that road use permits for forest service roads (for industrial use) will be permitted *only* if the activity will not cause inordinate disturbance to the natural environment.
- ✧The *Parks Act* inhibits the approval of any park use permits for logging on park land.

Non-Legal Conservation Mechanisms:

- ✧BMPs (PARC 2014) for resource road development (i.e., logging roads) recommend minimizing new construction and potential erosion, constructing during time periods when snakes are least active, deactivation of roads upon completion of use, and installation of underpasses and fencing to mitigate road mortality. They also suggest reducing ground disturbance by using harvesters or cable systems.

✧Direct persecution can be addressed by increasing public outreach and education to maintain a healthy relationship between snakes and people.

IUCN Threat 6 – Human Intrusion and Disturbance

(Overall Score = Low Risk; 1-9% decline anticipated)

The severity of the impact is thought to be slight; although, in the South Okanagan, a long-term mark-recapture study illustrated that in highly human-disturbed habitat snakes had lower body condition relative to other equivalent less disturbed areas (Lomas et al. 2019).

Human persecution is also still likely a threat to snake recovery; however, quantitation of direct impacts to snakes is challenging, if not impossible, to estimate. Fortunately, the impact of this threat is, today, estimated to be low relative to previous eras that documented disappointing levels of ignorance and intolerance for snakes in BC. The BC *Wildlife Act* prevents this type of behavior but without any means for compliance and enforcement individual residents' propensity for persecution persists.

Legal Conservation Mechanisms:

✧There is legislationure that applies to adventure tourism operators; however, no legal protections currently exist for public recreational use on crown land.

Non-Legal Conservation Mechanisms:

✧Provincial BMPs for recreational activities in grasslands provides suggestions for many recreational activities. Recommendations for recreational use include staying on trails, spreading out small groups if off trail, minimizing soil disturbance if building trails, minimizing cleaning of rock faces (for rock climbing) and, when encountered, providing wildlife with space.
Public outreach and education can also be used to maintain a healthy relationship between snakes and people and provide the public with information to mitigate harm to wildlife when encountered.

IUCN Threat 7 – Natural System Modifications

(Overall Score = Low Risk; <1% decline anticipated)

This threat is slight (ECCC 2019) with noted impacts from fire suppression resulting in an increase to tree and shrub density (shading and loss of basking opportunities). Accumulation of ground and ladder fuels from suppression may also lead to catastrophic wildfires which may be inescapable, causing mortality. Fireguards constructed during active fire suppression can cause accidental mortality and destroy habitat.

Legal Conservation Mechanisms:

✧The *Wildfire Act* allows regulations to be developed for fire control and protection of grassland resources.

✧There is currently no legislation to require potentially beneficial prescribed burning practices.

Non-Legal Conservation Mechanisms:

✧The BC Wildland Fire Management Strategy outlines the importance of including fire regimes in land management plans and can be used to support reduction of fire suppression.

✧BMPs (PARC 2014) recommend measures to control spread of invasive species (e.g., cheatgrass) as these species alter natural fire patterns. Recommendations also include consultation with prescribed fire specialists to reduce negative effects associated with fire suppression.

IUCN Threat 8 – Invasive and Other Problematic Species and Genes

(Overall Score = Unknown Risk)

The influence of depredation by domestic animals (primarily cats and dogs) is impossible to quantitate but is almost certainly severe with intensity of depredation and population detriment being directly proportional to proximity to residential areas. Although this is primarily a peri-urban issue domestic pets likely have a significant negative effect upon snake populations within 1 km of residential areas. Unfortunately, although well-meaning and naïve to the harm it causes, the propensity (particularly in rural areas) to let domestic animals roam freely outdoors is likely a cultural norm in BC.

There are also threats from pathogens; this threat is particularly challenging to estimate as the presence of *Ophidiomyces ophiodiicola* (an emerging fungal disease that affects snakes) has not been confirmed in BC. By converse, and although impossible to quantify, mortality due to depredation by domestic cats and dogs are ongoing, particularly in peri-urban areas. It is doubtful that educational efforts to inform citizens of this issue will result in any change; the culture of keeping out-door cats is pervasive and deeply rooted. Fortunately, this issue is largely an urban and peri-urban threat and, in consideration of habitat quality (i.e., loss of habitat IUCN threat two) the immediate threat from cats and dogs is likely low (ECCC 2019).

In addition, threats from invasive species (in particular, plants such as cheatgrass and knapweed) exacerbated by grazing but are not well understood – it is likely that changes in graminoid community composition may negatively effect prey abundance and availability.

Legal Conservation Mechanisms:

- ✧The *Wildlife Act* states that the owner of an escaped captive animal is liable for any loss or damage to wildlife or habitat. It also prohibits (without a permit) the import, possession, breeding, and trafficking of a controlled alien species by individuals.
- ✧The *Weed Control Act* states that there is a duty to control noxious weeds.

Non-Legal Conservation Mechanisms:

- ✧Mortality from predation by domestic animals can be mitigated through education and outreach. The Stewardship Centre for BC has a program regarding the effects of cats on wild bird populations.
- ✧Invasive species societies can work directly at removing invasive species (e.g., cheatgrass), or can implement programs such as Plant Wise to educate the public regarding invasive species identification and removal.
- ✧BMPs (PARC 2014) recommend prevention of establishment of non-native species through early detection and eradication.

IUCN Threat 9 – Pollution

(Overall Score = Unknown Risk)

Impacts to secondary ingestion of rodenticide have been documented (ECCC 2019); however, research on the topic is limited, in BC, to a single study by Bishop et al. (2016) (as cited in COSEWIC 2015). In this study C. Bishop modeled the risk of strychnine bait poisoning, to gopher snake, in the Okanagan; it was suggested that there was potential for a substantial impact. A GIS based model was used to estimate the population level impact of Strychnine[4] on gopher snake. This study estimated that consumption of

[4] Strychnine is an active ingredient in some rodenticides. This neurotoxin is often used, in natural environments, to suppress rodents (notably these are used to suppress pocket gophers (*Thomomys talpoides*); a key prey item for gopher snake).

poisoned pocket gophers, could result in a 50% loss of adult Gopher Snake in 25 years (i.e., a generation) (Bishop et al. 2016).
Also considered under IUCN threat nine are impacts from garbage and solid waste disposal. Snakes have become entangled in discarded agricultural netting (Lomas, pers. comm., 2014; Bishop, pers. comm., 2016 as cited in ECCC 2019).

Legal Conservation Mechanisms:

- ✧The 2021 Ministerial Order under the *Integrated Pest Management Act* banned the sale of pesticides containing brodifacoum, bromadiolone, and difethialone to anyone who is not an 'essential service'. However, essential services include pest management businesses and agricultural operations, and thus harmful pesticides are still available for broadscale application.
- ✧The *Waste Management Act* prohibits individuals to allow waste to be introduced to the environment, unless a permit is awarded (e.g., landfill permit).
- ✧The *Waste Management Act* requires that communities' development community-specific waste management plans.

Non-Legal Conservation Mechanisms:

- ✧The Landfill Criteria for Municipal Solid Waste (MOE 2016) requires that landfills are not located within 100 m of an environmentally sensitive area, including the habitat of any species of noted conservation concern (e.g., the habitat or rare, threatened, or endangered species listed under federal legislation). This document also states that a landfill should be operated and maintained to avoid effects on wildlife, including access to litter. It also encourages the use of wildlife exclusion fencing (Note: there are five documented dens immediately adjacent to, and affected by, the landfill at Grand Forks despite these criteria).
- ✧BMPs (PARC 2014) recommend minimizing the use of plastic mesh during road construction to avoid mortality from entanglement.

IUCN Threat 10 –Geological Events

(Overall Score = Unknown Risk)

This thought is thought to be negligible, and beyond any available mitigation. No legal or non-legal tools exist for protecting snakes from geological events.

IUCN Threat 11 – Climate Change

(Overall Score = Unknown Risk)

This threat is challenging to assess but it is undoubtable that rapid change to environmental conditions (i.e., temperature extremes, or variation in season precipitation rates) will influence both snake species but it is challenging to predict the severity and direction of influence. Extreme (summer) temperatures may alter foraging behavior, reducing foraging opportunity. Hot dry summers will also exacerbate instances of catastrophic stand replacing fires in summer (forested) habitats within the interior Douglas-fir and Ponderosa Pine BEC zones, with concomitant negative affects upon snake populations.

Legal Conservation Mechanisms:

- ✧There are several Acts that strive to reduce emissions to slow climate change (e.g., Greenhouse Gas Reduction Act, Zero-Emission Vehicles Act, Clean Energy Act).

Non-Legal Conservation Mechanisms:

✧There are government programs affording attention to reduction of carbon emissions to slow climate change (e.g. Carbon Neutral Government Program, Clean BC Roadmap to 2030).
✧BMPs (PARC 2014) and Reptile Conservation recommend affording protection and minimizing impacts to remaining stable habitats to reduce avoidable external stressors and increase the capacity of individuals to handle climate change.
✧The University of British Columbia has combined BEC zone mapping with Climate BC predictions to predict habitat shifts. This, combined with analysis of connectivity, can identify new areas that may qualify for additional survey.

Threat Assessment Summary

Unfortunately, mitigating the above noted threats, for Western Rattlesnake and Great Basin Gopher Snake, will continue to pose an arguably insurmountable challenge to snake recovery in BC. Not surprisingly, the threat assessments as reported above are consistent with threat descriptions in the Recovery Strategy (ECCC 2019). Unfortunately, where snake habitat occurs on privately or publicly owned lands there is little to no effective legal protection, for snakes or snake habitat. As such, there is little effective legal protection available for any IUCN threats (including the largest stressor; road mortality) as noted above. This lack of effective legal protection is further confounded by the fact that compliance and enforcement is fettered by a lack of funding; even where violation occurs (e.g., wildlife act violations that include intentionally persecution of snakes by humans) there is a very low likelihood of corrective, punitive, or remedial action.

This analysis suggests that conservation and recovery of both Western Rattlesnake and Great Basin Gopher Snake is largely relegated to provincial parks and federal lands or relegated to areas too remote to be of any near-term residential, commercial, or agricultural development interest (IUCN Threat 1: Residential and Commercial Development and IUCN Threat 2: Agriculture). In addition, the lack of effective legal protection from the most dominant stressor (IUCN Threat 4: Transportation Corridors), suggests that recovery will require conservation of areas that are not influenced by, or within several kilometres of, a paved road. These areas include Okanagan Mountain Provincial Park, the north shore of Kamloops Lake, and the west side of the Thompson River between Spences Bridge and Lytton. Federal lands at Osoyoos could have also provided a fourth conservation area as this formerly large area of ideal habitat on the Osoyoos Reserve lands was, until recently, capable of sustaining a large well-studied snake population. Unfortunately, the following account (see text box) reveals a troubling narrative.

Land Tenure

To better understand and implement conservation actions for snakes it is also important to understand land tenure within mapped (and unmapped) Critical Habitat for both species. Tenure is relevant for two reasons:

1. as the range of both species largely co-occurs within areas of high human population densities (i.e., the Southern Interior) and population growth is anticipated by Statistics Canada.
2. Available conservation and management policy and legislation in BC varies according to land tenure. An analysis of area by tenure *within* mapped core CH within the range of both species in BC yields a salient perspective.

To benefit this understanding all mapped CH polygons (in the Boundary area) were analyzed in a GIS environment, for both species, and reconciled against land tenure (as estimated from publicly available provincial layers depicting land private land ownership, First Nations reserve lands and designated Class 1 parks). **Figure 9** and **Figure 10** depict the relative distribution of CH by tenure type. Although the analysis was only completed within the boundary region this analysis illustrates a key issue for species recovery in BC as the relative distribution is reflective of the rest of the range of both species in the province.

Figure 9: Relative area by tenure for Western Rattlesnake.

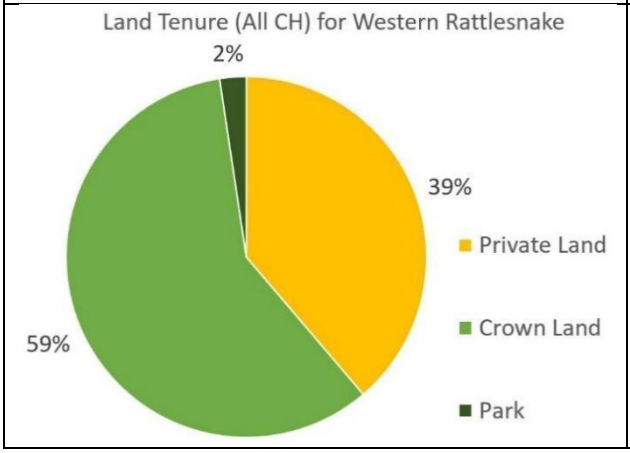
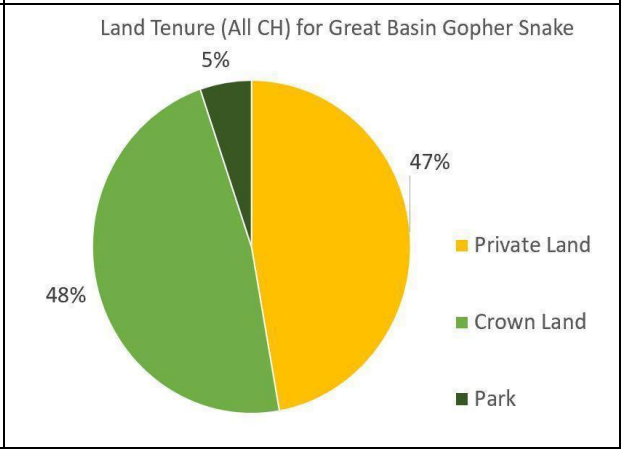


Figure 10: Relative area by tenure for gopher snake.



Unfortunately, and as described in the response to Question 4 (part one of this report) effective legal protection for SARA Schedule 1 listed species is extremely limited, or non-existent, to address most of the noted threats for each of the 11 IUCN threat categories. These limitations are even more apparent on privately owned lands. The text box below serves to illustrate the lack of effective legal protection to snake CH on privately owned lands; with recent and ongoing development of a quarry has permanently destroyed CH on private land near Midway, BC.

Lack of Compliance and Enforcement in Response to Destruction of Critical Habitat…

Recent quarrying activity (quarry development on private land) at Midway has resulted in the permanent destruction and loss of denning habitat immediately within federally mapped CH, and adjacent to a protected areas (WHA 8-437) designated under the BC *Forest and Range Practices Act*. In addition to excavation of talus at or near known denning habitat the dumping of waste-fill has covered a large area of Gopher Snake CH polygon 42 (also within Western Rattlesnake CH polygon 225).

The 2017 Recovery Strategy specifically identifies Mining and Quarrying in Table 3 (Activities likely to result in destruction of critical habitat) and states "*Mining and quarrying can result in direct loss of hibernacula as well as reduction/loss of suitability of other habitat features and attributes required by the species*".

Why is there no compliance and enforcement where there is clear violation of the federal SARA on lands that fall under provincial jurisdiction (which includes privately owned lands)? This activity is clearly not aligned with commitments under the Canada-British Columbia Agreement on Species at Risk. There are countless examples of harm to CH on provincial lands that go uncorrected.

Conservation Conclusion

Present management under current governance (municipal, provincial, federal) is unlikely to effectively prevent long-term (i.e., >100 years) extirpation of Western Rattlesnake and Gopher Snake within most of the habitats currently occupied by snakes in BC **unless threat of mortality along transportation corridors is addressed.**

Localized den extirpations have already occurred in many areas (e.g., Grand Forks, Midway, Vernon, Kelowna, Thompson, Similkameen, Okanagan). This pattern is likely to continue with little means of abatement unless wildlife overpasses can be installed at strategic locations where frequent use, by snakes, can be anticipated. Without costly mitigation measures (i.e., construction of overpasses to allow safe passage for wildlife) it is suggested that only those snake populations that are unimpacted by road mortality, or whose impact is below the population growth rate, will persist in the long term. These areas include the north shore of Kamloops Lake, the west side of the Thompson River from Spences Bridge to Lytton, and Okanagan Mountain Provincial Park.

The duration of persistence is an interplay between population growth rate and mortality rate as influenced by the stressors described herein, with the most pronounced and inevitable stressor being human-wildlife interactions particularly along linear transportation corridors. This is a disappointing conclusion. These enigmatic species are a compelling component of the grassland ecosystems in BC but unfortunately their future is tenuous throughout most of the species' range in BC.

Great Basin Spadefoot

Great Basin Spadefoot is a predominantly terrestrial small amphibian with a short, squat body and a slightly upturned nose. A dark, keratinous 'spade' (used for burrowing) is present on each hind foot.

