# COSEWIC
# Assessment and Status Report

on the

# Northern Rubber Boa
## *Charina bottae*

**in Canada**

**SPECIAL CONCERN**
**2016**

**COSEWIC**
Committee on the Status
of Endangered Wildlife
in Canada

**COSEPAC**
Comité sur la situation
des espèces en péril
au Canada

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

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Previous report(s):

COSEWIC 2003. COSEWIC assessment and status report on the rubber boa *Charina bottae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 14 pp.

Cameron, M., and R. St. Clair. 2003. COSEWIC status report on the rubber boa *Charina bottae* in Canada, *in* COSEWIC assessment and status report on the rubber boa *Charina bottae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-14.

Production note:
COSEWIC would like to acknowledge Linda Gregory for writing the status report on the Northern Rubber Boa (*Charina bottae*) in Canada. This report was prepared under contract with Environment Canada and was overseen by Kristiina Ovaska, Co-chair of the COSEWIC Amphibian and Reptile Species Specialist Subcommittee.

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Cover illustration/photo:
Northern Rubber Boa — Northern Rubber Boa (*Charina bottae*): adult (Pemberton, British Columbia). Photo by Photo by L.A. Lowcock.


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# COSEWIC
# Assessment Summary

**Assessment Summary – May 2016**

**Common name**
Northern Rubber Boa

**Scientific name**
*Charina bottae*

**Status**
Special Concern

**Reason for designation**
This species is patchily distributed within the southern half of British Columbia with concentrations in arid river valleys in the southern interior of the province. The species' life history traits, including low reproductive rate, delayed age at maturity, and longevity, and specific habitat requirements for hibernation and thermoregulation make it sensitive to human activities. There are inferred declines in mature individuals based on habitat trends, and some subpopulations continue to be threatened by habitat loss and fragmentation mainly from housing developments, roads, and transport corridors. The overall threat impact on the Canadian population is deemed to be low; however, the species could become Threatened if threats to local populations are not sufficiently managed and mitigated.

**Occurrence**
British Columbia

**Status history**
Designated Special Concern in May 2003. Status re-examined and confirmed in April 2016.

# COSEWIC
# Executive Summary

## Northern Rubber Boa
*Charina bottae*

### Wildlife Species Description and Significance

The Northern Rubber Boa is a short, stout snake with a short blunt tail. The head is rounded, blunt, and not distinguished from the neck. In adults, the back and sides are uniformly brown, although sometimes tinged with grey, yellow or green, and the underside is yellow. Juveniles are translucent and pale with no distinct margin between the dorsal and ventral surfaces. The body scales are small and smooth, giving the appearance of rubber. There is a pair of spurs, each in a pit, on each side close to the anal plate. The spurs in males are larger than those in females and are used by the males during courtship.

The Northern Rubber Boa is the only member of the ancient family Boidae in Canada, and one of only two species of this family living outside the tropics and subtropics (the other being the Southern Rubber Boa in California). It is of interest physiologically because of its cold-tolerance.

### Distribution

The Northern Rubber Boa is found from southern British Columbia south through Washington and Oregon to the northern half of California, and east to western Montana, western Wyoming, and Utah. In British Columbia, it occurs north almost to Williams Lake, west to Nelson Island and Sechelt Peninsula on the coast, and east to Radium Hot Springs and Canal Flats in the Rocky Mountain Trench. The easternmost records are less than 50 km from the Alberta border, but there are no records from Alberta.

### Habitat

In British Columbia, the Northern Rubber Boa occurs in humid mountainous regions and dry lowland areas, frequently in association with rock outcrops, rock piles, rock bluffs, or talus slopes. In the forest, the snakes are frequently found in openings under or near rocks and woody debris. In dry lowland areas, they may inhabit shrubby, treeless areas. The snakes require specific habitats for overwintering (hibernacula), thermoregulating, and foraging. The connections between these habitats are not well known.

## Biology

Northern Rubber Boas overwinter in hibernacula, usually communally. In British Columbia, the snakes usually emerge from hibernation in March, but individuals have been observed in February. The males remain near the overwintering sites, and courtship and mating occur soon after the females emerge, until early or mid-May. During gestation, the females thermoregulate by basking and moving in and out of rock crevices. In late July through to mid-September, the females give birth to 1 to 8 young. Males reach sexual maturity in 3 to 4 years and females in 4 to 5 years. Some females breed every other year, but others breed at frequencies of only every 3, 4, or 5 years or less often. The Northern Rubber Boa can live longer than 30 years in captivity. The generation time is probably 10 to 15 years.

Northern Rubber Boas feed on a variety of small prey, including rodents, birds, lizards, and the eggs of lizard and snakes. The Northern Rubber Boa is cold tolerant. It is mobile at night at low body temperatures but requires high temperatures for digestion and successful gestation, suggesting complex physiological adaptations to temperature.

## Population Sizes and Trends

Population sizes of the Northern Rubber Boa are virtually unknown, but given the species' wide distribution in southern British Columbia, the numbers may be in the tens of thousands, unevenly distributed across the range.

Population trends are unknown but the snakes continue to be found in many parts of their range in southern British Columbia, based on comparison of historical and more recent (since 2003) records. The Northern Rubber Boa occurs in six biogeoclimatic zones, four of which are ranked as imperilled or vulnerable. In five ecosystems within three biogeoclimatic units in the Okanagan and Similkameen River valleys, 33% – 74% of the habitat was lost between 1800s and 2003, and vineyards and housing developments continue to invade the land in these ecosystems further reducing the habitat for the Northern Rubber Boa. In Pemberton, southwestern British Columbia, at least six hibernacula are within an area of a proposed development. This loss of known hibernacula and overall habitat suggests a probable decrease in the overall abundance of the Northern Rubber Boa; specific required habitat features within these areas could be eliminated, and the fragmentation of the landscape would reduce movements and gene flow.

## Limiting Factors and Threats

Northern Rubber Boas have a "slow" life history, including low reproductive rate and long lifespan. They have specific habitat requirements for overwintering and thermoregulation, which include rocks, rock outcrops and/or talus slopes as well as loose forest soil and woody debris. These characteristics may limit population growth and distribution of the snakes.

The overall threat impact for this species is deemed low, based on expert opinion that considers the cumulative impacts of the multiple threats. The greatest threats are from agriculture and from transportation and service corridors, but these threats are assessed as having low impact on the population as a whole (expected population reduction $\leq$10% over the next three generations). The low rating is largely because of the wide distribution of the species. Local negative impacts due to residential and commercial development and recreational activities are probable, especially where hibernacula and/or summer thermoregulatory or foraging habitats are in a small area.

**Protection, Status and Ranks**

Northern Rubber Boa is listed as Special Concern on Schedule 1, the List of Wildlife Species at Risk under the federal *Species at Risk Act* (SARA). It is in Schedule A of the BC *Wildlife Act*, which offers it protection from direct persecution.

In British Columbia, the species is on the Yellow list (species and ecological communities are considered secure) and has a provincial rank of S4 (Apparently Secure - uncommon, but not rare; some cause for long-term concern due to declines or other factors). The national rank is N4, also apparently secure and the global rank is G5 (demonstrably widespread).

# TECHNICAL SUMMARY

*Charina bottae*

Northern Rubber Boa

Boa caoutchouc du Nord

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

**Demographic Information**

| | |
|---|---|
| Generation time | Probably 10 – 15 years<br><br>The generation time is based on the age of sexual maturity of the female and the frequency and total number of litters the female produces. It thus depends also on the lifespan of the female. The age of sexual maturity for Oregon snakes is about 5 years; it may be longer farther north in British Columbia. These snakes produce young every two to possibly more than five years. There is no estimate of adult survivorship, although the snakes can live for more than 30 years in captivity. |
| Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? | Yes, declines are inferred and projected based on habitat trends and threats to known den sites in localized areas. More widespread losses are possible due to road mortality. |
| Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations] | Unknown |
| [Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. | Unknown.<br><br>The numbers of records from pre-2003 (1926 - 2002) and from 2003 to 2015 are similar. This translates to more records per year since 2003, but this is more a matter of number of people recording the snake, and it does not give information about trends. |
| [Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. | Unknown but suspected to be $\leq$ 10% based on threats |
| [Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. | Unknown but suspected to be $\leq$ 10% based on threats |
| Are the causes of the decline a.clearly reversible and b.understood and c. ceased? | a. No; b. Partially; c. No<br><br>There are no data. The threats are largely speculative (see Description of Threats), except for localized housing developments, which are known and not reversible. |

| | |
|---|---|
| Are there extreme fluctuations in number of mature individuals? | No |

**Extent and Occupancy Information**

| | |
|---|---|
| Estimated extent of occurrence | 135,678 km²<br><br>Based on minimum convex polygon within Canada's extent of jurisdiction and including only confirmed records. 135,724 km$^2$ including unconfirmed records |
| Index of area of occupancy (IAO)<br>(Always report 2x2 grid value). | 748 km²<br><br>Or 187 grid cells (2 km x 2 km) based on confirmed records in Canada; 191 (764 km$^2$) if unconfirmed records are included. Both values are almost certainly underestimates, due to a detection bias associated with cryptic habits of the snakes and incomplete survey coverage. |
| Is the population "severely fragmented" ie. is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse? | a. Unknown but probably not<br><br>b. Unknown<br><br>Local populations within subpopulations seem to be concentrated around hibernacula, but there is minimal information on the locations of the hibernacula across the species' range, and the link between the hibernacula and summer thermoregulating and foraging areas is not well known (see **Dispersal and Migration**). |
| Number of "locations"* (use plausible range to reflect uncertainty if appropriate) | Unknown but large (>>>10)<br><br>A housing development such as the one proposed for the Pemberton area that will eliminate six hibernacula would be a "location", but the number of places where a single threatening event can rapidly affect all of the individuals is not known. |
| Is there an [observed, inferred, or projected] decline in extent of occurrence? | No<br><br>The extent of occurrence for the Northern Rubber including the confirmed and unconfirmed records for the pre-2003 and the pre-2003 plus 2003 to 2015 are similar (see **Extent of Occurrence and Area of Occupancy)**<br><br>The extent of occurrence given in COSEWIC (2003) is about half the present value. The comparison above is based on all of the known records in the two periods. |

