COSEWIC
Assessment and Update Status Report

on the

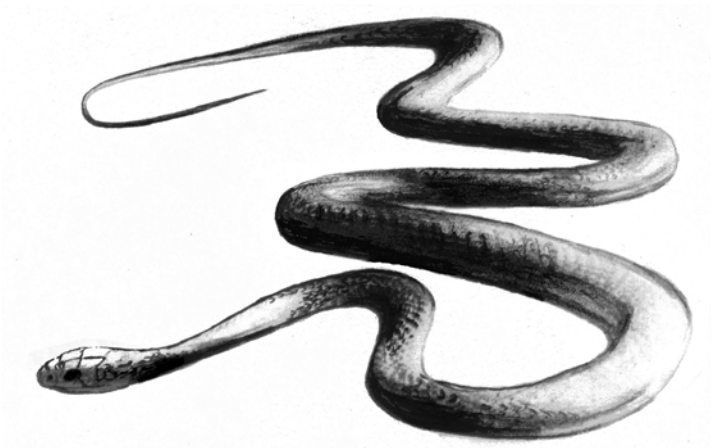
Eastern and Western Yellow-bellied Racers

Coluber constrictor flaviventris

and

Coluber constrictor mormon

in Canada



EASTERN YELLOW-BELLIED RACER - THREATENED
WESTERN YELLOW-BELLIED RACER - SPECIAL CONCERN
2004

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:

Campbell, C.A., and D.W. Perrin 1991. COSEWIC status report on the Racer *Coluber constrictor* in Canada. Committee on the Status of Endangered Wildlife in Canada with additions on the Eastern and Western Yellow-bellied Racers by J.M. Macartney and additions on the Blue Racer by B.D. Porchuk; revised and edited by F. Cook and R.J. Brooks. 36 pp.

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COSEWIC would like to acknowledge Kym Welstead for writing the update status report on the Eastern and Western Yellow-bellied Racers, *Coluber constrictor flaviventris* and *Coluber constrictor mormon* prepared under contract with Environment Canada, overseen and edited by Ronald J. Brooks, the COSEWIC Amphibians and Reptiles Species Specialist Subcommittee Co-chair.

Formerly assessed by COSEWIC as the Eastern Yellowbelly Racer and the Western Yellowbelly Racer.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Couleuvre agile à ventre jaune de l'est et de l'ouest (*Coluber constrictor flaviventris* et *Coluber constrictor mormon*) au Canada – Mise à jour.

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COSEWIC
Assessment Summary

Assessment Summary – November 2004

Common name
Eastern Yellow-bellied Racer

Scientific name
Coluber constrictor flaviventris

Status
Threatened

Reason for designation
This snake is restricted to two small areas in extreme southern Saskatchewan. It is at risk due to loss of habitat from agriculture, mortality on roads, loss of den sites and perhaps from effects of small population size. There may be a rescue effect from immigration from the United States, but this effect has not been observed.

Occurrence
Saskatchewan

Status history
Designated Special Concern in April 1991. Status re-examined and designated Threatened in November 2004. Last assessment based on an update status report.

Assessment Summary – November 2004

Common name
Western Yellow-bellied Racer

Scientific name
Coluber constrictor mormon

Status
Special Concern

Reason for designation
This snake occurs in five valleys in south-central British Columbia. It is susceptible to habitat loss and fragmentation from agriculture and urban development, especially as this species is particularly intolerant of urbanization. The ongoing expansion of the road network and traffic volumes increases mortality and further fragments the habitat. Pesticide applications in agricultural areas may impact the snakes both directly and via contamination of their insect prey. It is unlikely that there is a significant rescue effect because of extensive loss of habitat contiguous to the United States border.

Occurrence
British Columbia

Status history
Designated Not at Risk in April 1991. Status re-examined and designated Special Concern in November 2004. Last assessment based on an update status report.

COSEWIC
Executive Summary

Eastern and Western Yellow-bellied Racers
Coluber constrictor flaviventris
and
Coluber constrictor mormon

Species information

The Racer, *Coluber constrictor*, is the only species in the genus, *Coluber*, Family Colubridae, in North America. Three subspecies have been documented in Canada; the Eastern Yellow-bellied Racer, *Colubar constrictor flaviventris,* the Western Yellow-bellied Racer, *Colubar constrictor mormon* and the Blue Racer, *Colubar constrictor foxii*. Racers have long slender bodies, with olive-green to slate-blue dorsum and yellow to cream undersides. Juveniles have dark dorsal blotches or saddles that fade as they approach reproductive age. As their name suggests, Yellow-bellied Racers have pale yellow to bright yellow bellies.

Distribution

The Racer, *C. constrictor*, is a wide-ranging snake, found across North and Central America from Maine to southern British Columbia, south to the Florida Keys and northern Guatemala in Central America. In Canada, *C. c. flaviventris* occurs only in extreme south central Saskatchewan, and possibly the southeast corner of Alberta. *C. c. mormon* occurs in the south and central interior of British Columbia that encompasses the South Columbia, Kettle, Okanagan, Similkameen, Nicola, and Thompson watersheds.

Habitat

Racers utilize a variety of open habitats including grasslands, agricultural areas, marshes, sagebrush thickets, mixed-grass prairie, and desert. Racers lay their eggs in abandoned rodent burrows, rotting wood, stumps, decaying vegetable matter, beneath flat stones, in loose soil or on stable talus slopes. Racers hibernate through the winter in communal or non-communal hibernacula that are deep enough to protect them from freezing, and are usually on south-facing rocky slopes.

Biology

Female Racers mature at 2-3 years and produce a maximum of one clutch per year, although some may only reproduce every two years. Racers mate after emerging

from their winter dens in the spring. Clutch size is dependent on body condition, particularly fat reserves, and ranges from 4-20 eggs. Incubation lasts approximately two months. The diet of juvenile and adult *C. c. flaviventris* and *C. c. mormon* consists mainly of insects, mostly crickets and grasshoppers. Adult Racers will also take larger prey such as small mammals, reptiles, birds, and amphibians.

Population sizes and trends

In general, Racers are conspicuous because they are active during the day. This means that their abundance might be overestimated relative to other species of snakes that are mainly nocturnal. Nevertheless, it is evident that *C. c. flaviventris* is uncommon in Saskatchewan. *C. c. mormon* in British Columbia is also uncommon and its numbers have likely declined as a consequence of habitat loss and expansion of urban areas. The number of mature individuals of both subspecies is unknown.

Limiting factors and threats

Both *C. c. flaviventris* and *C. c. mormon* are vulnerable to habitat loss because they show a high degree of site fidelity and require suitable hibernacula, nesting sites and summer foraging habitat. Racer populations may be limited by the availability of suitable den sites and may not be able to relocate to other areas if dens are destroyed by human activities. Pesticide application reduces and contaminates their insect prey although effects of reduced, contaminated prey on Racer populations has not been determined. Recruitment of *C. c. mormon* may be limited by road mortality, which most strongly affects dispersing juveniles and gravid females during migrations. Finally, Racers often forage in agricultural habitats for insects and so are frequently killed by farm machinery such as mowers and hay balers.

Special significance of the species

All three subspecies found in Canada are at the northernmost extent of their range where populations are small and increasingly limited by lack of available habitat. *C. c. laviventris* and *C. c. mormon* utilize unique Canadian habitats, the mixed-grass prairie in Saskatchewan and the Great Basin region of British Columbia. This is the fastest snake in Canada.

Existing protection or other status designations

The Saskatchewan Wildlife Act 1988 prohibits unauthorized killing or possession of Eastern Yellow-bellied Racers, *C. c. flaviventris*. The provincial heritage status rank of *C. c. flaviventris* is S3 in Saskatchewan – indicating that the subspecies is rare or uncommon. There is no legal protection or ranking for Racers in Alberta as none of the few records from this province have been verified. Formal surveys are needed to verify whether there is a breeding population of Racers in Alberta. Nature Serve lists *C. c. flaviventris* as vulnerable to extirpated or extinct (N3) in Canada, and secure (G5T5) globally. In the United States, *C. c. flaviventris* is listed as widespread,

abundant and secure (N5). *C. c. flaviventris* was designated as Special Concern by COSEWIC in April 1991.

