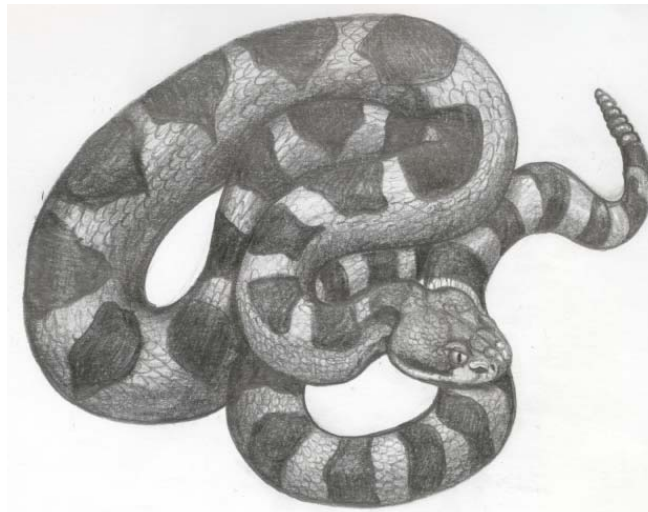


COSEWIC
Assessment and Status Report

on the

Western Rattlesnake
Crotalus oreganus

in Canada



THREATENED
2004

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA



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1. The report was overseen and edited by Ron Brooks, COSEWIC Co-chair (Reptiles) Amphibians and Reptiles Species Specialist Subcommittee.
2. In Crother *et al.* (2000), which COSEWIC has used as the basis for all reptile nomenclature, this snake is called the Northern Pacific rattlesnake, *Crotalus viridis oreganus*. A second subspecies of *C. viridis* in Canada was *C. viridis viridis*, the prairie rattlesnake. Currently, these two subspecies have been elevated to species: *C. oreganus*, the western rattlesnake and *C. viridis*, the prairie rattlesnake (Pook *et al.* 2000; Ashton and de Queiroz 2001; Douglas *et al.* 2003). The subspecies of the western rattlesnake found in Canada is *C. o. oreganus* (Holbrook 1840), the Northern Pacific rattlesnake. As it is the only subspecies of *C. oreganus* found in Canada, COSEWIC designates it by the current species name, the western rattlesnake, *Crotalus oreganus*.

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COSEWIC Assessment Summary

Assessment Summary – May 2004

Common name

Western rattlesnake

Scientific name

Crotalus oreganus

Status

Threatened

Reason for designation

This species is threatened by rapid expansion of human activities including urbanization, agriculture, forestry and range management in south-central dry valleys of British Columbia. This snake is particularly vulnerable to roads both from direct mortality and from habitat fragmentation. Rattlesnakes are subject to direct persecution and to destruction of critical habitat (hibernacula). The adult rattlesnake population is small, likely fewer than 5,000, and dispersed among only four valleys, probably with little interchange of snakes between valleys. Threats to the species are increased in effect because this snake has late maturity (~8 years), small litters and only breeds about once every 3-4 years.

Occurrence

British Columbia

Status history

Designated Threatened in May 2004. Last assessment based on a new status report.



COSEWIC
Executive Summary

Western Rattlesnake
Crotalus oreganus

Species information

The Western Rattlesnake (*Crotalus oreganus*) is the most venomous snake found in British Columbia. The species has a triangular head that is noticeably wider than the stout body. Adults range from 850 to 1000 mm snout-vent-length (SVL), and are yellow or greenish tan with tan to olive green blotches. Juveniles have more contrasting patterns and are browner in colour.

Distribution

The Western Rattlesnake ranges from south-central British Columbia south to Baja California and east to Idaho, eastern Utah and Arizona. In British Columbia, this rattlesnake occurs in the Thompson-Okanagan interior and has been recorded east along the Canada/USA border to Christina Lake, west to Lillooet and north to Kamloops and Cache Creek.

Habitat

Western Rattlesnakes overwinter in dens that generally occur on steep slopes in rock outcrops, along talus slopes or in earth-covered outcrops. Summer range habitats are in grassland areas that contain suitable basking sites, protected areas and food, or in riparian areas when temperatures are extremely hot. The snakes spend much of their time under or near cover such as rocks, fallen trees and anthropogenic objects such as boards and concrete structures.

Biology

Western Rattlesnakes emerge from their dens in the spring and disperse to feed and mate. After mating occurs in late summer or early fall, the dispersed snakes will return to the den. Most individuals stay within 1200 m of their dens. Gravid females will stay near the den to give birth in mid-September and early October. Newborn rattlesnakes and adults stay near the surface until mid-October or early November. Western Rattlesnakes feed on a variety of small mammals. The main predators of these rattlesnakes are probably mammals and large raptors.

Population sizes and trends

The number of Western Rattlesnakes in British Columbia is difficult to estimate; however, there are likely fewer than 5,000 adults. Modeling from available data on the net reproductive rate, mortality rates and the number of viable dens available, suggests that it is highly likely that the population is declining. Some populations south of Kamloops lake and in the Thompson River Valley have probably been extirpated in recent years.

Limiting factors and threats

Western Rattlesnakes use a home range that typically includes one or more dens, a transient area and a summer range. Loss of habitat from human activities limits home range areas, fragments populations, increases mortality rates from roadkill and persecution, and if dens are destroyed, can cause an entire population to collapse. Information on the numbers and population structure at the dens and the viability of the dens themselves is limited. Lack of knowledge and fear of rattlesnakes cause people to kill them.

Special significance of the species

The Western Rattlesnake in British Columbia is at the northern end of a north/south distribution of *Crotalus oreganus* and can offer insights on the relationships between energy use and thermoregulation in rattlesnakes. In addition, the Western Rattlesnake is the most venomous snake in British Columbia.

Existing protection or other status designations

Rattlesnakes are protected under the British Columbia Wildlife Act. Nationally, *Crotalus oreganus* is not protected under federal legislation. Some Western Rattlesnake grassland habitats are protected within Provincial Parks, Ecological Reserves and Wildlife Management Areas; however, 90% of remaining grassland areas are privately owned.

Editor's footnote:

In Crother *et al.* (2000), which COSEWIC has used as the basis for all reptile nomenclature, this snake is called the Northern Pacific Rattlesnake, *Crotalus viridis oreganus*. A second subspecies of *C. viridis* in Canada was *C. viridis viridis*, the Prairie Rattlesnake. Currently, these two subspecies have been elevated to species: *C. oreganus*, the Western Rattlesnake and *C. viridis*, the Prairie Rattlesnake (Pook *et al.* 2000; Ashton and de Queiroz 2001; Douglas *et al.* 2003). The subspecies of the Western Rattlesnake found in Canada is *C. o. oreganus* (Holbrook 1840), the Northern Pacific Rattlesnake. As it is the only subspecies of *C. oreganus* found in Canada, COSEWIC designates it by the current species name, the Western Rattlesnake, *Crotalus oreganus*.



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. 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 and include 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 organizations (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership, chaired by the Canadian Museum of Nature), three nonjurisdictional members and the co-chairs of the species specialist and the Aboriginal Traditional Knowledge subcommittees. The committee meets to consider status reports on candidate species.

DEFINITIONS (AFTER MAY 2004)

Species	Any indigenous species, subspecies, variety, or geographically or genetically distinct population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A 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 species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* 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.