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

| | |
|---|---|
| Is there an [observed, inferred, or projected] decline in index of area of occupancy? | Unknown, but possibly an inferred and projected decline due losses of hibernacula from housing developments, road construction, and expansion of agriculture, especially in areas where suitable habitat is uncommon.<br><br>The IAO for the confirmed pre-2003 records is 110 grids (440 $km^2$) and for the confirmed plus unconfirmed 111 grids (444 $km^2$). The IAO for the pre-2003 plus the 2003 to 2015 is 187 grids (748 $km^2$) for the confirmed and 191 grids (764 $km^2$) for the confirmed plus the unconfirmed. This increase reflects the number of new observations within the known range. |
| Is there an [observed, inferred, or projected] decline in number of subpopulations? | Yes, inferred and projected decline<br><br>There has been loss of some snakes due to housing developments (threat 1), agriculture (threat 2), and transportation corridors (threat 4), which could result in a decrease in local subpopulations. A few cases are known of dens being lost or projected to be lost due to development, which would result in the loss of the local subpopulation. |
| Is there an [observed, inferred, or projected] decline in number of “locations”*? | Yes, inferred and projected decline (see above) |
| Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? | Yes<br><br>Four of the six biogeoclimatic zones where the Northern Rubber Boa occurs are ranked as imperilled or vulnerable. Between 1800s and 2003 there has been a 33% to 74% loss of habitat within five ecosystems in the Okanagan and Simikameen River Valleys in British Columbia and these ecosystems are in three of the imperilled or vulnerable biogeoclimatic zones. |
| Are there extreme fluctuations in number of subpopulations? | Not likely, but no data are available. |
| Are there extreme fluctuations in number of “locations”∗? | Unknown |
| Are there extreme fluctuations in extent of occurrence? | No |
| Are there extreme fluctuations in index of area of occupancy? | No |

[+] See Table 3 ( Guidelines for modifying status assessment based on rescue effect)

**Number of Mature Individuals (in each subpopulation)**

| Subpopulations (give plausible ranges) | N Mature Individuals |
|---|---|
| Unknown | Unknown |
| | Maybe tens of thousands based on relatively wide range. |

**Quantitative Analysis**

| | |
|---|---|
| Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years]. | Not estimated due to lack of data |

**Threats (actual or imminent, to populations or habitats, from highest impact to least)**

The calculated overall threat impact for the Northern Rubber Boa is low. The low overall rating is largely because of the large distribution; local negative impacts due to residential and commercial development (threat 1) and recreational activities (threat 6.1) are probable, if the hibernacula and/or summer thermo-regulatory / foraging habitats are impacted.

i. Agriculture and aquaculture (low)
ii. Transportation and service corridors (low)

All others threat categories were negligible, unknown, or not applicable (see Table 1).

Was a threats calculator completed for this species and if so, by whom?

On March 21, 2014 Linda Gregory (consultant, Mill Bay, BC), Leah Westereng (B.C. Ministry of Environment [BCMOE]) and Kristiina Ovaska (Biolinx Environmental Research Ltd., Victoria, BC) updated the threats assessment initially prepared in December 2011 by Orville Dyer (B.C. Ministry of Forests, Lands and Natural Resource Operations), Purnima Govindarajulu (BCMOE) and Jared Hobbs (Hemmera, formerly BCMOE). This was prepared as part of the Draft management Plan for the Northern Rubber Boa (BC Ministry of Environment, 2015) and is used here by permission.

**Rescue Effect (immigration from outside Canada)**

| | |
|---|---|
| Status of outside population(s) most likely to provide immigrants to Canada. | Washington State and Montana: “apparently secure” ; Idaho: S5 (demonstrably widespread) |
| Is immigration known or possible? | Possible in some areas near the border in south-central British Columbia |
| Would immigrants be adapted to survive in Canada? | Probably, with the same thermal considerations as those in Canada (see **Physiology and Adaptability**) |
| Is there sufficient habitat for immigrants in Canada? | Unknown |
| Are conditions deteriorating in Canada? | Yes, especially in the Similkameen and Okanagan River Valleys and other areas where cross-border movements may occur |
| Are conditions for the source population deteriorating? | Unknown |
| Is the Canadian population considered to be a sink? | No |

| | |
|---|---|
| Is rescue from outside populations likely? | Could occur at very low levels in areas near the Canada-USA international border |

**Data Sensitive Species**

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|---|
| Is this a data sensitive species? No |

**Status History**

| |
|---|
| COSEWIC: Designated Special Concern in May 2003. Status re-examined and confirmed in April 2016. |

**Status and Reasons for Designation:**

| **Status:** | **Alpha-numeric codes:** |
|---|---|
| Special Concern | Not Applicable |

**Reasons for designation:**
This species is patchily distributed within the southern half of British Columbia with concentrations in arid river valleys in the southern interior of the province. The species' life history traits, including low reproductive rate, delayed age at maturity, and longevity, and specific habitat requirements for hibernation and thermoregulation make it sensitive to human activities. There are inferred declines in mature individuals based on habitat trends, and some subpopulations continue to be threatened by habitat loss and fragmentation mainly from housing developments, roads, and transport corridors. The overall threat impact on the Canadian population is deemed to be low; however, the species could become Threatened if threats to local populations are not sufficiently managed and mitigated.

**Applicability of Criteria**

| |
|---|
| Criterion A (Decline in Total Number of Mature Individuals):<br>Not met. While declines are inferred and projected, their magnitude is unknown. |
| Criterion B (Small Distribution Range and Decline or Fluctuation):<br>Not met. IAO is below threshold for Threatened but only one sub-criterion is met (b(iii) decline in habitat quality); the population is not severely fragmented, there are more than 10 locations, and the number of adults does not undergo extreme fluctuations. |
| Criterion C (Small and Declining Number of Mature Individuals):<br>Not met. The population size is unknown and possibly greater than 10,000 adults. |
| Criterion D (Very Small or Restricted Population):<br>Not met. The population is not very small or restricted. |
| Criterion E (Quantitative Analysis):<br>Not estimated due to lack of data. |

## PREFACE

The previous status report was prepared in 2003 (COSEWIC 2003). The updated information in this report is from four main sources: a review of all of the initial references and some unreported references in the 2003 report; new records, personal observations, and unpublished data about the Northern Rubber Boa provided by numerous herpetologists and naturalists; a summary of the paper by Lowcock and Woodruff (2014) on the distribution, ecology, movements and reproduction of the Northern Rubber Boa in Pemberton Valley, British Columbia presented at the Canadian Herpetological Society meeting in Sept. 2014; and material – including the results and discussion of the threats calculator - contained in the Draft Management Plan for the Northern Rubber Boa (BC Ministry of Environment 2015) and used by permission in this report. This new information has added to further understanding the biology of the Northern Rubber Boa, and provided more information on the distribution and habitat requirements of the species. It has also identified the important data gaps

## COSEWIC HISTORY

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

## COSEWIC MANDATE

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

## COSEWIC MEMBERSHIP

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

## DEFINITIONS (2016)

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

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

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

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

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

# COSEWIC Status Report

on the

# Northern Rubber Boa

*Charina bottae*

**in Canada**

2016

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## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and Classification

The taxonomy of *Charina bottae* (Rubber Boa) has had several changes, from three to two subspecies (Stewart 1977) to no subspecies (Gregory and Gregory 1999, based largely on Collins 1990) to the present recognition of two separate species (Crother *et al*. 2012). At the time of the previous status report (COSEWIC 2003), two subspecies were recognized: *C. b. bottae*, Northern Rubber Boa, and *C. b. umbratica*, Southern Rubber Boa, endemic to California; only the Northern Rubber Boa occurs in Canada. Using mitochondrial DNA sequences, Rodriguez *et al.* (2001) showed that the subspecies are sufficiently distinct to be elevated to species status, and their data agreed with allozyme studies by Weisman (1988). *Charina bottae*, the Northern Rubber Boa, and *Charina umbratica*, the Southern Rubber Boa, are now recognized by the Committee on Standard English and Scientific Names as distinct species (Crother *et al.* 2012).

The classification of the Northern Rubber Boa is as follows:

Class: Reptilia
Order: Squamata
Suborder: Serpentes
Family: Boidae
Genus: *Charina*
Species: *C. bottae (Blainville 1935)*

### Morphological Description

The Northern Rubber Boa is a short and stout snake with a short, blunt tail (Matsuda *et al*. 2006), which resembles the head (Nussbaum *et al*. 2006) and presumably functions to distract antagonists (Hoyer and Stewart 2000a) and predators (Greene 1973). The head is rounded, blunt, and not clearly distinguished from the neck (Matsuda *et al*. 2006), which may facilitate burrowing. The eyes are small with a vertical pupil of nocturnal animals. In adults, the dorsal surface is uniformly brown, although sometimes tinged with grey, yellow or green, and the underside is yellow (Matsuda *et al*. 2006). Juveniles are translucent and pale with no distinct margin between the dorsal and ventral surfaces (Hoyer and Stewart 2000a). The scales on the top of the head are large and irregular, while body scales are small and smooth (Matsuda *et al*. 2006), giving it the appearance of rubber. There is a single anal plate (enlarged scale anterior to the cloaca). Similar to other boas, Rubber Boas have a spur in a pit on each side of the body close to the anal plate. The spurs in males are larger than those in females and are used during courtship (Hoyer 1974; Hoyer and Storm 1992).

## Population Spatial Structure and Variability

The population spatial structure of the Northern Rubber Boa across its Canadian distribution is unstudied, but some broad-scale discontinuities are evident. In British Columbia, records of the species are clustered in major river valleys in the southern and central interior of the province (Figure 1; see **Canadian Distribution**). The river valleys and coast are separated by mountains, the Coast and Cascade Mountains in the west and the Columbia Mountains, including the Monashee, Selkirk, and Purcell ranges, and the Rocky Mountains in the east. The Central Plateau, the southern part of which is the Thompson Plateau, lies between the east and west mountains. The mountains preclude movement of the Northern Rubber Boa between many of the valleys and the coast, suggesting that there are several subpopulations.