The Great Basin Spadefoot spans the inter-montane region between the Rocky Mountains and the Coastal Ranges of western North America (Matsuda et al. 2006). This species is distributed throughout the Great Basin ecosystem in western USA, through the southern interior of BC, and northwards into the Cariboo region of BC's central interior. Breeding sites in BC are found at low elevations (<1250 m) in six geographic areas: Kettle, Granby, Okanagan/Similkameen, Nicola, Thompson, and Cariboo (ECCC 2017c). Population trends are difficult to determine although it's likely the species is in decline given the widespread loss and fragmentation of grassland habitat, especially in the rapidly developing Okanagan-Similkameen and Thompson valleys (COSEWIC 2007).

Ecology

Great Basin Spadefoot requires aquatic habitat for breeding and larval development. Migration to breeding ponds is prompted by heavy rains and can take place anytime from April to June (COSEWIC 2007). Female spadefoots lay 300-800 eggs on submerged vegetation or directly on the bottom of ponds (Sarell 2004a). The transformation from an egg to a metamorph takes four to eight weeks, the fastest among BC anurans, and is heavily influenced by water temperature and depth (Newman 1998; COSEWIC 2007).

Juveniles and adults remain in terrestrial habitat year-round (aside from the brief breeding period) where foraging, aestivation, migration, dispersal, and over-wintering take place. Spadefoots are fossorial, the majority of an individual's time during the active season (April - September in BC) is spent in self-dug underground burrows and to a lesser extent, small mammal burrows (Sarell 2004a). Radio-telemetry studies report variable results for movements within terrestrial habitats in BC, generally 300-500 metres (Garner 2012); Richardson and Oaten (2013) reported 66% of tagged individuals staying within 500 m of breeding sites but 10% making longer movements ranging from 750-2350 m.

Various water bodies types in BC including lakes, ponds, flooded fields, puddles, cattle dugouts, ditches, and artificial water features can support Great Basin Spadefoot breeding (COSEWIC 2007; Garner and Packham 2011). Spadefoots show a strong preference for vernal sites with shallow water (< 1 m) that dry annually, presumably because these sites typically lack aquatic predators (i.e. fish and large invertebrates) and maintain temperatures suitable for larval development (Sarell 2004*a*, COSEWIC 2007). Water at these sites is required for a period of four to eight weeks for successful recruitment to occur. In these vernal systems water levels can fluctuate greatly with environmental conditions (Newman 1998; Boorse and Denver 2003).

Terrestrial habitat is characterized by bunchgrass grasslands, shrub-steppe and open pine and Douglas-fir forests (Matsuda et al. 2006). The fossorial nature of spadefoots dictates the need for habitat

features that permit burrowing; most often this species is found in areas with deep, loose and friable soils, although the ability to burrow into relatively fine and compacted soils has been observed (J. Garner, pers. obs.; SIRAWG 2016 and references therein).

Livestock can have a significant effect on amphibian aquatic habitat through changes in water quality, habitat structure, or direct mortality (Sarell 2004a; Cragg 2007; Schmutzer et al. 2008). Trampling and grazing of vegetation in and around the perimeter of the wetland can create larval 'traps' in deep hoof marks and alters habitat quality. Overgrazing can lead to soil compaction and changes in plant community structure, including a shift from bunchgrass communities (i.e. well-spaced clumps of vegetation) to invasive, sod-forming communities (i.e. uniform ground coverage; Daubenmire 1970; Gayton 2004).

The federal recovery strategy for Great Basin Spadefoot outlines methods used to map CH, and summarizes essential functions, biophysical features and key habitat attributes for both core and connectivity habitats. Aquatic breeding habitats are described for courtship, egg-laying, development, and foraging; terrestrial habitats are described for foraging, overwintering and movement between breeding and terrestrial habitats.

Tiger Salamander

The Blotched Tiger Salamander is a pond-breeding amphibian with a blunt snout, rounded head, and small eyes. They exhibit a blotched or barred pattern (yellow, cream, green or olive coloured) on a dark background (Corkran and Thoms 2006; COSEWIC 2012).

Larval tiger salamanders have large heads and very long (longer than the head) gills. Under certain circumstances, larvae may develop into neotenic individuals, which are sexually-mature, permanently aquatic individuals that look similar to larvae but are much larger (Corkran and Thoms 2006; COSEWIC 2012). Neotenic tiger salamanders have only been observed at five sites in BC (SIRAWG 2016) (shown in image above).

There are two species of tiger salamanders found in North America; the eastern tiger salamander (*A tigrinum*), found in the eastern provinces and states of Canada and the US (respectively), and the Western Tiger Salamander (*A. mavortium*), which is west of the continental divide (COSEWIC 2012). The western tiger salamander is wide-ranging in Canada, its distribution is continuous throughout a large portion of south-central Alberta, Saskatchewan, and Manitoba (*A. mavortium melanostictum* and *A. m. diaboli*). In BC, the species is restricted to arid valleys in the extreme southern interior of the province (*A. m. melanostictum*). There are a total of 86 known Tiger Salamander breeding wetlands within three geographic areas of BC (Okanagan/Similkameen, Midway, and Kootenay Boundary Region) found at elevations from valley bottom (300 m) up to 1,250 m (SIRAWG 2016, ECCC 2017b).

Ecology

Tiger Salamanders require both aquatic and terrestrial habitat to complete their life cycle. Breeding and larval development occur within aquatic habitats. The onset of heavy spring rains in March through April prompts adults to migrate from upland terrestrial habitat to breeding sites (Richardson et al. 2000, SIRAWG 2016). Females lay single eggs in shallow (< 1 m) water and attach them to submerged vegetation or other debris below the water's surface (Corkran and Thoms 2006; COSEWIC 2012). Larvae hatch after two to three weeks where they remain for a total of three to four months until they emerge as metamorphs. Length of the larval rearing period is influenced by several factors, including water temperature, hydroperiod, density of larvae, and food resources available (SIRAWG 2016 and references therein). Newly metamorphosed salamanders emerge in August (the earliest recorded date of emergence in BC is July 22) and remain close to breeding ponds until rain permits overland travel (Richardson et al. 2000, Sarell 2004*b*; SIRAWG 2016).

Outside the breeding season Tiger Salamanders use terrestrial habitat surrounding breeding sites. Although this species spends the majority of its time on land in subterranean refuges it is known as a highly vagile salamander species (Sarell *2004*b*;* Trenham and Shaffer 2005; Searcy and Shaffer 2011). Observations of radio-tagged Tiger Salamanders in the South Okanagan (White Lake), suggest that adults use terrestrial habitat within 500 m of the breeding site; road observations from the same area indicate that it is not uncommon for movements > 500 m to occur although the majority of this subpopulation is thought to remain within 1 km of the breeding site (SIRAWG 2016 and references therein). As for all herptiles, when these movement corridors are bisected by roads mortality is usually extensive resulting in localized extirpation at even low traffic volumes.

Tiger Salamanders in BC are found exclusively in areas characterized by grassland, shrub-steppe, or open forest (COSEWIC 2012). They breed in vernal ponds (seasonal and temporary wetlands) and permanent waterbodies (SIRAWG 2016) including saline meadows, marshes, shallow-water wetlands, artificial wetlands, and shallow water wetland zones along the edges of permanent ponds or lakes (Sarell 2004b). A key component of all breeding sites is the presence of shallow (< 1 m) water. The temperature within shallow water zones facilitates egg development and larval rearing and the shallow water depth permits

growth of emergent vegetation, which is the typical substrate for egg deposition (Sarell 2004*b*). Water must be maintained within breeding sites for a period of at least five months (mid-March until August) for successful recruitment to occur (Sarell 2004*b*, SIRAWG 2016). Hydroperiod can influence both the number and fitness of emerging metamorphs, with longer hydroperiods under suitable water conditions (i.e. temperature, prey availability, etc.) allowing more time for larval growth and development, resulting in larger metamorphs with higher survival and reproduction rates (Semlitsch et al. 1988; McMenamin and Hadly 2010). Additional factors influencing successful recruitment include the availability of adequate food (invertebrates and small vertebrates) and the absence of predators, specifically fish (SIRAWG 2016). Tiger Salamander terrestrial habitat is characterized as open and dry areas with sandy, friable soils (Richardson et al. 2000; Searcy et al. 2013; Welsh 2015). These habitat attributes are apparent on a large scale, as they are only found in the driest areas of the province.

Maintenance of body moisture, even in the driest areas, is facilitated through selection of suitable refuge sites (Preest and Pough 1989). Small mammal subterranean burrow complexes and soil loosened from excavation activity provides ideal refuge sites for tiger salamanders, so much so that the species' distribution is closely associated with the presence of burrowing small mammals, specifically Northern Pocket Gophers (*Thomomys talpoides*) and Great Basin Pocket Mouse (*Perognathus parvus*) (Richardson et al. 2000; Welsh 2015). Richardson et al (2000) found adult Tiger Salamander to exclusively use Great Basin pocket mouse burrows and areas of excavated soil throughout the summer.

Livestock grazing is prevalent throughout this species range and is described as a threat (SIRAWG 2016). Light to moderate grazing may not negatively affect Tiger Salamanders at the population level, however site-specific effects of high-density grazing can be detrimental. Such effects include soil compaction, loss of riparian vegetation, excessive nutrient input into water, reduced water volume due to livestock drinking, and trampling within wetland habitat leading to direct mortality off eggs/larvae (Cragg 2007, SIRAWG 2016 and references therein) or causing larvae to become stranded in deep hoof marks (J. Hobbs and J. Garner, pers. obs.).

IUCN Threat Ratings – Blotched Tiger Salamander and Great Basin Spadefoot

An understanding of current threats, for each IUCN threat category, is necessary to inform subsequent assessment of available conservation and planning tools (or legislation) to facilitate recovery (**Table 11**). This understanding is also required to evaluate challenges facing recovery.

The summary of current threats, as summarized below, provides context, for each threat, based on impacts realized since pre-European settlement. Based on that understanding future threats are anticipated and described. To complete this evaluation a fulsome consideration of available literature for Blotched Tiger Salamander and Great Basin Spadefoot were reviewed to ensure currency. Experience and familiarity with the focal taxa, and familiarity with field conditions throughout the species range, also informed the description of each IUCN threat.

Table 11: Summary of threat assessment for Blotched Tiger Salamander and Great Basin Spadefoot each IUCN Threat classification category.

IUCN Threat Category	Scope	Severity Rating	Overall Threat Rank
1. Residential & commercial development	Large	Serious	High Risk; 10-49% decline anticipated
2. Agriculture & aquaculture	Pervasive	Moderate	Medium Risk; 8-30% decline anticipated)
3. Energy production & mining	Small	Slight	Low Risk; <1% decline anticipated
4. Transportation and Service Corridors	Pervasive	Extreme	Extreme Risk; 50-100% decline anticipated
5. Biological resource use & harm	Restricted	Slight	Low Risk; 1-3% decline anticipated
6. Human intrusions & disturbance	Restricted	Slight	Low Risk; 1-3% decline anticipated
7. Natural system modifications	Restricted	Moderate	Low Risk; 1-9% decline anticipated
8. Invasive & other problematic species & genes.	Restricted	Moderate	Low Risk; 1-9% decline anticipated
9. Pollution	Large	Moderate	Medium Risk; 3-21% decline anticipated
10. Geological events	Not assessed	Not assessed	Unknown Risk
11. Climate change & severe weather	Pervasive	Serious	High Risk; 22-70 decline expected

Description of Threats and Conservation Tools - Blotched Tiger Salamander and Great Basin Spadefoot

The overall province-wide office-based assignations for anticipated threats to Blotched Tiger Salamander were rated as "high"; threats to Great Basin Spadefoot were rated as "Medium to High". (ECCC 2017b; ECCC 2017c). Both the federal and provincial assessments (e.g., IWMS 2004a and ECCC 2019) considered multiple threats that may commonly result in cumulative impacts. Threats, and relevant legal and non-legal conservation mechanisms, are noted for Blotched Tiger Salamander and Great Basin Spadefoot as follows.

IUCN Threat 1 – Residential and Commercial Development

(Overall Score = High Risk; 10-49% decline anticipated)

This threat results in loss of breeding habitat and alteration and loss of foraging habitat. Infilling of wetlands results in substantial loss of breeding habitat (range-wide, both species). Mortality, during habitat conversion, occurs in all age classes (adults, eggs, and larvae (or tadpoles)) (COSEWIC 2007). Developed surfaces, including hard landscaping (i.e., roads, buildings) and soft-landscaping (e.g., use of sod-forming grasses for lawns) prevent spadefoot from digging burrows to avoid depredation and desiccation). Obviously, this loss is not absolute as extant breeding populations of spadefoot (and likely tiger salamander are still detected in agricultural areas, but populations will be reduced and at-risk. This threat is directly correlated with human density and use and is more pronounced in residential and agricultural areas (relative to rural areas).

Legal Conservation Mechanisms: Legal:

- ✧Riparian Areas Protection Act: The Riparian Areas Protection Regulation (RAPR) was enacted under Section 12 of the Riparian Areas Protection Act in February 2016. The RAPR calls on local governments to protect riparian areas during residential, commercial, and industrial development by ensuring that a Qualified Environmental Professional (QEP) conducts a science-based assessment of proposed activities. This regulation; however, does not afford any protection to amphibians and non-fish bearing riparian systems (e.g., ephemeral ponds).
- ✧The Agricultural Land Commission Act allows designation of Agricultural Land Reserves (ALRs). Within ALRs certain developments are restricted unless a permit is acquired. This affords consideration, but not protection, to some harmful land development activities.

Non-Legal Conservation Mechanisms:

- ✧BMPs advise to maintain riparian and emergent vegetation cover, course woody debris, and small waterbodies. If required, restoration of these structures and the creation of artificial refuges and buffers is recommended.
- ✧The Develop with Care document provides regionally specific advice on environmentally conscious developments that aligns with, and references, the BMP recommendations above.
- ✧Environmental stewardship organizations can prioritize public education to promote retention of habitat to enhance habitat connectivity within residential developments.

IUCN Threat 2 – Agriculture

(Overall Score = Medium Risk; 8-30% decline anticipated)

Impacts from planting and harvest of annual and perennial non-timber crops reduces habitat quality, or eliminates habitat, depending on the crop. This threat is most pronounced as lower elevations; unfortunately, these lower elevation habitats are the areas where both Spadefoot and Tiger Salamander likely (previously) occurred in highest abundance. Valley bottom habitats in the south Okanagan River valley are now almost completely developed for intensive agricultural purposes, or for residential and

commercial uses. These areas still support relict populations in a few areas but both species have been otherwise eliminated from most areas. In the remaining areas that still support key biophysical attributes, for example where agricultural areas abut more natural habitats, persistence is more likely.

Livestock farming and ranching is also included within IUCN Threat Category #2, and is pervasive (i.e., grazing by cattle), occurring throughout most of the species' ranges. Great Basin Spadefoot and Tiger Salamander occur within ecosystems associated with aquatic features that have historically supported native grasslands dominated by perennial grasses. As grazing intensity increases, soil compaction typically occurs, and ground cover species composition often shifts to favour sod-forming grasses with a concomitant reduction in perennial bunchgrasses. Soil erosion may also increase, and water retention may be reduced as the cryptogamic crust (comprised of mosses, lichens, algae, bacteria) is disturbed. Livestock ranching is prevalent over much of the range of Great Basin Spadefoot and Tiger Salamander in the southern interior region. Deleterious effects related to livestock ranching include: "*trampling of nearshore aquatic vegetation and bottom substrate, soil compaction and burrow collapse, increased nutrients that may facilitate increased levels of pathogens (see summary in Sarell 2004a and 2004b), and reduced water volume caused by livestock drinking, especially in shallow ponds during drought years (Richardson, pers. comm., 2000)*" (ECCC 2017b).

Effects of Cattle on Key Biophysical Attributes for Pond Breeding Amphibians

Compaction can directly affect habitat suitability by alienating areas of potential habitat from use by either tiger salamander or spadefoot. If livestock density is concentrated (i.e., near water features in dry years) trampling by livestock may result in direct mortality to adults, eggs, or larvae. Intensive use, by cattle, can also negatively impact suitable substrates available for egg-laying and promote loss of cover for larvae for both species.

These effects may be particularly pronounced in shallow wetlands. Although grazing activities are managed under FRPA there are opportunities for improvement, particularly in the ponds where pugging is occurring. Wildlife Habitat Areas can (theoretically) be used to encourage development of mitigative measures that still allow equivalent function to the range tenure holder but also serve to reduce pugging and trampling. Single point access, controlled by fencing, would effectively address this issue at these sites.

An example of pugging, by cattle, at Ingram Pond in the Kettle River area.