C. c. mormon is protected by the British Columbia Wildlife Act, which protects it from being killed, collected or held captive. *C. c.mormon* is listed as Identified Wildlife under the *Forest and Range Practices Act*. In British Columbia, *C. c. mormon* is 'Blue listed' because it is restricted to dry grassland habitat which is currently under threat. The provincial heritage status rank of *C. c. mormon* is S3S4 in British Columbia, where S3 indicates 'rare or uncommon, may be susceptible to large-scale disturbances', and S4 indicates 'frequent to common apparently secure but may have restricted distribution or there may be perceived future threats. NatureServe lists *C.c. mormon* as N3N4 in Canada, N5 in the United States, and G5T5 globally. *C. c.mormon* was designated 'Not at Risk' by COSEWIC in 1991 (Campbell and Perrin, 1991).

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 5th 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 agencies (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 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 (NOVEMBER 2004)

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 it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for atleast 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 wildlife species for which there is inadequate information to make a direct, or indirect, assessment of its 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.

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

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and

Coluber constrictor mormon

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2004

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SPECIES INFORMATION

Name and classification

Class:	Reptilia
Order:	Squamata
Suborder:	Serpentes
Family:	Colubridae
Subfamily:	Colubrinae
Species:	*Coluber constrictor* (Linnaeus, 1758), common name - Racer
Subspecies:	There are three subspecies of *C. constrictor* in Canada. The two subspecies addressed in this report are: *C. c. flaviventris,* Eastern Yellow-bellied Racer (Say, 1823), and *C. c. mormon*; Western Yellow-bellied Racer (Baird and Girard, 1852) The third subspecies in Canada, *C. c. foxii*, was dealt with in a separate COSEWIC update report (Wilson and Rouse 2002).
Common names:	The Eastern Yellow-bellied Racer and Western Yellow-bellied Racer following Crother *et al.* (2000). In French, the Yellow-bellied Racer is called Couleuvre agile (Nimble grass snake). *Coluber constrictor flaviventris* is called Couleuvre agile à ventre jaune de l'est and *C. c. mormon* is Couleuvre agile à ventre jaune de l'ouest.

Wilson (1978) reviewed 11 subspecies of Racers in North America, three of which are known to occur in Canada, *C. c. flaviventris,* (Say, 1823), *C. c. foxii* (Linnaeus, 1758), and *C. c. mormon* (Baird and Girard, 1852). There has been some debate over the separation of the three subspecies. The separation of *C. c foxii* (the Blue Racer) as a distinct subspecies from *C. c. flaviventris* has been recognized by several authorities (Conant and Collins 1991, Harding 1997, Crother *et al.* 2000,). Because the taxonomic status of *C. c. flaviventris* has been treated differently through the years, the subspecies has acquired numerous vernacular names including (Eastern) Blue Chaser, Fox's Black Snake, Fox's Blue Racer, Green Racer, Olive Racer, Plains Blue Racer, (Western) Racer, (Western) Yellow-bellied Adder, Yellow-bellied Black Snake (Wright and Wright 1957), and the Eastern Yellowbelly Racer (Campbell and Perrin 1991). Given that *C. c. flaviventris* was formerly included with *C. c. foxii as C. c. constrictor* there is also overlap in their common names. The vernacular names Blue Racer, Eastern Blue Racer, and Eastern Yellow-bellied Racer were used by Logier (1939, 1958) and Logier and Toner (1955, 1961) to describe Ontario Racers that were treated as *C. c flaviventris*.

Fitch *et al.* (1981) elevated the Western Yellow-bellied Racer, *C. c. mormon*, to species status (as *C. mormon*) due to the supposed lack of intergradations with *C. c. flaviventris*. However, Greene (1984) and Corn and Bury (1986) have subsequently provided evidence of intergradations and reinstated it as the subspecies, *C. c. mormon*. This reinstatement was followed by other authors (e.g., Nussbaum *et al.*

1983, Gregory and Campbell 1984, Orchard 1984, Stebbins 1985). In 1991, Collins (1991) reinstated *C. c. mormon* to species status. However, allopatry was not suitably demonstrated and Anderson (1996 as cited in Crother *et al.* 2000) argued that *C. c. mormon* should remain a subspecies based on allozyme data. Several common names exist for *C. c. mormon* including the Western Blue Snake (Carl 1944), Yellow-bellied Racer (Carl 1944), Black Chaser, Black Snake, Green Racer, Mormon (Blue) Racer, Western Blue Racer, Yellow-bellied Black Snake, the Yellow Coachwhip Snake (Wright and Wright 1957) and the (Western) Yellowbelly Racer (Campbell and Perrin, 1991) .

Formerly, a fourth subspecies was thought to occur in Canada, but records for the Northern Black Racer, (*C. c. constrictor* Linnaeus, 1758), are now discounted. The range of the Black Racer was previously thought to include localities in the Canadian Maritime Provinces (Mills 1948, Logier and Toner 1955, 1961; Bleakney 1958; Conant 1958) based on unverified sight records and on anecdotal reports from the 1800s (Bleakney 1958; Cook 1967; Martin 1969; Gorham 1970; Gilhen 1984). Cook (1967) outlined reasons for doubting these observations and recommended deletion of *C. c. constrictor* from Canadian lists. Subsequently, Conant (1975), Wilson (1978), Cook (1984), and Gilhen (1984) followed this suggestion. However, Froom (1972: p 54) argued, "some published reports of this snake's occurrence in Nova Scotia date between 1865 and 1890, so there is the possibility that it did indeed exist there at that time".

Description

Morphologically, Racers are built for speed; with long, slender, smooth bodies, they are capable of speeds up to 7 km/hr (CARCNET 2003). They have relatively wide distinct heads, with round snouts and large eyes with rounded pupils. Their tails are long and whip-like (Figure 1). The anal plate is divided; scales are smooth and arranged in 17 rows.

Colouration is highly variable across the Racer's range. There is often variation even among individuals in the same population, and there may be geographic variation within subspecies. Yellow-bellied Racers are named for the colour of the belly, which can be bright yellow (*C. c. flaviventris*) to yellowish white (*C. c. mormon*). Dorsally, *C. c. mormon* are commonly green, olive-green, yellowish-brown or occasionally reddish brown in some areas (Wilson 1978, Stebbins 1985). A reddish dorsum has not been observed in Racers in British Columbia (Macartney pers. comm. as cited in Campbell and Perrin 1991). *C. c. flaviventris* tend to be more bluish, bluish green, or grey. Interscale colour is usually black and they have white throats.

There are size differences between the two subspecies. *Coluber constrictor flaviventris* tends to be more slender and longer than *C. c. mormon*. Macartney (as cited in Campbell - and Perrin, 1991) found that *C. c. flaviventris* adults in Saskatchewan ranged from 61 to 94 cm snout-vent length (SVL), with total lengths of the largest individuals exceeding 1 m, with a maximum of 177.8 cm (Conant 1975: 179). *Coluber constrictor*

mormon tends to be under 1 m in total length, *and* ranges from 50 to 182 cm (Stebbins 1985), or 60 to 120 cm (Nussbaum *et al.* 1983). *Columber constrictor mormon* is considered to be more stocky than *C. c. flaviventris* and is on average a shorter snake (Fitch *et al.* 1981).