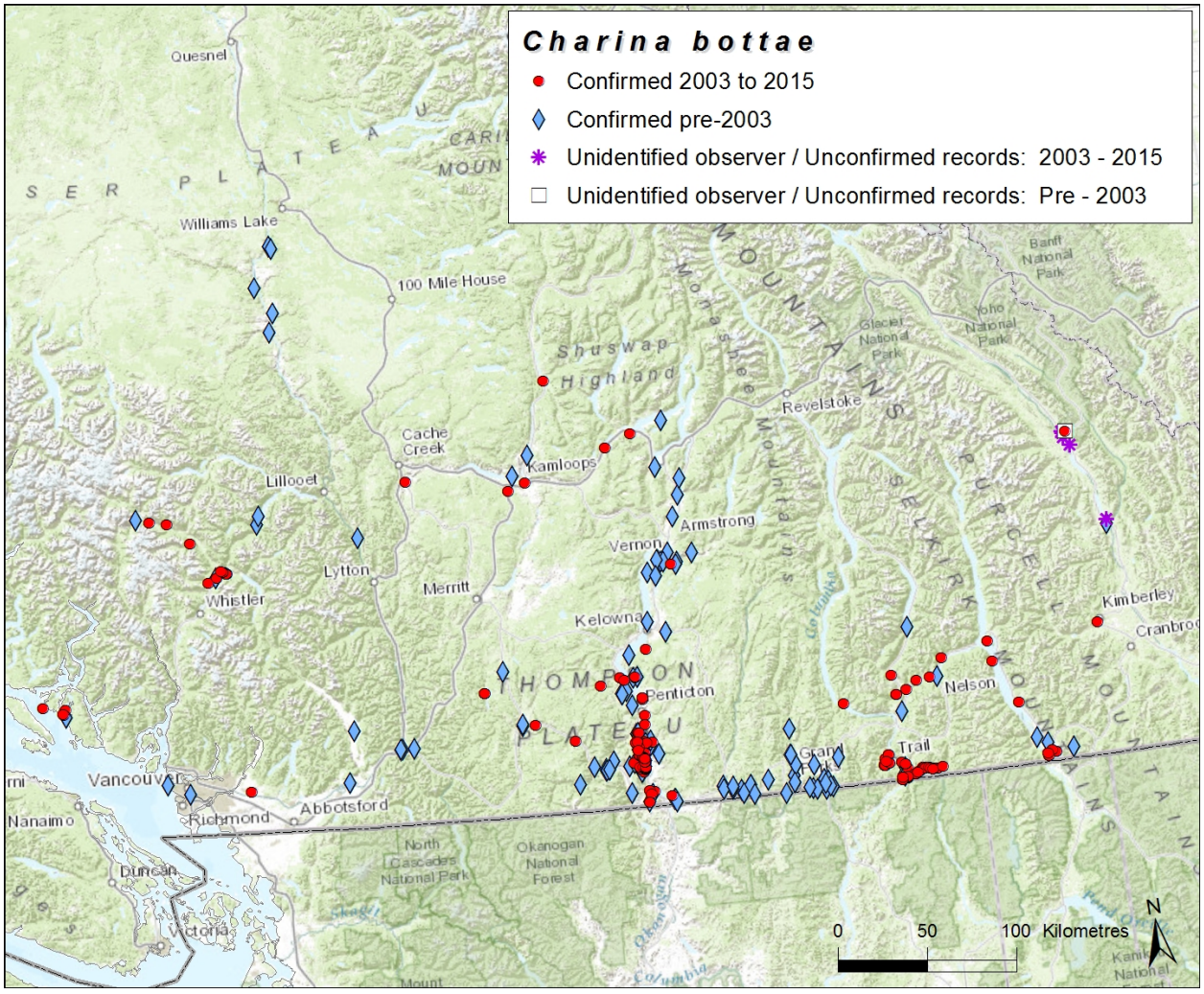


Figure 1. Canadian distribution of Northern Rubber Boa in British Columbia. Map prepared by Jenny Wu (COSEWIC Secretariat).

In addition to physical barriers, the extent of movement of Northern Rubber Boas would also affect the population structure. Home range sizes for two of the five snakes St. Clair (1999) radio-tracked were 0.298 ha and 1.203 ha (St. Clair unpubl. data 2015). The latter includes a 450 m movement to the hibernaculum. These values are well within the mean home range areas and the distances moved to hibernacula for a variety of snake species (Macartney *et al*. 1988), suggesting that the Northern Rubber Boa is not dissimilar to other snakes in British Columbia and that separate subpopulations occur within contiguous river valleys, but these may be further divided based on habitat suitability at the landscape-level.

There are further probable divisions within the Columbia River Valley due to its drainage pattern. First, it flows from the headwaters in southern British Columbia north to latitudes beyond the distribution of the Northern Rubber Boa suggesting that the subpopulation in the headwaters, including Canal Flats and Radium Hot Springs, would be isolated from northern movement due to latitude. Second, the Kootenay River flows south from British Columbia into Montana and Idaho and then north back to Canada. This separates the East Kootenay subpopulation, although it is represented by only one record to date. Third, the Kettle River also dips in and out of Washington, but it ultimately meets the Columbia River in Washington, suggesting that the Kettle River drainage is a separate subpopulation in British Columbia. Finally, the Similkameen River meets the Okanagan River in Washington, and the Okanagan (spelled Okanogan in Washington) River flows into the Columbia River farther south in Washington, suggesting that Northern Rubber Boa from the Okanagan and Similkameen valleys are separate subpopulations. The Kootenay River Valley from the border with the USA north to Kootenay Lake and west from the lake to the Columbia River and south on the Columbia River including the Pend d'Oreille River Valley in British Columbia to the border with the USA is contiguous in British Columbia and is considered a subpopulation.

Records of the species from the Fraser River drainage are sparse and, although the main river and tributaries are contiguous in British Columbia, the separation distances and apparent clustering of records suggest that they represent three to four subpopulations: the Chilcotin, Thompson, and Lillooet River valleys (including the lower Fraser River), and possibly another subpopulation along the Fraser River itself between the Chilcotin and Lillooet River valleys. Finally, the records from coastal British Columbia indicate that snakes in this area would also constitute a subpopulation, as would those in the Skagit River basin.

The genetic structure of subpopulations has not been studied.

## Designatable Units

The Northern Rubber Boa occurs in two COSEWIC Terrestrial Ecological Areas (Pacific Ecological Area and the Southern Mountain Area) and three COSEWIC Terrestrial Amphibian and Reptile Faunal Provinces (Pacific Coast, Intermountain, and Rocky Mountain). However, there is no information available on genetic, morphological or behavioural differences across its Canadian distribution; nor are there obvious disjunctions or gaps in the distribution that could suggest local adaptations. Therefore, there is insufficient evidence for more than a single designatable unit.

## Special Significance

The Northern Rubber Boa is the only member of the ancient family Boidae in Canada (COSEWIC 2003), and one of only two boid species living outside the tropics and subtropics (Crother *et al*. 2012). This species is of interest physiologically because it is active and forages at low body temperatures at night and has even been observed moving on snow in early spring (Sarell pers. comm. 2014). However, it requires higher body temperatures for successful digestion and reproduction.

# DISTRIBUTION

## Global Range

The Northern Rubber Boa occurs from southern British Columbia south through Washington and Oregon to the northern half of California, and east to western Montana, western Wyoming, and Utah (Matsuda *et al*. 2006; Figure 2). Less than 25% of the species' range is in Canada.

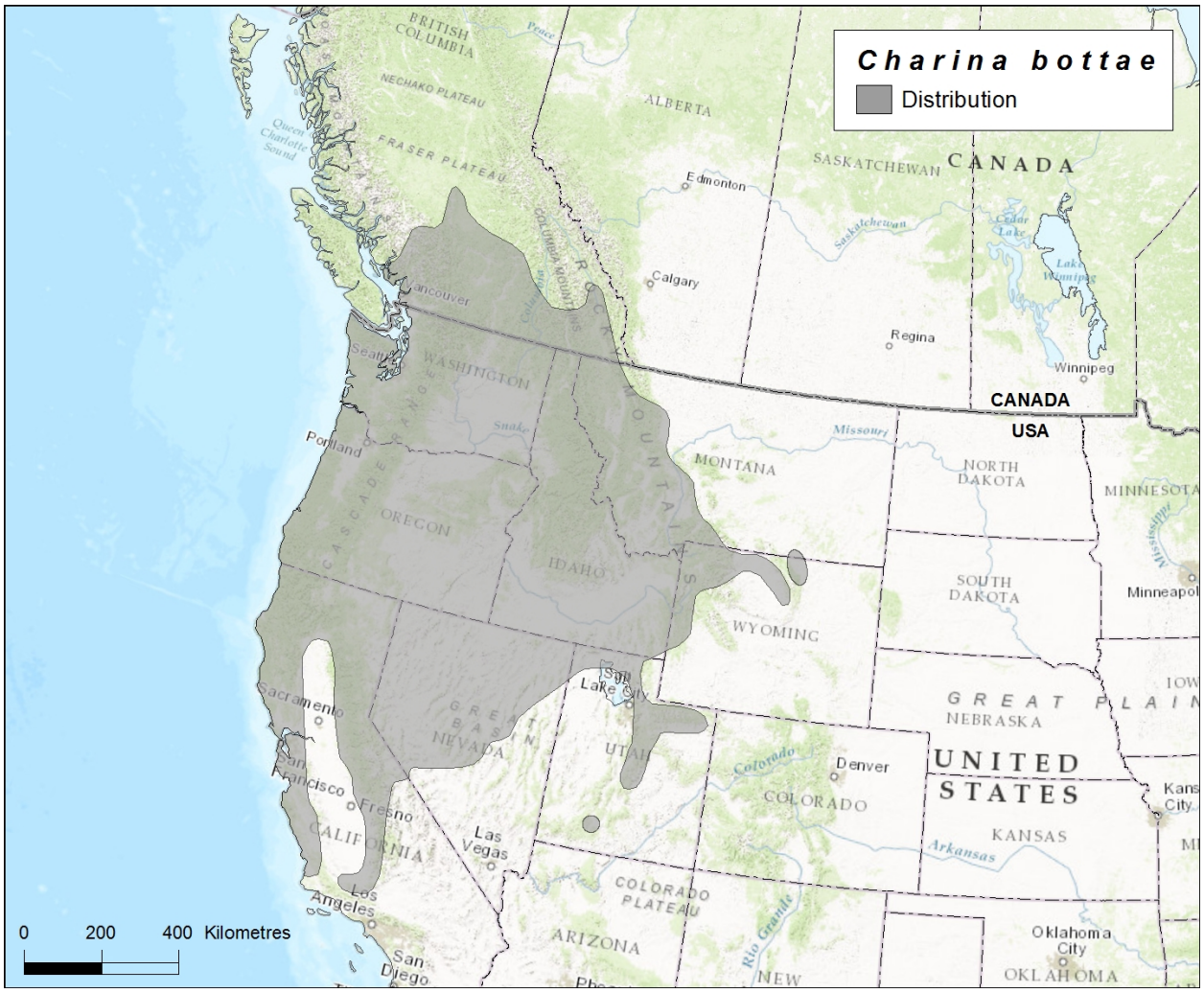


Figure 2. Global distribution of the Northern Rubber Boa in Canada and the United States. Map prepared by Jenny Wu (COSEWIC Secretariat).

## Canadian Range

The Northern Rubber Boa occurs across much of southern British Columbia, from the mainland coast eastward almost to the Alberta border (Figure 1). There are records north almost to Williams Lake, west to Nelson Island and Sechelt Peninsula on the south coast, and east to Radium Hot Springs and Canal Flats in the Rocky Mountain Trench (Matsuda *et al*. 2006; Pearson 2010; Figure 1). The snakes are found primarily within the Columbia and Fraser River Basin valleys with additional subpopulations on the coast and in the Skagit River basin (see **Population Spatial Structure and Variability**). The easternmost records are less than 50 km from the Alberta border, but there are no records from Alberta (Russell and Bauer 2000).

Most of the records are from large river valleys: Columbia River near its headwaters and further downstream with the main southern tributaries (Kootenay River, Kettle River, Pend d'Oreille, Okanagan, and Similkameen rivers); Fraser River south from the mouth of the Chilcotin River and including the Chilcotin River and additional main tributaries (Thompson and Lillooet rivers); and Skagit River. Along the coast, there are records from the Sechelt Inlet area.