Legal Conservation Mechanisms:

- ✧The Government Actions Regulations (GAR), under FRPA, enables designation of WHAs, UWRs, Old-Growth Management Areas and Wildlife Habitat Features. These designations allow for area (and species) specific grazing and forestry practices regulations to conserve habitat values for identified species of wildlife (as listed on the Category of Species-at-risk or the Category of Ungulates).
- ✧For Great Basin Spadefoot and tiger salamander, FRPA recommendations include installing exclusion fencing and ensuring there are no livestock attractants placed within a WHA.
- ✧The Range Act enables the suspension of a range use license if non-compliance is found to potentially cause imminent damage to key biophysical attributes in a WHA.
- ✧The *Wildlife Act* states that the owner of an escaped captive animal (i.e., livestock outside of permitted range land) is liable for any loss or damage to wildlife or habitat.
- ✧The *Parks Act* ensures no range activities may be permitted within designated park land.

Non-Legal Conservation Mechanisms:

- ✧BMPs (PARC 2014) suggest controlling the access of livestock to wetlands and streams by installing exclusion fencing. To minimize necessity of livestock to enter watercourses, establishment of alternative water sources (e.g., troughs) is also recommended.
- ✧There are no recommendations for range management within riparian areas provided in the provincial Grazing Management Guide. It does provide reference to the provincial Riparian Management Guide, which simply requires ranchers to limit livestock access to small watercourses if bands or beds are being consistently damaged.

IUCN Threat 3 – Energy Production and Mining

(Overall Score = Low Risk; <1% decline anticipated)

Although localized within the Kootenay-Boundary Region threats associated with quarrying activities are severe with complete loss of function to directly affected amphibian habitat. Indirect effects from IUCN Threat #3 might also pronounce up to several hundred metres from the area of direct influence as these activities will affect amphibians that attempt to move through mined areas. The recovery strategies for both species considered this threat to be negligible.

Legal Conservation Mechanisms:

- ✧The Mineral Tenure Act prohibits application, by a recorded mineral tenure holder, for any mining activities within five specified protected designations (e.g., designated parks, ecological reserves, Land Act designations under 93.1, etc.).
- ✧The land use operation policy for aggregate and quarry materials states that quarry activities must have “due regard” for environmental sensitivities and minimize any adverse impacts.

Non-Legal Conservation Mechanisms:

- ✧Provincial best management practices for aggregate extraction require site inventory and mapping of all water bodies, including ephemeral wetlands. All mining activities must be conducted >50 m from any watercourse. Other suggestions include proper planning and survey of wildlife prior to mine development, minimizing habitat loss within quarry boundaries, directing water from the quarry to retention ponds, and ensuring adequate remediation.
- ✧BMPs (PARC 2014) suggest retaining 30 buffers between water courses and mining activities/infrastructure (e.g. roads), controlling sediment runoff by use of settling ponds (note: advise against the use of tailings ponds), avoidance of development that results in habitat degradation and prevention of development of barriers that restrict amphibian movement. Other third party BMPs provide information on impacts, and relevant mitigation, of other mining

activities unrelated to quarries. These operations include exploration, construction, reclamation, and road access relevant to hard-rock mining.

IUCN Threat 4 – Transportation and Service Corridors

(Overall Score = Extreme Risk; 50-100% decline anticipated)

Federal and provincial recovery documents identify transportation as amongst the highest impact threat to both tiger salamander and spadefoot, range wide (ECCC 2017b; ECCC 2017c); assignations for future impact were High-Medium, scope was pervasive, and severity was Serious-Moderate.

For Great Basin spadefoot a provincial analysis in ECCC 2017c concluded that 80% of the species range was within 500m of roads and almost 100% within 3km. Crosby (2014 - as cited in ECCC 2017b) posited that spadefoot comprised 87.4% of all amphibians observed on roads (and 46.5% of road killed individuals) in her study. Crosby (2014) suggested that Great Basin spadefoot also appear to use paved surfaces for thermoregulation and water absorption (Crosby 2014) thus increasing susceptibility to this threat.

Threat severity varies depending on proximity to paved roads, road traffic use and road placement. Near major highways (e.g., Highway 3 and Highway 97) resident populations (both species) have been severely impacted and status is likely tenuous.

Legal Conservation Mechanisms:

- ✧None; the highways act does not mention environmental values within its legislation. The Ministry of Transportation and Infrastructure is responsible for planning and managing the upkeep of the province's entire public road network but there are no specific provisions for management of impacts to wildlife.

Non-Legal Conservation Mechanisms:

- ✧Provincial BMPs (e.g., Develop with Care) advise avoidance of roadway development in sensitive areas. When this cannot be achieved, the document recommends providing corridors for wildlife passage (e.g., tunnels, wildlife overpasses, etc.) or installation of fencing to reduce wildlife access.
- ✧Similarly, other BMPs (PARC 2014) also suggest installation of safe passages under roads.
- ✧BMPs provide additional suggestions including increased signage for wildlife crossings in relevant areas and reducing salt and herbicide use (for road/ditch maintenance) near watercourses.

IUCN Threat 5 – Biological Resource Use and Harm

(Overall Score = Low Risk; 1-3% decline anticipated)

For forest dependent species this IUCN threat is typically significant (e.g., Williamson's Sapsucker) as it considers affects from commercial forest harvest practices, but for both xeric (grassland) amphibian species this threat is low with the noted exception of accidental mortality that may result during low elevation access road construction, harvesting, and timber hauling. Impacts from forestry are unknown Both species can occur in forested areas with tiger salamander being more likely to use forested habitats but impacts from this threat are likely slight.

Threats from direct persecution (and, to lesser degree, collection) are challenging to quantify but are likely negligible.

Legal Conservation Mechanisms:

✧*FRPA* allows prescription of regulations to support wildlife objectives. The designation of WHAs under this act can be used as a tool to afford management to breeding sites. The act also states that a person must not carry out a forest practice that results in damage to the environment. Accounts and measures for both taxa suggest implementing road closures to reduce road mortality during periods of increased activity (e.g., migration).

✧The *Forest Act* states that road use permits for forest service roads (for industrial use) will be permitted *only* if the activity will not cause inordinate disturbance to the natural environment. The *Parks Act* inhibits the approval of any park use permits for logging on park land.

Non-Legal Conservation Mechanisms:

✧BMPs (PARC 2014) for resource road development recommend minimizing new construction and potential erosion, constructing during time periods when amphibians are least active, deactivation of roads upon completion of use, and installation of underpasses and fencing to mitigate road mortality. They also provide suggestions for reducing impacts within cut blocks, like minimizing ground disturbance by using harvesters or cable systems and maintaining shrubs around small temporary ponds that may be utilized by breeding populations post-logging.
Other third party BMPs (WSP 2009) stress having adequate drainage to maintain natural flow regimes and to minimize erosion until sites can be remediated.

IUCN Threat 6 – Human Intrusion and Disturbance

(Overall Score = Low Risk; 1-3% decline anticipated)

The severity of the impact from human intrusion and disturbance to both species is thought to be slight, with the dominant stressor attributed to off-road vehicle use (i.e., mud-bogging). The ECCC recovery strategy for Tiger Salamander did not describe this threat (although this is an inappropriate omission as it is likely a source for some direct mortality); the recovery strategy for Great Basin Spadefoot rated severity (for this threat) as moderate-slight and noted the wide range for this rating was due to uncertainty over the frequency of interaction with mud-bogging activities. Direct mortality has been documented (J. Garner. Pers. comm and as cited in ECCC 2017c).

Legal Conservation Mechanisms:

✧There is legislature that applies to adventure tourism operators; however, no legal protections currently exist for public recreational use on crown land.

Non-Legal Conservation Mechanisms:

✧Provincial BMPs for recreational activities in grasslands provides suggestions for many recreational activities. Recommendations for recreational use include staying on trails, spreading out small groups if off trail, minimizing soil disturbance if building trails and, when encountered, providing wildlife with space.

✧BMPs (WSP 2009) suggest off-road vehicles drive around wetlands and not through them. However, if necessary, to accelerate slowly (rather than spinning wheels) to minimize damaging soils.

✧Public outreach and education can also be used to maintain a healthy relationship between amphibians and people and provide the public with information to mitigate harm to wildlife when encountered.

IUCN Threat 7 – Natural System Modifications

(Overall Score = Low Risk; 1-9% decline anticipated)

The most pronounced interaction is in relation to water management. Over-prescribing licensed use of water (for agricultural purposes) from ponds, and lotic inputs, may cause early drying of ephemeral ponds or drying of otherwise permanent lentic features, particularly in abnormally drier or hotter summer conditions such as those experienced in 2021 (see Threat 11 – Climate Change).

Legal Conservation Mechanisms:

✧*Riparian Areas Protection Act*: The Riparian Areas Protection Regulation (RAPR) was enacted under Section 12 of the Riparian Areas Protection Act in February 2016. The RAPR calls on local governments to protect riparian areas during residential, commercial, and industrial development by ensuring that a Qualified Environmental Professional (QEP) conducts a science-based assessment of proposed activities.

✧The *Water Sustainability Act* allows regulation for the use, alteration, and deactivation of works (i.e., anything that is used for water movement, collection, or measuring) to be implemented. If efforts are implemented to research proper prescriptions for lotic inputs, this clause would allow over-prescriptions of ponds to be corrected; thus, ensuring ephemeral ponds are sustained for the breeding season and metamorphosizing phases.

Non-Legal Conservation Mechanisms:

✧Water conservation initiatives (e.g., BC's Climate Action Toolkit) attempts to encourage domestic water-use licensees to minimize water usage, allowing more water retention in the natural water table.

IUCN Threat 8 – Invasive and Other Problematic Species and Genes

(Overall Score = Low Risk; 1-9% decline anticipated)

This threat is particularly challenging to estimate or predict as the introduction of predatory fish (i.e., sport fish), goldfish (Carassius auratus) and American bullfrogs (Lithobates catesbeianus) is on ongoing, illegal and unpredictable event, particularly in peri-urban areas. ECCC (2017b) states "the spread of non-native fish over the past 10–20 years has been extensive throughout the South Okanagan River valley (Herborg, pers. comm., 2012) and Boundary region (Tedesco, pers. comm., 2016)." Legal stocking, by the BC government, continues in previously stocked lakes and, although new stocking plans are currently not proposed within Blotched Tiger Salamander range, illegal stocking of perch, trout, and bass still takes place (Southern Interior Reptile and Amphibian Recovery Team 2008). It is ironic that the same government agency that perpetuates stocking (to develop a recreational sport-fishing industry) is also tasked with tiger salamander conservation and recovery. Mitigating and preventing stocking seems a prudent and obviously necessary first step for amphibian conservation.

Non-government stocking attempts also occur—the thoughtless, reckless, and illegal introduction of goldfish is a blatant continued activity under IUCN Threat #8. Declines and disappearances of Tiger Salamander has been documented from several lakes, in direct association with fish introductions (Sarell 1996; Ashpole et al. 2011; as cited in ECCC 2017b).

In addition, illegal introduction of bullfrogs is well documented, from several foreign source points to many locations in BC. This alien invasive species is particularly problematic for Tiger Salamander as they have not evolved a coping (i.e., avoidance) mechanism to these introduced predators. Due to an unpredictable probability of introduction this threat is impossible to quantify but given that there have been several known introductions of both bullfrogs and goldfish (in BC) public outreach to educate residents, and government programs, seems prudent.

Threats from pathogens are impossible to quantify with current data; a recently described chytrid fungus, *Batrachochytrium salamandrivorans*, poses a new and potentially grave threat, if it undergoes a global spread but fortunately it has not been documented in natural systems in BC at this time (ECCC 2017b). Similarly, Tiger Salamanders are highly susceptible to highly infectious and lethal iridoviruses with die-offs of Blotched Tiger Salamander reported across North America (Jancovich et al. 2005 as cited in ECCC 2017b). Spadefoot have also tested positive for chytrid fungus (*Batrachochytrium dendrobatidis*) in BC (although no direct mortality was observed (ECCC 2017c).

Finally, domestic pets are another stressor included under IUCN Threat 8. Effects from depredation by domestic animals (primarily cats and dogs) are also impossible to quantitate but is almost certainly ongoing with intensity of depredation and population detriment being directly proportional to proximity to residential areas. This threat likely continues to deleteriously affect tiger salamander and spadefoot in peri-urban environments (where they still occur). Unfortunately, although well-meaning and naïve to the harm it causes, the propensity (particularly in rural areas) to let domestic animals roam freely outdoors is likely a cultural norm within areas within the distributional range of both focal amphibian species in the Kootenay-Boundary Region.

Legal Conservation Mechanisms:

- ✧The *Wildlife Act* states that the owner of an escaped captive animal is liable for any loss or damage to wildlife or habitat. It also prohibits (without a permit) the import, possession, breeding, and trafficking of a controlled alien species by individuals. Despite this law there are instances where the individual identity was known to have introduced problematic species and there was no enforcement consequence (e.g., the former mayor of Grand Forks introduced goldfish to Saddle Lake; a key breeding area for tiger salamander).
- ✧The *Weed Control Act* states that there is a duty to control noxious weeds.

Non-Legal Conservation Mechanisms:

- ✧Mortality from predation by domestic animals, or released animals, can be mitigated through education and outreach. The Stewardship Centre for BC has a program regarding the effects of cats on wild bird populations.
- ✧Provincial eradication programs (e.g., BCCF Bullfrog Program) paired with citizen science and focused monitoring initiatives can reduce population size of invasive species. Invasive plant species societies can work directly at removing invasive species (e.g., aquatic plants), or can implement programs such as Plant Wise to educate the public regarding invasive species identification and removal.
- ✧BMPs (PARC 2014) recommend prevention of establishment of non-native species through early detection and eradication. They also advise against introducing provincially native sport fish into watercourses outside of their natural establishment (i.e., where they do not occur naturally).

IUCN Threat 9 – Pollution

(Overall Score = Medium Risk; 3-21% decline anticipated)

Exposure to toxic and teratogenic substances can impair reproduction and development in amphibians. Effects upon hatching success, from herbicide application, have been documented (by Bishop, as cited in ECCC 2017c) on Spadefoot in BC. Similarly, application of Vectobac®, Malathion and bacterium-based mosquito (adult and larval) control agents in lentic features appears to be widespread. Malathion is already approved for use by regional government. Mosquito control agents are purportedly being applied to several important Tiger Salamander breeding features with concomitant direct (poisoning) and indirect (reduction in prey abundance) effects to both Spadefoot and Tiger Salamander.

Similarly, application of commonly used herbicides, pesticides, and fertilizers all undoubtedly affect eggs, tadpoles, larvae and adults; application of these contaminants (previous, current and ongoing) is likely particularly widespread in agricultural areas

Several known breeding features have been, and continue to be, impacted by pollution through intentional BC government permitted and unpermitted applications of these toxic and teratogenic substances. Effects, and application of pesticides, fertilizers, and herbicides, are challenging if not impossible to quantify but this threat is thought to be large or pervasive with moderate to slight affect.

Legal Conservation Mechanisms:

- The *Waste Management Act* prohibits individuals to allow waste to be introduced to the environment, unless a permit is awarded.
- The *Riparian Areas Protection Regulation* ensures protection of riparian zone natural features that support the life processes of protected fish from any harmful alterations, including pollution in surface runoff. This regulation; however, does not afford any protection to amphibians and non-fish bearing riparian systems (e.g., ephemeral ponds).
- The *Integrated Pest Management Regulation* requires individuals to prepare a management plan that incorporates environmental values prior to becoming a permitted license holder.

Non-Legal Conservation Mechanisms:

- The provincial Herbicide Field Handbook does not provide any recommendations (or prohibitions) for applying herbicides near watercourses.
- BMPs (PARC 2014) recommend limiting the use of chemical herbicides, pesticides, and fertilizers in all applications. If chemical controls cannot be avoided, application should be limited to spot removal treatments (as opposed to broad applications) and upland habitats (away from wetted or seasonally wetted areas).

IUCN Threat 10 –Geological Events

(Overall Score = Unknown Risk)

This thought is thought to be negligible, and beyond any available mitigation. No legal or non-legal tools exist for protecting snakes from geological events.

IUCN Threat 11 – Climate Change

(Overall Score = High Risk; 22-70 decline expected)

With climate change water tables are expected to continue to drop and water demands are expected to increase (MFLNRORD 2014a). In the Similkameen an emergency order was invoked, for the first time ever by the BC government in 2021, to restrict water use (for irrigation of agricultural crops) in response to unprecedented warm water temperatures attributed to record low water levels. Many lentic features dried completely in 2021 – based on vegetation, and local accounts this was an unusual if not unprecedented situation. Spadefoots are less likely to be impacted by these cyclic extremes as their reproductive cycle is relatively condensed, with emergence of terrestrial sub-adults from breeding ponds occurring as early as late May. For Tiger Salamander, the earliest emergence (in BC) is July 25th; in dry years (with conditions like those experienced in 2021) it is likely that many lentic features would have dried prior to emergence resulting in the loss of an entire breeding year. Xeric-adapted amphibians can tolerate a missed breeding year but if these conditions persist over successive years localized extirpations are likely.