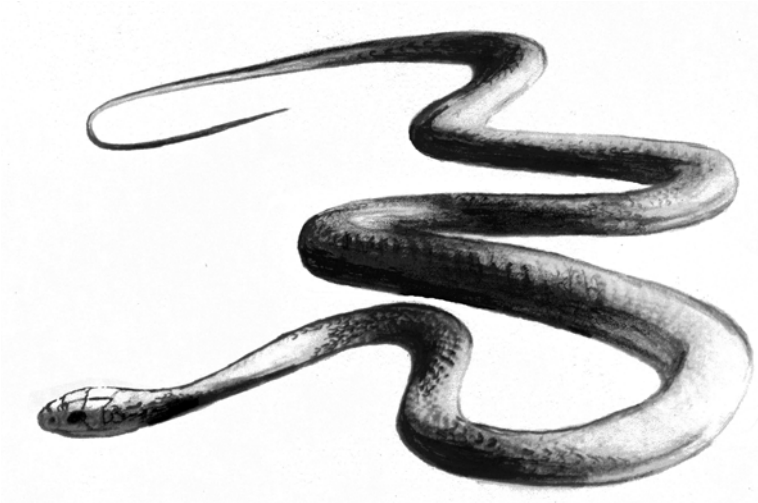

Figure 1. Illustration of a Yellow-bellied Racer, *Coluber constrictor*. Illustration By Kym Welstead.

There is little variation in the total length or proportions (ratio of tail/total length) between the sexes; a mature male *C. c. flaviventris* ranges from 51-111 cm long SVL (mean 72 $\pm$ 0.8); whereas females are marginally longer, ranging from 54-121 cm SVL (mean 79 $\pm$ 0.1; Brown and Parker 1984, Fitch *et al.* 1981). The ratio of tail/total length is 23.2 for males and 20.9 for female *C. c. flaviventris* (1984, Fitch *et al.* 1981). In British Columbia, adult *C. c. mormon* males typically ranged from 60 to 70 cm SVL, whereas females were slightly longer ranging from 70 - 80 cm SVL (Macartney, unpublished data as cited in Campbell and Perrin, 1991). Shewchuk and Waye (1995) also reported that female *C. c. mormon* in British Columbia have a slightly larger total length, with a mean adult female length of 85 cm (max 116 cm) and mean adult male length of 78 cm (max 112 cm). In other regions, the same pattern of slightly larger female *C. c. mormon* has been observed. Mature male *C. c. mormon* range from 40-70 cm SVL (mean 54 $\pm$ 0.6) and mature females range from 41-74 cm SVL (mean 58 $\pm$ 0.7; Brown and Parker 1984; Fitch *et al.* 1981). The ratio of tail/total length is 26.76 for males and 25.07 for female *C. c. mormon* (Brown and Parker 1984, Fitch *et al.* 1981).

Juvenile Racers are similar to adults in body form but differ in colour with lateral blotches and a series of saddles or partial cross-bands dorsally. The dorsal saddles/bands may be grey, brown or reddish on a light grey background and are boldest on the neck, fading towards the middle of the body (St. John 2002). *Coluber constrictor mormon* has 70-85 bands, whereas *C. c. flaviventris* has 65-80 bands (Ortenburger 1928), although the number of bands varies geographically and bands

become less distinct as an individual grows and reaches sexual maturity. In *C. c. flaviventris*, this pattern starts to fade at around 40 cm SVL although bands were observed in *C. c. flaviventris* as long as 61 cm SVL in Saskatchewan. In *C. c. mormon*, the bands also become faint by 45 to 60 cm (Stebbins 1985), and are usually absent at SVLs > 45 cm for individuals in British Columbia (Macartney unpublished data as cited in Campbell and Perrin, 1991).

The two subspecies, *C. c. mormon* and *C. c. flaviventris,* can be separated using several morphological characteristics. However, the distinctiveness of these traits has been debated because there is overlap between the subspecies (Corn and Bury 1986, Fitch *et al.* 1981). Use of differences in body size, proportions, colour and the number of teeth to separate the subspecies should be approached with caution because individual variation results in overlap of these characteristics (Fitch *et al.* 1981). In general, the number of dentary teeth and maxillary teeth for *C. c. mormon* are 14-16 and 13-14, respectively, whereas for *C. c. flaviventris* the range is 18-19 dentary teeth and 15-16 maxillary teeth (Ortenburger 1928). However, Auffenberg (1955) found that the numbers of maxillary teeth for *C. c. flaviventris* range from 13-16, overlapping with that of *C. c. mormon*. There is also variation in the number of supralabial scales (Corn and Bury 1986), making the distinction of 8 supralabial pairs for *C. c. mormon* and 7 for *C. c. flaviventris* observed by Ortenburger (1928) unreliable.

In Saskatchewan, *C. c. flaviventris* may be confused with the Smooth Greensnake, (*Opheodrys vernalis*) in body form, but the Smooth Greensnake is a bright, brilliant green. Juvenile Gophersnakes (*Pituophis catenifer*) may be confused with juvenile *C. c. flaviventris,* because they both have dorsal cross-bands but Gophersnakes have keeled scales.

In British Columbia, species that might be confused with *C. c. mormon* include the Rubber Boa, *Charina bottae*, which has similar colouration. However, the Rubber Boa has a blunt tail, wider body and tiny eyes. Several species in British Columbia have crossbars and thus could be mistaken for a juvenile *C. c. mormon*. These species include the Night Snake, *Hypsiglena torquata*, and young Gophersnakes, *Pituophis catenifer*. However, the Night Snake has vertical pupils, and the Gophersnake has keeled scales (St. John 2002).

DISTRIBUTION

Global range

The Racer, *C. constrictor*, is a wide-ranging snake, found across North and Central America from Maine to southern British Columbia, south to the Florida Keys and northern Guatemala in Central America (Figure 2; Ortenburger 1928, Auffenberg 1955, Wright and Wright 1957, Conant 1975, Wilson 1978, Stebbins 1985). The Racer is the only representative of the genus *Coluber* in North America and has been partitioned into 11 subspecies (Wilson 1978).