Since the previous COSEWIC (2003) status report, there have been numerous additional records of the Northern Rubber Boa (Figure 1). Most of these are within the known distribution. There are clusters of new records from the Pemberton area and from the Columbia and Kootenay River valleys, from Creston to Nelson to Trail and the USA border. This is in part because Dulisse (2006, 2007) recorded all Northern Rubber Boa observations in his studies targeting other reptiles in the Columbia and Kootenay River Valleys, and Lowcock and Woodruff (2014) summarized four years of observations of the Northern Rubber Boa in the Pemberton area. The additional observations in the Okanagan River Valley are from ongoing observations by naturalists in this area. The new records for the Thompson River Valley are opportunistic observations. Lack of new records for the Northern Rubber Boa along the Chilcotin and Kettle River valleys appears to reflect lack of search effort rather than the disappearance of the species.

The two records for Vancouver (UBC in 1948; Marine Drive in 1960) may represent subpopulations lost to development. In addition, several dens in the Pemberton area in the southwest of British Columbia are on land where a large residential development is proposed (Lowcock pers. comm. 2014).

The record given in COSEWIC (2003) for near Quesnel (Cannings *et al*. 1999, presumably based on Keddie 1975) is incorrect (Keddie pers. comm. 2014).[1] The correct locality is in Figure 1 at the junction of the Chilcotin and Fraser rivers, a considerable distance south of Quesnel.

**Extent of Occurrence and Area of Occupancy**

The extent of occurrence (EOO) and index of area of Occupancy (IAO) from COSEWIC (2003) and the values calculated from the records in Figure 1 are summarized in Table 1. Figure 1 includes records that are confirmed and ones that are unconfirmed. The latter are included because they are from Kootenay National Park staff; however, they remain unconfirmed because the observer is not identified and there is no photograph or official confirmation of the identity of the animal. However, confirmed records are available from the general area, including from the Kootenay National Park near Radium Hotsprings (St. Clair and Dibb 2004), suggesting that the unconfirmed records might be valid and are useful inclusions. Most of the records in the Pemberton area and the Okanagan and the Kettle River valleys (Figure 1) are from hibernacula. Many of the others represent isolated observations. However, St. Clair (1999) found that summer foraging areas were near overwintering areas, and Lowcock and Woodruff (2014) observed snakes at or near the

[1] Keddie (1975) gave the location as the mouth of the Chilcotin River, but the coordinates were obtained from field maps and were inaccurate (Keddie pers. comm., 2014).

hibernacula for several months before and after the overwintering period, suggesting that the isolated observations of the snakes were probably close to a hibernaculum.

**Table 1. The index of area of occupancy (IAO) and the estimated extent of occurrence (EOO) for the Northern Rubber Boa given in COSEWIC (2003) and calculated from all known records of the snake shown in Figure 1 and separated into pre-2003, 2003 to 2015 and pre-2003 to 2015. See text for explanation of confirmed and unconfirmed data.**

| Time Period or Source* | Confirmed Records | | Confirmed + Unidentified Observer/Unconfirmed Records | |
|---|---|---|---|---|
| | EOO $km^2$ | IAO $km^2$ 2 x 2 km grids = $km^2$ | EOO $km^2$ | IAO grids = $km^2$ |
| COSEWIC 2003 | 73,000 | 24,300 $km^{2*}$ | | |
| Pre-2003** | 124,017 | 110 = 440 | 134,222 | 111 = 444 |
| 2003 to 2015** | 108,925 | 92 = 368 | | |
| Pre-2003 & 2003 to 2015** | 135,687 | 187 = 748 | 135,724 | 191 = 764 |

*Given as AO; calculation method unknown
** From data used in Figure 1.

The EOO is based on a minimum convex polygon around all the known records within Canada as shown in Figure 1. All records, rather than only post-2003 records were used because many historical sites have not been revisited and their omission would result in serious underestimate of the both EOO and IAO. It is not clear why the EOO of 73,000 $km^2$ in the COSEWIC (2003) report is only 59% of the pre-2003 value (124,017 $km^2$), as calculated from the records in Figure 1. Comparing the EOO for the pre-2003 confirmed records (124,017 $km^2$) and all of the confirmed records (135,687 $km^2$) indicates an increase in the known EOO. This is probably because of the new confirmed record at Radium Hot Springs and near Kimberley, as well as the new records in the Columbia River Valley. These are unlikely to represent range expansion but are from areas not previously explored. The position of unconfirmed pre-2003 records from Radium Hot Springs in from Kootenay National Park staff was later confirmed (St. Clair and Dibb 2004), and the inclusion of these records in the convex polygon calculation would have substantially increased the previous calculation of the EOO (See Figure 1). The lower EOO for the 2003 to 2015 period is simply a function of places that were investigated during that period. However, some of the sites included in the pre-2003 records would have been lost to development, notably in the Lower Mainland. In addition, several Northern Rubber Boa hibernacula in the Pemberton area are expected to be lost due to development.

The IAO is based on 2 km x 2 km grid cells superimposed on the distribution and counting the number of occupied cells. The AO in COSEWIC (2003) was recorded as 24,300 $km^2$; IAO was not calculated. This larger value may represent the entire area of the major river valleys where the species occurs. The IAO was calculated here from the confirmed pre-2003 records as 440 $km^2$ (110 grid cells) and from all confirmed records to date as 748 $km^2$ (187 grid cells). There are areas within the overall distribution that have not been surveyed, and thus the IAO is probably an underestimate.

**Search Effort**

There have been few targeted surveys for this species, and most records are by-catch from surveys for other species or serendipitous observations. The search effort has varied by study and is often not specified. The snakes are cryptic and easily missed unless rocks and other cover objects are flipped (Dorcas and Peterson 1998; Lowcock and Woodruff 2014).

Over three years in the late 1990s, more than 1000 hours were spent looking for the snakes in the Creston Wildlife Management Area (36.125 ha), and 65 Rubber Boas were found (COSEWIC 2003). Assuming an 8-hour day, this translates to one snake every two days. At the same site, Hoyer (pers. comm. 2014) used labour-intensive methods and found more than ten snakes in one day. Gregory (pers. comm. 2014) flipped rocks and other cover objects and found three snakes in one day. Lowcock and Woodruff (2014) observed Northern Rubber Boa over a 4-year period, primarily at hibernacula in the Pemberton area and found them everywhere in the vicinity where there was obviously suitable habitat, presumably rocks or other cover objects, and also in areas that did not seem be in such habitat; at one site the numbers exceeded 25 individuals. Dulisse (2006) documented the occurrence of the Northern Rubber Boa while conducting surveys for the Western Skink (*Plastiodon skiltonianus*) and recorded 27 Northern Rubber Boas at 17 of the 41 sites where skinks were found. This involved looking under 13,033 cover objects (rocks and coarse woody debris) over a total of 63.5 hours in the summers of 2004 and 2005. Snakes were located during eight days with an average of three to four snakes per day. However, in areas where the skinks were not found, 16,393 objects were overturned, and the Northern Rubber Boa was found only at three of the 56 sites surveyed. Given the hours searched at these sites (67.3 hours), this translates to one snake every two days.

In general, the Northern Rubber Boa may be common at or near hibernacula and surveys should be conducted at hibernacula until more is known about the summer range and movements.

# HABITAT

## Habitat Requirements

Across its global range, the Northern Rubber Boa occurs in diverse habitats, from sage brush and grasslands to shrub lands and deciduous and evergreen forests (Nussbaum *et al*. 1983; St. Clair 1999; Matsuda *et al*. 2006; Sarell pers. comm. 2014). Within these habitats, the snakes require specific features that allow them to forage, thermoregulate, and overwinter.

Habitat features for thermoregulation include soils loose enough for burrowing, rodent holes, leaf litter, woody debris (including logs and rotting stumps), rock outcrops, and talus (Dorcas and Peterson 1997; Dorcas and Peterson 1998; St. Clair 1999; Sarell pers. comm. 2014). These habitat features are necessary because the Northern Rubber Boa may bask in the open in spring but regulates its body temperature in summer by moving under different sized rocks and burrowing in the soil, woody debris, or talus.

Rock outcrops and talus slopes are frequently used as hibernacula (Dorcas and Peterson 1998; Lowcock and Woodruff 2014; Sarell pers. comm. 2014), although the Northern Rubber Boa also overwinters in forest soils (about 1 m below surface; St. Clair 1999 *in* St. Clair and Dibb 2004) and compost and burn piles (Sarell pers. comm. 2014).

In British Columbia, the Northern Rubber Boa occurs in humid mountainous regions and dry lowland areas (Matsuda *et al*. 2006) and is frequently associated with rock outcrops, rock piles, rock bluffs, or talus slopes (St. Clair 1999; Pearson pers. comm. 2014; Sarell pers. comm. 2014). In the forests, the snakes are frequently in openings, where they shelter under or near rocks (St. Clair 1999; Dulisse 2006; Matsuda *et al*. 2006). In the dry lowland areas, they may occur in habitats with shrubs, grasses, and rocks or talus slopes (Sarell pers. comm. 2014).

In western Oregon, Hoyer (1974) found the Northern Rubber Boa in most habitats, including disturbed areas such as railway and highway right of ways, vacant city lots, large grassy fields, and near industrial plants. It was not present on agricultural lands used for grazing or cultivation, or in areas that were subject to flooding (Hoyer 1974). In British Columbia, near Pemberton, the Northern Rubber Boa has been found in disturbed areas using old quarry material as a hibernaculum.

## Habitat Trends

The Northern Rubber Boa occurs in six biogeoclimatic zones (Table 2). Austin *et al*. (2008) developed a conservation status rank for each of the zones based on criteria that included rarity, trends, and the level of threat from human activity using specific threats that correspond closely to those used in this report. Their assessment emphasizes all species of concern within the zones, whereas this report deals only with the Northern Rubber Boa. However, it is important to note that many species in the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir zones are imperilled or vulnerable (Table 2), and these are important

habitats for the Northern Rubber Boa. This indicates that the habitat for the Northern Rubber Boa is decreasing or under threat. Further support for habitat loss is the number of hectares lost between 1800 (pre-European settlement) and 1938 (livestock, commercial orchards, and vineyards) and 2003 (extensive orchards and vineyards) in five of the ecosystems within three biogeoclimatic units (Lea 2008) (Table 3). The three biogeoclimatic units are the Okanagan Very Dry Hot Bunchgrass variant, the Okanagan Very Dry Hot Ponderosa Pine variant, and the Okanagan Very Dry Hot Interior Douglas-fir variant found in the lower Similkameen River Valley from near Keremeos to the border with the USA and the Okanagan River Valley from Enderby south to the border with the USA. These three units are within three of the biogeoclimatic zones that are ranked as imperilled or vulnerable (Austin *et al*. 2008; Table 2). All of the ecosystems experienced a loss of land in both periods, with the total loss over the whole period from 33 to 74% (Table 3). The loss of natural ecosystems continues. For example, the land used for wine grapes increased 20% between 2004 and 2006 to 2600 ha and is expected to peak at over 4000 ha (Lea 2008). Fragmentation of habitat reduces potential movement, but loss of specific habitats required for thermoregulation and hibernacula is critical; the Northern Rubber Boa appears to spend much of the time at or near the hibernacula, and the loss of even one hibernaculum may disproportionally affect the local subpopulation. As the land is cleared for developments or vineyards, the required habitat will be eliminated.