Legal Conservation Mechanisms:

✧There are many acts that purport to reduce emissions to slow climate change (e.g., Greenhouse Gas Reduction Act, Zero-Emission Vehicles Act, Clean Energy Act) but effectiveness and adoption vary.

Non-Legal Conservation Mechanisms:

✧There are government programs affording attention to reduction of carbon emissions to slow climate change (e.g., Carbon Neutral Government Program, Clean BC Roadmap to 2030).

✧BMPs (PARC 2014) recommend affording protection and minimizing impacts to remaining stable habitats to reduce avoidable external stressors and increase the capacity of individuals to handle climate change.

✧The University of British Columbia has combined BEC zone mapping with Climate BC predictions to predict habitat shifts. This, combined with analysis of connectivity, can identify new areas that may qualify for additional survey.

Threat Assessment Summary

Unfortunately, mitigating the above noted threats, for Blotched Tiger Salamander and Great Basin Spadefoot, will continue to pose an arguably insurmountable challenge to species' recovery in BC. The threat assessments as reported above are consistent with threat descriptions in the Recovery Strategy (ECCC 2017b). Unfortunately, where breeding habitat occurs on privately or publicly owned lands there is little to no effective legal habitat protection. As such, there is little effective legal protection available for any IUCN threats (including the largest stressor; road mortality) as noted. This lack of effective legal protection is further confounded by the fact that compliance and enforcement is fettered by a lack of funding; even where violation occurs (e.g., wildlife act violations that include stocking with goldfish, or illegal use of pesticides for mosquito control) there is a very low likelihood of corrective, punitive, or remedial action.

This analysis suggests that conservation and recovery of Blotched Tiger Salamander and Great Basin Spadefoot is largely relegated to provincial parks and federal lands or relegated to areas too remote to be of any near-term residential, commercial, or agricultural development interest (IUCN Threat 1: Residential and Commercial Development and IUCN Threat 2: Agriculture). In addition, the lack of effective legal protection from the most dominant stressor (IUCN Threat 4: Transportation Corridors), suggests that recovery will require conservation of areas that are not influenced by, or within several kilometres of, a paved road. Given its relatively restricted range these options are very restricted for Blotched Tiger Salamander. In contrast, Great Basin Spadefoot persistence and recovery is more likely particularly in the portion of the species range along key areas in the Thompson and Fraser River basins.

Land Tenure

To better understand and implement conservation actions for snakes it is also important to understand land tenure within mapped (and unmapped) Critical Habitat for both species. Tenure is relevant for two reasons:

1. As the range of both species largely co-occurs within areas of high human population densities (i.e., the southern interior) and population growth is anticipated by Statistics Canada.
2. Available conservation and management policy and legislation in BC varies according to land tenure. An analysis of area by tenure *within* mapped core CH within the range of both species in BC yields a salient perspective.

To benefit this understanding all mapped CH polygons (within two isolated populations) were analyzed in a GIS environment, for both species, and reconciled against land tenure (as estimated from publicly available provincial layers depicting land private land ownership, First Nations reserve lands and designated Class 1 parks). **Figure 11** and **Figure 12** depict the relative distribution of CH by tenure type. Although the analysis was only completed within the Kootenay-Boundary Region the analysis illustrates a key issue for species recovery in BC as the relatively distribution is reflective of the rest of the range of both species in the province.

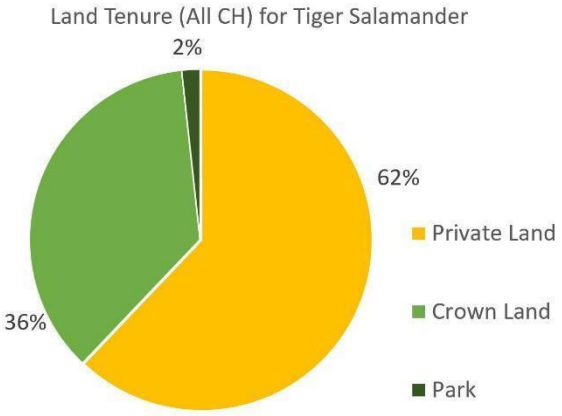


Figure 11: Tenure type as shown by percentage, of mapped CH for tiger salamander.

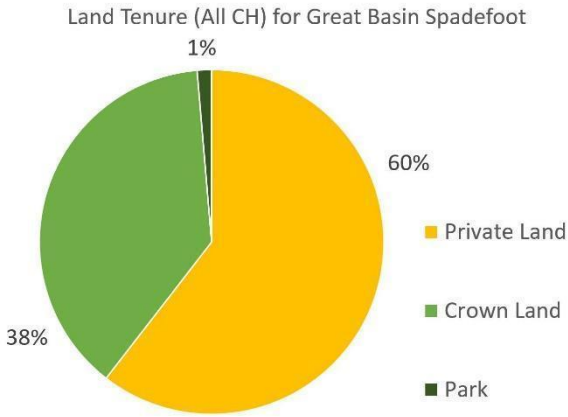


Figure 12: Tenure type as shown by percentage, of mapped CH for Great Basin spadefoot.

Unfortunately, where Spadefoot or Tiger Salamander habitat occurs on privately owned lands (i.e., the majority of mapped CH) there is little effective legal protection that can be applied at the provincial or municipal level (see Evaluation of IUCN Threats - **Results** section). As such, there is very little effective legal protection available for any other IUCN threats.

This lack of effective legal protection is further confounded by the fact that compliance and enforcement is fettered by a lack of resources; even where violation occurs (e.g., stocking Saddle Lake with goldfish, poisoning Ward Lake with pesticides or abuse of water licenses by tenure holders) there is a very low likelihood of corrective, punitive, or remedial action.

Conservation Conclusion

Present management under current governance (municipal, provincial, federal) is unlikely to effectively prevent long-term extirpation of Tiger Salamander and Spadefoot within most of the habitats previously or currently occupied by either species (i.e., within both AOs). In several areas localized extirpations have also already occurred within many previously extant populations in the Okanagan and Kootenay-Boundary Regions. This pattern is likely to continue with little means of abatement as mitigation measures are not required, but instead recommended, under MFLNRORD (2014a). Additional guidance is provided under Herptile BMPs (MFLNRORD 2014b); although recommendations are well-developed, they are still a non-legal requirement during resource and land development. As such, it is likely that only those populations that are unimpacted by road mortality, or whose impact is below the population growth rate, will persist in the long term. The duration of persistence is an interplay between population growth rate and mortality rate as influenced by the stressors described herein, with the most pronounced and inevitable stressor being human-wildlife interactions particularly along linear transportation corridors.

North Area

The North Area is the largest geographic region of the province—slightly larger than the combined areas of the Coast and South areas. It extends roughly from the Highway 16 corridor in the south to the Yukon and Northwest Territory boundaries in the north. The area includes three MFLNRORD regions, the Skeena Region in the west, the Omineca Region in the central portion, and the Northeast (Peace) Region east of the Rocky Mountains. The North Area is dominated by sub-boreal and boreal ecosystems with a much colder climate than the Coast and South Areas. The southwestern portion of the North Area includes the North Coast, which contains coastal and coast-transitional ecosystems and experiences a northern maritime climate. The terrain in the North Area is dominated by a series of north-south trending mountain ranges, including the Coast Mountains, Omineca Mountains and Rocky Mountains. Notable portions of the North Area with more subdued topography include a large interior plateau in the south-central portion of the area, from Prince George to Houston to Fort St. James, and in the Northeast Region the boreal foothills plains extend east of the Rocky Mountains.

Most of the North Area experiences a continental climate with warm, dry summers and long, cold winters, with snow on the ground from November through March. Forest fires are the primary natural disturbance agent over most of the region.

The North Area is dominated by five biogeoclimatic (BEC) zones: Sub-boreal Spruce, Engelmann Spruce – Subalpine Fir, Boreal Black and White Spruce, Spruce – Willow – Birch, and Boreal Altai Fescue Alpine. Four additional BEC zones occur in the coast-influenced portion of the area in the southwest (Coastal Western Hemlock, Interior Cedar Hemlock, Mountain Hemlock, and Coastal Mountain Heather Alpine). Sub-boreal Pine and Spruce, Montane Spruce, and Interior Mountain Heather Alpine occur in limited extents along the southern edge of the North Area.

The degree of human disturbance varies substantially across the North Area. The human population is much lower in the North Area relative to the Coast or South areas and human settlements and transportation corridors are mostly limited to the southern and eastern portions of the area. In the southern portions of all three MFLNRORD regions industrial logging is extensive, and annual harvest rates have exceeded the long-term sustainable yield over the last two decades, purportedly to “salvage” large areas of forest killed by mountain pine beetle. Oil and gas exploration, development, and transportation is also extensive in the Northeast Region. Mining and mineral exploration is widespread across the North Area, though the footprint of mining-related developments is much smaller than that of the forestry and oil and gas sectors. Much of the northwestern portion of the North Area, constituting approximately a quarter of the area, is largely unsettled and free of resource developments, save for mineral exploration and guide outfitter operations.

Woodland Caribou were selected as a case-study species for the North Area due to their iconic status as a northern species, the significant range-wide population declines the species has experienced over the last fifty years, and because of the substantial conservation efforts being invested in the species. Similar to the previous examples, this case study (i) summarizes the ecology and status of the species as foundational material then (ii) evaluates IUCN treats to the species, (iii) summarizes the existing legal and non-legal conservation measures currently available to address each threat and (iv) evaluates the success of the existing conservation measures and identifies where measures are deficient or lacking.

Caribou

Taxonomy and Classification

All Caribou and reindeer in the world belong to one species, *Rangifer tarandus*. Three subspecies of Caribou occur in Canada; all Caribou in British Columbia are of the woodland Caribou subspecies (*R. tarandus Caribou*).

Classification of Caribou subspecies into populations has evolved over the last two decades. The current classification integrates an earlier system consisting of eight Canadian Nationally Significant Populations (NSP) (used in the SARA listings) with a more recent classification consisting of 12 Designatable Units (DUs) (COSEWIC 2011). The resulting integrated classification splits the Southern Mountain Caribou (SMC) Nationally Significant Population into three groups, the Southern Group, Central Group, and Northern Group (**Table 12, Figure 12**). Two other Nationally Significant Populations (NSPs) (the Northern Mountain Caribou and Boreal Caribou populations) also occur in BC.

Conservation Status

The conservation status of the five NSP/DU Caribou populations in British Columbia is summarized in **Table 12.** The Central Mountain and Southern Mountain populations remain classified as Threatened on the SARA Schedule 1 list despite an upgrade of those two populations to Endangered by COSEWIC (2014a). The reason for designation of Endangered for these two populations includes substantial population declines, extirpation of several subpopulations, small size of many subpopulations, and severely limited dispersal potential among most subpopulations. Surveys have shown consistently high adult mortality and low calf recruitment. Threats are continuing and escalating (COSEWIC 2014a). The Northern Mountain population was designated Special Concern because several of the herds are declining and due to increasing industrial developments that could affect predator-prey dynamics (COSEWIC 2014b). The Boreal population is considered Threatened due to substantial population declines across much of its range related to ongoing habitat loss and increased predation, likely due to human activities (ECCC 2020).

Table 12: Conservation status of Caribou in British Columbia by current SARA and COSEWIC classifications *(BC Caribou Recovery Program 2021).*

SARA Nationally Significant Populations / COSEWIC Group (Designatable Unit)	SARA Schedule 1 Status	COSEWIC Status
Southern Mountain Caribou		
Southern Group (DU9)	Threatened	Endangered (2014)
Central Group (DU8)	Threatened	Endangered (2014)
Northern Group (DU7)	Special Concern	Special Concern (2014)
Northern Mountain Caribou (DU7)	Special Concern	Special Concern (2014)
Boreal Caribou (DU6)	Threatened	Threatened (2014)

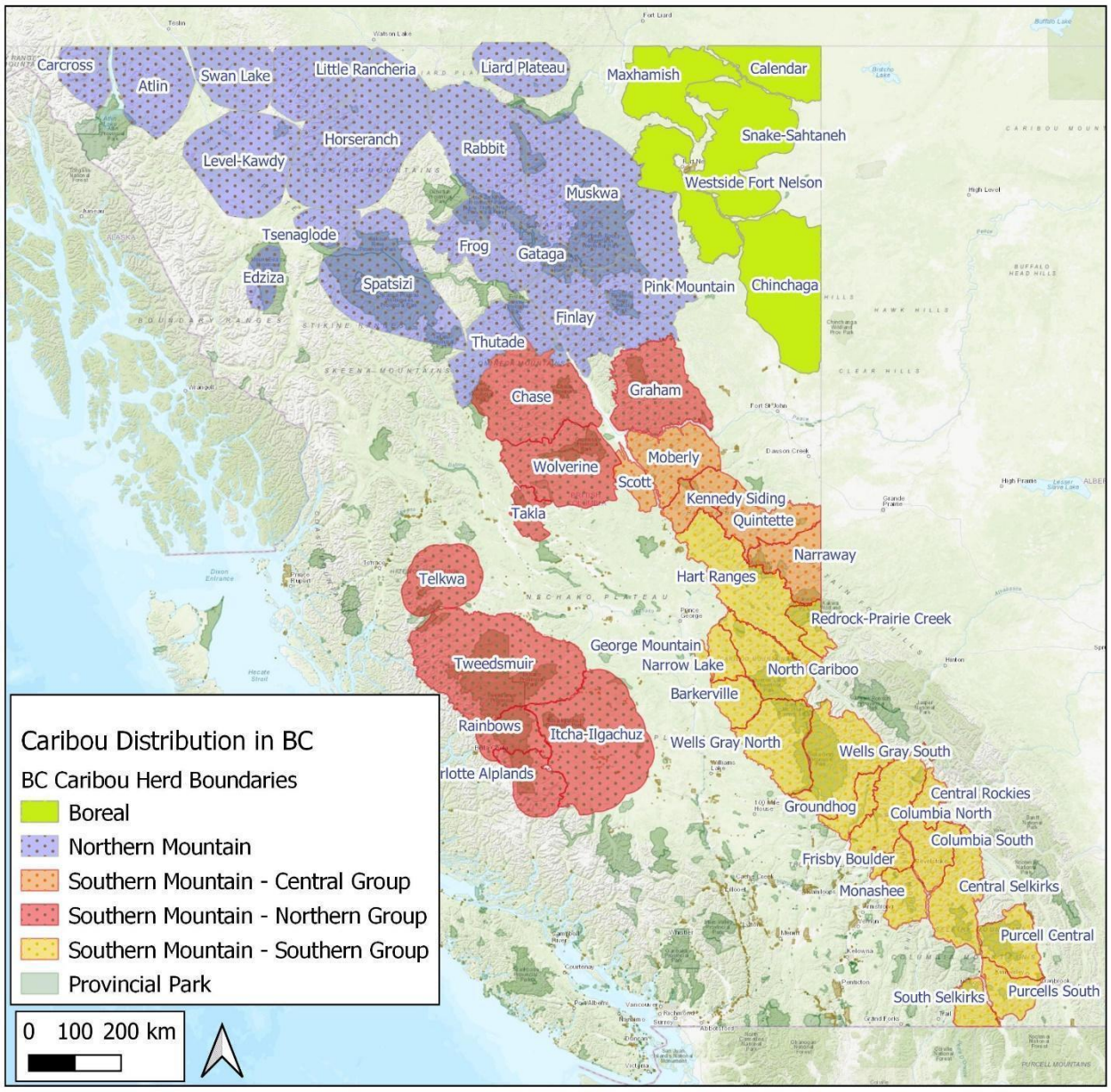


Figure 12: Distribution of 54 woodland Caribou herds in British Columbia (BC Caribou Recovery Program 2021).

General Ecology

Caribou are a member of the deer family, *Cervidae*, and are unique among the family in that both males and females develop antlers. The primary life strategy of Caribou is to occupy regions with relatively low vegetative productivity (e.g., alpine areas and mature conifer forests) which reduces competition with other ungulates and reduces predation risk. One adaptation that facilitates this strategy is the ability to digest lichens, which is unique among large mammals. Another adaptation is large, concave hooves, which support the animal on snow and muskeg, and function as efficient scoops to paw through the snow to reach lichens and other food in winter.

During the growing season Caribou forage on a variety of graminoids (grasses), forbs, and shrubs. During the winter lichens typically dominate the diet. In areas that receive relatively shallow snowpack (<approximately 75 cm; including many of the herds in the Northern and Central groups of the SMC), terrestrial lichens typically dominate the diet. In areas that receive relatively deep snowpack (including most herds in the Southern group) arboreal lichens are primarily used.

Predation is the primary limiting factor for most woodland Caribou herds and predation risk is believed to play a major role in the distribution and habitat selection of woodland Caribou. Wolves are the primary predator of Caribou but bears (including both black bear (*Ursus americanus*) and grizzly bear (*Ursus arctos*) can cause significant mortality to the young calf cohort. During summer, insect harassment (including biting and parasitic insects) and heat stress can be important factors affecting Caribou behaviour, distribution, and habitat selection. For example, insect avoidance often results in reduced foraging time and selection of areas with suboptimal forage, such as snow patches and bare, windy alpine ridges.