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

COSEWIC Status Report

on the

Western Rattlesnake

Crotalus oreganus

in Canada

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2004

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SPECIES INFORMATION

Name and classification

There are two species of rattlesnake in western Canada. Both are members of the genus *Crotalus* in the family Viperidae and until recently, both were considered as subspecies of the Western Rattlesnake, *Crotalus viridis* (Rafinesque 1818). Using several and different molecular techniques, Pook *et al.* (2000), Ashton and de Queiroz (2001) and Douglas *et al.* (2003) confirmed that *Crotalus viridis* includes an eastern and a western clade, separated by the Rocky Mountains. In addition, Ashton and de Queiroz (2001) suggested that the differences between clades are sufficient to give each clade species status. Douglas *et al.* (2003) proposed further phylogenetic separations. Their data suggested that the eastern clade (*Crotalus viridis viridis* and *Crotalus viridis nuntius*) is one species. In addition, they suggested that six of the subspecies of the western clade (*Crotalus viridis abyssus*, *Crotalus viridis cereberus*, *Crotalus viridis concolor*, *Crotalus viridis helleri*, *Crotalus viridis lutosus* and *Crotalus viridis oregonus*) be elevated to species status. However, Ashton and de Queiroz (2001) noted that two of these subspecies (*Crotalus viridis oregonus* and *Crotalus viridis helleri*) interbreed extensively. Until the issue of species vs. subspecies is resolved, the species representing the eastern and western clades are *Crotalus viridis* (Rafinesque 1818), the Prairie Rattlesnake and *Crotalus oregonus* (Holbrook, 1840), the Western Rattlesnake, respectively.

Description

The Western Rattlesnake, *Crotalus oregonus* is one of two venomous snakes in British Columbia (the other is the tiny Nightsnake (*Hypsiglena torquata*) which has a mild venom and is harmless to humans). It is a long stout snake with a triangular head, noticeable neck, blotches on the back and side and a tail that ends in a rattle (Gregory and Campbell, 1984). The large blotches on the back range in colour from tan to olive green and are contained by light coloured borders on a yellow or greenish tan base. They appear as dark bands towards the tail. The side blotches are smaller. Juveniles have lighter but more contrasting patterns.

DISTRIBUTION

Global range

Crotalus oregonus is a western snake (Figure 1) with a range that extends from south central British Columbia south to Baja California and east to Idaho, eastern Utah and Arizona (Stebbins, 1985; Ashton and de Queiroz, 2001). It is absent along the Pacific coast of British Columbia, Washington and Oregon and the lowlands of the southwestern states. The Northern Pacific Rattlesnake, *Crotalus oregonus oregonus*, occurs in British Columbia, eastern Washington and the northern half of California.

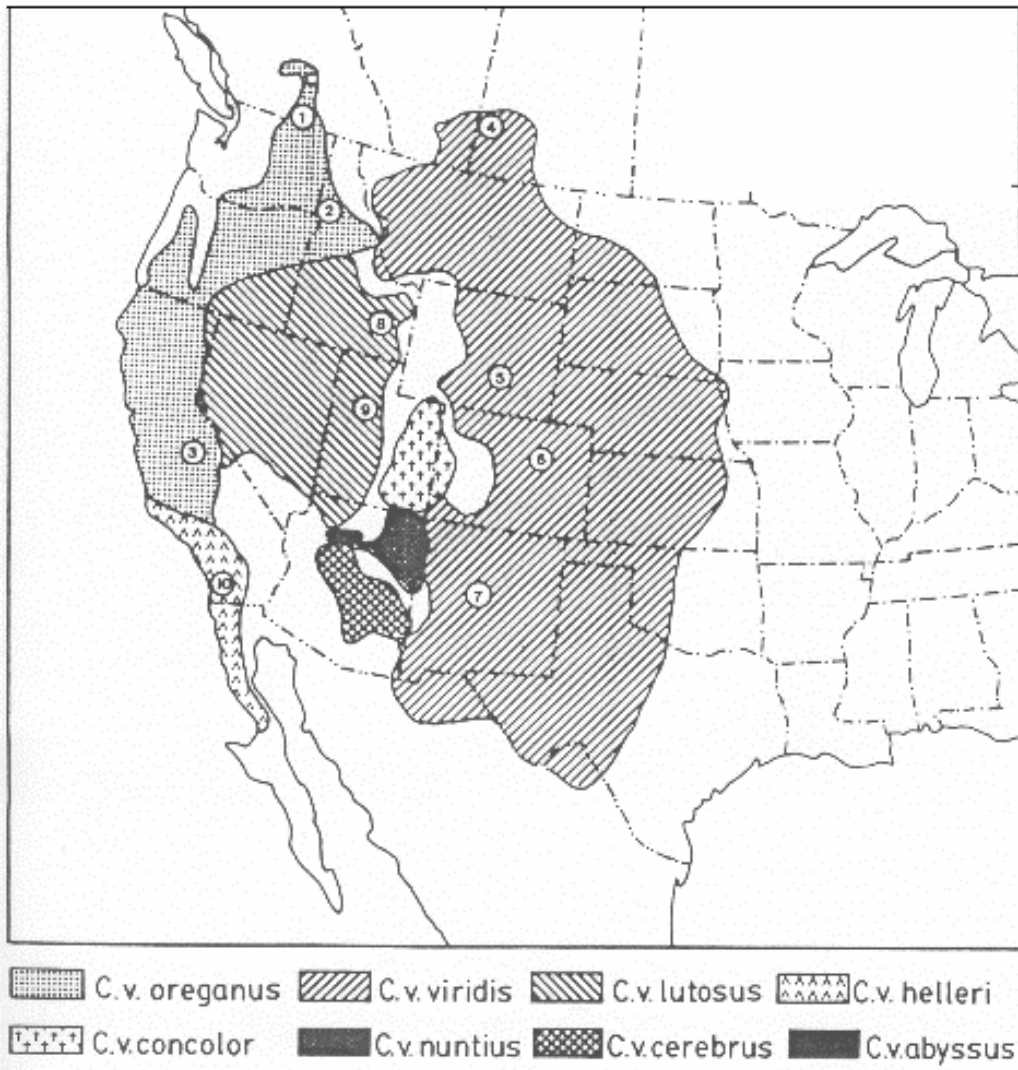


Figure 1. Distribution of *Crotalus viridis* from Macartney (1985). *Crotalus viridis oregonus*, *Crotalus viridis abyssus*, *Crotalus viridis cerebrus*, *Crotalus viridis concolor*, *Crotalus viridis helleri*, and *Crotalus viridis lutosus* are now subspecies of the western clade *Crotalus oregonus*. See text for details. The numbers correspond to population referred to by Macartney (1985).

Canadian range

In British Columbia, the Northern Pacific Rattlesnake is found in the Thompson-Okanagan interior drybelt (Gregory and Campbell, 1984). The location records extend east along the Canada / USA border to Christina Lake, west to Lillooet and north to Kamloops and Cache Creek, a total of 4 separate regions (Figure 2).