**Table 2. Biogeoclimatic zones and their occurrence and ranking in the area of British Columbia where the Northern Rubber Boa occurs. Imperilled (S2) = At high risk of extinction due to restricted range, steep declines or other factors, vulnerable (S3) = At moderate risk of extinction or extirpation due to restricted range, recent and widespread declines, or other factors, and apparently secure (S4) = uncommon but not rare, and usually widespread. Some cause for concern. Ranking from Austin *et al.* 2008.**

| Biogeoclimatic Zone | Occurrence in BC within the range of the Northern Rubber Boa | Rank |
|---|---|---|
| Bunchgrass | Narrow fingers of land along the river valleys of the Okanagan and Thompson River basins and the Fraser River basin from the Chilcotin River to the Lillooet River | Imperilled (S2) |
| Coastal Douglas-fir | Fringe along the south coast | Imperilled (S2) |
| Ponderosa Pine | Low elevations along the very dry valleys of BC's southern interior<br>(Fraser River valley in Lytton & Lillooet, lower Thompson, Nicola, Similkameen and lower Kettle River valleys, adjacent to Okanagan Lake and in southeastern BC near Cranbrook and Lake Kookanusa | Imperilled/Vulnerable (S2/S3) |
| Interior Douglas-fir | Low to mid-elevations in the east Kootenays, the Okanagan-Similkameen and Thompson region, and southern parts of the Chilcotin | Vulnerable (S3) |

| Biogeoclimatic Zone | Occurrence in BC within the range of the Northern Rubber Boa | Rank |
|---|---|---|
| Coastal Western Hemlock | Lower elevations west of the Coast Mountains from very wet and exposed outer coast to drier and more sheltered areas on the inner coast along BC's coast and east of the coast mountains along major river valleys | Apparently secure (S4) |
| Interior Cedar-Hemlock | Southeast BC on lower slopes of Columbia and Rocky Mountains | Apparently secure (S4) |

**Table 3. Five ecosystem types in the Similkameen/Okanagan River Valleys and the hectares of habitat present in 1800, 1938 and 2003 and the calculated hectares lost between the different time periods. Data from Lea (2008).**

| Ecosystem Type | Hectares Present | | | Percent Loss | | |
|---|---|---|---|---|---|---|
| | 1800 | 1938 | 2003 | 1800 - 1938 | 1938 - 2003 | 1800 - 2003 |
| Douglas-fir – Pinegrass (gentle slope) | 23,177 | 17,882 | 15,428 | 23 | 14 | 33 |
| Ponderosa pine – Bluebunch wheatgrass (gentle slope) | 15,307 | 12,091 | 7,767 | 21 | 36 | 49 |
| Idaho fescue – Bluebunch wheatgrass steppe | 19,528 | 8,924 | 5,017 | 54 | 44 | 74 |
| Overall Big sagebrush shrub steppe | 12,458 | 10,402 | 8,266 | 16 | 21 | 34 |
| Antelope-brush – Needle-and-thread grass shrub-steppe | 9,895 | 7,325 | 3,178 | 26 | 57 | 68 |

## BIOLOGY

The information on the biology of the Northern Rubber Boa in British Columbia is from St. Clair (1999), St. Clair and Dibb (2004), and Lowcock and Woodruff (2014), and from personal observations by these and other herpetologists and naturalists (e.g., P. Gregory and M. Sarell). Most information on the biology of the Northern Rubber Boa is from populations in Oregon and Idaho (Hoyer and Storm 1992; Dorcas 1995; Dorcas and Peterson 1997; Dorcas *et al*. 1997; Dorcas and Peterson 1998; Hoyer and Stewart 2000a, b), and from museum specimens (Rodrigues-Robles *et al*. 1999).

## Life Cycle, Reproduction and Growth

In British Columbia, Northern Rubber Boas overwinter in communal hibernacula containing small numbers of individuals (2 to 25 or more; St. Clair 1999; Lowcock and Woodruff 2014; Lowcock pers. comm. 2014; Sarell pers. comm. 2014). The snakes usually emerge in March (Sarell pers. comm. 2014), but individuals have been observed in February (Grant 1969). Males remain near hibernacula and, soon after females emerge, begin courting by stroking them with their well-developed anal spurs (Hoyer 1974; Lowcock and Woodruff 2014).

The Northern Rubber Boa is viviparous giving birth to live young. During gestation, females thermoregulate by basking and by moving in and out of rocks and rock crevices (Dorcas and Peterson 1998; Lowcock and Woodruff 2014). Females do not generally feed during gestation (Dorcas and Peterson 1998) and give birth at the hibernacula primarily between late July and mid-September (St. Clair 1999; Hoyer and Storm 2002; Lowcock and Woodruff 2014). In Oregon, the number of young in 378 litters born in captivity ranged from 1 to 8 with a mean of 4.2. Three litters in British Columbia had 4 to 6 young (COSEWIC 2003). Both sexes of Northern Rubber Boas from Oregon are approximately the same size as neonates (males: N=576, $\bar{x} = 8.1$ g, $\bar{x}$ =256 mm long; females: N = 687, $\bar{x} = 8.2$ g, $\bar{x} =$ 257 mm long), but males mature earlier and at a smaller body size than do females (Hoyer and Storm 1992).

For Northern Rubber Boa in Oregon, Hoyer and Storm (1992) suggest that males can reach sexual maturity in 3 to 4 years and females in 4 to 5 years. This is based primarily on the body size of released and recaptured neonates, and the size of the smallest courting male (total length = 457 mm) and the smallest gravid female (total length = 559 mm). Two of the females released as neonates were gravid at age of 5 years (Hoyer and Storm 1992), suggesting that the time to maturity, based on the size of recaptured neonates, is accurate. Age at maturity in Canadian subpopulations is unknown but is expected to be at least 4 to 5 years for females and may be even longer within the northern portion of the species' range.

In Oregon, female Northern Rubber Boas are on average larger than males (males: N=153, total length (mm) $\bar{x}$ = 534.6, range 454 – 638; females $\bar{x}$ = 650.9, range 546 – 781; Hoyer 1974). St. Clair (1999) noted that there was a similar size discrepancy between male and female Northern Rubber Boa in British Columbia but provided no data.

Breeding frequency for eight adult Northern Rubber Boas from Oregon (Hoyer and Storm 2002) is summarized in Table 4. There is no evidence that females breed every year, although there are data gaps and inconsistent cycles for individual snakes. Snakes with sufficient data to describe at least one cycle include biennial (every two years, snake number 2), triennial (every three years, snake number 4), and quinquennial (every five years, snake number 7) and quinquennial or greater (snake number 8). Snake number 1 is either annual or biennial. Snake number 3 appears to be biennial, and snake numbers 5 and 6 are probably triennial or quadrennial (every 4 years). The samples are from a series of years from 1979 through 1992 and in any one year there were gravid and non-gravid females. After parturition, some, but not all of the females feed and replenish their fat reserves for the winter. Females that do not eat post-partum can survive the winter in Oregon (Hoyer pers. comm. 2014). The biennial to quinquennial clutch frequencies suggests that it takes more than one summer following breeding to reach the condition for another breeding cycle and stresses the importance of longevity in the Northern Rubber Boa.

**Table 4. Breeding frequencies for eight adult Northern Rubber Boas from Oregon (from Hoyer and Storm 1992). G = Gravid, N = Non Gravid, ? = Not Recaptured. Biennial = every 2 years, Triennial = every 3 years, Quadrennial = every 4 years, Quinquennial = every 5 years.**

| Snake No | Pattern | Probable frequency of breeding |
|---|---|---|
| 1 | G ? G ? G | Biennial or possibly yearly |
| 2 | G ? ? G N G N N | Biennial and possibly triennial or greater |
| 3 | G ? G ? ? ? G N | Biennial? |
| 4 | N G N N G N N G N N | Triennial |
| 5 | G ? N G ? ? N | Unknown – probably triennial and perhaps quadrennial |
| 6 | N ? G ? ? ? G N ? G | Unknown – probably triennial and quadrennial |
| 7 | N G N N N N G N ? N G | Quinquennial and either biennial or quadrennial |
| 8 | N N N N G | Quinquennial or greater |

The Northern Rubber Boa appears to be a long-lived species. This is based on Hoyer's personal (unpublished) observations of four snakes recaptured after ten to 24 years and one captured as an adult and kept in captivity for > 30 years, in Oregon. The one in captivity produced a litter at an estimated age of over 30 years. An additional female was first captured as a sub-adult in 1991 (32.7 g, total length 435 mm) and then nine more times until 2012, when it weighed 113.5 g and was 622 mm in total length.

The generation time is based on the age of sexual maturity of the female, and the frequency and total number of litters the female produces. It thus depends also on the lifespan of the female. The generation time is probably 10 to 15 years, based on age of sexual maturity at 4 to 5 years and longevity of 30 years in Oregon (Hoyer and Strom 2002).

## Physiology and Adaptability

The Northern Rubber Boa has unique thermal requirements and tolerances. In Idaho, Dorcas and Peterson (1998) found it active at low body temperatures ($T_b$) at night (6 to 28° C, mode 14°C), and in British Columbia it has been observed on snow in the Okanagan Valley in early spring (Sarell pers. comm. 2014) and basking in February near Westwold, also in the Okanagan, on a day when the maximum temperature was 13.3°C (Grant 1969).

In Idaho, the Northern Rubber Boa did not maintain its body temperature close to the thermal preference ($T_b$ = 27.2$^0$C), perhaps to reduce metabolic costs, unlike the small viviparous Western Gartersnake (*Thamnophis elegans*), which had a stable body temperature 90% of the time (Dorcas and Peterson 1998).

The Northern Rubber Boa requires a high $T_b$ for some physiological processes, such as digestion, but there are also maximum and minimum body temperatures below and above which the snake cannot perform the processes. Dorcas *et al.* (1997) found the maximal rate of gastric digestion at a body temperature of 26.7$^0$C with a thermal preference range (temperatures at ≥ 80% of maximum performance rate) of 21.9 - 30.6$^0$C. At body temperatures of 10$^0$C and 35$^0$C the snakes regurgitated the food (Dorcas *et al*. 1997). Dorcas and Peterson (1998) observed gravid females on rocks with body temperatures that straddled the preferred body temperature of 31.7$^0$C. However, unfavourable summer temperatures can prevent development of the young and result in abortions or stillbirths (Dorcas and Peterson 1998; St. Clair pers. comm. 2014). The snakes' tolerance to cold during activity but their requirement for high $T_b$ for digestion and successful reproduction suggest complex physiological adaptations to temperature.