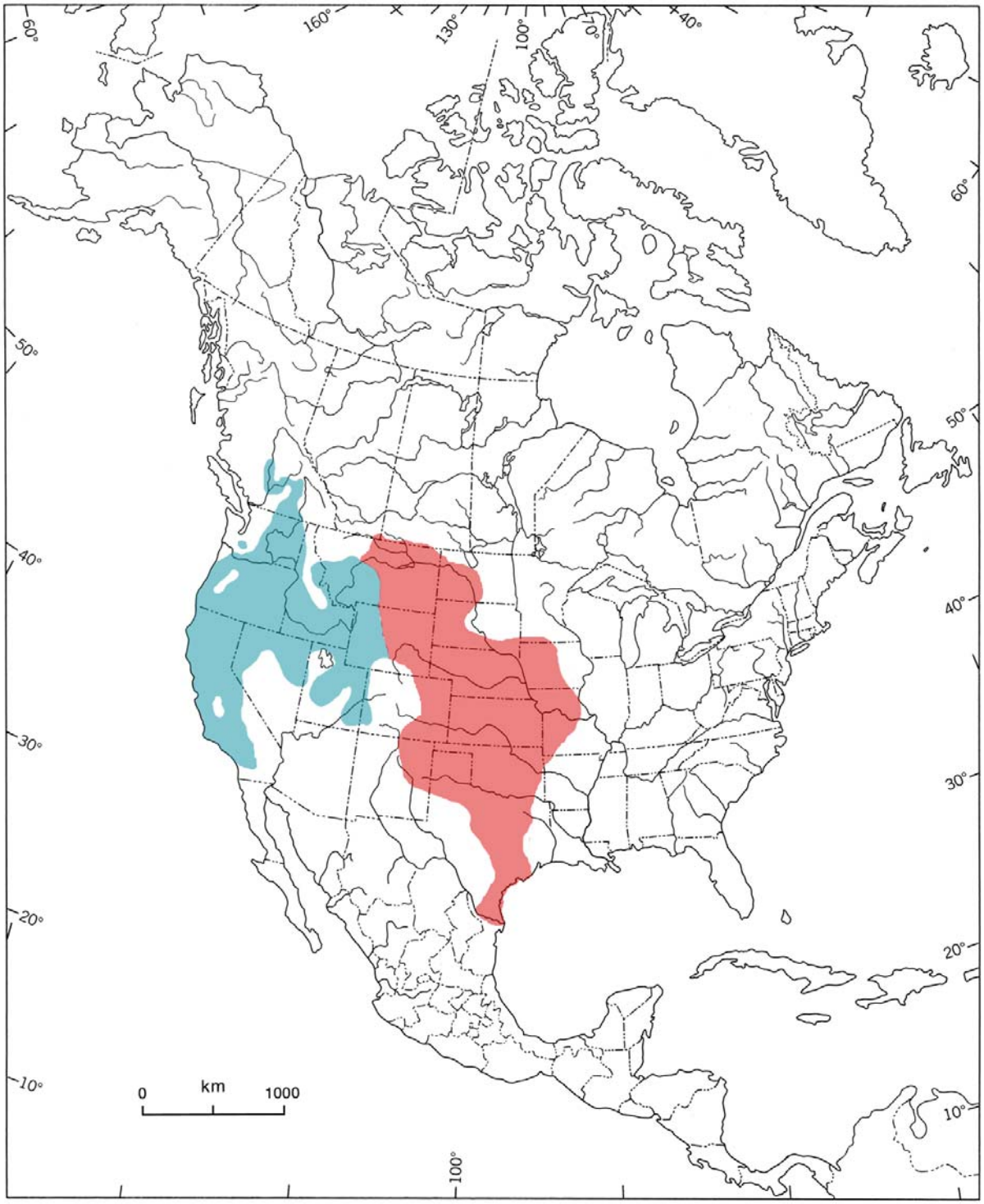

Figure 2. Distribution of the Racers, *Coluber constrictor flaviventris* and *C. c. mormon*, in North America (Gregory and Campbell 1984, Campbell and Perrin 1991, Shewchuk and Waye 1995, Hobbs and Sarell 2002). *C. c. flaviventris* in dark grey and *C. c. mormon* in light grey.

Canadian range

In Canada, *Coluber constrictor flaviventris* has been confirmed only in extreme south central Saskatchewan (Figure 3). Most of these records have been incidental observations occurring during rattlesnake studies. More thorough studies focused on *C. c. flaviventris* are needed to estimate accurately their numbers and distribution. In Saskatchewan, *C. c. flaviventris* has been recorded from the Frenchman River Valley near Val Marie in the southwestern portion of the province to the Big Muddy Valley in the south central portion (Maher and Beck 1964, Cook 1966, 1977, 1984, Morrison 1969, Cook and Van Zyll de Jong 1975, Secoy and Vincent 1976, Finley and Jasieniuk 1978, Kreba 1978, Lynch 1978, Secoy 1978, Wayne Harris, pers. comm., J Malcolm Macartney, pers. comm. as cited in Campbell and Perrin, 1991.

Figure 3. Range of the Eastern Yellow-bellied Racer, *C. c. flaviventris,* in Saskatchewan. Range is shown as dark grey shading (red in the colour version). Sight records or locations of captured specimens are shown by asterisks. Records from southeastern Alberta (area not shaded, but bounded by dashed line) have not been verified.

Kissner *et al.* (1996) surveyed 14 Prairie Rattlesnake (*Crotalus viridis viridis*) dens in Grasslands National Park near Val Marie, and captured and tagged 48 *C. c. flaviventris* during the study. In 1987, Mackay conducted a survey of snake dens in the Frenchman River Valley, southeast of Val Marie on behalf of the Saskatchewan Natural History Society. Mackay observed or captured Racers at two sites and found one road kill (Macartney, pers. comm. as cited in Campbell and Perrin, 1991). During a

field survey of rattlesnakes by Macartney in 1990 in the same valley, 13 *C. c. flaviventris* were captured and 3 carcasses examined at 7 sites throughout the valley. Macartney (pers. comm. as cited in Campbell and Perrin, 1991) commented that, "these sites were hibernacula used primarily by Prairie Rattlesnakes, Bullsnakes (*Pituophis catenifer sayi*), and Gartersnakes (*Thamnophis spp*.)".

Information on *C. c. flaviventris* populations in Alberta is limited because no formal surveys have been conducted on this species. There are apparently no verified records of Racers in Alberta. One record from Onefour, Alberta is an observation of a Burrowing Owl (*Athene cunicularia*) bringing a dead Racer to its burrow (J. Nicholson pers. comm.). There was another unconfirmed sighting in the same area in July 2001. Additionally, a rancher, near Wildhorse caught a Racer 15 – 20 years ago in the extreme southeast corner of Alberta. These latter observations are problematic at best.

Coluber constrictor mormon occurs in the south and central interior of British Columbia, a range that encompasses the South Columbia, Kettle, Okanagan, Similkameen, Nicola, and Thompson Watersheds (Sarell 2003). In the past, the range of *C. c. mormon* was considered restricted to the 'Arid Transition Zone in the Okanagan, Similkameen, and Fraser Valleys", eastward to Midway, westward to Seton Lake (by Lillooet) and north to Kamloops (Cowan 1936, Carl 1944, Gregory and Campbell 1984). However, a recent increase in snake research in British Columbia has resulted in additional sightings that have expanded the range of *C. c. mormon*. Eastward, Sarell and Alcock (2000) captured 47 *C. c. mormon* at Beaver Creek Provincial Park near Trail, confirming the previous observations by Dulisse (1999). This area is a unique habitat for *C. c. mormon* because it is situated in the dry interior Western Cedar – Hemlock (ICH) biogeoclimatic zone (Sarell and Alcock 2000). Also, *C. c. mormon* used a communal rattlesnake den called the 'Elephants Head' den in the Grand Forks area (Hobbs and Sarell 2001). To the northwest, Hobbs (unpublished data, pers. comm.) observed 2 adult *C. c. mormon* in 2002, north of D'arcy near Anderson Lake, also in a novel habitat of mature Douglas Fir on the border of the Squamish and Merrit Forest Districts. Northward, Hobbs (unpublished data, pers. comm.) observed an adult *C. c. mormon* 20 km south of Lillooet on the west side of the Fraser River. This confirms the suspected range 'to at least Chum Creek' (Campbell and Perrin, 1991) which is nearby. Hobbs and Sarell (2002) observed a *C. c. mormon* road-killed near Dog Creek on the east side of the Fraser River up the west end of Canoe Creek, nearly 100 km north of Lillooet in the 100 Mile House Forest District, which represents the most northerly sighting for *C. c. mormon*. Slightly south of Dog Creek, two shed Racer skins were found near a potential egg-laying site on the bank of the Fraser River in the Big Bar Creek area, near Churn Creek (Hobbs and Sarell 2002). Observations near the south end of Shuswap Lake, north of Vernon, have been recorded (Gregory and Campbell 1984, Green 1975 unpublished data as cited in Campbell and Perrin, 1982) and indicate a connection between two of the larger discrete populations (see below). However, these records could not be verified in 2004 (J. Hobbs, pers. comm. July 2004).