Range of the Western Rattlesnake in BC

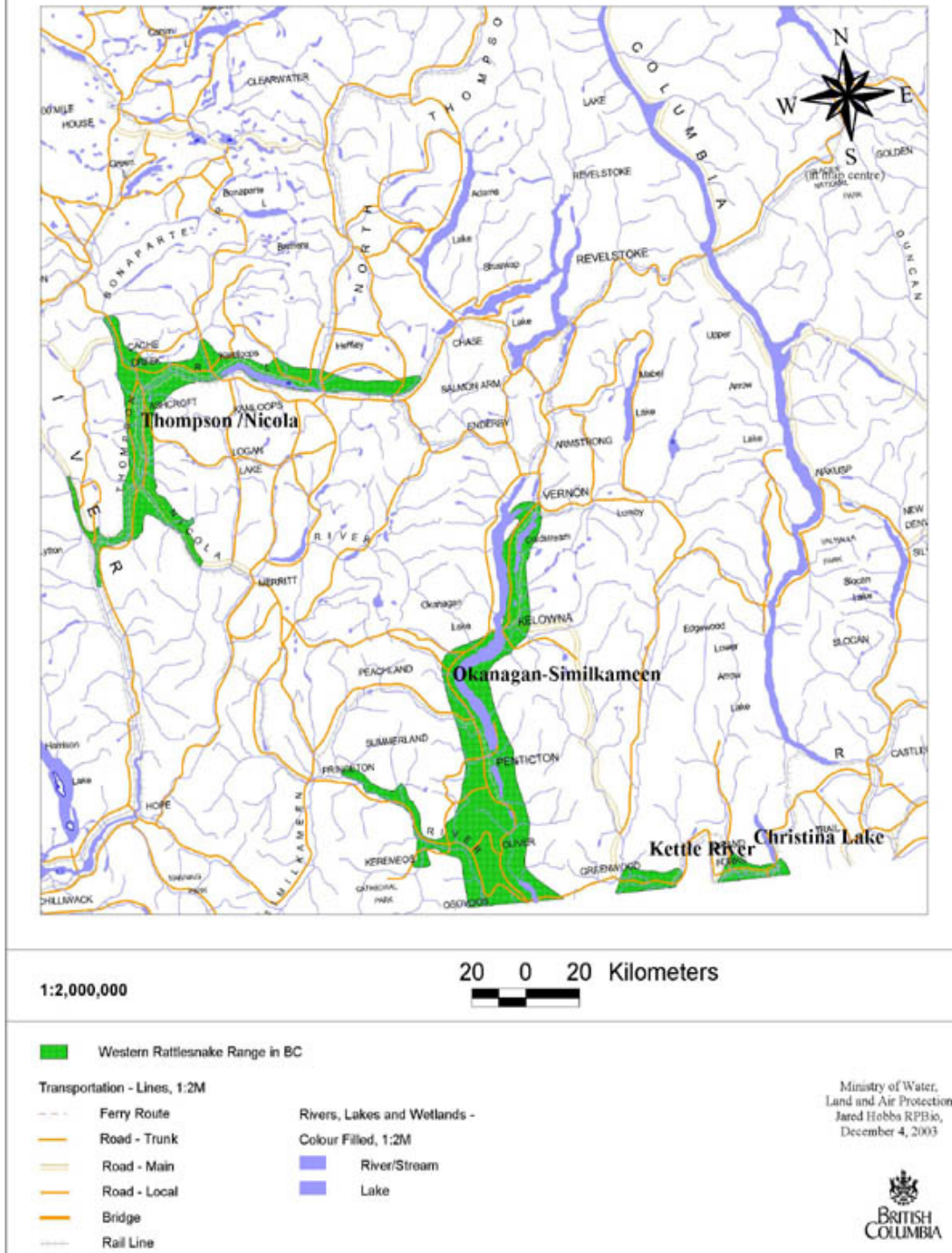


Figure 2. Distribution of *Crotalus oreganus oreganus* in British Columbia. Map provided. By J. Hobbs and M. Sarell.

HABITAT

Habitat requirements

Crotalus oreganus require overwintering hibernacula with suitable thermal conditions and summer habitats that provide basking sites, protected areas and food. In addition, they require transient habitat for moving between dens and summer habitat. In this report, the sum of the dens, transient habitat and summer habitat is designated the home range. The home range may or may not be equivalent to just the den plus summer habitat because the summer habitat may be either adjacent to or distant from the hibernacula.

Macartney (1985) and Bertram *et al.* (2001) used minimum convex polygon estimates based on locations of snakes at different times to determine sizes of home ranges of *Crotalus oreganus*. The results were extremely variable. Bertram *et al.* (2001), using radio-telemetry, recorded home ranges of 0.12 to 103.5 ha with the smallest being from a gravid female. Macartney (1985), using mark-recapture methods, determined home ranges of 1.2 to 171.1 ha from 167 individuals at 16 dens. More specific habitat requirements of hibernacula and summer ranges are considered separately below.

Hibernacula in the Thompson, Okanagan and Merritt Regions have been found by locating snakes in the spring and fall, by radio-tracking animals from the summer range to the dens and by talking to local residents (Macartney, 1985; Sarell 1993, Hobbs and Sarell, 2000; Bertram *et al.*, 2001; Hobbs and Sarell, 2001; Hobbs, 2001). Den characteristics vary in detail but in general occur on relatively steep south (southwest to southeast) facing slopes (Macartney, 1985, Sarell 1993). Bertram *et al.* (2001) recorded slopes of 56.6% to 62.3% and aspects of 71.7° to 168.3° (east to south). Hobbs (2001) suggests that aspects of 170 to 240 (south to southwest) are more important. In addition, dens have cracks and fissures and are contained in rock outcrops, along talus slopes or earth covered rock outcrops (Macartney, 1985; Hobbs and Sarell, 2000; Bertram *et al.*, 2001; Hobbs, 2001; Hobbs and Sarell, 2001;). Macartney *et al.* (1987) determined the depth of one den to be greater than 1.3 m. Although there are known external physical characteristics of areas where dens occur (Hobbs and Sarell, 2000), Macartney (1985) found no relationship between den population size and external features. Furthermore, Macartney *et al.* (1989) showed that external features were not indicative of suitable underground thermal conditions, at least for a site near a known den used by the gartersnake, *Thamnophis sirtalis*. This does not obviate the importance of using the general criteria to identify general areas and thus locate specific dens by the presence of *Crotalus oreganus*. This procedure is used by experienced field biologists.

Macartney *et al.* (1989) measured the temperature profile of one hibernaculum used by about 50 *Crotalus oreganus* from mid-October through mid-May. In fall, when air temperatures decreased, a negative temperature profile developed and when the air temperature increased a partial reversal of the gradient occurred. As the gradient developed and changed in spring and fall, snakes moved laterally within the

hibernaculum, probably to warmer microhabitats. During the coldest part of the winter when air temperatures were below freezing, the core temperature (temperature at lowest depth) varied from 3° to 5° C. Snow cover reduced the rate of cooling (Macartney et al., (1989) and might be important in reducing dehydration of snakes within the den (Gregory, 1982).

The lifespan of a den is not known. However, dens identified by Mackie in the 1930s were still used by *Crotalus oregonus* in the 1980s. One limitation to the life span of a hibernaculum used by Timber Rattlesnakes (*Crotalus horridus*) is shading by trees (Brown, 1993). The vegetation types where Timber Rattlesnakes and Western Rattlesnakes occur are very different with trees more abundant at the dens of *Crotalus horridus*. However, some dens in the Okanagan are in forested areas, and increased vegetation growth and shading may be a factor influencing the lifespan of these dens and of basking areas. Observed problems due to shading in the north Okanagan study area are considered in Protection/ownership section.

Crotalus oregonus move away from the hibernacula along specific dispersal routes to the summer range. In the Vernon study area, the dispersal routes and summer range were along shallow north-facing slopes that were more homogeneously covered by Bluebunch Wheat Grass (*Agropyron spicatum*), Ponderosa Pine (*Pinus ponderosa*) and numerous species of native shrubs. Macartney (1985) argued that this habitat may be suitable for prey, provide appropriate microhabitats for foraging and reduce radiational cooling. The same general vegetation type areas were used by *Crotalus oregonus* in the Thompson River Valley (Bertram et al., 2001). The areas on the south side of the Thompson River where the Western Rattlesnake has been extirpated are more open and perhaps more susceptible to increased pressures associated with increased human development (Bertram et al., 2001).

Bertram et al. (2001) almost always found *Crotalus oregonus* under or near cover objects and near rock outcrops, bluffs or large rocks. Cover objects included rocks, vegetation (dead trees, dead and live shrubs and bark), and anthropogenic objects (e.g. concrete berms, plywood and scarp building materials).

In general, there is little evidence that grazing has negative impact on rattlesnakes. Clearly, this land use is less detrimental than agricultural uses such as cereal cropping or vineyards. However, high intensity grazing pressure may compact soil and damage or block hibernacula, or cause damage to cover indirectly by soil erosion. Snakes may become more exposed to predation. These potential threats have not been studied in detail.