Caribou occur in distinct herds (or subpopulations) that typically undertake long distance movements among seasonal ranges within their overall annual herd range[5]. Caribou require large ranges of relatively undisturbed and interconnected habitat which allows them to (i) spatially separate themselves from predators, (ii) access different food resources in different seasons, and (iii) modify range and habitat use in response to various natural and human events and disturbances (e.g., varying snow depths across years, changes in seral stage distributions due to wildfire, and human industrial and recreational activities) (COSEWIC 2014a).

Most Southern Mountain Caribou require both high elevation alpine areas and lower elevation forested areas within their annual ranges (COSEWIC 2014a). Most herds spend the summer and fall in alpine habitats with adult females giving birth in subalpine or alpine areas. Winter use patterns vary more. In the Southern Group, where snowpacks are typically deep, most herds winter in mature and old forests that provide arboreal lichens. Often there is a general pattern of using lower elevation areas earlier in the winter and then moving up in elevation as the snowpack accumulates. In the Central and Northern groups, where snowpacks are generally shallower, Caribou typically forage more on terrestrial lichens either in low elevation coniferous forests or on windswept alpine slopes (though arboreal lichens are still important for some herds depending on annual snow depths).

Population Trends

Woodland Caribou are experiencing dramatic population declines across most of their populations, including in British Columbia. The Southern Mountain population has declined from about 2,500 animals in 1995 to about 1,450 animals in 2021 (Province of BC 2022). The Central Mountain population had declined by 64% over three generations (COSEWIC 2014a). The nine southern subpopulations of the Northern group had declined by 27% since the last assessment (COSEWIC 2014a). Of the 54 Caribou herds in BC, seven have been extirpated in the last two to three generations and 28 are declining (**Table 13**).

[5] The Recovery Strategy uses the term Local Population Unit (LPU)to refer to clusters of current subpopulations that historically may have been the same subpopulation (i.e., before populations declines and fragmentation led to the current herd distributions).

Table 13: Summary of population trends for 54 Caribou herds in British Columbia, 2021 (BC Caribou Recovery Program 2021).

Nationally Significant Population / Group	Historic Population Trend*					
	Increasing	**Stable**	**Decreasing**	**Extirpated**	**Unknown**	**Total**
Southern Mountain Caribou	**0**	**3**	**21**	**7**	**1**	**32**
Southern Group (DU9)	0	2	9	6		17
Central Group (DU8)	0	0	4	1	1	6
Northern Group (DU7)	0	1	8	0		9
Northern Mountain Caribou (DU7)	**0**	**0**	**5**	**0**		**5**
Boreal Caribou (DU6)	**2**	**0**	**2**	**0**	**13**	**17**
Total	2	3	28	7	14	54

*Trend over the last 2-3 generations (18-27 years). Four herds showed short-term (2-5 year) increases associated with emergency measures (predator control, prey management, maternal penning). One herd (Telkwa) is increasing (following two population augmentations) but is at very low abundance and is at continued risk of extirpation.

Threats

There are several causes of Caribou declines. Some threats interact and have cumulative effects. Most Caribou herds (or Local Population Units (LPUs)) are exposed to multiple threats. The following list highlights the four primary threats impacting woodland Caribou in BC, in decreasing order of magnitude (Environment Canada 2014; ECCC 2020). The list includes reference to IUCN Threats that are assessed in the next section, also in decreasing order of magnitude:

- Altered predator-prey dynamics due to extensive habitat change from resource development activities (see 'Habitat-Mediated Predation' box, below) (Serrouya et al. 2019) (IUCN Threats 8, 3, 5).
- Direct and indirect habitat loss due to resource development, notably timber harvest in winter range (Stevenson 1991) (IUCN Threats 3, 5, 6, 8)
- Sensory disturbance from human activities, resulting in habitat displacement and increased stress/energetic costs. Snowmobiling in high-elevation winter range is a particular issue for some herds, but almost all herds incur some degree of impact from human recreation and industrial activities (Environment Canada 2014) (IUCN Threats 6, 3, 5)
- Fragmentation of herds due to human development and transportation corridors between herd ranges that has reduced/eliminated inter-herd movements. Connectivity is believed to be important for the long-term persistence of subpopulation via metapopulation dynamics (van Oort et al. 2011) (IUCN Threats 4, 5, 3, 6, 2, 1)

Habitat-Mediated or Facilitated Predation and Competition…

Elevated predation rates result from extensive habitat change caused by industrial resource development; these are believed to be the primary threat to many Caribou subpopulations (Environment Canada 2014). The process includes both a numerical increase in predators (primarily wolves) and a functional increase in per-capita predation rates.

The numerical increase in predators is due to increased abundance of conspecific ungulates (i.e., Moose (*Alces alces*) and White-tailed Deer (*Odocoileus virginianus*)), in response to increases in early seral habitats associated with human activities (notably, forestry and oil and gas development), as well as natural disturbances (i.e., fire). The increase in moose and deer populations supports a higher population of predators, which results in higher predation rates to Caribou (Wittmer et al. 2007; Anderson et al. 2018; Serrouya et al. 2019). This process is often referred to as apparent competition (i.e., moose/deer appear to be competing with Caribou but, in reality, the impact is due to an increase in predation rates). The functional increase in predation rates on Caribou is due to the creation of linear features (roads, trails, seismic lines, pipelines, powerlines) and, in winter, packing of snow, that allows wolves to travel faster and farther, which can result in increased encounters with and predation of Caribou (Dickie et al. 2017; DeMars and Boutin 2018). This process is often referred to as facilitated predation.

IUCN Threat Ratings - Caribou

The following threat assessment considers the Southern Mountain and Boreal Caribou populations, which, broadly, are experiencing similar threats and patterns of decline. An assessment was not conducted for the Northern Mountain population as threats to that population are lower. Major differences in threats between the Southern Mountain and Boreal populations are noted where they occur. Threat ratings follow the IUCN Threat Rating Classification Scheme Ver. 3.2. For this exercise Scope was assessed relative to the extents of the 37 herds (LUPs) that occur in BC (i.e., vs. population numbers) (see **Figure 13**). Severity Ratings refer to the potential magnitude of effects to LPUs where the Threats are within the spatial Scope of those LPUs. The Threat Impact Score integrates Scope and Severity according to criteria in the IUCN Threat Rating Classification Scheme Ver. 3.2.

A summary of threat ratings across the IUCN Level 1 Threat Categories is presented for Southern Mountain Caribou in **14** and for Boreal Caribou in **15**. The justification for threat ratings is outlined in the next section. The overall Threat impact for Southern Mountain and Boreal Caribou populations in British Columbia are both rated "High-Very High", based on the occurrence of ≥2 High ratings for the Level 1 Threat Categories. This corresponds to a potential population reduction of 22 - 100% over three generations. This projection is consistent with observed declines >50% in the Southern and Central Groups of the SMC population over the previous three generations, including the extirpation of several subpopulations (COSEWIC 2014a).

The threat ratings in this assessment are similar to the threat assessments presented in the recovery strategy for the southern mountain population (Environment Canada 2014); however there is one important difference. In the recovery strategy, the threat associated with habitat-mediated predation is assigned primarily to the proximate cause—problematic native species. The ultimate causes of the impact—logging and energy production—were rated Medium-Low. In this assessment the ultimate causes of habitat-mediated predation effects were rated High. Another difference in the threat ratings here is that climate change and severe weather are rated Medium (compared to Unknown in the recovery strategy). When the recovery strategy for the Southern Mountain population was published in 2014, many of the impacts of climate change were considered to have too high an uncertainty regarding the potential influence with the assessment timeframe (i.e., three generations) to have a threat impact assigned. However, since many of the predicted effects of climate change are now being observed in BC, including severe weather (e.g., summer heat waves and winter icing events) and extensive habitat alteration (due to forest pests and wildfires), it seems appropriate to assign a rating here.

Table 14: Summary of threats assessment for the Southern Mountain Caribou population in British Columbia, following IUCN criteria.

IUCN Level 1 Threat Category	Scope	Severity Rating	Threat Impact
1. Residential & commercial development	Small	Slight	Low
2. Agriculture & aquaculture	Small	Slight	Low
3. Energy production & mining	Restricted (Energy) Restricted (Mining	Serious (Energy) Moderate (Mining)	Low-medium
4. Transportation and Service Corridors	Small	Slight	Low
5. Biological resource use & harm (logging)	Large	Serious	High
6. Human intrusions & disturbance	Restricted	Slight (non-motorized) Moderate (motorized in winter)	Low
7. Natural system modifications	Pervasive	Slight	Low
8. Invasive & other problematic species & genes.	Pervasive	Serious-Extreme	High-Very High
9. Pollution	Small	Slight	Low
10. Geological events	Restricted	Moderate	Low
11. Climate change & severe weather	Pervasive	Moderate	Medium

Table 15: Summary of threats assessment for the Boreal Caribou population in British Columbia, following IUCN criteria.

IUCN Level 1 Threat Category	Scope	Severity Rating	Threat Impact
1. Residential & commercial development	Small	Slight	Low
2. Agriculture & aquaculture	Small	Slight	Low
3. Energy production & mining	Large (Energy) Restricted (Mining)	Serious (Energy); Moderate (Mining)	High
4. Transportation and Service Corridors	Restricted	Slight	Low
5. Biological resource use & harm (logging)	Large	Serious	High
6. Human intrusions & disturbance	Restricted	Slight (non-motorized) Moderate (motorized in winter)	Low
7. Natural system modifications	Pervasive	Slight	Low
8. Invasive & other problematic species & genes.	Pervasive	Serious-Extreme	High-Very High
9. Pollution	Small	Slight	Low
10. Geological events	Small	Slight	Low
11. Climate change & severe weather	Pervasive	Moderate	Medium

Description of Threats and Conservation Tools

IUCN Threat 1 – Residential and Commercial Development

(Scope = Small, Severity = Slight, Overall Threat = Low Risk; <1% decline anticipated)

Most Caribou LPU ranges do not overlap human settlements and commercial areas, although some ski resorts occur in historical Caribou ranges. Residential and commercial developments do contribute to human use corridors that may limit regional movements between Caribou LPUs.[6]

Legal Conservation Mechanisms:

- ✧ Not applicable due to low threat level.

Non-Legal Conservation Mechanisms:

- ✧ Not applicable due to low threat level.

IUCN Threat 2 – Agriculture

(Scope = Small, Severity = Slight, Overall Threat = Low Risk; <1% decline anticipated)

Like residential and commercial development, most Caribou LPU ranges do not overlap with agricultural areas. Therefore, impacts are minimal. However, agricultural areas do contribute to human use corridors that may limit regional movements between Caribou LPUs (see footnote for IUCN Threat 1 and Threat 4, below).

Legal Conservation Mechanisms:

- ✧ Not applicable due to low threat level.

Non-Legal Conservation Mechanisms:

- ✧ Not applicable due to low threat level.

IUCN Threat 3 – Energy Production and Mining

(Southern Mountain Caribou: Overall Threat = Low Risk; 1-9% decline anticipated)
(Boreal Caribou: Overall Threat = High; 10-49 % decline anticipated)

Energy production and mining, though combined as an IUCN threat category, have very different effects on Caribou. In BC, the method of energy production that has the largest overlap with Caribou ranges is conventional oil and gas development, although wind energy is also being investigated in several of the SMC Central Group LPUs.

Conventional oil and gas developments typically consist of low-moderate intensity/density disturbances (seismic lines, roads, pipelines, well pads, and processing facilities) that occur over large areas (i.e., thousands of square kilometres), sometimes covering entire LPU ranges. Within BC, oil and gas operations are most widespread in the Northeast Region (i.e., affecting Boreal Caribou), but also overlap several LPUs in the Central Group of SMC.

[6] Human settlement and development, agriculture, transportation, and resource industries can cumulatively create human use corridors that restrict immigration and emigration movements among Caribou LPUs. These movements are believed to be important for gene flow and population maintenance over long time periods (van Oort et al. 2011). However, within the relatively short time periods that are the focus of the IUCN assessment, the impacts associated with human use corridors are rated low.

Conversely, mining operations tend to consist of intensive developments (i.e., a mine pit with an adjacent facilities area and one haul road accessing the site) within a relatively small area (i.e., typically <300 ha).

Both energy and mining both impact Caribou via direct and indirect habitat loss and habitat-mediated predation effects, though habitat-mediated predation effects are generally greater for energy development due to its more extensive footprint.

Legal Conservation Mechanisms:

✧Although CH has been mapped for Caribou LPUs as part of the recovery strategies, that designation, by itself, does not provide protection for the majority of the mapped CH areas. This is because (i) the federal SARA does not have legal authority on provincial crown land, and (ii) no BC legislation has been created or designed specifically to protect CH. Sixteen different provincial legislative instruments have been or could be used to protect or restore Caribou habitat in BC (Government of Canada 2017)[7]. The primary legislative instruments used to protect Caribou habitat in the SMC population in BC are Section 15, 16, and 17 Land Act withdrawals, Ungulate Winter Range (UWR), Wildlife Habitat Areas (WHAs), and Old Growth Management Areas (OGMAs) (Government of Canada 2017; Palm et al. 2020). The Land Act withdrawal areas tend to be primarily focussed in alpine areas, whereas the UWRs, WHAs, and OGMAs are more focussed on forested areas where forestry and oil and gas activities are more likely to occur.

✧The Environmental Protection and Management Regulation, under the Oil and Gas Activities Act specifies conformance with regulatory objectives for WHAs, UWRs, and OGMAs.

✧A major problem with the existing legal mechanisms to protect Caribou habitat is that they (i) do not include all CH and (ii) for CH designated under some forms of legislation, resource development activities are often still permitted to occur, resulting in further habitat loss within those areas.

✧Where Provincial Parks, Ecological Reserves, and Protected Areas overlap with Caribou ranges, they protect Caribou and Caribou habitat from most kinds of resource development and, often, from motorized recreational activities. However, these types of protected areas are normally used to protect a suite of environmental values and are not instruments used specifically to protect Caribou Critical Habitat.

Non-Legal Conservation Mechanisms:

✧*A Compendium of Wildlife Guidelines for Industrial Development Projects in the North Area, British Columbia* (MFLNRO 2014c) provides recommended work timing windows for sensitive seasons (rut, winter, calving) to mitigate effects, such as behavioral disruption, habitat displacement, and predation risk.

✧*The Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia* (Golder Associates 2015) provides guidelines for restoring linear features associated with oil and gas exploration and development.

✧*Interim Operating Practices for Oil and Gas Activities in Identified Boreal Caribou Habitat in British Columbia* (Anonymous 2011) provides guidelines to meet regulatory objectives for Caribou within WHAs, UWR and OGMAs.

IUCN Threat 4 – Transportation and Service Corridors

[7] Refer to the Critical Habitat section, below, for a more detailed discussion of legal measures to protect Caribou habitat, including a table listing all 16 legislative instruments available to protect Caribou habitat in BC.

(Overall Threat = Low Risk; <1-3% decline anticipated)

For this assessment consideration of transportation and service corridors was focussed on highways and major energy transmission features that cover long distances (e.g., tens to thousands of kilometres). Local roads and transmission features within resource development areas (e.g., oil and gas fields and areas with logging) were considered as part of Threat 3 (Energy production & mining) and Threat 5 (Biological resource use & harm).

Some transportation features exist as isolated features (e.g., one transmission line); however, multiple features often exist in close spatial proximity (e.g., one or more highways, railroads, pipelines and electrical transmission lines). Other types of human development/activities often occur in association with transportation corridors, especially residential and commercial developments, and agriculture, resulting in cumulative effects from different threat types. Generally, the severity of the impacts is related to number of disturbances, their combined extent and intensity of use. For example, in the Bulkley Valley, where the Highway 16 corridor contains a major highway, a railroad, a transmission line, pipelines, extensive rural residences and agriculture, the corridor appears to provide a functional barrier to Telkwa Caribou, which historically crossed the valley. Conversely, where the Highway 16 corridor traverses through the North Cariboo herd range in the upper Fraser River valley, development is limited to the highway, a railroad and logging, and Caribou still occasionally cross the highway there to access low elevation winter range.

Although transportation and service corridors do have significant overlap with certain Caribou LPUs, the scope of impacts was deemed limited, overall, due to the predominant location of transportation corridors in low elevation valley, which are mostly outside of current Caribou ranges. However, as mentioned for Threat 1, the combination of transportation corridors, residential & commercial development, and agriculture can cumulatively restrict immigration and emigration movements among Caribou LPUs over long timeframes (i.e., multiple generations). These movements are believed to be important for gene flow and population maintenance over long time periods (van Oort et al. 2011). However, within the relatively short time periods that are the focus of the IUCN assessment, the impacts associated with transportation and service corridors are rated as low.