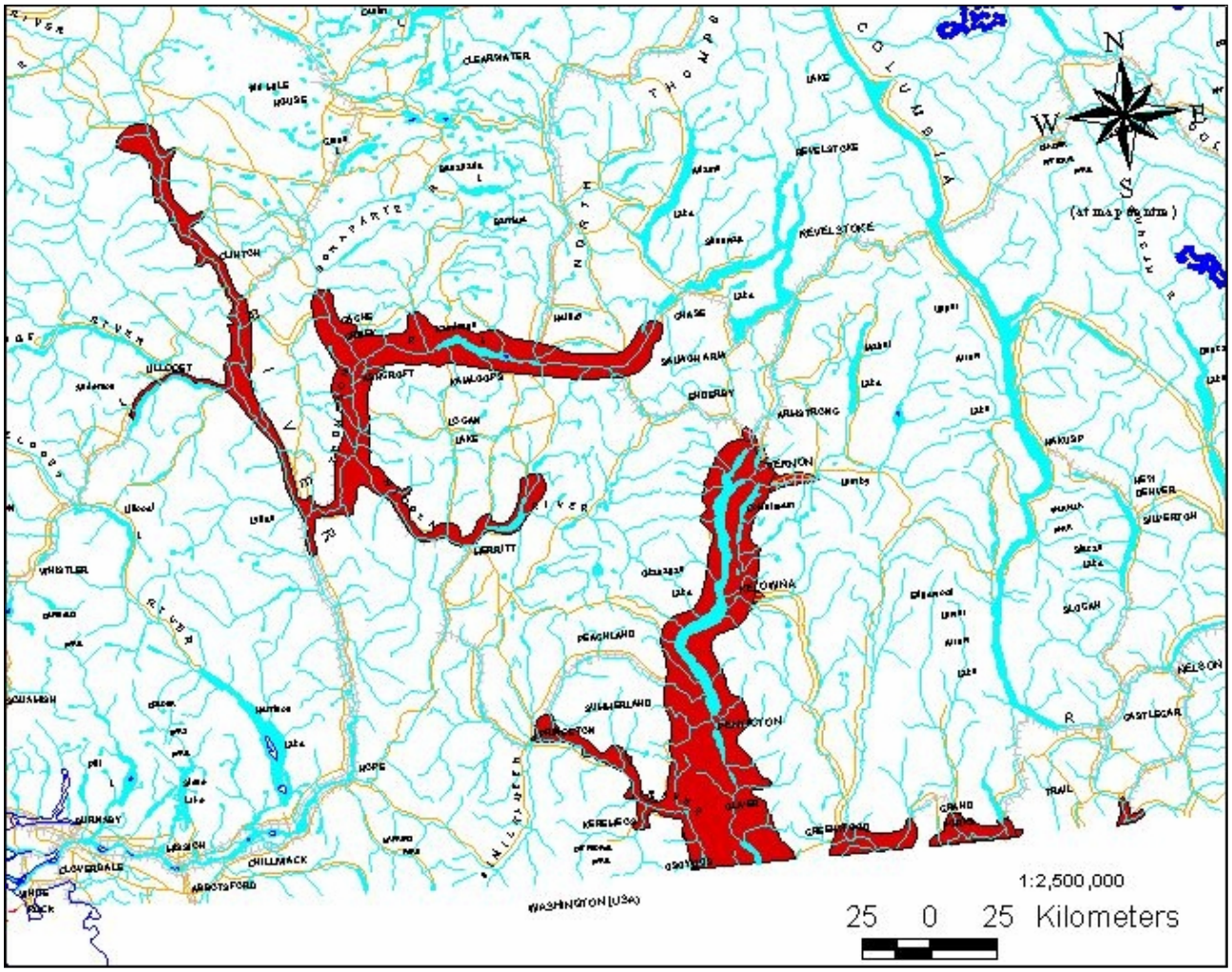

Figure 4. Range of the Western Yellow-bellied Racer, *C. c. mormon,* in British Columbia (shown as black (or red) shaded areas). Courtesy of J. Hobbs. Ministry of Water, Land and Air Protection 2004.

These new range data suggest that *C. c. mormon* consists of five discrete populations in British Columbia (Hobbs and Sarell 2002). Three of the four southern populations are small and occur near Trail, Grand Forks and Midway (Figure 4). The fourth population, the 'Okanagan/Similkameen population', includes the majority of the species' range in Canada and encompasses the Okanagan and Similkameen watersheds. The four southern populations are potentially contiguous with Washington State populations. Early records from the Fraser Valley (Campbell *et al*. 1982) signify a connection to an extirpated coastal Washington population that once extended down the eastern coast of Puget Sound in the 1930s (Storm and Leonard 1995). The fifth population, the 'Thompson/Fraser population', represents the northern range and probably was connected with the four southern populations during the Hypsothermic period, 8,000 BP (Cannings and Cannings 1996 as cited in Hobbs and Sarell 2002), but has since separated due to a range contraction.

HABITAT

Habitat requirements

In general, Racers utilize a variety of open habitats. In Saskatchewan, *C. c. flaviventris* have been recorded in grasslands, sagebrush thickets, and mixed-grass prairie. In Kansas, *C. c. flaviventris* has been recorded from original or regenerated prairie, pastures, old fields and open woods (Fitch 1963: 375-377).

Coluber constrictor mormon also prefers open habitat, but occasionally occurs in forested areas with an open canopy (Sarell *et al.* 1996 & 1997, Sarell and Alcock 2000). Gregory and Campbell (1984: 74) characterize *C. c. mormon* habitat as open, sparsely treed country. Despite their apparent heat-tolerance, Racers require habitat that has some moisture. *Coluber constrictor mormon* is generally found from low to mid-level elevations up to 900 m in British Columbia (Sarell *et al.* 1997). Brown *et al.* (1995) found *C. c. mormon* up to 1080 m in Washington. *Coluber constrictor mormon* has been found in four biogeoclimatic zones in British Columbia, the bunchgrass (BG; Orchard 1984, Cannings *et al.* 1999), interior douglas fir (IDF; Cannings *et al.* 1999), ponderosa pine (PP; Orchard 1984, Cannings *et al.* 1999), and the dry interior western cedar – hemlock (ICH) biogeoclimatic zone (Sarell and Alcock 2000, Sarell 2003). However, they most frequently occur in the ponderosa pine and bunchgrass biogeoclimatic zones (Orchard 1984). In Osoyoos, *C. c. mormon* have been recorded in wet valley bottoms, sandy terraces on the side of the valley and on the rocky slopes of the valley walls (Shewchuk and Waye 1995). Racers are visual predators that forage during the day and are also often found in sandy terrace/riparian margins where there are optimal thermal conditions and high prey abundance (Shewchuk and Waye 1995).

Egg-laying habitat

There are few data on the egg-laying habitat of *C. c. flaviventris.* K. Kissner (pers. comm.) collected a number of juvenile *C. c. flaviventris* in a stump in front of the main entrance of a large rattlesnake hibernaculum. Fitch (1963: 417) reported that *C. c. flaviventris* may use rodent burrows as egg-laying cavities.

Brodie *et al.* (1969) described communal nesting sites for *C. c. mormon* in Oregon. *Coluber constrictor mormon* has been observed sharing nesting sites with Gophersnakes (Shewchuk 1996). As many as 56 *C. c. mormon* hatchlings were found in one communal nesting site with 13 Gophersnake hatchlings. The nesting site was a rodent burrow on a sandy hill with sparse vegetative cover and warm southern exposure (Shewchuk and Waye 1995, Shewchuk 1996). Eggs were laid 15 cm below ground in the abandoned rodent burrow and the entrance to the burrow remained open. Female *C. c. mormon* have also been seen excavating chambers in sandy banks (Sarell 2003). Stable talus slopes with southern exposure may also be used for nesting (Cannings *et al.* 1999, Brodie *et al.* 1969). Rate of development of young is influenced by incubation temperature (Shewchuk 1996) which might explain why females prefer warm slopes as egg-laying sites (Sarell 2003). *Coluber constrictor mormon* displays site fidelity, laying eggs in the same subterranean chambers for several years (Sarell 2003).

Hibernation

Research on rattlesnakes has demonstrated the importance of suitable hibernacula for overwinter survival (Gannon 1978, Macartney and Weichel 1989). This knowledge can be extrapolated to the other species using the dens and provides insight into Racer habitat requirements. Racers hibernate through the winter months in the same hibernaculum each year. However, Fitch (1963: 386) notes that occasionally some individuals of the subspecies *C. c. flaviventris* may shift from one den site to another for no known reason. The hibernacula need to be suitably deep to prevent freezing during winter. Temperature is a critical element of the Racer's habitat, particularly in Canada where the species is at its northern limit.