Trends

There is a continual influx of people and associated roads and housing developments in the Thompson and Okanagan Valleys. For example, the population of the Central Okanagan has grown from 152,836 in 1999 to 168,062 in 2003, an average of 2.5% per year and is

projected to reach 247,000 by 2021 (www.edccord.com/economic/pop_proj.htm). Growth is largely (~92%) from immigration. Another study projects a more rapid increase to 270,000 by 2018 (ibid). Similarly, significant growth is projected for Kamloops which has planned to expand to 120,000 in the near future, including planned increase of 4,700 people on Reserve #1 of the Kamloops Indian Band (<http://www.city.kamloops.bc.ca/transportation/pdfs/travelsmart/tslandstrategy.pdf>). In the Okanagan Valley, vineyards are replacing the natural vegetation on the valley slopes. The result in both the Okanagan and Thompson valleys is that habitats are continually degraded, fragmented and/or lost. This trend is not expected to stop because 90% of the grassland in British Columbia is privately owned (K. Larsen, pers. comm. 2003) and this includes the summer habitat used by *Crotalus oreganus*.

The number of people in Vernon, Kelowna, Penticton and Osoyoos increased from 231,075 to 244,864 (6%) between 1996 and 2001 (Statistics Canada, 2002). Although the population increase in towns does not reflect the absolute loss of habitat in the Okanagan Valley, it emphasizes the potential for changes in land use and gives some indication of the rate of habitat loss. Roads and housing developments have also decimated hibernacula (Sarell 1993). This trend is continuing as developments encroach up hillsides.

Protection/ownership

In the Thompson and Okanagan Valleys and Plateaus *Crotalus oreganus* is found in large Provincial Parks (e.g. Kalamalka Lake Park, Okanagan Mountain Park, White Lake Provincial Park and Lac Du Bois Grasslands Park), Ecological Reserves, and Vaseux Bighorn National Wildlife Area, land owned by the Nature Trust of British Columbia and managed for conservation. These habitats should be stable, although in at least one case, the close proximity to a road and increased use by people may be harmful to the rattlesnake populations. Also, Lac Du Bois Grasslands Park contains the summer habitat but the hibernacula are on municipal or private lands just outside the park (Larsen, pers. comm.). The recent forest fires (2003), in Okanagan Mountain Park and in more southern areas (e.g. Vaseux Bighorn National Wildlife Area) most probably affected the rattlesnakes, but the nature of such impact is utterly unknown. In addition, small protected areas frequently lose vertebrate species, including snakes through stochastic events (e.g. Gurd and Nudds, 1999).

Hobbs (2001) and Hobbs and Sarell (2000, 2001) summarized the ownership of the land at the dens they visited. Most are located on crown land or private land although one is in White Lake Provincial Park. In addition, they identified potential concerns such as proximity to roads, adjacent land use (grazing, vineyards etc.) and encroachment of housing developments with respect to the long-term survival of the den populations. Using the land ownership and adjacent land use, they identified Wildlife Habitat Areas (WHAs). These are established on Crown land, where forest and range activities should be discouraged in order to alleviate the stress on the snake populations. These areas are not restricted to *Crotalus oreganus* but contain dens and some summer habitat for one or several snake species in British Columbia. Bertram (pers. comm.) summarized

the ownership of lands for the 16 hibernacula she studied. Of the 16 hibernacula she studied, 5/16 (31%) are in Provincial Parks or Wildlife Management Areas, 6/16 (38%) on crown land, and 5/16 (31%) on private or city owned land.

In 2002, Macartney (pers. comm.) and Larsen (pers. comm.) independently revisited the north Okanagan study area 20 years after their original study. They found a substantial increase in the grassland understory and that previous basking areas had become shaded by shrubs. Macartney (pers. comm.) suggests that the increased growth may be part of the natural cycle or due to intentional fire suppression.

BIOLOGY

General

Most of the information on the biology of the Western Rattlesnake in British Columbia is from studies near Vernon in the northern part of the Okanagan valley (Macartney, 1985; Charland, 1987). Some additional information from the southern Okanagan is in Preston (1964). Using available information, Charland *et al.* (1993) discussed the biology of *Crotalus oregonus* with respect to annual activity cycle, reproductive capabilities, movement patterns and adaptability. Therefore, their summaries are used as a basis for this report. However, the original references are included and new information and observations are added.

The annual cycle of the Western Rattlesnake in British Columbia is described by Macartney (1985) and summarized below. *Crotalus oregonus* moves seasonally between overwintering hibernacula (or dens) and summer ranges. The snakes emerge from hibernacula in spring; most appear at the surface in April but timing depends on the weather and can be as early as March. The gravid females stay near the den although they may move onto the summer range for short periods in early summer. The males and non-gravid females disperse to the summer range to feed and mate. Mating occurs in late summer or early fall after which all of the dispersed snakes start returning to the den. The gravid females that stay near the den give birth between mid-September and early October. The newborn rattlesnakes (neonates) stay at the den. All of the rattlesnakes are at the hibernacula by October. They stay at the surface or emerge for several hours on warm days until mid-October or in isolated cases until November.

Reproduction

Data on the age of first reproduction, gestation period, litter size and frequency of reproduction are basic to understanding factors that might affect reproductive success. Male *Crotalus oregonus* in British Columbia mature at 3 to 5 years (≥ 535 mm snout-vent-length, SVL), but only large males (> 720 mm SVL) were observed mating (Macartney and Gregory, 1988; Macartney *et al.*, 1990), perhaps due either to the large size advantage of these males in male / male conflicts (Shine, 1978) or to female preference. Females mature later than males, at 5 to 7 years (≥ 650 mm SVL), and

have their first litter at 7 to 9 years of age (700 to 760 mm SVL) (Macartney *et al.*, 1990). Female *Crotalus oreganus* in Idaho and California mature earlier and at smaller sizes, 3 years in California and 4 to 6 in Idaho (Fitch and Twining, 1946; Diller and Wallace, 1984). Differences in sizes between the mature females in British Columbia and those in California and Idaho are probably related to the north-to-south gradient in body size of *Crotalus oreganus* (see Survival section).

Mating occurs on the summer range in July and early August in small (2 to 8 individuals) aggregations (Macartney and Gregory, 1988). Most of the aggregations are pairs and not all of the pairs are from the same hibernaculum (Macartney, 1985; Macartney and Gregory, 1988). The mating time corresponds to peak spermatogenic activity in males and is post-ecdysis for most females. Follicles of the mated females begin vitellogenesis prior to hibernation. Ovulation and fertilization occur in June after emergence from the hibernacula; parturition in September and October. Between ovulation and parturition, the gravid females behave differently from other mature females. Most gravid females stay at or near the hibernaculum and do not eat. Small litters (mean 4.6, $n = 28$, range 2 to 8) of relatively large neonates are born at the den and spend the first winter in the same hibernaculum as their mothers. The post-partum females do not feed before entering hibernation and emerge the following spring in an emaciated condition due to the cumulative weight loss during gestation (6%), parturition (37%) and overwintering (6%) (Macartney and Gregory, 1988). Subsequent mating depends on body mass recovery, but body mass recovery is not the only factor because *Crotalus oreganus* with similar weight gains do not necessarily mate (Macartney and Gregory, 1988). The result is reproductive cycles that are biennial, triennial and quadrennial, with triennial apparently the most common (Macartney and Gregory, 1988). Annual cycles could occur only if there was sperm storage because the time between mating and parturition is more than one year. Therefore in any one active period, there are gravid females, post-partum females that may or may not mate and newly sexually mature females that may or may not mate. Any factor that affects females during a particular stage of their reproductive cycle will have less impact on the population than if all of the females were at a similar reproductive stage each year. However, because the females do not mate until 7 to 9 years and only every 3 to 4 years thereafter, there must be a critical number of females in each population to sustain that population. This number is unknown.

Survival

Body size is a function of phylogeny and the local factors that affect growth. The Western Rattlesnake in British Columbia is a relatively small rattlesnake. Large females are typically 850 to 900 mm SVL and large males 950 to 1000 mm SVL (Macartney *et al.*, 1990). Ashton (2001) found a positive relationship between body size of *Crotalus oreganus* and temperature and a negative relationship between body size and latitude. The relationships were reversed for *Crotalus viridis*. Body size of *Crotalus viridis* is greatest at the northern end of its distribution where winters are more harsh, whereas the body size of *Crotalus oreganus* is greatest at the southern end of its distribution where there is a longer active period and greater time for growth. Explanations for

these observed body size trends include competition, food availability, overwinter survival and heat budgets (Ashton, 2001).