Legal Conservation Mechanisms:

- None. The Highways Act does not mention wildlife values.

Non-Legal Conservation Mechanisms:

- Major highways often utilize a combination of awareness signs, reduced speed limits, and reflectors to reduce vehicle collisions with ungulates in areas with high historical collision rates.

IUCN Threat 5 – Biological Resource Use and Harm

(Overall Threat = High; 10-49 % decline anticipated)

Commercial forest harvest (i.e., logging) is the primary mechanism, under the IUCN biological resource Threat category, that affects Caribou in BC. Logging operations occur within or adjacent to most of the Boreal Caribou and SMC LPUs in BC. Logging severely impacts Caribou via direct and indirect habitat loss (e.g., harvesting of mature and old forest that provides lichen forage) and and via habitat-mediated predation effects (Serrouya et al. 2019). Specifically, logging elevates predation rates on Caribou via both (i) apparent competition, by creating early seral habitats that increase moose densities (and deer in some areas), which in turn elevates wolf densities, and (ii) facilitated predation, via construction of resource road networks, which allow wolves to travel and hunt more efficiently.

The legal and non-legal conservation mechanisms to address logging are essentially the same as those used to address energy and mining, because the primary threats (habitat-mediated predation) are similar across these resource development sectors.

Legal Conservation Mechanisms:

- ✧Although CH has been mapped for Caribou LPUs as part of the recovery strategies CH designation does not provide protection for the majority of the designated areas. That is because (i) the federal SARA does not have legal authority on provincial crown land, and (ii) no BC legislation is designed specifically to protect Critical Habitat. Sixteen different provincial legislative instruments have been or could be used to protect or restore Caribou habitat in BC (Government of Canada 2017)[8]. The primary legislative instruments used to protect Caribou habitat in the SMC population in BC are Section 15, 16, and 17 Land Act withdrawals, Ungulate Winter Range (UWR), Wildlife Habitat Areas (WHAs), and Old Growth Management Areas (OGMAs) (Government of Canada 2017; Palm et al. 2020). The Land Act withdrawal areas tend to be primarily focussed in alpine areas, whereas the UWRs, WHAs, and OGMAs are more focussed on forested areas where forestry and oil and gas activities are more likely to occur.
- ✧A major problem with the existing mechanisms to protect Caribou habitat is that they (i) do not include all Critical Habitat and (ii) for Critical Habitat that is designated under some form of legislation, resource development activities are often still permitted within them, resulting in further habitat loss within those areas.
- ✧Where Provincial Parks, Ecological Reserves, and Protected Areas overlap with Caribou ranges, they protect Caribou and Caribou habitat from most kinds of resource development and, often, from motorized recreational activities. However, these types of protected areas are normally used to protect a suite of environmental values and are not instruments used specifically to protect Caribou Critical Habitat.

Non-Legal Conservation Mechanisms:

- ✧*A Compendium of Wildlife Guidelines for Industrial Development Projects in the North Area, British Columbia* provides recommended work timing windows for sensitive seasons (rut, winter, calving) to mitigate effects, such as behavioral disruption, habitat displacement, and predation risk.

[8] Refer to the Critical Habitat section, below, for a more detailed discussion of legal measures to protect Caribou habitat, including a table listing all 16 legislative instruments available to protect Caribou habitat in BC.

IUCN Threat 6 – Human Intrusion and Disturbance

(Overall Threat = Low Risk; <1-9% decline anticipated)

In addition to human disturbances associated with resource industries, human recreational activities can cause significant impacts to Caribou. Recreational activities that affect SMC include: snowmobiling, heli-skiing, cat-assisted skiing, alpine/downhill skiing, backcountry skiing/snowshoeing, ATV use, hiking, and hunting (Environment Canada 2014). Recreational activities can affect Caribou by displacing them from important habitats (Powell 2004; Seip et al. 2007), increasing levels of stress (Powell 2004), creating packed trails during winter that facilitate predator access to Caribou habitat (Powell 2004), and increasing vigilance and movement after human-caused sensory disturbance (Powell 2004). Recreational activities often interact with resource industries by using the access features created by industrial activities (i.e., roads and seismic lines) thus preventing or delaying the restoration of those access areas.

Although winter recreation is a significant issue for certain herds, the overall scope of the impact at the subpopulation level is restricted, therefore the overall threat is considered low.

Legal Conservation Mechanisms:

- The *Motor Vehicle Prohibition Regulation,* under the *Wildlife Act* is the primary legal mechanism used to manage recreational access and use within Caribou ranges in BC. The number and extent of closure areas has increased substantially over the last decade and, as of 2021/21, much of the high elevation winter ranges for the Southern Mountain Caribou subpopulation are protected by MVP closures. Notwithstanding, compliance with MVP closures remains a problem in many areas - the Province is active in education, consultation, monitoring and enforcement activities with recreational user groups.

Non-Legal Conservation Mechanisms:

- Historically, the province has negotiated voluntary closure areas and best management practices with recreational groups and tour operators. The use of voluntary agreements has decreased over the last few years as the number and extent of regulatory MVP closures has increased.
- Relevant best management practices and guidelines relating to recreational activities within Caribou ranges include:
  - Snowmobiling and Caribou in British Columbia
  - A Snowmobilers Guide to Environmental Stewardship in B.C.
  - A Strategy to Manage Backcountry Recreation in Relation to Wildlife and Habitats
  - Wildlife Guidelines for Backcountry Tourism/Commercial Recreation in B.C.
  - Management of Motorized Access in High Elevation Mountain Caribou Habitat
  - A Guide to Commercial Backcountry Skiing Standard Operating Practices for Ski Run Development, Helicopter Landing and Pickup Site Development, and Snow Trail Development in Mountain Caribou Habitat
  - Peace Region Guidelines for Aircraft Operations/Wildlife Interactions

IUCN Threat 7 – Natural System Modifications

(Overall Threat = Low Risk; <1-10% decline anticipated)

Over a half century of fire suppression may have contributed to the large extent and severity of forest fires and forest pest epidemics in BC over the last two decades. Fire and forest pests reduce Caribou winter habitat and contribute to apparent competition. However, those effects are driven primarily by climate change (see below).

Legal Conservation Mechanisms:

There are no legal or non-legal conservation tools that specifically protect Caribou from natural system modifications, and this is not currently deemed a priority area for conservation.

Non-Legal Conservation Mechanisms:

There are no legal or non-legal conservation tools that specifically protect Caribou from natural system modifications, and this is not currently deemed a priority area for conservation.

IUCN Threat 8 – Invasive and Other Problematic Species and Genes

(Overall Threat = High-Very High; 22-100% decline anticipated)

Altered predator prey dynamics due to extensive resource development activities (i.e., habitat mediated predation) is believed to be the primary factor limiting most woodland Caribou LPUs (Environment Canada 2014; B.C. Caribou Recovery Program 2021). The projected decline of 22-100% is consistent with observed declines >50% in the Southern and Central Groups of the SMC population over the previous three generations, including the extirpation of several LPUs (COSEWIC 2014a). The recent rate of decline is expected to continue or accelerate in the future because the previously altered habitat remains a threat (functional habitat restoration can take decades) and additional habitat alteration is continuing.

Although the proximate cause of this threat is elevated predation from natural predators, it is important to recognize that the ultimate cause of this threat is due to habitat alteration from resource development. Primary industries include forestry in the Southern Mountain population and energy in the Boreal population (see Threats 3 and 5). Measures aimed at controlling predators (i.e., wolf control) and alternative prey have demonstrated short-term success in reducing Caribou declines (Serrouya et al. 2019) but are unlikely to be successful in recovering LPUs and populations in the long terms unless the underlying habitat issues are addressed (Palm et al. 2020).

A more detailed discussion of this issue is provided in the following sections, beginning with Recovery Strategy Development, below.

Legal Conservation Mechanisms:

- The federal *Species-at-risk Act* is the primary legal tool that applies to this threat. SARA does not specify specific actions, but it does require that recovery plans identify key threats to the species and develop strategies to address those threats to recover the species. SARA specifies specific timelines for development of the recovery strategy and for recovery implementation plans. Implementation of the recovery strategy is normally a provincial responsibility, but there are provisions for the federal government to take over responsibility if the responsible federal Minister forms the opinion that an endangered or threatened species is not effectively protected through existing federal or provincial legislation.

For a summary of legal and non-legal tools used to address the ultimate cause of habitat alteration, refer to Threat 3 and Threat 5, above.

Non-Legal Conservation Mechanisms:

✧The province employs a variety of management actions, coordinated by the Caribou Recovery Program, to assess or mitigate the effects of elevated predation on Caribou. These include:

- Conservation breeding,
- Caribou re-location,
- Maternal penning,
- Predator management,
- Primary prey management; and,
- Supplemental feeding.

Refer to the Caribou Recovery Program's website, here, for a description of each activity. Most of these activities have been used in an applied research context over select Caribou LPUs. As mentioned, these activities are emergency short-term measures to halt the immediate decline of specific Caribou LPUs. They will not achieve population recovery, in isolation, without first addressing the fundamental issue of habitat alteration resulting from resource development within and adjacent to Caribou ranges.

IUCN Threat 9 – Pollution

(Overall Threat = Low Risk; <1% decline anticipated)

Most Caribou ranges are located far from urban, agricultural, and industrial pollution sources (including potentially deleterious substances such as pesticides and fertilizers). However, there is a small potential for Caribou to be exposed to chemical and petrochemical spills at industrial sites, such as mining or oil and gas drilling sites. Pollution is not considered a significant concern for woodland Caribou in BC.

Legal Conservation Mechanisms:

✧Several pieces of legislation in BC prohibit or regulate the release of deleterious substances into the environment, including the *Waste Management Act*, the *Environmental Management Act*, and the *Water Act*.

Non-Legal Conservation Mechanisms:

✧In addition to environmental acts, regulations related to human health and safety, such as Worker Hazardous Materials Information System (WHMIS) and Transportation of Dangerous Goods (TDG), provide standards for storing and transporting deleterious substances that minimize potential for their release into the environment.

IUCN Threat 10 –Geological Events

(Southern Mountain Caribou: Overall Threat = Low; 1-9% decline anticipated)
(Boreal Caribou: Scope = Small, Severity = Slight-, Overall Threat = Low; <1% decline anticipated)

Primary geological events that can affect Caribou in BC are snow avalanches. Avalanches have been responsible for up to 15% of mortalities in some of the SMC LPUs, and the last remaining five Caribou in the Banff LPU were sadly killed in a single avalanche (Environment Canada 2014). In that context, these effects are limited to LPUs where steep mountainous terrain occurs.

The majority of avalanches occur naturally, but avalanche control occurs in certain areas to protect human safety and property, such as along highways and railroads, and in proximity to ski resorts and some mining operations.

Legal Conservation Mechanisms:

There are no legal mechanisms to protect Caribou from geological events.

Non-Legal Conservation Mechanisms:
Where avalanche control is conducted, it is standard practice to survey the target area and runout zone for wildlife and people, prior to triggering an avalanche event. However, formal best practices for pre-control surveys are not published.

IUCN Threat 11 – Climate Change

(Overall Threat = Medium-Low; 1-30% decline anticipated)
Climate change can have a wide range of direct and indirect effects on Caribou and this pervasive threat is believed to be a significant factor contributing to the decline of Caribou globally (Vors and Boyce 2009). Outcomes of climate change that can negatively affect Caribou include (Vors and Boyce 2009; Festa-Bianchet et al. 2011; Boutin et al. 2012; Mallory and Boyce 2018):

- More frequent severe weather events (e.g., icing events, summer heat waves),
- Shifts in habitat, such as decrease in alpine areas and reduction of mature-old forest areas,
- Changes in plant communities that reduce forage, such as a reduction of lichen biomass,
- Alteration of predator-prey dynamics, such as an expansion of deer into Caribou range,
- Changes in seasonal phenology, that could affect Caribou migrations; and,
- Increased occurrence and severity of diseases, pests, and parasites.

The timing and magnitude of impacts from climate change are impossible to predict; however, when they occur, they can be severe and wide-ranging. For example, the recent Mountain Pine Beetle epidemic (and associated provincially permitted salvage timber harvesting) in central BC has dramatically altered Caribou habitat in low elevation winter range for several SMC LPUs. The number, size and severity of wildfires has also increased substantially over the last two decades and has potential to affect forested Caribou ranges.

Legal Conservation Mechanisms:
✧There are many acts that strive to reduce emissions to slow climate change (e.g., Greenhouse Gas Reduction Act, Zero-Emission Vehicles Act, Clean Energy Act); however, there is no legal legislation that directly addresses the effects of climate change on Caribou.
Non-Legal Conservation Mechanisms:
✧There are government programs affording attention to reduction of carbon emissions to slow climate change (e.g., Carbon Neutral Government Program, Clean BC Roadmap to 2030) but, again, nothing that is specific to Caribou.

Threat Assessment Summary

Recovery planning for all species-at-risk is challenging due to the large number and sizes of herd ranges, the variation in ecology and threats among herds, and the significant economic and social costs associated with conservation actions.

The summary of the threat assessment is complex, and nuanced, and required a more fulsome consideration of various components and considerations. These are described in each of the respective following sub-sections.

Effectiveness of Recovery Strategies and Conservation Tools to Recover Woodland Caribou
Although woodland Caribou are subject to threats from multiple sources, a common component of the primary threats is that they all relate to habitat in some way (i.e., habitat-mediated predation, direct habitat loss, habitat displacement due to sensory disturbance, and habitat fragmentation that reduces

inter-herd movements). The importance of habitat protection and restoration is broadly recognized in SAR recovery planning processes and the designation of CH is a key component of Caribou recovery strategies. The remaining sections of the Caribou case study evaluate the effectiveness of CH protection and restoration within the broader context of the SMC Recovery Strategy. This assessment reveals that:

- Although existing legislative instruments provide adequate tools to meet protection and restoration objectives, threats are not being effectively mitigated (i.e., impacts are permitted to continue) and the SMC population continues to decline.
- The main causes for not meeting conservation targets are:
    - Delays in the development and implementation of the recovery strategy and its related implementation and action plans.
    - Compromises to science-based conservation plans, in favour of social and economic values, that continue to permit resource development and recreational access within designated Caribou Critical Habitat.

Recovery Strategy Development and Implementation

The process for listing and recovering Southern Mountain Caribou began over 20 years ago. COSEWIC originally designated Southern Mountain Caribou as Threatened in 2000 and the population was listed on the SARA Schedule 1 list as Threatened in 2003. The Recovery Strategy (Environment Canada 2014), including partial mapping of Critical Habitat for all LPUs, was released in 2014, seven years after its statutory due date under Sections 42 and 43 of the SARA. The Recovery Strategy identified a completion date of December 2017 for an Action Plan, per SARA requirements. However, no Action Plan has been released as of April 2022. In February 2020, the Government of BC entered two co-management agreements related to Southern Mountain Caribou under section 11 of SARA:

1) The Canada British Columbia Conservation Agreement for Southern Mountain Caribou in British Columbia is an agreement between the federal government and the province of British Columbia, whereas "*Canada and British Columbia wish to cooperate in the identification and taking of Conservation and Recovery Measures to respond to the imminent threats and support the conservation and recovery of the Southern Mountain Caribou in the province of British Columbia, recognizing that immediate action must be taken with the best available information, while new information and knowledge continues to develop*."

2) The Partnership Agreement for the Conservation of the Southern Mountain Caribou is an agreement between the governments of Canada, British Columbia, the Saulteau First Nation and West Moberly First Nations that strives to protect southern mountain Caribou in the northeastern part of their range while considering the social and economic well-being of communities and stakeholders in the region.

Within British Columbia recovery actions for Caribou are coordinated by the BC Provincial Caribou Recovery Program. "*The Provincial Caribou Recovery Program's fundamental purpose is to develop, implement, and monitor new management actions and provincial strategies to ensure we are meeting or exceeding provincial and federal population and habitat objectives. The province also recognizes the* (competing) *need to balance social and economic needs of all British Columbians. This includes a commitment to protecting Indigenous rights and interests while maintaining BC's robust and diverse natural resource sector."*

To meet its recovery goals for Caribou, the Caribou Recovery Program employs a variety of different management activities, including:

- Adaptive management,
- Conservation breeding,
- Habitat protection,
- Habitat restoration,
- Herd planning,
- Caribou re-location,
- Maternal penning,
- Predator management,
- Primary prey management,
- Snowmobile management,
- Supplemental feeding; and,
- Tourism and recreation management

A description of each activity is provided here.

As part of the Program's goal to ensure that Caribou management actions are open, transparent and reported on regularly, the Program produces annual reports that document management objectives and ongoing management and monitoring activities that occurred across the province each year.