## Dispersal and Migration

Using telemetry data, St. Clair (unpubl. data) calculated home ranges of two Northern Rubber Boas, including the hibernaculum, as 0.298 and 1.203 ha. In the latter case, the hibernaculum was about 450 m from the general area that the snake used in summer and did not extend across a road. These values are well within the range of other species of snakes (Macartney *et al*. 1988). The Northern Rubber Boa has been found on roads, particularly on warm summer evenings in the Okanagan (Gregory pers. comm. 2014; Sarell pers. comm. 2014) and Creston (Gregory pers. comm. 2014). Although Northern Rubber Boas are generally slow moving and easily captured, Gregory (pers. comm. 2014) found they can move very quickly on warm summer evenings and some do get hit by cars. These evening movements are during summer foraging and not during migrations to and from the hibernacula.

Because they had radio-transmitters, St. Clair (1999) was able to locate the snakes in hibernacula. He found three hibernacula and all of them were in forest soil. The snakes spent the summer moving under rocks – at least during the day – in areas adjacent to the hibernacula, suggesting that the snakes migrated in spring and fall.

The hibernacula observed by Lowcock and Woodruff (2014) in the Pemberton area were primarily on hillsides in rock outcrops, although there was also an artificial hibernacula composed of waste talus from a quarrying operation. Lowcock and Woodruff (2014) noted that there were insufficient data to define the home range but that the snakes remained at or near the hibernaculum for several months before and after overwintering. When they did move, some travelled short distances (≤100 m) to the valley bottom. Although some snakes moved to different areas in the summer, others remained in the vicinity of the hibernacula. It appears that there is some movement to and from the hibernacula and additional movement during the summer foraging period. Gregory (pers. comm. 1979) found a dead Northern Rubber Boa on the Pemberton/Lillooet highway in July 1979, suggesting that the snake was moving during summer foraging as was the case in the Okanagan and Creston.

**Interspecific Interactions**

There are two main interspecific interactions: feeding and antagonists and predators, as discussed below. In addition, the Northern Rubber Boa was found at the hibernaculum of the Great Basin Gophersnake (*Pituophois catenifer deserticola*) (Shewchuk 1997), suggesting that it could overwinter with other species.

**Feeding**

The main stomach contents of Northern Rubber Boas from California museum specimens and 35 field records (Rodríguez-Roble *et al*. 1999) are mammals (66%), followed by lizards (17%), birds (7%), and squamate (lizard and snake) eggs (4.5%). There is an age/size shift with smaller boas (144 - 268 mm) feeding on squamate eggs and lizards, and larger boas (352 – 711 mm) continuing to consume lizards, but adding mammals and birds to their diets (Rodríguez-Roble *et al*. 1999). Of the 57 Northern Rubber Boas with food, 21% had greater than one food item and in each case, the multiple items were the same species (e.g., nestling mammals).

Northern Rubber Boas are known to climb into bird nesting boxes (Copper *et al.* 1978) and up stumps to mammal nests (Ross 1931). Ambush hunting may occur for lizards and small mammals. Rubber Boas kill their food by constriction, causing suffocation or heart failure (Matsuda *et al*. 2006).

There are only four records of food items from stomach contents of the Northern Rubber Boa in British Columbia: three with small mammals (St. Clair unpubl. data; Dulisse unpubl. data) and one with a small lizard (Gregory pers. comm. 2014). Both the live-bearing Northern Alligator Lizard (*Elgaria coerulea*) and the egg-laying Western Skink are found at the study site of St. Clair (1999) in Creston (Rutherford and Gregory 2001), and both lizards are also found with Northern Rubber Boa in other parts of the Columbia Basin (Dulisse 2006). In fact, the Northern Alligator Lizard occurs across much of the distribution of the Northern Rubber Boa (Matsuda *et al*. 2006). These lizards and perhaps Western Skink and its eggs are probably an important food source for Northern Rubber Boa.

### Antagonists and Predators

Injuries and scarring are frequently found on the bodies and tails of adult Northern Rubber Boas (Hoyer 1974; Nussbaum and Hoyer 1994; Dulisse pers. comm. 2014). The occurrence of scars increases with age (snake size) and is greater in females than males (Hoyer 1974; Nussbaum and Hoyer 1974). Apparently, defensive behaviour of prey accounts for many of these scars (Hoyer and Stewart 2000a). The tails of the Rubber Boas are short and blunt, stiffened by fused terminal vertebrae (Hoyer 1974; Nussbaum *et al*. 1983; Matsuda *et al*. 2006) and shaped like the boa's head (Nussbaum *et al.* 1983). During encounters with small mammals and their litters, potential prey, the Northern Rubber Boa positions its body and tail to protect the head (Hoyer and Stewart 2000a). The similarity of the tail to the head presumably keeps the antagonist from damaging the head.

Known predators of the Northern Rubber Boa that occur in British Columbia include the Night Snake (*Hypsiglena torquata*), Common Raven (*Corvus corax*), Red-tailed Hawk (*Buteo jamaicensis*), and Raccoon (*Procyon lotor*) (Dorcas and Peterson 1998; Hoyer and Stewart 2000a). Outdoor house cats (*Felis catus*) may also prey on the snakes (Dorcas and Peterson 1998).

## POPULATION SIZES AND TRENDS

### Sampling Effort and Methods

Surveys for the Northern Rubber Boa have mostly focused on locating the species rather than obtaining population estimates (see **Search Effort**); consequently, little information is available on population sizes and abundance. The species has a cryptic and largely crepuscular or nocturnal habit (Ross 1931; Nussbaum *et al.* 1983; Dorcas and Peterson 1998; Lowcock and Woodruff 2014), spending the days under cover (Dorcas and Peterson 1998; St. Clair 1999; Dulisse 2006, 2007; Lowcock and Woodruff 2014). The exceptions are in spring upon emergence, when they are observed basking (Sarell pers. comm. 2014) and in summer when gravid females are basking (Dorcas and Peterson 1998). Unless the sampling effort includes looking under rocks and other potential cover objects, the sampling would not expect to yield high numbers.

## Abundance

Population sizes of the Northern Rubber Boa are virtually unknown, but given the species' wide distribution in southern British Columbia, the numbers may be in the tens of thousands, unevenly distributed across the range. Most of the records are from larger river valleys the southern interior of the province (Figure 1), where the species may occur in highest abundance, but the pattern may also reflect search effort and the number of naturalists in the area.

The Northern Rubber Boa is found relatively infrequently during surveys (see **Search Effort**), partially due to the cryptic habits of the snakes. Their specific habitat requirements and tendency to linger around hibernacula may also be contributing factors to their scarcity across the landscape and their often clumped distribution**.** The snakes hibernate in small groups of 2 to 25 or more. Lowcock (pers. comm. 2014) found over 25 Northern Rubber Boa at an artificial hibernaculum near Pemberton during spring observations.

## Fluctuations and Trends

There are a total of 324 confirmed records for the Northern Rubber Boa in British Columbia (Figure 1). Of these, 46% are from pre-2003 (1926 to 2003). Of the additional 20 unconfirmed records, 1 or 5% are from pre-2003. This means that more than half the records are recent, from 2003 to 2015. The records include hibernacula and isolated observations and are from studies on the Northern Rubber Boa, other reptiles, and opportunistic sightings. They suggest that the Northern Rubber Boa continues to be found in many areas of British Columbia where naturalists are looking for them, but they do not reveal information on fluctuations or trends.

The Northern Rubber Boa occurs in six biogeoclimatic zones and four of these are ranked as imperilled or vulnerable (Austin *et al*. 2008; Table 2; see **Habitat Trends**). Land conversion has been particularly severe in the Okanagan/Similkameen River Valley (Lea 2008; Table 3), and habitat continues to be lost and fragmented in this and other areas across the species' range (see **Habitat Trends**). Based on habitat loss, it can be inferred that there has been historical loss of local subpopulations due to loss of hibernacula and summer foraging habitat. A continuing decline is predicted, as habitat continues to be lost to development and land conversions. For example, a housing development is currently proposed in Northern Rubber Boa habitat in the Pemberton area (see **Threats**). The low reproductive rate of the Northern Rubber Boa and the dependence on longevity for fitness suggest that a loss of small numbers of snakes could seriously affect local subpopulations. The overall rate of decline for the Canadian population over the next three generations (30 – 45 years) is projected to be <10%, based on a low overall threat impact (see **Threats**), but there is much uncertainty associated with this estimate.

## Rescue Effect

The Columbia River drainage includes important subpopulations of the Northern Rubber Boa, which are divided in part due to the movement of the rivers between British Columbia and Washington State (see **Population Spatial Structure and Variability**). The Kootenay River flows out of British Columbia into Montana and re-enters the province via Idaho. Similarly, the Kettle River dips in and out of Washington State, and eventually re-enters Washington, where it flows into the Columbia River. The Similkameen and Okanagan drainages are also connected to the Columbia River via the Okanogan River in Washington. It is possible that snakes could move into British Columbia from these American river valleys. However, such movements are expected to be confined to the vicinity of the border and provide limited rescue potential for the Canadian population.

# LIMITING FACTORS AND THREATS

## Limiting Factors

Three characteristics of the Northern Rubber Boa may act as limiting factors: (1) The snakes have a "slow" life history, including low reproductive rate and long lifespan (see **Life Cycle, Reproduction and Growth**); (2) while they have a tolerance to cold for activity, they require relatively high body temperatures for digestion and successful reproduction, limiting them to areas with relatively high summer temperatures; (3) they have specific habitat requirements for overwintering and thermoregulation, which result in their clumped distribution across the landscape. Loss of these habitat features can result in serious declines of local subpopulations.

## Threats

Description of Threats

The Northern Rubber Boa is not well studied in British Columbia, and much of the information about this species is from Oregon and Idaho. The threat assessment in Appendix 1 is based on expert opinion, but the suggested consequences are – as indicated in the description of the threats – frequently based on more general literature and speculation. In addition, the wide distribution of the Northern Rubber Boa in southern British Columbia was also considered to compensate for localized disruptions. This is reflected in the threat impact ratings for particular categories.

The overall threat impact for this species was assessed as "low"[2]. This threat impact considers the cumulative impacts of the multiple threats given in Appendix 1. While the greatest threats are from agriculture and from transportation and service corridors, these threats were assessed as having low impact (expected median rate of population reduction or range decline = 3%). Details are discussed below under the Threat Level 1 headings, in order of the perceived importance of the threats.

[2] The overall threat impact was calculated following Master *et al.* (2012) using the number of Level 1 threats assigned to this species

*IUCN-CMP Threat 2: Agriculture & aquaculture (low impact)*

This threat is due largely to vineyards and ranching. The vineyard development is restricted primarily to the Okanagan and Similkameen valleys, and the area of potential new vineyard development in the next 10 years within the range of the Northern Rubber Boa is considered to be less than 1% (negligible). Conversion of land into vineyards results in extreme and immediate loss of habitat, particularly because the rocky areas essential for Northern Rubber Boas are frequently eliminated during vineyard development resulting in extreme severity (70–100% decline).