Body size also may affect survival within populations. In general, overwinter survival is greater for larger snakes presumably because of the physiological benefit of large size (Gregory, 1982). These benefits include higher energy reserves and a reduced surface area to volume ratio and thus reduced water loss and dehydration (Gregory, 1982). Macartney (1985) confirmed this correlation between body size and overwinter survival. He found that overwinter survivorship increased from neonates (approximately 25 %) through juveniles (approximately 50%) to adults (90 to 100%). Among the adults, post-partum females had the lowest survivorship, which was not unexpected given their emaciated condition. However, given the reproductive cycles of female *Crotalus oregonus*, less than one-third are post partum each year and thus a particularly harsh winter should have less effect on survivorship than if all of the females were post partum. Charland (1989) found 55% survivorship of neonates from the same population as Macartney (1985) but in a different year, suggesting there are differences among years. Charland (1989) found that neonate survivorship was independent of weight and condition at birth, but that there were differences in patterns of weight loss. Charland (1989) suggests that body size of neonates may be more critical for survival through the first summer presumably because sufficiently small food items are limited in availability.

Growth of *Crotalus oregonus* in British Columbia differs among age groups, between sexes and among years (Macartney *et al.*, 1990). Neonates are born at the den and although they shed they do not eat or gain body mass before entering the hibernaculum 3 to 5 weeks later (Macartney *et al.*, 1990). The average size of 258 neonates measured in 1981, 1982 and 1985 was 275 mm SVL (210 to 345 mm SVL). Juveniles have the greatest and most variable growth. If survival increases with increased size, a rapid growth rate may enhance survivorship. As previously noted, males grow faster and attain sexual maturity earlier than females. Macartney *et al.* (1990) attributed differences in annual growth to weather and the concomitant differences in productivity and food availability. However, food availability did not affect weight gain of post-partum females (Charland, 1989). Charland (1989) fed post-partum females at high and low rates and found no significant difference in weight gain. He suggested that females respond to low food levels by behaviourally maintaining a lower body temperature and reducing energy costs. This suggests that there may be an interaction between weather and food availability affecting growth.

Physiology

Crotalus oregonus in British Columbia is at the northern limit of its distribution. This makes it particularly important in studying factors that limit the northern distribution of the species. *Crotalus oregonus* are viviparous and ectothermic. Charland and Gregory (1990) used the Western rattlesnake to test thermoregulatory behaviour in gravid and non-gravid females. They found a consistent daily pattern of body temperatures in both gravid and non-gravid females: an increase in the morning, a

Gregory (1990) used the Western rattlesnake to test thermoregulatory behaviour in gravid and non-gravid females. They found a consistent daily pattern of body temperatures in both gravid and non-gravid females: an increase in the morning, a plateau in the afternoon and a decrease in the evening. However, there was less variation in the afternoon plateau temperatures of gravid females, and there was an increase in the mean plateau level of the gravid females in late summer. In addition, individual variation among snakes was important. In cool climates, there are numerous possible conflicts for energy use in ectotherms, resulting in many unresolved questions about thermoregulation and energy partitioning in *Crotalus oregonus*. Also, there may be physiological adaptations of these snakes to the low temperatures that are found in the more northerly British Columbia sites.

Movements/dispersal

Crotalus oregonus move seasonally between overwintering hibernacula and summer ranges. Emergence begins as early as March and peaks in April and early May (Macartney, 1985). Adult females emerge first, followed in no particular sequence by neonates, juveniles and adult males (Macartney, 1985). Mating does not occur at the hibernacula and dispersal begins soon after emergence. By June, *Crotalus oregonus* are found up to the limit of their dispersal distance (Macartney, 1985; Bertram *et al.*, 2001) and between mid-July and mid-August the snakes are evenly distributed by distance between the dens and the outer limit of the summer range (Macartney, 1985). Gravid females do not disperse but remain within 400 m of the hibernacula, frequently at group basking areas called rookeries (Macartney, 1985; Bertram *et al.*, 2001). Bertram *et al.* (2001) tracked 10 non-gravid adults from a location on the summer range back to a hibernaculum. The linear distance moved varied from 290 to 3000 m; however, these snakes were from different hibernacula. Data are limited but it appears that the distance moved varies with hibernaculum. The snakes that moved the greatest distance (1400 to 3000 m) were from the same den. Presumably, this large movement is in part because the terrain surrounding the den is not suitable summer range habitat. *Crotalus oregonus* from the same den in the Okanagan Valley moved variable distances within the same summer range (Macartney, 1985). One juvenile was found 1575 m from its den, but most individuals were within 1200 m of their dens.

Dispersal from the dens in the north Okanagan occurs along specific corridors over a ridge to north and northwest facing slopes. Preston (1964) also found specific dispersal corridors for a population of *Crotalus oregonus* in the south Okanagan. No dispersal data are available for rattlesnakes from the Thompson River Valley. Macartney (1985) found that over 80% of the males and non-gravid females moved in the same direction over at least two consecutive years, but only 56% moved to the same sites on the summer range.

Snakes from different hibernacula mixed on the summer range but generally returned to their own den in fall (Macartney, 1985). Movement back to the hibernacula began in September and by late October all of the snakes were in dens (Macartney, 1985; Bertram *et al.*, 2001).

Nutrition and interspecific interactions

In British Columbia, *Crotalus oreganus* emerge from hibernacula in March and April and, except for gravid females, disperse to the summer range. Macartney (1989) used the presence and type of food in the stomach or faeces in the cloaca to determine dietary composition and feeding frequency. Feeding was low from March through May (22/2057 snakes with food), increased and remained consistent at 17% through June, July and August (111/656 with food) and dropped to 7.9 % in September (75/945 with food). Very little feeding occurred in October when the snakes were at the hibernaculum. Also, during October, Macartney (1989) observed an abundance of scats at the dens suggesting that the snakes begin overwintering without food in their digestive tracts, perhaps to prevent putrefaction of the gut contents (Gregory, 1982). The gravid females stay near the hibernaculum through the summer and do not eat (Macartney, 1985; Macartney, 1989).

The size of prey items ingested by the Western Rattlesnake was positively related to snake size (Macartney, 1989). The diet of juveniles was almost exclusively small mammals especially shrews (*Sorex*, 11.5%), deer mice (*Peromyscus*, 40.5%) and voles (*Microtus*, 40.5%). Other food items included pocket gophers (*Thomomys*, 5.1%), chipmunks (*Eutamias*, 1.2%) and birds (1.2%). The diet of juveniles in California included small lizards and amphibians (Fitch and Twining, 1946). Although small amphibians were present at the study sites, Macartney (1989) suggests that their absence in the diet of Western Rattlesnakes in British Columbia was due to low numbers of these prey or to competition for these food items by the Common Gartersnake, *Thamnophis sirtalis*. The diet of adult *Crotalus oreganus* was more diverse than those of juveniles. Deer mice and voles accounted for 60.5% and the larger items, pocket gophers and wood rats (*Neotoma*), accounted for 25.8%. Adults also consumed shrews, pocket mice (*Perognathus*), marmots (*Marmota*) and squirrels (*Tamiasciurus*). Klauber (1956) concludes that snakes are rarely eaten by rattlesnakes, except in captivity. However, in the south Okanagan, Sarell (pers. comm.) found an adult Racer (*Coluber constrictor*) in the stomach of a dead rattlesnake.

Predators of the Western Rattlesnake were identified from scats, stomach contents of predators and field observations (Macartney, 1985; Lacey *et al.* 1996, Bertram *et al.* 2001). Potential predators were identified by relating scar marks on the rattlesnakes to a probable means of wound infliction (Macartney, 1985). Confirmed predators include a Nightsnake (*Hypsiglena torquata*, Lucey *et al.*, 1996) a Badger (*Taxidea taxus*, Bertram *et al.*, 2001), a Black Bear (*Ursus americanus*) and Striped Skunk (*Mephitis mephitis*) (Macartney, 1985). Macartney (1985) observed skunk tracks at excavations near several hibernacula and basking areas, suggesting that skunks actively pursue rattlesnakes.