Records of *C. c. flaviventris* in Saskatchewan have been associated with investigations of denning areas for the Prairie Rattlesnake, *Crotalus viridis viridis*, (Maher and Beck 1964). Macartney (cited in Campbell and Perrin, 1991) described the dens shared by snakes in the Frenchman River Valley as a series of deep holes in soft soil in the sides of hills that were usually facing south. Holes created by mammals may also be used (Macartney, unpublished observations as cited in Campbell and Perrin, 1991). The use of abandoned cisterns as den sites was reported by Minton (1972: 267) and Owens (1949). Fitch (1963: 377, 380) found that *C. c. flaviventris* in Kansas hibernated in or near rock ledges always in deep crevices in strata of limestone near hilltops. Kissner *et al.* (1996) recorded *C. c. flaviventris* in communal dens with Prairie Rattlesnakes, Bullsnakes, Western Plains Gartersnakes and possibly the Western Hog-nosed Snake (*Heterodon nasicus*). Communal denning is most common at high latitudes and may be a result of limited availability of suitable denning sites (Gregory 1982).

Hibernacula for *C. c. mormon* in British Columbia were usually in rocky outcrops, talus slopes, and small rock piles on steep south-facing slopes (Shewchuck and Waye 1995). *Coluber constrictor mormon* commonly shares dens with Western Rattlesnakes, *Crotalus oreganus*, Great Basin Gophersnakes, *Pituophis catenifer deserticola*, Nightsnakes, *Hypsiglena torquata,* and Common Gartersnakes, *Thamnophis sirtalis*, (Hobbs and Sarell 2001, Sarell 1993, Shewchuk 1996, Gregory and Campbell 1984). Terrestrial Gartersnakes (*Thamnophis elegans*) also hibernate with this group of snakes but are never found with the Common Gartersnake (Hobbs and Sarell 2002). Most rattlesnake dens had only 1-5 Racers using the same site. The low numbers of Racers observed at the dens may be an artefact of Racers not lingering outside dens like other species (Sarell 1993). The Western Rattlesnake is a good indicator of Racer dens but the *C. c. flaviventris* range extends into the Cariboo region where Rattlesnakes are absent. In Trail, British Columbia, *C. c. mormon* appeared to use the warm slopes between the terraced land extending down the bank into the Columbia River as hibernacula and may have also used the burrows of small mammals (Sarell and Alcock 2000).

Hobbs and Sarell (2002) describe four main attributes that make suitable denning sites. These attributes include fracturing, humidity, cover and thermal momentum. Fracturing is most common in basalt and gneiss rocks and is important to ensure that the temperature remains above freezing and allows access to geothermal heat to help

maintain a temperature between 4-9 °C (Macartney 1996 as cited in Hobbs and Sarell 2002). Based on Macartney's work in 1995, Racers are prone to desiccation rather than starvation. Thus sufficient humidity may be an important component of a hibernaculum. Cover, such as boulders, bushes and coarse talus outside the dens might be important for thermoregulation of emerging snakes and to provide travelling corridors and foraging habitat. Finally, thermal momentum, the dens' ability to absorb and retain heat, is influenced by aspect, slope, mass, position and surface albedo (Hobbs and Sarell 2002). Each of these components is useful for evaluating the suitability of denning sites. However, there may also be trade-offs between the components that allow snakes to use seemingly unsuitable sites.

Trends

Canadian populations of Racers are at the northern limit of the subspecies' range and their distribution may be limited by geographical features (barriers to dispersal, lack of suitable hibernating sites, etc.) as well as by lack of suitable habitat and by human activities or persecution. For example, the native prairie grassland in Saskatchewan has been substantially altered since the arrival of settlers and mechanized farming. In the southern portion of the province, there has been much overgrazing, but whether this has had, or will have, an impact on *C. c. flaviventris* populations is difficult to determine. The Frenchman River Valley is sparsely populated, so road mortality is likely a minor component of mortality. The one report of deliberate killing by humans of a *C. c. flaviventris* at one den in Saskatchewan was apparently an isolated incident, and there was no evidence of human visitation or disturbance at any of the other sites where Racers were seen in the 1987 or 1990 studies by Macartney (unpublished observations as cited in Campbell and Perrin, 1991). Conversely, killing of snakes or disturbance of hibernacula are unlikely to be detected because of the paucity of detected surveillance or study. *Coluber constrictor flaviventris* was probably never common in Saskatchewan or Alberta within historic times. However, loss of habitat in the area has undoubtedly resulted in at least local declines. The low number of records of *C. c. flaviventris* may also reflect inadequate surveillance and studies.

In British Columbia, intense habitat alteration in the densely populated Okanagan Valley has led to the loss of much suitable Racer habitat, especially on the west bank of the Okanagan Valley. Orchards made possible through irrigation in and near the valley bottoms and ranching on the adjacent slopes has without question resulted in declines of local populations of *C. c. mormon* on the valley floor. For obvious reasons, subdivisions are built on the same sunny south facing slopes that snakes use for hibernating sites. This loss of low-elevation grassland habitat is the primary threat to *C. c. mormon* habitat (Shewchuk and Waye 1995).

Losses of native grassland in the areas occupied by Yellow-bellied Racers vary considerably and tend to be greater on the valley floor and less at higher elevations where the snakes are fewer because of thermal constraints (Grasslands Conservation Council of British Columbia, 2004). In the Okanagan-Similkameen region, the percent loss of native grassland varies from 11-45%, with the higher percentages being in the

northern Okanagan Basin. About 10% of remaining grassland is protected in provincial parks etc. (Grasslands Conservation Council of British Columbia, 2004). In the Thompson region, 10-20% of grasslands have been lost. About 7% is protected. It is likely that Racers have been extirpated on the urban and intensively cultivated lands so declines of 10-45% could be guesstimated from the grasslands data. Much of the remaining grassland is grazed or otherwise harvested. The impact of grazing on Racers is hard to assess. In the Okanagan-Similkameen and the Thompson regions, the Western Yellow-bellied Racer, Western Rattlesnake and Great Basin Gophersnake are all blue-listed (Grasslands Conservation Council of British Columbia, 2004).

Protection/ownership

Two of the *C. c. flaviventris* hibernation sites in the Frenchman River Valley in Saskatchewan are located within the existing boundaries of Grasslands National Park; other sites are on Crown land leased for cattle grazing. Snakes and dens receive protection within the park. Outside the park, the Wildlife Act protects snakes, but does not protect the den sites from damage or development (Macartney, pers. comm. as cited in Campbell and Perrin, 1991). Eastern Yellow-bellied Racers are to be listed as vulnerable in Saskatchewan's Wild Species at Risk Regulations (Jeanette Pepper, pers. comm.)

Several suitable areas of *C. c. mormon* habitat are within protected areas. These include Okanagan Mountain Provincial Park, Throne Ecological Reserve, White Lake Protected Area, Kobau Provincial Park, Churn Creek Protected Area, and other areas managed by the Nature Trust of BC (Sarell 2003). Some habitat is protected within Ecological Reserves under the Wildlife Act (1982) (Shewchuk and Waye 1995). However, these areas are small and disconnected from each other and few contain both the summer and winter habitats required to sustain populations (Cannings *et al.* 1999). The majority of the suitable habitat is located in areas that have development potential (valley bottoms) and is not protected.

BIOLOGY

Reproduction

More research is needed to gain even a basic understanding of the reproductive biology of Racers, particularly of *C. c. flaviventris* in Saskatchewan. Data are lacking because most Racers are caught at dens in the early spring before the females would have enlarged follicles.

A possible indication of sexual maturity is the size at which the juvenile pattern is lost. However, Minton (1972) found that a female 120 cm in length still displayed the blotched pattern of a juvenile. Campbell observed one 76 cm male and one 99 cm male (a road-kill), both of which were blue without the juvenile markings (Campbell and Perrin, 1991). Fitch (1963: 365) considered female *C. c. flaviventris* in Kansas to be mature at 2-3-years-of-age. This is similar to Rosen's review (1991), which reported females reaching sexual maturity at 3 years of age in Utah, 2-3 years in Kansas and 2 years in

Michigan. In British Columbia, female *C. c. mormon* are suspected to mature at 3-4 years (Macartney, unpublished observations as cited in Campbell and Perrin, 1991). The smallest female with enlarged follicles or eggs palpable in the abdomen was 57 cm SVL (Shewchuk and Waye 1995). Fifteen females, caught in early June, had eggs palpable in their abdomen, and body size ranged from 61 to 83 cm (Macartney, unpublished data as cited in Campbell and Perrin, 1991). Male *C. c. mormon* may mature as young as 13.5 months, or at 39 cm SVL, and may be reproductive in their first season (Brown and Parker 1984). Mature male *C. c. mormon* carry sperm year round and likely mate annually (Brown and Parker 1984). Some mature *C. c. flaviventris* females, however, may not reproduce yearly (Fitch 1963: 414, 449). The frequency of reproduction of *C. c. mormon* can be either annual or biennial, depending on body condition, mainly fat reserves (Shewchuk and Waye 1995). In years of drought, egg production is radically reduced in southern populations (Brown and Parker 1984).