Ranchlands extend throughout the Okanagan and north through the central interior resulting in a large scope. The effect of ranching will be some loss of habitat due to grazing and trampling, particularly with respect to cover (rocks, rodent holes, debris), which is required by the Northern Rubber Boa. Areas that are highly grazed and trampled by livestock may also limit movement by the Northern Rubber Boa, resulting in isolated subpopulations or limited movement between summer and overwintering habitat. The reduced cover may have an indirect effect on food availability due to loss of habitat for small mammals, an important food source. The severity due to ranching is deemed slight.

*IUCN-CMP Threat 4: Transportation & service corridors (low impact)*

The road networks across British Columbia within the range of the Northern Rubber Boa are extensive, resulting in a large scope. During construction of new roads, habitat will be destroyed and individuals will be killed, such as during the loss of an active den due to construction of the Bentley Road to Okanagan Lake Parkway Highway Project (Summit Environmental Consultants 2010). Road mortality can also occur due to maintenance and expansion of existing roads due to disruption of the roadside habitat. Northern Rubber Boas are occasionally found along roads at night (Gregory pers. comm. 2014; Sarell pers. comm. 2014), and the observations include both live and dead snakes (Gregory pers. comm. 2014). However, the numbers are probably lower than those for the larger Western Rattlesnake (*Crotalus oreganus*) and Great Basin Gophersnake, which undertake extensive seasonal migrations and are more visible and intentionally killed by some motorists. The severity of the impact due to traffic, construction of new roads, and road maintenance is deemed slight, because of the large distribution of the Northern Rubber Boa, although it may be locally significant.

*IUCN-CMP Threat 1: Residential & commercial development (negligible impact)*

The relatively large range of the Northern Rubber Boa in British Columbia (Figure 1) suggests that the overall scope of the threat from residential and commercial development is negligible. However, where development does occur, the severity will be extreme and immediate due to loss of habitat and individuals and possible isolation of subpopulations and reduced movement corridors. For example, the two records from Vancouver (Marine

where timing = High or Moderate, which included 2 Low, 4 Negligible, and 3 Unknown (Table 1).The overall threat impact considers the cumulative impacts of multiple threats.

Drive 1960 and UBC 1948; Figure 1) probably represent individuals from historical subpopulations lost to development. Such development will continue and can have a high local impact. For example, a large housing subdivision that is planned in Northern Rubber Boa habitat near Pemberton could eliminate at least six dens, one of which is used by > 25 Northern Rubber Boa (Lowcock pers. comm. 2014). Mitigation measures are possible but may not be economically feasible, leading to the loss or decline of this Northern Rubber Boa subpopulation.

*IUCN-CMP Threat 3: Energy production & mining (negligible impact)*

Any activities associated with energy production and mining will be localized, resulting in a negligible scope. Quarrying for gravel can destroy rocky habitat, which is an important requirement for the Northern Rubber Boa. Mining activities such as quarrying and blasting can also result in direct mortality of individuals. Thus, where this activity occurs, the severity of this threat is extreme. However, the scope of this threat is negligible, and so the impact is also negligible.

*IUCN-CMP Threat 5: Biological resource use (negligible impact)*

The Northern Rubber Boa is not a known targeted species for collectors and, unlike the larger Western Rattlesnake and Great Basin Gophersnake, they appear not to be intentionally destroyed. The range of the Northern Rubber Boa is significantly greater than those of either of the above species, which are restricted to the southern dry interior. In addition, the Northern Rubber Boa is a small snake that spends much of its time under cover, so it is not visible to most people. The hibernacula contain relatively small numbers of individuals and are not an easy target for collectors.

The Northern Rubber Boa is found in a variety of habitats, including forests, particularly in clearings where there is cover from woody debris and rocks (Dorcas 1995, cited in Dorcas and Peterson 1998; St. Clair 1999; Dulisse 2006). Logging and wood harvesting activities are active in the West Kootenay region, which is an important area for the Northern Rubber Boa (Figure 1). Harvesting will have an immediate impact due to the machinery and activity in the forests that will kill some snakes and prey and will disturb substrates, including coarse woody debris. However, given the large range of the Northern Rubber Boa, the scope is deemed negligible. Overall impact due to logging is thought to be negligible.

*IUCN-CNP Threat 6: Human intrusion & disturbance (negligible impact)*

Rock climbing or exploring talus slopes and rock outcrops can damage overwintering habitat. In the Pemberton area, Lowcock and Woodruff (2014) have occasionally found dead Northern Rubber Boas on mountain bike trails, and one trail crossed a talus area that included a subsurface basking area used most of the summer and a communal hibernaculum. This threat is localized, resulting in a negligible scope and impact rating for the Canadian population as a whole.

*ICUN-CNP Threat 7: Natural system modifications (unknown impact)*

The areas burned by fires in the south Kootenays, and presumably across the range of the Northern Rubber Boa, are highly variable (Utzig *et al.* 2011). The mean area at risk of wildfires is increasing due to climate change, with a predicted minimum fourfold increase in the south Kootenays from the baseline (1919 to 2008) to the 2050s (Utzig *et al.* 2011). These increases are due largely to an increase in the mean monthly maximum temperature for the hottest month (July or August) and the climatic moisture deficit (Utzig *et al.* 2011). Given the wide distribution of the Northern Rubber Boa and the variability of the areas burned, the scope is deemed restricted or small.

The main characteristics of fires that determine the abundance and distribution of animals are the intensity and rate of spread, which in turn depend on the interaction of the vegetation and the physical conditions (Whelan 1995). The intensity varies both horizontally (fire line energy) and vertically (up to canopy and down into soil) and determines the patchiness and loss of shelter and food for reptiles and the conditions in the years following the fire (Friend 1993; Whelan 1995). The Northern Rubber Boa is found under rocks and other cover and at depth in the soil (Dorcas and Peterson 1998; St. Clair 1999; Dulisse 2006), suggesting that it could survive fires unless they are intense. The effect of fire suppression is controversial (Bridge *et al.* 2005; Cumming 2005), but controlled burns are sometimes recommended to enhance snake habitat in the interior of British Columbia, particularly to remove vegetation that shades rocky basking areas (Larsen pers. comm. 2014). Also, after a fire, new vegetation appears and the abundance of small mammals, which are important prey for the Northern Rubber Boa, increases (Friend 1993). The uncertainty about the conditions for each fire results in an unknown severity; however, there will be an immediate impact followed by the potential for improved conditions after the fire following vegetation recovery.

*IUCN-CMP Threat 9: Pollution (negligible impact)*

Numerous types of pesticides may be used in vineyards and orchards (Wilson *et al.* 2001; Bostanian *et al.* 2009; Gregoire *et al.* 2010; Bishop *et al*. 2013). The possible effect on the Northern Rubber Boa would be indirect due to bioaccumulation from food, but no data are available. Also, the extent of pesticide use and the actual effect on the Northern Rubber Boa are not known, although Bishop *et al*. (2013) suggests that Great Basin Gophersnakes that consume a Pocket Gopher (*Thomomys talpoides*) that has ingested the rodenticide with strychnine will die. Orchards and vineyards are an important land use in the Okanagan and Similkameen valleys, which also provide important Rubber Boa habitat. This results in an unknown severity, but negligible scope. If pesticides do accumulate in the Northern Rubber Boa, they could result in death or an inability to reproduce, resulting in an immediate population effect.

*IUCN-CMP Threat 11: Climate change & severe weather (unknown impact)*

Two possible consequences of climate change are likely to influence Northern Rubber Boas in Canada: habitat shifting and alteration, and droughts. Wang *et al.* (2012) found that the geographic distribution of climatic conditions for different ecosystems has shifted since the 1970s, and the predicted climatic conditions (2020, 2050, and 2080) supporting grasslands, dry forests, and moist continental cedar-hemlock forests are expected to expand substantially. These include habitats where the Northern Rubber Boa is found, resulting in a large to restricted scope. Increased habitat may be beneficial to the snakes, provided that is accessible to the snakes within the fragmented landscapes.

Also associated with climate change is increased frequency and duration of droughts (Bonsal *et al.* 2004). The British Columbia Interior is highly susceptible to drought due to the variability of precipitation in time and space (Bonsal *et al.* 2004), resulting in a large to restricted scope. The severity that drought may have for Northern Rubber Boa populations is unknown; however, it could modify the habitat and limit the available cover for effective thermoregulation resulting in loss of some individuals. Drought may also have an indirect effect on the Northern Rubber Boa due to possible loss of prey availability.

### Number of Locations

The most important plausible threats to the Northern Rubber Boa are those that impact hibernation sites. The number of threat-based locations is impossible to determine with confidence because of the wide range of the species and incomplete information on the distribution and localities or hibernacula and the threats facing them. Threats vary among localities across the species' range, and the snakes and their hibernacula in different localities are subjected to a different complement of threats. A housing development such as the one proposed for the Pemberton area that will eliminate six hibernacula would be a "location", but the number of places where a single threatening event can rapidly affect all of the individuals is not known but could be in the 100s.

## PROTECTION, STATUS AND RANKS

### Legal Protection and Status

The Northern Rubber Boa is included as Special Concern on Schedule 1, the List of Wildlife Species at Risk, under the federal *Species at Risk Act* (SARA). Smallwood (2003) states that the basic prohibitions against harming a species or its residence and the prohibition against destruction of critical habitat do NOT apply to a species listed under SARA as species of Special Concern and that a management plan must be prepared for the species and its habitat within three years of listing. A provincial management plan (BC Ministry of Environment 2015) and a federal addition have been proposed (Environment Canada 2016). The objectives of the management plan are to (1) to protect suitable habitat across the range of the Northern Rubber Boa; 2) to mitigate threat impacts to local populations where necessary; 3) to address current knowledge gaps in the range

distribution of the Northern Rubber Boa; 4) to assess population size at various locations and habitat across the range to refine the provincial population estimate; and 5) to address knowledge gaps in habitat requirements including thermoregulation, refuge, foraging, and overwintering habitats.

The Northern Rubber Boa is included in Schedule A of the BC *Wildlife Act*, which prohibits killing, harassment, and capture of wildlife without a permit.