Critical Habitat

One of the primary recovery actions specified the in the Recovery Strategy is establishment of Critical Habitat for each LPU in the population. The Recovery Strategy, defines Critical Habitat as '*habitat possessing those biophysical attributes required by southern mountain Caribou to carry out life processes'* (Environment Canada 2014). Several types of Critical Habitat (CH) are described in the Recovery Strategy but they can be generalized into two broad types:

1) Core CH - includes the primary seasonal ranges that are regularly occupied within an LPU, including high and low elevation areas.
2) Matrix CH - includes infrequently used areas within an LPU range (Type 1 Matrix), such as migration routes, as well as areas outside an LPU annual range where regional predator prey dynamics that can affect the LPU (Type 2 Matrix).

Even though the Recovery Strategy explicitly defines Critical Habitat as '*habitat possessing those biophysical attributes required by southern mountain Caribou to carry out life processes'* CH mapped as part of the Recovery Strategy are very large polygons that include non-habitat areas, such as recent logging cutblocks. Instead of defining critical habitat at the stand-level (e.g., a stand of old conifer forest likely to provide arboreal lichen), the Recovery Strategy uses a more general criteria of disturbed *vs*. undisturbed habitat condition. Disturbance is defined as the area affected by human-caused disturbance, including a 500 m buffer around the disturbance to account for avoidance by Caribou, and the area affected by natural disturbances such as fire and avalanches. A minimum level of 65% undisturbed habitat has been identified as a threshold to maintain or recover Boreal Caribou (Environment Canada 2011).

Amounts of Undisturbed Habitat within Caribou Ranges

Within the 5 Boreal Caribou LPUs, the amounts of undisturbed habitat, as of 2012, ranged from 13-42% (Environment Canada 2012), well below the 65% threshold targeted for population persistence/recovery. The amounts of disturbed and undisturbed habitat within the SMC population have not been published.

For lack of data specific to SMC, the SMC Recovery Strategy has taken the 65% threshold identified for Boreal Caribou as the best available information and utilizes it as the threshold value for low elevation winter range (Core CH) and Type 1 matrix habitat (Matrix CH) for the Northern and Central Groups. For the Southern Group the target for undisturbed habitat within high/low elevation seasonal ranges is 100%. For Type 2 matrix habitat in all Groups, and Type 1 matrix in the Southern Group, habitat thresholds are not specified. Instead the objective is to ensure an arguably intangible and unmeasurable goal to "*maintain predator densities consistent with performance indicators*" (Environment Canada 2014).

Provincial Tools to Protect Critical Habitat for Caribou

There are several pieces of legislation in BC that are used to manage land-based activities on publicly owned lands (i.e., crown land) and private land. Most legislation is targeted at specific activities, such as forestry, mining, oil and gas, and recreation. There is no legislation which has a specific purpose of protecting Caribou or Caribou habitat, but Caribou habitat is explicitly considered in the designation and application of many of the legislative tools available in the various acts and regulations. A 2017 study conducted by the federal and BC governments for the Southern Mountain Caribou (Central Group) identified 16 "legislative instruments" that have or could be used to protect or restore Caribou populations and habitat (**Table 16**) (Government of Canada 2017). Most legislative instruments can be implemented under multiple forms of legislation.

Table 16. Provincial legislative instruments that can be used to protecting Caribou and Caribou habitat in British Columbia (Government of Canada 2017).

Legislative Instrument	Associated Legislation
Ecological Reserve	Ecological Reserve Act Ecological Reserve Regulations Protected Areas of British Columbia Act Offence Act Violation Ticket Administration and Fines Regulation
Class A Provincial Park	Protected Areas of British Columbia Act Park Act Offence Act Violation Ticket Administration and Fines Regulation
Protected Area	Environment and Land Use Act Park Act Offence Act Violation Ticket Administration and Fines Regulation
Wildlife Habitat Area (WHA)	Forest Act Forest and Range Practices Act (FRPA) Administrative Orders and Remedies Regulation Forest Planning and Practices Regulation Woodlot Licence Planning and Practices Regulation Government Actions Regulation Offence Act Oil and Gas Activities Act (OGAA) Environmental Protection and Management Regulation
Ungulate Winter Range (UWR)	
FPPR Section 7 and WLPPR Section 9 notice area	Forest and Range Practices Act (FRPA) Forest Planning and Practices Regulation Woodlot Licence Planning and Practices Regulation Offence Act
Old Growth Management Area	Land Act Forest Act Forest and Range Practices Act (FRPA) Forest Planning and Practices Regulation Oil and Gas Activities Act (OGAA) Environmental Protection and Management Regulation
Resource Review Area	Petroleum and Natural Gas Act Oil and Gas Activities Act (OGAA)
Petroleum and Natural Gas Act (PNGA) s.72 reserve area	Petroleum and Natural Gas Act Oil and Gas Activities Act (OGAA)
s. 15 OIC Reserve	Land Act Offence Act
s. 16 Withdrawal	
s. 17 Conditional Withdrawal	
No Registration Reserve (mineral and/or placer)	Mineral Tenure Act Mines Act
Coal Land Reserve	Coal Act Mines Act
Motor Vehicle or Public Access Prohibition	Wildlife Act Motor Vehicle Prohibition Regulation Public Access Prohibition Regulation
Reviewable Projects	Environmental Assessment Act

The Canada-British Columbia Southern Mountain Caribou (Central Group) Protection Study (Government of Canada 2017) provides a description of each legislative instrument, examples of how it can be used to protect Caribou habitat, and the extents of areas protected via each instrument for Caribou in the Central Group. The primary legislative instruments used to protect Caribou habitat in the SMC population in British Columbia are Section 15, 16, and 17 Land Act withdrawals, Ungulate Winter Range (UWR), Wildlife Habitat Areas (WHAs), and Old Growth Management Areas (OGMAs) (Government of Canada 2017; Palm et al. 2020). The Land Act withdrawal areas tend to be primarily focussed in alpine areas, whereas the UWRs, WHAs, and OGMAs are more focussed on forested areas where forestry and oil and gas activities are more likely to occur. Regulations under the Forest and Range Practices Act and the Oil and Gas Activities Act allow the BC Minister of Environment and Climate Change to establish UWRs, WHAs, and OGMAs. UWRs and WHAs established to protect southern mountain Caribou either prohibit forest harvesting activities in high elevation winter areas ("no harvest zones") or allow for harvest with some restrictions in low elevation winter areas and corridor areas ("conditional harvest zones"). OGMAs prohibit tree cutting except for cases of insect infestation and disease.

Short-term Measures for the SMC Population

Although long term management of habitat is the key action required to address the ultimate threat to Caribou (i.e., human-caused habitat alteration that results in elevated predation and habitat loss), the Provincial government has also employed emergency measures to certain subpopulations to attempt to address the proximate cause of Caribou population declines (i.e., elevated predation) in the short-term. These measures included predator control, primary prey management, Caribou re-locations, and maternity penning (Serrouya et al. 2019). Serrouya et al. (2019) found that these treatments were successful in reducing or reversing population declines in most herds that were treated compared to control herds. While these emergency measures appear to have had limited success in reversing population declines in some herds (BC Caribou Recovery Program 2021), it is important to recognize these measures only have short-term effects, and that population decline is likely to resume once treatments cease. Emergency measures should only be used as tools to complement long term efforts that address the ultimate cause of Caribou declines (i.e., human-caused habitat change) (Palm et al. 2020).

The Federal 'Backstop' Orders for Woodland Caribou

SARA includes two key provisions for the federal government to designate legal protection of terrestrial Critical Habitat on non-federal lands.

1) Section 61 provides that the federal government may issue an order that applies the critical habitat protections of SARA on provincial lands if the responsible Minister forms the opinion that an endangered or threatened species is not effectively protected through existing federal or provincial legislation (including any SARA section 11 conservation agreements, see below).
2) Section 80 provides that the federal government may, on the recommendation of the responsible inister, issue an emergency protection order on any habitat that is deemed necessary for the protection of a listed species and to prohibit activities that may adversely affect the species or its habitat. However, the federal government has considerable discretion with respect to forming opinions and issuing orders under Section 61 and 80, including the consideration of social and economic effects, and such orders are rarely issued (none for Section 61 and 2 for Section 80).

A third provision under SARA that provides legal protection of terrestrial CH on non-federal lands is Section 11. Section 11 allows the federal government to form a conservation agreement with any government, organization, or landowner to benefit a listed species. The federal government has indicated its preference to negotiate solutions for Caribou protection and recovery over exercising its authority to issue an order under Section 61 or 80 and has entered into two Section 11 agreements relating to protection of the SMC in 2020. The Canada British Columbia Conservation Agreement for Southern Mountain Caribou in British Columbia establishes a framework for intergovernmental cooperation and outlines several measures and strategies intended to recover all three groups of southern mountain Caribou; however, the agreement does not explicitly prohibit any activities, such as timber harvest, that have the potential to destroy critical habitat. The Partnership Agreement for the Conservation of the Southern Mountain Caribou provides more concrete measures to protect and restore habitat, including moratoria on new logging and road construction within a 7,551 km² area of provincial Crown land.

The Federal Backstop – an example from Alberta

Woodland Caribou were assessed by COSEWIC in 2002, listed on SARA Schedule 1 in 2003 and listed as at-risk In Alberta in 2005 and yet nothing was being done to arrest the decline and prevent continued habitat loss to forestry, energy development (oil and gas exploration).

In 2010, a coalition comprised of Indigenous communities and conservationists took action; 81% of the 51 herds (n=37) were declining. The Alberta government was legally required (under SARA S.42(2)) to identify CH for Caribou but socioeconomic considerations prevailed, in a quote from Alberta Environment and Parks M. Dykstra stated, "*Alberta understands the importance of protecting Caribou, while also protecting northern Alberta jobs and communities*". Clearly competing economic objectives prevailed again—Woodland Caribou herds continue to decline rapidly "*due to increased habitat disturbance and fragmentation, largely as a result of energy corridor, forestry and oil development*" (Canada and Alberta Sign Caribou Conservation Agreement - Landscapes & Letters (landscapesandletters.com).

Like BC, Alberta lacks stand-alone species-at-risk legislation to facilitate the necessary assessment and protection measures needed for recovery of species-at-risk. In response, in 2019, an Albertan coalition petitioned the federal Minister of Environment to advance an emergency order for woodland Caribou – to intervene to protect CH. Finally, in October 2020, the federal and provincial (AB) government reached a promising conservation agreement; by then it was 16 years overdue. Although this action appeared promising on the surface the conservation agreement adopted a federal "Range Plan Guidance" target of 65% retention of undisturbed habitat in a herd's range; this was the minimum prescribed target, and, even if achieved, scientific guidance note that there remains a significant risk (40%) that Caribou populations will continue to decline. Ironically, this is an exact mimic of the BC government's earlier plans for Spotted Owl recovery; these also targeted a 65% habitat retention target. Over a decade later Spotted Owls are now functionally extinct in BC under this same management approach.

Delays, and conservative conservation targets that favour continued resource development seem to repeatedly compromise recovery, and contravene Canadian law, when it comes to recovery of species-at-risk in Canada.

Assessment of Critical Habitat Implementation for the Southern Mountain Caribou Population.
The Province of BC does not provide regular monitoring updates on the status of key recovery actions, such as tracking of CH designations making it difficult to assess and monitor the outcome of recovery actions. A recent independent study examined the outcome of CH designation for the SMC population (Palm et al. 2020); specifically, the researchers examined the degree to which CH covered Caribou LPU annual range boundaries and the extent of logging that occurred within CH.

Palm et al (2020) found that not only has logging continued within designated CH (since designation in 2014), the rate of logging within those areas has actually increased. The researchers calculated that 314 km² (31,400 ha) of Core CH and 595 km² (59,500 ha) of Matrix CH was logged in SMC ranges in the five years following CH identification. Those amounts reflect increases of the area logged over the prior five-year period of 49% for Core CH and 57% for Matrix CH. Applying the 500-m buffer that defines disturbed habitat under the Recovery Strategy increased the total area of newly disturbed Critical Habitat by 1,422 km² (142,200 ha) in Core CH and by 2,956 km² (295,600 ha) in Matrix CH. This emphasizes that CH designation, in and of itself, does not contribute meaningfully to species' recovery as the province is not enabling effective legal protection within CH designations on Crown land.

As mentioned above, UWRs, WHAs and OGMAs are the primary regulatory tools available in BC to protect areas from resource development. UWRs and WHAs include "no harvest zones" (primarily in high elevation winter areas) and "conditional harvest zones" (primarily in low elevation winter areas and corridor areas). Combined, OGMAs and no harvest zones within UWRs and WHAs overlap 51% of the Core CH. Inclusion of parks, protected areas and ecological reserves increase the extent of protected Core CH to 63% (i.e., currently only 37% of the Core CH remain available to some form of resource development). Approximately 19% of Matrix CH was protected by parks (14%) and OGMAs (4%) and none by UWRs or WHAs. Where OGMAs and no harvest zones within UWRs and WHAs were established, they were mostly successful in protecting Core CH (<7 km² of those areas were logged in 2014-2019). However, logging was extensive in the portions of CH within conditional harvest zones and in areas without any protection.

The location of cutblocks in relation to finer-scale habitat characteristics was not examined by Palm et al. (2020). However, where timber harvesting is permitted within CH, it is likely that timber harvesting will continue to impact the highest quality Caribou habitats. This is because the highest quality timber values and highest quality Caribou habitat often co-occur. For example, forest stands that Caribou use for winter range (including stands that provide terrestrial or arboreal lichens) are often mature-old coniferous stands that are also targeted by logging companies (COSEWIC 2014a). The current management process allows forest companies to choose cut-block locations based on stand level characteristics (i.e. timber quality and volume); however, the resolution of Caribou habitat quality is normally limited to the broad management zonation (e.g., all habitat within a given UWR is considered the same quality for Caribou). This is the same challenge experienced during recovery planning for both Spotted Owl and Marbled Murrelet in BC; continued declines result, with Spotted Owl now functionally extirpated from Canada under this management regime.

Conservation Conclusion

Since the release of the *Recovery Strategy for Woodland Caribou, Southern Mountain population* (Environment Canada 2014) the population has continued to decline and several subpopulations have become extirpated. Ongoing delays in recovery planning, implementation and effective monitoring result in continued habitat impacts and population decline, which increases challenges with Caribou recovery.

The primary threat to woodland Caribou in British Columbia is human-caused habitat change. Existing legislative tools and recovery processes have provided incomplete protection of CH, including (i) incomplete designation of critical habitat areas within herd ranges and (ii) continued permitting of resource development activities and human recreation activities that destroy or degrade habitat within designated CH. For example, the increase of logging by 50% within CH areas for the SMC Population (after CH was formally designated) is a major red flag. The effects of habitat loss may be exacerbated as the current management regime allows forest companies to place cutblocks based on stand level characteristics that often correspond to high quality foraging habitat, but all CH (that includes a range of habitat qualities) is generally erroneously treated as equivalent value from a Caribou recovery perspective.

Emergency measures, such as predator control, primary prey control, Caribou re-locations, and maternity penning, are tools that can reduce the proximate cause of Caribou declines in the short-term, but long-term recovery of woodland Caribou is ultimately dependent on protection and restoration of large areas of CH within Caribou ranges.

Despite the continued decline of woodland Caribou in BC, and the deficiencies of provincial-led measures to protect CH, the federal government has failed to exercise authority under Sections 61 and 80 of the SARA. These authorities were meant to 'backstop' these clear and continued failures in provincial recovery efforts. Instead, the federal government has chosen to enter into co-management agreements with the Province of BC and First Nation governments that consider only a subset of Caribou subpopulations. This approach, though well-intended to foster respectful co-management among provincial, federal and First Nation governments, results in continued habitat loss and population decline for woodland Caribou.

Timely and effective recovery actions for woodland Caribou appear to be compromised by the discretion of provincial and federal governments to consider social and economic consequences of SAR recovery actions.

Development and enactment of provincial SAR legislation that include non-discretionary measures that address the limitation of existing laws and policies may be critical to addressing the systematic deficiencies noted for Critical Habitat protection, and broader Recovery Strategy objectives.

Understanding Conservation Needs

Canada encompasses approximately ten million square kilometres of terrestrial and freshwater ecosystems. We are the second largest country in the world, harbouring almost 9% of the worlds total forested area and about 25% of the world's wetlands (Ray et al. 2021). An estimated 80,000 species occur in Canada, including over 300 endemic species. Of these 80,000 species, about 30,000 species have sufficient information to assess conservation status and approximately 20% of these are imperiled to some degree. According to the World Wildlife Federation about half of 903 monitored wildlife species in Canada experienced population declines between 1970 and 2014 (Rays 2021).

Provincial and Territorial Responsibilities…

The primary responsibility of protecting the majority of federally listed terrestrial species falls to the provinces and territories as federally managed lands currently constitute only a small portion of Canada's total land area. Regardless, the federal government is responsible for ensuring that all species-at-risk in Canada have some basic level of protection.