Three main types of scars were found on 123 of 1596 or 7.7% of the snakes studied by Macartney (1985). The most common (84.5%) were slash-like or circular punctures probably due to teeth, talons or claws of small predators. Spinal injuries, possibly due to larger raptors, accounted for 9.7%, and deformed or missing tails

damaged or lost while escaping under cover objects accounted for 4.9%. Scars were most frequently on adults (88 / 123 or 72%), either because they were older, more visible to predators or more able to escape from the predator. If selection of *Crotalus oregonus* is for larger snakes that are more able to escape predators, as suggested by Ashton (2001), the latter should apply.

There are two other important causes of rattlesnake mortality; cars and people. Drivers may intentionally or unintentionally drive over rattlesnakes that either are moving across roads or basking on pavement which retains heat in the evening. Therefore, the distribution of roads within habitats used by rattlesnakes and ways of keeping the snakes away from roads are subjects that require further study. Some people kill rattlesnakes because they are afraid of them or just dislike snakes in general. Increased development and its intrusion onto the summer habitat of the Western Rattlesnake will increase the frequency of encounters of people and snakes and most probably increase mortality rates of snakes. Some preliminary results on ways of educating the public are discussed by Bertram *et al.* (2001) and considered in Limitations and Threats section.

Behaviour/adaptability

The ecology and basic biology of *Crotalus oregonus* in the north Okanagan is well known from studies by Macartney (1985), Charland (1987), Charland (1989), Macartney (1989), Macartney and Gregory (1988), Macartney *et al.* (1989), Charland and Gregory (1990) and Macartney *et al.* (1990). However, we do not know the extent to which rattlesnakes are able to adapt to intrusions on their habitats by people. Three examples suggest that they may in fact be adaptable to some disturbances and that knowledge of their behaviour in such situations can be used in management plans.

The first example is summarized by Charland *et al.* (1993). It involved the coordinated efforts of the British Columbia Ministry of Highways, Ecological Reserves and P.T. Gregory from the University of Victoria in developing a plan to mitigate the effects of a highway construction project near a known *Crotalus oregonus* hibernaculum. The den is located a few km south of Vernon and adjacent to Highway 97 on one of a series of earth-covered rock outcrops about 7 m above the highway (Macartney 1985). The Ministry of Highways planned to straighten, raise and widen the highway, which presented two potential problems. First, the activity and blasting associated with the construction might disrupt the snakes. Second, the summer basking area for gravid females would be removed. A plan based on the knowledge of the annual cycle of the rattlesnakes at the den was developed. No work was conducted near the den until June 16, 1986, when all of the snakes had emerged, and it was completed before fall when the snakes returned. A fence was erected around the den and an enclosure built away from the construction area. This allowed the collection of all emerging gravid females and their placement in the enclosure for the summer period. After construction was completed, the Ministry of Highways installed a fine mesh fence along the highway so that any snakes that did move down the outcrop were not able to reach the highway. In fact, a couple of snakes were found on the

highway side of the fence and construction personnel used tongs to put these snakes back over the fence. Finally, the Ministry of Highways removed the vegetation from a rock outcrop slightly north of the den to act as a new summer basking area for gravid females. The project appears to have been a success. The females in the enclosure were released at the den and at least one gave birth. Since the construction, *Crotalus oreganus* have been found in the spring or fall at the hibernaculum and gravid females and other snakes have used the new basking area (P. Gregory, pers. comm. 2003; J. Hobbs, pers. comm. 2003). No data are available on the change or stability of the population size or structure.

The second example is a study by Bertram *et al.* (2001). They radio tracked 10 Western Rattlesnakes from their summer range back to hibernacula. Each snake was re-located about 23 times and over 90% of the time the snakes were under or near cover objects. The snakes used both natural and anthropogenic cover objects. Among the anthropogenic cover objects were concrete berms close to highways. Use of these berms brings the snakes close to highways but perhaps selective placement of these berms or other cover objects might help to provide suitable summer habitat features away from highways and roads and closer to hibernacula.

The third example is re-colonization of disturbed dens and use of new dens, summarized by Macartney (1985). In the 1930s to 1950s, Rev. A.C. Mackie of Vernon, British Columbia hunted rattlesnakes almost to extinction at two of the locations (22 dens). Macartney (1985) studied these same dens and used the careful records kept by Mackie to reconstruct histories of recovery for two of the dens. Mackie removed 183 rattlesnakes from the first den by blasting and Macartney (1985) found only 30 at this den. However, Macartney (1985) found about 150 rattlesnakes using a previously unrecorded den just below the one dynamited by Mackie. This suggests that the rattlesnakes will use a new den in the vicinity of a former den. At the second den Macartney (1985) found over twice as many rattlesnakes as Mackie had removed. Overall, Macartney (1985) found about 650 rattlesnakes at one location where Mackie had removed 400. It appears that between the 1960s and 1980s conditions for these rattlesnakes were conducive to population growth.

Bertram *et al.* (2001) translocated one Western Rattlesnake 400 m and this snake moved to a hibernaculum in the fall. Presumably this translocation was within the summer range of the snake. Reinert and Rupert (1999) translocated 11 *Crotalus horridus* (Timber Rattlesnakes) large distances (8 to 172 km) away from their home populations. These snakes were more active, moved further and suffered significantly greater mortality than resident snakes, leading the authors to conclude that translocation is not recommended. Because of increased human development on the summer ranges and increased contact between people and rattlesnakes, attempts at translocation may become more frequent. These should be considered only as part of a carefully designed management program.

It appears that rattlesnakes can withstand some changes within the habitat they use but translocations of snakes away from these areas are more risky and the

consequences are not well studied. Management plans developed for rattlesnakes within the existing habitat must be based on knowledge of the biology of these animals.

Recently, drift fences and in-ditch funnel traps have been installed during pipeline construction, and snake fencing was placed around a vineyard to reduce hazards to people and snakes. The success and impact of these measures is being assessed in ongoing research (J. Hobbs pers. comm. Dec 2003).

POPULATION SIZES AND TRENDS

Macartney (1985) marked rattlesnakes from 24 dens at four locations in the north Okanagan. The number of dens at each location varied from 1 to 15, and the estimated number of individuals per den ranged from 8 to 133. Two of the locations had more than one den (7 and 15). The rattlesnakes from dens at both of these locations were present together on the summer range and were found together in mating aggregations, indicating that the locations rather than the individual dens represent populations. Macartney (1985) marked 659 and 826 individuals from these two locations. The densities of these snakes on the summer range were 1.6 and 2.5 rattlesnakes / ha, respectively. Although the numbers varied extensively between locations and among dens at the same location, the size and the composition of single dens were stable. These results emphasize the problem of extrapolating information about populations from data on population size and structure obtained from only one den. Lacey (in Sarell 1993) found one den that contained 250 individuals (adults and juveniles) from mark recapture efforts. There was only a maximum of about 50 snakes ever seen outside the den at one time. Most dens have significantly smaller numbers of snakes (fewer than 25) and total numbers of adult snakes is likely less than 5,000 in British Columbia (J. Hobbs pers. comm. 2003).

Life table data for *Crotalus oregonus* are incomplete, largely because of undersampling of younger age classes (Macartney, 1985). Furthermore, birth and death rates vary temporally, so projecting future population trends from life tables is difficult. Nonetheless, some preliminary estimates have been made from the available data. Female rattlesnakes first mate at 6 to 8 years, give birth to small numbers (mean = 5) of snakelets more than one year later, and mate only every 3 to 4 years. Using this information, and considering the limitations of the data, Macartney (1985) developed a life table and found a net reproductive rate suggesting that the populations are in decline. He estimated that 20% of females would have to live about 20 years to obtain long-term equilibrium. Brown (1983) concludes that each den representing a population of *Crotalus horridus* must have at least 45 snakes to maintain a population.