**Non-Legal Status and Ranks**

The Northern Rubber Boa has the following listings and ranks, according to the BC Conservation Data Centre (2015; sub-national ranks in Canada) and NatureServe (2015; global, national, and USA sub-national ranks):

- BC List: Yellow (species and ecological communities are secure)
- BC Rank: S4 (2012) (Apparently Secure - uncommon, but not rare; some cause for long-term concern due to declines or other factors)
- National Rank: N4 (2012) (Apparently Secure - uncommon, but not rare; some cause for long-term concern due to declines or other factors)
- Global Rank: G5 (2006) (Demonstrably Widespread)
- California: SNR (unranked)
- Idaho: S5 (Demonstrably Widespread)
- Montana: S4 (Apparently Secure)
- Nevada: S3S4 (Special Concern, vulnerable to extirpation or extinction; Apparently secure)
- Oregon: S4 (Apparently Secure)
- Utah: S4 (Apparently Secure)
- Washington: S4 (Apparently Secure)
- Wyoming: S2 (Imperilled – nationally or sub-nationally because of rarity due to restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province

The species is listed under the British Columbia Conservation Framework as follows (6 level scale: Priority 1 - highest priority through Priority 6 - lowest priority):

- Goal 1: Contribute to global efforts for species and ecosystem conservation. Priority 5 (2010)
- Goal 2: prevent species and ecosystems from becoming at risk. Priority 1 (2010)
- Goal 3: maintain diversity of native species and ecosystems. Priority 3 (2010)

## Habitat Protection and Ownership

The distribution of the Northern Rubber Boa includes numerous protected areas, such as Ecological Reserves, Wildlife Management Areas, and Provincial and Federal Parks. The species has been documented from the Creston Valley Wildlife Management Area, Campbell Brown Ecological Reserve, just south of Vernon, Doc English Bluff Ecological Reserve near Williams Lake, Ellison Provincial Park near Vernon, and Kootenay National Park near Radium Hot Springs. There are several large Provincial Parks and Protected Areas within the distribution of the Northern Rubber Boa (e.g., Garibaldi Park, Manning Park, Lac du Bois Grasslands Protected Area, Fintry Provincial Park and Protected Area, Kalamalka Lake Protected Area, White Lake Protected Area, and West Arm Provincial Park). Many of these areas are large enough to sustain subpopulations. However, the habitat is not fully protected in provincial parks: In March 2014, Bill 4, an amendment to the *Parks Act* was passed by the BC government, allowing for exploratory drilling, ore sampling, and road building within BC Parks. In addition to protected areas, the South Okanagan - Similkameen Conservation Program (SOSCP) operates in the Southern Interior of the province, working on stewardship of habitats on private lands, which would benefit the Northern Rubber Boa. The overall proportion of the species' range in protected areas is unknown but is probably small, with most of the distribution remaining unprotected.

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## BIOGRAPHICAL SUMMARY OF REPORT WRITER

Linda Gregory obtained her BSc at Queen's University and then moved on to the University of Manitoba, where she completed an MSc in fish physiology. Following a period of employment as a biologist with the British Columbia Ministry of Environment (BCMOE), she completed a PhD at the University of Victoria on nutrient movement from a cattle feedlot to groundwater and an adjacent river and then moved on to a postdoctoral fellowship at the University of British Columbia. She has taught several courses in the Department of Biology and in the Faculty of Education at the University of Victoria and prepared numerous contract reports for the BCMOE and Environment Canada. She has spent a significant amount of time in the field helping her husband (Dr. Patrick Gregory) in his research projects on snake ecology and published a number of papers with him. Her other publications on reptiles include three COSEWIC reports, two species accounts, a recovery strategy, the species descriptions for the Reptiles of British Columbia and a distribution summary of the reptiles and amphibians in British Columbia.

## Appendix 1. Threats calculator spreadsheet for the Northern Rubber Boa.

**THREATS ASSESSMENT WORKSHEET**

| | |
|---|---|
| **Species or Ecosystem Scientific Name** | Northern Rubber Boa |
| **Element ID** | **Elcode** |
| **Date (Ctrl + ";" for today's date):** | 21/03/2014 |
| **Assessor(s):** | Linda Gregory; Kristiina Ovaska; Leah Westereng [Follow-up from assessment done in Dec 2011 by Purnima G; Jared Hobbs; Orville Dyer; Francis Iredale; John Surgenor] |
| **References:** | COSEWIC status report (2003); draft COSEWIC SAS report (2014). |

**Overall Threat Impact Calculation Help:**

| Threat Impact | | Level 1 Threat Impact Counts: high range | low range |
|---|---|---|---|
| A | Very High | 0 | 0 |
| B | High | 0 | 0 |
| C | Medium | 0 | 0 |
| D | Low | 2 | 2 |
| | **Calculated Overall Threat Impact:** | Low | Low |

| | |
|---|---|
| **Assigned Overall Threat Impact:** | **D = Low** |
| **Impact Adjustment Reasons:** | |
| **Overall Threat Comments** | Result of 2 Low Threat Impact is same as that found in threat assessment done in December 2011. |

| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| 1 | Residential & commercial development | | Negligible | Negligible (<1%) | Extreme (71-100%) | High (Continuing) | |
| 1.1 | Housing & urban areas | | Negligible | Negligible (<1%) | Extreme (71-100%) | High (Continuing) | Overall scope is negligible given size of the range; however there are some developments going on, e.g., a development is planned for the Pemberton Rubber Boa and Sharp-tailed Snake site. |
| 1.2 | Commercial & industrial areas | | Negligible | Negligible (<1%) | Extreme (71-100%) | High (Continuing) | |
| 1.3 | Tourism & recreation areas | | Negligible | Negligible (<1%) | Slight (1-10%) | High (Continuing) | |
| 2 | Agriculture & aquaculture | D | Low | Large (31-70%) | Slight (1-10%) | High (Continuing) | |
| 2.1 | Annual & perennial non-timber crops | | Negligible | Negligible (<1%) | Extreme (71-100%) | High (Continuing) | Scope is negligible based on the assumption that there are more snakes to be found in other areas than in the Okanagan area (low search effort over much of the range). Threat is mostly from vineyard development, not from other types of non-timber crops. |
| 2.2 | Wood & pulp plantations | | | | | | |

| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| 2.3 | Livestock farming & ranching | D | Low | Large (31-70%) | Slight (1-10%) | High (Continuing) | Ranching is mostly in the interior portion of the range, but not in all habitats. Severity of impact is due to decrease in cover for snakes, which may alter foraging behaviour; loss of cover may also result in a decreased food supply of small mammals (see prey reduction in Section 7.3). |
| 2.4 | Marine & freshwater aquaculture | | | | | | |
| 3 | Energy production & mining | | Negligible | Negligible (<1%) | Extreme (71-100%) | High (Continuing) | |
| 3.1 | Oil & gas drilling | | | | | | |
| 3.2 | Mining & quarrying | | Negligible | Negligible (<1%) | Extreme (71-100%) | High (Continuing) | Overall impact is negligible, but at a very local scale, this threat could have extreme effects e.g., quarrying for gravel for roads at den or refuge sites. |
| 3.3 | Renewable energy | | | | | | |
| 4 | Transportation & service corridors | D | Low | Large (31-70%) | Slight (1-10%) | High (Continuing) | |
| 4.1 | Roads & railroads | D | Low | Large (31-70%) | Slight (1-10%) | High (Continuing) | Roadkill does occur occasionally but is not thought to be as much of a problem as for larger snakes in the area that move greater distances from dens to foraging areas (e.g., Gophersnake and Western Rattlesnake). |
| 4.2 | Utility & service lines | | | | | | |
| 4.3 | Shipping lanes | | | | | | |
| 4.4 | Flight paths | | | | | | |
| 5 | Biological resource use | | Negligible | Negligible (<1%) | Negligible (<1%) | Insignificant/Negligible (Past or no direct effect) | |
| 5.1 | Hunting & collecting terrestrial animals | | Negligible | Negligible (<1%) | Negligible (<1%) | Insignificant/Negligible (Past or no direct effect) | Not targeted for direct persecution. Although Rubber Boas may be desired for pets, they are less likely to be found due to their cryptic behaviour and timing of movements. |
| 5.2 | Gathering terrestrial plants | | | | | | |
| 5.3 | Logging & wood harvesting | | Negligible | Negligible (<1%) | Slight (1-10%) | High (Continuing) | |
| 5.4 | Fishing & harvesting aquatic resources | | | | | | |
| 6 | Human intrusions & disturbance | | Negligible | Negligible (<1%) | Negligible (<1%) | High (Continuing) | |

| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| 6.1 | Recreational activities | | Negligible | Negligible (<1%) | Negligible (<1%) | High (Continuing) | Seasonal and localized threat with little overall impact. Rock climbing and other activities on talus or rock outcrops could affect snakes at den sites, although it is unlikely that these activities would result in much damage to this habitat. |
| 6.2 | War, civil unrest & military exercises | | | | | | |
| 6.3 | Work & other activities | | | | | | |
| 7 | Natural system modifications | | Unknown | Restricted - Small (1-30%) | Unknown | High (Continuing) | |
| 7.1 | Fire & fire suppression | | Unknown | Restricted - Small (1-30%) | Unknown | High (Continuing) | Wildfires can be a threat, if fire suppression results in more intense and larger fires. However, over the long term, fire can be positive by rejuvenating vegetation and increasing prey base of small mammals. Effects can be positive or negative depending on size and intensity of fires. Fires are predicted to increase with droughts and climate change. |
| 7.2 | Dams & water management/use | | | | | | |
| 7.3 | Other ecosystem modifications | | Unknown | Unknown | Unknown | High (Continuing) | Reduction in prey base from droughts or pesticides is possible. Effects on Rubber Boas are undocumented and speculative, hence scored as unknown. |
| 8 | Invasive & other problematic species & genes | | | | | | |
| 8.1 | Invasive non-native/alien species | | Negligible | Negligible (<1%) | Negligible (<1%) | High (Continuing) | Snake fungal disease or other emerging disease was not discussed at the initial conference call, but it is a potential, speculative threat. |
| 8.2 | Problematic native species | | | | | | |
| 8.3 | Introduced genetic material | | | | | | |
| 9 | Pollution | | Negligible | Negligible (<1%) | Unknown | High (Continuing) | |
| 9.1 | Household sewage & urban waste water | | | | | | |
| 9.2 | Industrial & military effluents | | | | | | |

| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| 9.3 | Agricultural & forestry effluents | | Negligible | Negligible (<1%) | Unknown | High (Continuing) | Secondary poisoning from feeding on small mammals contaminated with orchard pesticides, including strychnine-based poisons, is possible, as predicted for Great Basin Gophersnakes in the Okanagan (Williams and Bishop 2011). Note: technically, effects on prey are under threat 7.3 whereas accumulation of toxins (resulting in reduced reproduction or death) to snakes are under this threat. |
| 9.4 | Garbage & solid waste | | | | | | |
| 9.5 | Air-borne pollutants | | | | | | |
| 9.6 | Excess energy | | | | | | |
| 10 | Geological events | | | | | | |
| 10.1 | Volcanoes | | | | | | |
| 10.2 | Earthquakes/tsunamis | | | | | | |
| 10.3 | Avalanches/landslides | | | | | | |
| 11 | Climate change & severe weather | | Unknown | Large - Restricted (11-70%) | Unknown | High (Continuing) | |
| 11.1 | Habitat shifting & alteration | | Not Calculated (outside assessment timeframe) | Pervasive (71-100%) | Unknown | Low (Possibly in the long term, >10 yrs/3 gen) | |
| 11.2 | Droughts | | Unknown | Large - Restricted (11-70%) | Unknown | High (Continuing) | Increased frequency, severity, and duration of summer droughts are predicted under climate change scenarios and appear already to be happening in parts of BC. Effects on snakes would be from possible reduction in reproductive frequency (e.g., skipping years) and/or changes in foraging behaviour. |
| 11.3 | Temperature extremes | | | | | | |
| 11.4 | Storms & flooding | | | | | | |

Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).