There is a tendency for clutches of Racers to be larger towards the northern and eastern limits of the species' range. The number of eggs in a clutch is generally proportional to the size of the female, and Racers tend to be larger in the north and in the east. The mean clutch size is about 6 eggs in Utah, 12 eggs in Kansas, and 15 in Michigan (Rosen 1991). Two-year-old *C. c. flaviventris* in Kansas produced clutches of 5-20 eggs with an average of 9.2 eggs (Fitch 1963: 421). *Coluber constrictor mormon* in British Columbia generally lays 3-7 eggs (Sarell 2003). Nussbaum *et al.* (1983: 263) gave 3-6 eggs as the clutch size for *C. c. mormon* in Idaho. Macartney recorded the mean clutch size of Racers in British Columbia, based on palpation, as 6.3 eggs with a range of 4-12 (Macartney, unpublished data as cited in Campbell and Perrin, 1991).

Once laid, eggs can double in mass before hatching by absorbing moisture from the surrounding soil (Fitch 1963). Eggs of *C. c. mormon* are 24-39 mm in length and 14-21 mm in width, and at hatching the young are 205 to 305 mm in length (Gregory and Campbell 1984). Nussbaum *et al.* (1983) gave the egg size as 30-42 mm by 19-21 mm, a hatchling's total length as 215-220 mm, and its weight as 4-5 g. In Saskatchewan, the only *C. c. flaviventris* neonate found in the field was 230 mm SVL (snout-vent length; Macartney, unpublished data as cited in Campbell and Perrin, 1991). In British Columbia, the mean size of *C. c. mormon* neonates found in September/October was 22.6 cm SVL, and the range was 21.5-24.5 cm SVL, for 12 individuals (Macartney, unpublished data as cited in Campbell and Perrin, 1991). Shewchuk and Waye (1995) recorded the average mass of *C. c. mormon* neonates as 5.3 g for females (24 cm mean length), and 5.0 g for males (23 cm mean length).

Several male *C. c. flaviventris* may simultaneously court and mate the same female (Fitch 1963: 409-11). The trailing movements by males and subsequent mating behaviour are described by Lillywhite (1985). In Kansas, *C. c. flaviventris* mate in spring (Fitch 1963: 414) and it is likely that Racers in Saskatchewan also mate after emerging from their dens in spring.

In British Columbia populations, *C. c. mormon* mate in May after emerging from their winter dens in late March to April (Sarell 2003). Mating generally occurs in their

summer range away from the den sites (Shewchuk and Waye 1995). Egg production is rapid and *C. c. mormon* will lay their eggs in June or July (Nussbaum *et al.* 1983, Sarell 2003). Depending on temperature, incubation lasts 40 days to 2 months after laying (Nussbaum *et al.* 1983, Sarell 2003).

In Saskatchewan, Fitch (1963: 445-449) found a balanced sex ratio of 1:1, for mature *C. c. flaviventris.* This ratio, however, varied with age. Percentages of males and females in the 5 year age class were 45% and 55%, respectively, but those of males and females 6-years-of-age and over were 38.7% and 61.3%, respectively. This may indicate that males are at greater risk than females, perhaps because they are more active. Macartney (unpublished data as cited in Campbell and Perrin, 1991) found a near 1:1 sex ratio of 7 males to 6 females.

Coluber constrictor mormon also had a sex ratio of near 1:1 (Shewchuk and Waye 1995), Macartney found 105 males to 110 females (unpublished data as cited in Campbell and Perrin, 1991). Sarell and Alcock (2000) also found an even sex ratio in 47 captures in Trail, British Columbia (19 males: 16 females). However, it is common in snake studies to obtain samples with a strongly biased sex ratio toward males in the spring and fall.

Survival

The survival of individual snakes is aided by the following factors: speed, excellent vision, large size of the adult, the semi-arboreal habits of adults, and the blotched coloration of young, which aids in camouflage. Egg and hatchling mortality are assumed to be high. Fitch (1963: 363) found very few young Racers during his extensive study of *C. c. flaviventris* in Kansas, perhaps because they are very secretive and exhibit cryptic coloration. Fitch (1963: 447) speculated that under ideal conditions in the wild, a population of approximately 100 adult *C. c. flaviventris* (presumably with a sex ratio of 1:1) could produce a minimum of 300 eggs, of which 50% could be lost before or during incubation. Of the expected 150 surviving hatchlings, at least one-third could be lost by the following spring, and of the 100 remaining young snakes another 50% could be lost by autumn. Fitch's studies indicate that mortality was responsible for the loss of 41.5% of the population in the 2-year-old age class. This decreased to 17.8% of the population in the 3-year-old age class. Studies by Brown and Parker (1974) on *C. c. mormon* also indicate that survival potential increases when snakes reach maturity. In general, young of the year and adult female snakes tend to experience high mortality during dispersal and during egg-laying migrations (Bonnet *et al.* 1999). Age distribution of *C. c. mormon* followed a normal distribution but with a slightly higher then expected number of young of the year, which may have been sampling bias (Shewchuk and Waye 1995). Survivorship data for Racers are particularly hard to obtain because juveniles do not always return to their parents' dens. In captivity, Racers generally live 15—30 years; however, Racers do not adapt well to captivity. In the wild, Racers live to at least 7-8 years (Fitch 1963). Further research is required to estimate age-specific survivorship patterns.

Competition, predators, and parasites

Fitch (1963:439-441) notes that Crows, Marsh Hawks, Kestrels and Broad-winged Hawks occasionally take Racers. Fitch (1963: 43) and Minton (1972: 268) noted cannibalism by adults on young Racers. In Saskatchewan, a Swainson's Hawk was observed killing a large Racer at a den in the spring. At the same den, the tail of another large Racer was found among the diggings of a mammal, either a coyote or a badger (Macartney, unpublished data as cited in Campbell and Perrin, 1991). In British Columbia, hawks, falcons, skunks, and badgers are suspected predators, based on circumstantial evidence (Macartney, unpublished data as cited in Campbell and Perrin, 1991).

Auffenberg (1955) noted that mites and their larvae ("chiggers") are prevalent parasites of *C. c. flaviventris*. However, no mites or ticks were seen on any British Columbia individuals (Macartney, unpublished data as cited in Campbell and Perrin, 1991).

Hibernation

Racers hibernate throughout winter. In British Columbia, *C. c. mormon* hibernates from November to March and emerges in late March or April (Sarell 2003). Hibernacula are used by solitary or communal individuals and Racers occasionally hibernate with other species of snake (Brown and Parker 1976, Macartney 1985, Charland 1989, Sarell 1993). Large densities of Racers in communal dens are rarely observed; however, Racers do not linger outside den sites, so their apparent low numbers may be an artefact of their behaviour. Racers generally return to their den site in September but will occasionally remain active into October or even as late as November (Hobbs and Sarell 2002, Shewchuk and Waye 1995). Snakes appear to return to the dens in response to the onset of colder nights when the temperature drops below 9 ^{o}C (Hobbs and Sarell 2002).

Movements/dispersal

Racers are diurnal snakes, with most daily activity occurring in the morning (Ernst and Barbour 1989). Racers are heat tolerant and have been observed moving around at >32 ^{o}C when other snakes are not active (Ernst and Barbour 1989). Racers move across the ground with raised heads. Racers are also excellent climbers and are often found basking on the lower branches of bushes (Gregory and Campbell 1984).