Bertram *et al.* (2001) note that anecdotal reports indicate that historically the Thompson Plateau had more numerous sightings of rattlesnakes than at present. Similarly, there are stories of more numerous sightings of rattlesnakes in the Okanagan and Nicola Valleys, in past years. Bertram *et al.* (2001) suggest that the rattlesnake populations from the south side of the Thompson River between Chase and at least the

west end of Kamloops Lake are extirpated. This area corresponds to less suitable habitat and increased human disturbance. However, R. Heinrich (J. Hobbs pers. comm.) located an active den about 10 km east of the west end of Kamloops Lake suggesting some rattlesnakes are still present in this disturbed habitat. Populations south of Kamloops Lake and in the Thompson Valley have also likely been extirpated (J. Hobbs pers. comm. 2003).

Decreases in population size also have important genetic consequences. Reduced effective population size and inbreeding can affect the long-term survival of populations through increased frequencies of harmful recessive alleles and reduced fitness. Furthermore, fragmentation may isolate populations from one another and reduce gene flow among them; some populations thus may ultimately disappear because they lack the required genetic input from other areas. Information on genetic diversity within and among rattlesnake populations and the extent of gene flow among them in the Thompson and Okanagan is recommended for developing conservation strategies.

The number of *Crotalus oregonus* within their British Columbia distribution is not known. Macartney (1985) found 8 to 133 individuals per den. If there are 236 dens in British Columbia (Sarell 1993), the number of snakes could be fewer than 2,000 or over 25,000. However, Hobbs (2001) and Hobbs and Sarell (2000, 2001) have located only 100 dens that might be used by *Crotalus oregonus*. If these were the true numbers, then the number of rattlesnakes in British Columbia would be 800 – 13,300. However, not all these snakes would be reproductively mature. Based on discussion in 2003 with J. Hobbs and M. Sarell, an average of 15 adults per den was thought to be reasonable. Given 235 “known” dens and an upper estimate of 500 for British Columbia (M. Sarell, pers. comm. Dec. 2003), then the total number of adults would be 3,540-7,500.

LIMITING FACTORS AND THREATS

There are three inter-related limitations to the continued survival of viable populations of *Crotalus oregonus*: habitat loss and the unknown size and distribution of home ranges; mortality due to cars and people; and viability of existing dens. As previously indicated, the home range typically/historically includes one or more dens, a transient area and a summer range. Macartney (1985) and Bertram *et al.* (2001) determined the distance of individuals from their hibernacula and estimated home range areas. The general direction in which the snakes moved was consistent, but the distances moved were quite variable. It is not known what dictates the extent of movement away from the den, but the size of the summer range is probably influenced by prey abundance, ease of locating mates and availability of cover objects and basking areas. The direction and extent of movement of different populations of *Crotalus oregonus* in relation to habitat type and habitat fragmentation warrants further investigation.

Roads occur within the home ranges of *Crotalus oregonus*. As previously indicated, rattlesnakes either move across roads or lie on them in evenings because the

dark asphalt retains heat. Thus snakes may be killed on roads unintentionally or intentionally. The absolute numbers killed are not known as some carcasses are scavenged by wildlife and others by people, but in 2003 35 western rattlesnakes were observed dead on roads in a small area within the south Okanagan and this annual number has been declining, likely due to reduced population sizes (M. Sarell, unpubl. data from pers. comm. Dec. 2003). Fifty percent of 106 dens where some knowledge of impacts was obtained were subject to regular mortality from roadkill and to damage from road construction (Sarell 1993). Additionally, added mortality from haying and persecution from people occurred at 45% of the dens (Sarell 1993). Although the relationship between road locations and snake movements is not known, selective use of cover objects might keep snakes away from roads, in some cases. Additional information on the relationship of roads to the movement within home ranges is required.

People kill rattlesnakes for a variety of reasons, ranging from fear to dislike. Bertram *et al.* (2001) assessed various means of increasing public education and awareness about rattlesnakes in the Kamloops area. They distributed information pamphlets, prepared news items for the media (radio, television and newspapers) and set up a snake hotline. They found that people's indifference was largely a result of lack of knowledge about rattlesnakes. The immediate response to increasing people's awareness seemed positive. However, Gomez (2002) found that improved attitudes towards rattlesnakes quickly dissipated over several months, at least for grade 2 students. People continue to kill rattlesnakes (Bertram *et al.*, 2001) and methods to reduce unnecessary deaths of rattlesnakes should be examined.

Hobbs (2001) and Hobbs and Sarell (2002, 2001) identified fewer than 100 dens in the Thompson, Okanagan, Merritt and Boundary districts. Their objective was to locate the dens, describe the surrounding habitat and identify potential threats. Bertram *et al.* (2001) also located several dens in the Thompson area. Only Macartney (1985) obtained information on snake numbers and survivorship at different dens and locations. Information on the numbers and population structure (at least some measure of the number of gravid females) at the dens, life expectancy of the dens and relationship among dens is essential. Lack of this information is a limitation in making effective decisions about the future of *Crotalus oregonus* in British Columbia.

SPECIAL SIGNIFICANCE OF THE SPECIES

Rattlesnakes have been studied extensively and represent model organisms for learning about organismal biology (see review by Beaupre and Duvall, 1998). This is, in part, because many rattlesnakes are large and suitable for radio-telemetry studies, they are available in large numbers at dens and often have large geographic distributions. The Western Rattlesnake is at the northern end of a large north / south distribution of *Crotalus oregonus* (30° to 50° N) and Macartney (1985) emphasized differences in its ecology from individuals further south. *Crotalus oregonus* are viviparous and ectothermic and the suggested evolutionary relationship between viviparity and cool

climates (e.g. Shine, 1985) has initiated at least one study on energy use and thermoregulation in the Northern Pacific rattlesnake in British Columbia (Charland and Gregory, 1990).

EXISTING PROTECTION OR OTHER STATUS

The legal status of rattlesnakes in British Columbia is summarized by Charland *et al.* (1993). Rattlesnakes are wildlife and protected by the Wildlife Act (1982), which prohibits killing of wildlife except where they are a menace. The amendment to Section 27(2) also allows wildlife to be killed in order to protect life and property. Some people may consider the mere presence of a rattlesnake as a threat to life or property and people who dislike and fear rattlesnakes will most probably kill rattlesnakes rather than avoid them. Therefore, rattlesnakes are well protected only in theory. Nationally, *Crotalus oreganus* is not protected under federal legislation. As previously indicated, 90% of the grassland in British Columbia is privately owned (Larsen, pers. comm.) and the summer range of *Crotalus oreganus* is largely in grassland areas. Only habitat within Provincial Parks, Ecological Reserves and Wildlife Management Areas is protected.

Nature Serve's Conservation Status ranks (2003) classify the status of *C. oreganus* as G5 (demonstrably secure globally). In Canada *C. oreganus* is classified as S3 (vulnerable) in British Columbia. In the United States: S5 (secure) in Arizona, California, Idaho, Utah.

SUMMARY OF STATUS REPORT

A key factor in the persistence of any animal is that the area they occupy must remain intact so the species has access to necessities for survival such as food and shelter. For snakes, these necessities include foraging areas, hibernacula, gestation sites, shelter from predators and areas for basking and thermoregulation. All of these requirements can be considered aspects of critical habitat.

Crotalus oreganus are at hibernacula from October through April and on summer habitats from May through September. The specific times are weather dependent and thus vary each year. Some individuals (e.g. gravid females) remain at or near the hibernacula throughout the summer, but most individuals in the Okanagan study area moved linear distances of about 1200 m from the den (Macartney, 1985) and individuals in the Kamloops area moved as far as 3000 m (Bertram *et al.*, 2001). The total land area used by individuals from different dens varied from 1.2 to 171.1 ha (Macartney, 1985). Radio-tracked individuals used 0.12 to 103.5 ha (Bertram *et al.*, 2001). These home ranges must be intact for the snakes to persist.