Sections 34 and 35 of SARA state "*that if the Minister believes that a species is not adequately protected by the laws of a province or territory, then a federal 'basic prohibition safety net' order can extend sections 32 and 33 prohibitions on harming species and their residences to provincial and territorial lands*" (SARA 2002, Turcotte et al. 2021). Unfortunately, this provision has never been engaged, despite the lack of protection for many species on provincial Crown lands (Bolliger et al. 2020).

Critical habitat safety orders are also available under section 61 of SARA. In this instance the federal Minister may intervene in provincial management and prohibit destruction of CH (on territorial or provincial lands) if the competent Minister believes that existing provincial (or territorial) laws do not effectively protect critical habitats.

Finally, according to section 80 of SARA, an emergency order can also be applied if the Minister feels that the species "faces imminent threats to its survival or recovery." If enforced, an emergency order can be used to provide protection for the species and its habitat on public and private provincial or territorial lands (SARA 2002) (e.g., Sage Grouse and Western Chorus Frog: Great Lakes / St. Lawrence Canadian Shield Population).

Unfortunately, these powers are rarely, if ever, exercised despite provincial non-compliance.

When considering the IUCN threats key stressors are consistent with those summarized earlier and include land conversion, climate change, pollution, invasive alien species and, particularly in BC, resource extraction with logging estimated to have the most pronounced and widespread ill-effect. Despite our ecological and economic wealth, and our robust political systems, the complexity of conservation policy is daunting, with administration managed at a federal, provincial, and territorial scale. This complexity confounds efficiency with conservation efforts; clearly there is a need for a unified act for BC to manage the needs of wildlife and ecosystems more effectively in our province. To fulfill commitments in the National Accord for the Protection of Species-at-risk, Canada enacted the federal SARA (in 2002), but immediate application was limited to federal lands, aquatic species, and some migratory birds. Since 1996, most other provinces and territories have passed standalone legislation; however, British Columbia (along with Yukon, Alberta, Saskatchewan, and Prince Edward Island), have yet to pass standalone legislation within their jurisdictions.

An audit of recovery progress, by Ray et al. (2021), recognizes an underlying assumption in all Canadian natural resource management and development statutes: they are predicated on the assumption that threats or impacts from individual projects can be managed to reduce or eliminate harm to biodiversity elements. In contrast given the overall declining trends and biodiversity indicators it is clear that these impacts are not being successfully managed or mitigated. This was attributed to three causal factors:

> 1) Land use decisions are made in isolation (for each sector and each project) with little consideration for cumulative impacts (Rays 2021). Inexplicably, and to the detriment of many species in BC, the forestry sector seems sacrosanct to any such consideration—cumulative impacts seemingly aren't considered, monitored, measured, or mitigated effectively in BC.
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> 2) It was recognized that there are substantial deficiencies during consideration of impacts from resource development upon biodiversity (Rays 2021). Mitigation is far too limited in most cases and full cost valuation systems are not in place. This leads to biased consideration of the value of resource extraction operations and, disappointingly, promotes government subsidies to support industries that repeatedly damage natural resources, including biodiversity. Subsidies to reduce costs to logging companies are numerous, ill-founded and counterproductive to species recovery efforts (e.g.: The great tree robbery: Policy Note).
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> 3) Decisions regarding resource development consistently favor resource development sectors (Rays 2021). The provincial government's BC Timber Sales (BCTS) program is the epitome of this problem. Representatives from the pro-forestry sector make repeated unfounded claims of unlimited old growth and never-ending resources but key biodiversity indicators suggest otherwise (Merkel and Gorley. 2020). In this strategic review the authors recognized that "*society is undergoing a paradigm shift in its relationship with the environment, and the way we manage our old forests needs to adapt accordingly.*" According to the strategic review BC's approach to forest management has resulted in a "*high risk to loss of biodiversity in many ecosystems, risk to potential economic benefits due to uncertainty and conflict, and widespread lack of confidence in the system of managing forests*" (Merkel and Gorely. 2020).

A new strategy, with drastic revision to supporting policies and programs is direly needed. As iterated in the strategic review of old-growth forest management it is imperative that this new strategy "*be developed through dialogue with Indigenous governments, communities, and stakeholders in a manner that reflects the ecological, historical, and socio-economic uniqueness of each region"* (Merkel and

Gorely. 2020). The values espoused as important to Canadian citizens and Indigenous people are being badly neglected and compromised by our elected officials and this reality spans multiple government regimes in Canada and in BC.

While some of the immediate issues faced during species recovery can be addressed within the existing policy framework, continued application of policy and practices that have imperiled so many species in BC will not enable or achieve recovery as envisioned under SARA or as expected by the public. Legislation varies among provinces and territories with markedly different resultant outcomes and approaches; evaluation and effectiveness monitoring are hampered by this disparity, and by lack of sufficient resourcing by governments (Turcotte et al. 2021). In addition, the reluctance of the federal government to intervene, and to implement corrective actions when the province's fail to afford effective legal protection to species' and their habitats, result in inefficient application of SARA on all non-federally managed lands. Provincial efforts often fall far short of achieving parity with SARA, despite lofty claims to do so (Bolliger et al 2020). Bolliger et al. (2020) critique the consequence of the restricted application of SARA to only federal lands, with the expectation of parity to be achieved by the province. At a national level federal lands provide protection to only 8.1% of species' ranges, and 63.1% of 252 terrestrial species-at-risk that were assessed have protection within less than 5% of their ranges (Bolliger et al 2020). Adding provincial and territorial protected areas to this consideration slightly improves this optic, with protection thus afforded to 14.6% of 252 terrestrial species' ranges (Bolliger et al 2020), but these are disappointing and alarming statistics. Bolliger et al. (2020) conclude that "*Canada's capacity to protect SAR via SARA could be improved by greater coordination among national, provincial and Indigenous governments, the creation of a more effective protected area network, exercising SARA's provision for emergency protection orders where applicable, and facilitating greater SAR protection on public and private lands.*"

Ambiguity in the process and ultimately the definition of CH, along with complete and flagrant disregard for legislated deadlines, impede the efficacy of SARA (Turcotte et al. 2021, Martin 2017). Several authors of policy review papers also bring attention to the repeated failure to incorporate Indigenous knowledge and cooperation in species-at-risk recovery. If the current provincial and federal government agencies responsible for resource management, including responsibility for recovery of species-at-risk (as per the intent of SARA), are genuine in their repeated commitments and recognition of the need for biodiversity conservation we need to change the way we are currently managing our shared landscape.

Conservation of the biodiversity in BC must be the foundational goal of any new strategy and should be recognized and afforded value during resource management decisions using full-cost evaluation principles. The continued one-sided consideration of material benefit from resource development, by government and industry leaders, will continue to fail to recognize the intrinsic and inherent values associated with ecosystem function. The value of sustained biodiversity to community health (including human communities) was well recognized by Indigenous people throughout history, but this sage approach is arguably lost in our current management system that affords exaggerated priority to the short-term and all-too-often development-biased economic advantage. This bias is to the detriment of common values we, as Canadians, share.

Challenging Points for Government Consideration

1. How can we correct misinterpretation of legislation by responsible elected officials and ensure these mistakes are not perpetuated and are avoided in future? Understandably, interpretation of law and policy is not simple, but accurate interpretation is required under the statue of the College of Applied Biology in BC as a right to practice. Unfortunately, consequential interpretive errors are all too common.

Example 1 - The Wildlife Act: An Example of Misinterpretation Resulting in Harm

Both subspecies of the Great Blue Heron (*Ardea herodias*) are blue-listed by the BC CDC with the coastal subspecies (*A. h. fannini*) listed as Special Concern on SARA Schedule 1 in recognition of declining populations, and sensitivity to human activities.

In April 2021 an interior biologist (M. Machmer) and resident heron expert raised concern regarding logging activities near an active nest colony located on private land at the Granite Pointe Golf Club near Nelson, BC. Machmer, along with a registered professional forester (L. Price) attempted to persuade the golf course that they should not log within a 200-meter buffer zone of the nest trees citing Section 34 of the *Wildlife Act*, which disallows disturbance of the nests of specific birds (including herons). Despite this request the golf club logged to the base of the nest trees.

The golf club at first denied the existence of the heron nests, but when confronted with evidence of the birds, the golf club president suggested that the active logging was beneficial as it would encourage them to nest elsewhere. A complaint was submitted to the province, and, in October (2021), a ministry biologist provided the opinion, as supporting rationale to excuse the government's failed intervention "*that the logging was not a violation of Section 34 of the Wildlife Act because it occurred on private land. Had it been on public land the province might have taken action*" (anonymous quote provided by the Nelson Star).

This interpretation is erroneous and regrettable; Section 34 of the *Wildlife Act* makes no distinction between public and private land. When the ministry was asked to explain why it made this distinction in this case, and why it has not acted to prevent machinery working close to the nests in 2021 and 2022 the ministry apparently declined response. (Source: Nelson golf club president denies existence of threatened heron nests at course – Nelson Star).

This level of misunderstanding and inaccurate interpretation of existing laws further fetters conservation and recovery efforts.

Example 2 - SARA: An Example of Misinterpretation Resulting in Harm

In 2022, a lawsuit was advanced against the federal environment minister (Steven Guilbeault) for failing to meet his statutory duties.

A protection statement issued by Guilbeault misinterpreted his own government's Act (SARA) by limiting protection of CH for at least 25 at-risk bird species, including marbled murrelet. Guilbeault' s misinterpretation promoted the clearly erroneous position that the federal government's obligation does not extend beyond protections afforded only to bird nest (as required under the MBCA) (See **Appendix 2**) and was ignorant of the obligation to ensure that protection of CH is achieved, by the province, on provincial lands. The minister's contradiction fails to recognize federal requirements under SARA Sections 34, 35, 61 & 80 (see example on p. 125). Guilbeault is also ignoring commitments made under the BC-Federal Agreement on Species at Risk (2005). Finally, this position also ignores the fundamental recognition that habitat loss is the main cause of decline for most species in Canada. Rightfully, Ecojustice has advanced legal challenge regarding the competency of Guilbeault' s performance in fulfilling his statutory duties.

The trigger for this action was in response to logging of old growth forested marbled murrelet nesting habitats within federally mapped CH on southern Vancouver Island. Research had confirmed >300 marbled murrelet detections within a proposed cut block identified to be logged by Teal-Jones Group. No federal or provincial action was taken to stop logging; the area was logged shortly after the federal and provincial governments were notified of the marbled murrelet detections.

Like the previous example (for great blue heron) this level of misunderstanding and inaccurate interpretation of existing laws further fetters conservation and recovery efforts.

2. The Schedule of Studies within Recovery Strategy documents are often cited as cause for delay; unfortunately these study requirements are not required to be time-bound and hence often used as stalling tactics by stakeholders and by the provincial government (Martin 2016). This needs to be addressed in a more responsible manner that is consistent with the intent of this policy.

3. The province needs to address the disparity in legal management requirements (for species-at-risk) management between its own imposed regulations within the forest resource development sector versus other resource development sectors. Continued non-compliance with the BC *Wildlife Act*, during logging operations in BC, is inexplicable and repeatedly damaging to conservation goals and outcomes. The FRPA alone does not afford parity with SARA. The spatial footprint of clearcut harvest practices dwarfs the footprint of all other resource development sectors in BC. Why are forests repeatedly clear-cut with no requirement to mitigate impacts to species that use mature forests for nesting or as security habitat during critical periods (e.g., hibernation)?

4. Unreasonable delays in mapping CH need to be addressed at both a federal and provincial level. On average, posting of recovery documentation (i.e., a Recovery Strategy (or equivalent)) and delineation of CH was 9.8 years behind scheduled requirements as stipulated and legally required under SARA. The range of delinquency (for those species for which CH has been mapped) was 0-17 years for 78% (n=50 of 64) of BC's Schedule 1 SARA listed terrestrial and freshwater vertebrate species. Furthermore, within these focal taxa, CH mapping is still overdue for 22% of the currently listed species assessed herein (14 of 64 species). Delays are a result of poor resourcing and spurious demands for additional study from stakeholders and governments.

5. There is a systemic lack of compliance monitoring. Harmful activities repeatedly impact species-at-risk on non-federal lands with no recognition or corrective action (see page 83 and page 91 for examples).

6. It is standard practice for ECCC to approve and post Recovery Strategy documents that state that within the geospatial areas mapped as CH unsuitable areas that do not possess any of the (habitat) features and attributes are excluded from identification as CH. This is a potentially consequential dismissal of CH, yet policy is silent on the responsibility for determination of presence of (habitat) features and attributes. This responsibility needs to be assigned to Qualified Environmental Professionals that meet legal requirements for the right to practice under the BC College of Applied Biologists but, currently, the responsibility for determination is not explicitly stated by ECCC. Clear bias exists with some resource development stakeholders; this responsibility should not fall under their purview.

The Path Forward

Many authors, from multiple analyses, have converged on some common themes (as outlined above), and have advanced, in unison, suggestions for reform to increase accountability and efficiency. The following suggestions are presented in a non-hierarchical order, each of these suggestions are likely essential to more effective implementation of recovery efforts:

1) The province needs to prioritize implementation of all forms of existing legal protection (in particular, under FRPA) to address the most egregious detrimental resource development activities in BC. WHAs should be designated as applicable, and future inventory to identify additional conservation opportunities should be better funded, supported, and resourced.

2) The province should release long-promised amendments to the outdated BC *Wildlife Act* to enable effective legal protection to species-at-risk, including their residences and Critical Habitat.

3) The province should prioritize development of effective legal protection to mitigate impacts from deleterious activities, particularly where there is high potential for conservation gain (e.g., re-evaluating policy and management of commercial forestry in BC) and where mitigation is attainable.

4) Canada needs to embrace a science-based and non-politically influenced automatic listing process to avoid bias (Turcotte et al. 2021). Almost 30% of COSEWIC-recommended species have not been listed for protection (Turcotte et al. 2021). COSEWIC has assigned 810 species to at-risk categories; only 688 species are listed under SARA (Kraus et al. 2021).

5) Federal, provincial, and municipal governments need to seek Indigenous cooperation in the species protection process (Turcotte et al. 2021).

6) The federal government needs to set firm thresholds that trigger the safety net (or emergency order) provisions within SARA, and these need to be triggered without debate or influence from biased political and socio-economic considerations. This needs to be extended to all provincial and territorial lands (Turcotte et al. 2021). Turcotte et al. (2021) point out that "*while COSEWIC applies a consistent and arms-length framework for status assessment by independent experts, no counterpart exists at the recovery strategy or action planning stage.*" As a result, the best available science is often not followed (e.g., Spotted Owl recovery in BC). When science is ignored, courts are petitioned to arbitrate when nongovernmental organizations identify issues; this has been the case for several species including Nooksack dace *(Rhinichthys cataractae)*, greater sage-grouse *(Centrocercus urophasianus),* and southern resident killer whale *(Orcinus orca).*

7) Identification of CH must follow existing (or improved) well-defined procedures and challenges with identification should not be used to delay protections. A precautionary approach, in favour of habitat conservation, should be adopted (It is feasible to lessen protections if they are excessive; by converse it is impossible to replace limiting habitat once it has been destroyed). Identification of CH should not be a pre-requisite to trigger protections and data-deficiency resulting in uncertainty cannot be used to promote delays in conservation (Turcotte et al. 2021, Buxton et al. 2022).

8) Endemic and globally threatened species should be afforded higher priority for implementation of their action plans (Turcotte et al. 2021).

9) Discretionary language and ambiguous terminology and definitions (in SARA, and the current BC *Wildlife Act*) need to be replaced with clear and measurable wording and outcomes.

10) The federal process used to map CH is often poorly informed, based on old or incomplete data and inadequate engages species experts. As such, errors of both inclusion and exclusion are frequent.

The duration of persistence, and the likelihood of recovery, is an interplay between a species' population growth rate and its mortality rate—this relationship is influenced by the stressors described for each IUCN threat category. Present management under current governance is unlikely to effectively enable recovery for most SARA Schedule 1 listed species. This statement is supported by observation of continued declines as documented (by WWF) in over half of 903 monitored species between 1970 and 2014 (Rays 2021). This pattern is likely to continue with little means of abatement as mitigation measures are not required for most stressors currently being realized by species-at-risk in BC. This is particularly true if non-legal approaches (i.e., guidance and BMPs) are relied upon for species recovery. Continued declines, documented for so many species-at-risk experiencing threats on private and publicly owned lands, provide evidence that non-legal approaches are not sufficient to alter or stop harmful resource and land development practices. Clearly it is time for change!

"*We shall be remembered not for what we have created, but instead for what we have refused to destroy*" (Sierra Club)

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Appendices

Appendix 1: Federal-Provincial Agreement of Species-at-risk

Available at: Canada-British Columbia agreement on species-at-risk (sararegistry.gc.ca)