Hibernacula must provide access to depths below freezing temperatures and usually consist of crevices and cracks in rock outcrop areas. Several dens may occur within a small area (Macartney, 1985, Sarell 1993). The summer habitat must include

basking sites, access to protection from predators and a sustainable food supply. In addition, the summer habitat is where mating occurs. The summer habitat is on grassland and 90% of the grassland in British Columbia is privately owned (Larsen, pers. comm.) and is steadily being encroached upon for housing developments and agricultural land (e.g. vineyards). Between 1996 and 2001, the number of people in Vernon, Kelowna, Penticton and Osoyoos increased by over 2500 people per year (Statistics Canada, 2002). This number does not include rural increases. Also, there are 30 wineries and associated vineyards listed by Tourism British Columbia for the Okanagan in 2003 and most of these have developed in the last 10 to 20 years. Vineyards represent intensive agriculture and destroy rattlesnake habitat more or less completely. In addition, vineyards add to mortality from increased road traffic, activity of farm machinery, application of pesticides and deliberate killing of snakes, particularly by migrant workers. Serious fires in Okanagan Mountain Park and in areas further south such as Vaseux Lake during the summer of 2003 also significantly affected known habitat of *Crotalus oregonus*. All of these changes represent major habitat loss for the Western Rattlesnake.

The Okanagan, Similkameen, Thompson, Nicola and Kettle River Valleys as well as the Christina Lake area are popular tourist destinations. The increase in number of tourists and permanent residents increases the traffic on roads. *Crotalus oregonus* move across roads that bisect their home ranges and bask on dark asphalt roads that retain heat. Most of the roads in the range of the Western Rattlesnake are asphalt and drivers kill rattlesnakes both intentionally and unintentionally. The numbers are not known but the presence of dead rattlesnakes on the roads is not uncommon and certainly poses a serious threat to some den populations.

Female *Crotalus oregonus* do not reach maturity until 5 to 7 years but do not have their first litter until 7 to 9 years and then only biennially thereafter at best. The litters are small and over-winter survival of the neonates is approximately 25%. A critical but unknown number of females is required by a den population to sustain the population. Macartney (1985) found 8 to 133 individuals per den but in two locations there were several dens and interbreeding occurred among individuals from different dens. In locations where there are limited numbers of individuals per den, loss of only one or two females could eliminate the den population.

The dens are only one part of the required habitat and if the area in the vicinity of these dens is used for housing, the rattlesnakes will be more visible and vulnerable. Bertram *et al.* (2001) found that people killed rattlesnakes for a variety of reasons. Increased visibility will increase the destruction of individuals of the small and slowly reproducing population of *Crotalus oregonus*.

In summary, the loss of habitat due to altered land use and fires, the increased traffic on roads, the encroachment of people on or near the home ranges of the Western Rattlesnake, the long time to maturity of *Crotalus oregonus*, the limited size and number of reproductive events per female, and the destruction of rattlesnakes out of fear or dislike are acting synergistically and threatening the long-term survival of *Crotalus oregonus*.

TECHNICAL SUMMARY

Crotalus oreganus

Western Rattlesnake

Crotale de l'ouest

Range of Occurrence in Canada: Okanagan/Similkameen, Kettle, Christina Lake, Thompson/ Fraser/Nicola valleys, British Columbia

Extent and Area Information	
• <i>Extent of occurrence (EO)(km²)</i>	4,852 km ²
• <i>Specify trend in EO</i>	Declining
• <i>Are there extreme fluctuations in EO?</i>	No
• <i>Area of occupancy (AO) (km²) (based on estimate of area of hibernacula)</i>	<10 km ²
• <i>Specify trend in AO</i>	Declining
• <i>Are there extreme fluctuations in AO?</i>	No
• <i>Number of known or inferred current locations (currently the BC-CDC has 40 occurrences mapped and estimates that the true number is 60-80 - Ramsey, 2004)</i>	4 south-central BC valleys
• <i>Specify trend in #</i>	Declining
• <i>Are there extreme fluctuations in number of locations?</i>	No
• <i>Specify trend in area, extent or quality of habitat</i>	Declining in extent and quality of habitat
Population Information	
• <i>Generation time (average age of parents in the population)</i>	12-15 years
• <i>Number of mature individuals</i>	Based on estimate of 15 adults average per hibernaculum and 236 (estimated known)-500 (upper estimate) = 3,540 to 7,500
• <i>Total population trend:</i>	Declining
• <i>% decline over the last/next 10 years or 3 generations.</i>	Unknown
• <i>Are there extreme fluctuations in number of mature individuals?</i>	No
• <i>Is the total population severely fragmented?</i>	Geographically fragmented between metapopulations and increasingly fragmented within metapopulation
• <i>Specify trend in number of populations</i>	Declining Min. est. 236 dens, at least several extirpated
• <i>Are there extreme fluctuations in number of populations?</i>	No
• <i>List populations with number of mature individuals in each:</i>	Exact number of adults unknown. BC-CDC estimates >1,000 adults, perhaps about 3,000 (Cannings <i>et al.</i> 1999). Hobbs (p.12) estimates less than 5,000. Okanagan/Similkameen, Kettle, Christina, Thompson/Fraser/Nicola

Threats (actual or imminent threats to populations or habitats)	
<ul style="list-style-type: none"> ✓ Direct human persecution ✓ Increased number of roads and traffic leading to increased road mortality and increasing contact with humans ✓ Loss of habitat to agriculture (vineyards, orchards, rangeland) and urbanization ✓ Destruction of hibernacula ✓ Risk of pesticide accumulation and forest fires ✓ Intensive grazing pressure 	
Rescue Effect (immigration from an outside source)	
<ul style="list-style-type: none"> • <i>Status of outside population(s)?</i> USA: [other jurisdictions or agencies] 	Not currently at significant risk*
<ul style="list-style-type: none"> • <i>Is immigration known or possible?</i> 	Minimal
<ul style="list-style-type: none"> • <i>Would immigrants be adapted to survive in Canada?</i> 	Yes
<ul style="list-style-type: none"> • <i>Is there sufficient habitat for immigrants in Canada?</i> 	Probably not
<ul style="list-style-type: none"> • <i>Is rescue from outside populations likely?</i> 	Probably not
Quantitative Analysis [provide details on calculation, source(s) of data, models, etc]	

*taxonomic change may affect this entry

Status and Reasons for Designation

Status: Threatened	Alpha-numeric code: [Met criteria for Endangered, B2ab(i,ii,iii,v), but designated as Threatened, B2ab(i,ii,iii,v); C1+2a(i); D2, because the population is still widespread although sparse.]
Reasons for Designation: This species is threatened by rapid expansion of human activities including urbanization, agriculture, forestry and range management in south-central dry valleys of British Columbia. This snake is particularly vulnerable to roads both from direct mortality and from habitat fragmentation. Rattlesnakes are subject to direct persecution and to destruction of critical habitat (hibernacula). The adult rattlesnake population is small, likely fewer than 5,000, and dispersed among only four valleys, probably with little interchange of snakes between valleys. Threats to the species are increased in effect because this snake has late maturity (~8 years), small litters and only breeds about once every 3-4 years.	
Applicability of Criteria	
<p>Criterion A: Not applicable as there are not sufficient data to specify a rate of decline.</p> <p>Criterion B: Meets Endangered B2, a (severely fragmented), b (i, ii, iii, v). But recommended as Threatened because there are still rattlesnakes across a wide area, so they are unlikely to be at imminent risk of extinction.</p> <p>Criterion C: Meets Threatened C1 (seems certain there has been more than 10% decline in 40 years) 2a(i).</p> <p>Criterion D: Qualifies as Threatened under D2 with AO <20 km², and vulnerable to human activities and stochastic events.</p> <p>Criterion E: Not applicable.</p>	

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No information available on J.M. Macartney or L.A. Gregory.

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