In British Columbia, Racers usually emerge from their dens in April but may emerge as early as March in warmer years (Shewchuk and Waye 1995). Racers do not linger at the den sites like other species but rather quickly disperse to their summer range (Shewchuk and Waye 1995). Radio telemetry studies by Brown and Parker (1974, 1976) conducted on *C. c. mormon* in 1971 and 1972 indicate maximum dispersal distances of 1.6 and 1.8 km from 2 den sites in Utah. Average dispersal distance from *C. c. mormon* denning sites was 781 m for males and 663 m for females (Brown and Parker 1976). Brown *et al.* (1995) and Brown and Parker (1976) also observed that *C. c. mormon* travel

up to 1.8 km from their dens to their summer habitat but their home range is generally within 1 km of den sites. Gravid females will travel more than 500 m to suitable egg-laying sites (Sarell 2003). Daily movements are generally only a short distance. Shewchuk and Waye (1995) found that daily movements are generally less than 200 m within their home ranges and may follow a circuit returning to a regular overnight roost. Brown and Parker (1976) found that the average daily movements were only 31.6 m.

Nutrition and interspecific interactions

The species name "*constrictor*" is a misnomer (Wilson 1978) as this species does not constrict its prey. Racers usually grab and swallow small prey alive, whereas larger prey may be restrained by using a loop of the body to pin it against the ground until manoeuvred into the mouth for swallowing. Racers actively seek out their prey.

Racers are foraging generalists, consuming mostly insects and small mammals. Studies of the diet of *C. c. flaviventris* by Fitch (1963) in Kansas, by Klimstra (1959) in Illinois and Iowa, where *C. c. flaviventris* and *C. c. foxii* meet, and by Pope (1944) in Illinois have demonstrated that insects are important as prey. Grasshoppers and other Orthoptera are favoured. Young *C. c. flaviventris* in Indiana also favour insects (Minton 1972: 268). Other food items include mice, young rabbits, voles, rats, chipmunks, moles, weasels, birds, birds' eggs, frogs and snakes. Racers in Kansas may occasionally eat gartersnakes, Brownsnakes (*Storeria dekayi*) and frogs (Fitch, 1963).

Shewchuk and Austin (2001) examined the stomach and faecal material of 323 *C. c. mormon* in the South Okanagan, British Columbia, and found that arthropods made up the bulk of their diet (91.5%) mostly from the family Orthoptera (Grasshoppers). Mammals made up only 7.5% and reptiles and amphibians were rarely observed (1%). Their study indicated that diets varied with SVL, with larger snakes ingesting more vertebrates and increasing their range of prey items. Orchard (1984) found that the stomachs of 37 *C. c. mormon* from British Columbia contained grasshoppers, crickets, caterpillars, Pacific Treefrogs (*Hyla regilla*), and voles. Gregory and Campbell (1984) listed frogs, lizards, other snakes, small mammals, birds, and insects as potential prey items, but remarked that small mammals and insects are probably the most important foods. McIntosh (1976) recorded a bat, the long-eared myotis*, Myotis evotis*, being swallowed by a *C. c. mormon* in British Columbia, and concluded that this was an example of opportunism in feeding by Racers.

Seasonal changes in diet likely reflect food availability, with mammals making up a higher proportion of *C. c. mormon* diet early in spring (see Klimstra 1959). Klenner suggested that changes in fire history could result in changes in small mammal abundance which in turn could influence snake populations (as cited in Shewchuk and Waye 1995).

Behaviour/adaptability

Racers are active and wary making them difficult to study in their natural environment. Small Racers tend to be more defensive than larger individuals (Campbell

and Perrin, 1991). Defensive behaviour usually includes vibration of the tail, gaping and hissing, and, under continued provocation, striking and lashing out with the tail (Campbell and Perrin, 1991). Racers are non-venomous and do not pose a threat to humans, although they may act aggressively and bite when cornered.

Racers evidently do not adapt well to urbanization. Neill (1950) failed to find any Racers in urban study plots in Georgia, even though these snakes are common in the state. Minton (1968) found Racers to be among the first snakes to disappear from suburban areas. In general, Racers do not do well in captivity and will often die of starvation and exhaustion from stresses (but see Kreba 1978).

POPULATION SIZES AND TRENDS

Eastern Yellow-bellied Racers were probably never widespread or abundant in Canada, and all verified records are from 7 locations in Saskatchewan. Prior to Kissner *et al.* (1996), who captured about 45 *C. c. flaviventris*, during her study on rattlesnakes, only a few scattered records were available for *C. c. flaviventris* all from southern Saskatchewan. During his 1990 survey in the Frenchman River Valley in Saskatchewan, Macartney (unpublished data as cited in Campbell and Perrin, 1991) found 1-4 Racers at 7 of the 9 documented snake hibernacula in the area. These were 1 neonate, 2 juveniles and 10 adults. Wayne Harris (pers. comm.) suggested that there have been declines in the Frenchman River Valley because no Racers had been seen for several years, and in the fall of 1990, communal snake dens in the area were devoid not only of Racers but also of the Prairie Rattlesnakes with which they had shared their dens. Harris suggested that there is increased mortality during severe winters in these dens. Regardless, we still do not have sufficient information to evaluate population trends reliably. Total number of adults is similarly unknown, but given that fewer than 100 adults have been captured and that the total area occupied is quite restricted, it seems that there are many fewer than 10,000 adults in Saskatchewan.

There have not been any comprehensive surveys of *C. c. mormon* in British Columbia and thus there are not enough data to estimate the population size accurately. Cannings *et al.* (1999) estimated the population at over 3000 individuals; however, there is no indication that these were mature individuals or how this number was derived. Brown (1973) estimated the population density of *C. c. mormon* to be 0.65/ha in Utah. Population density was lower in his later study at 0.32/ha suggesting a decline in the area (Brown and Parker 1984). Fitch (1963) estimated *C. c. flaviventris* population to be 0.45/ha to 1.1/ha in Kansas. In better habitat the density can reach up to 1.2 adults per ha. Shewchuk and Waye (1995) predicted that the population density in British Columbia is likely much lower. Racers appear to be more abundant in the South Okanagan where the habitat is better than in the peripheral populations (Shewchuk and Waye 1995). Of 215 Racers that were captured, marked and released in south-central British Columbia on four sites, only 11 were recaptured after periods of 1 month to 3 years (Macartney, unpublished data as cited in Campbell and Perrin, 1991). This suggests that only a small fraction of the Racer population was actually marked at any of the sites.

It is difficult to census snake populations accurately. However, it is generally accepted that British Columbia populations are declining because of extensive habitat loss throughout most of their range. Sarell (pers. comm.) commented that Racer numbers must be declining due to habitat loss and road mortality. Both habitat loss and road mortality also increasingly fragment populations within each of the five main locations of Racers in British Columbia. Furthermore, because Racers seem particularly sensitive to urban development (see previous section), population declines are especially likely to occur where rapid suburban expansion is occurring especially in the Okanagan.

The number of mature Western Yellow-bellied Racers in British Columbia is difficult to assess. It appears that they are seen much more often than the Great Basin Gophersnake and about equally often as the Western Rattlesnake (Jeff Brown, pers. comm. August 2004). Racers are more diurnal than these species and move about more so they could be seen relatively more easily than the other two species. Conversely, they are faster and smaller and could be less easily seen despite their more diurnal habits. Numbers of the more widely studied Western Rattlesnake have been estimated at less than 10,000 (Didiuk *et al*. 2004) and Gophersnake numbers have been estimated at less than 5,000 (Waye and Shewchuk 2002), so it is reasonable to estimate a similar number of Racers (5,000-10,000 mature snakes) given the similar distribution, common usage of hibernacula, and frequency of sightings.

LIMITING FACTORS AND THREATS

Both subspecies have experienced similar threats that are shared with other snake species in the areas that they inhabit. Critical habitats for Racers include suitable hibernacula, nesting sites and summer ranges that provide adequate shelter and food. Anthropogenic threats include habitat loss, direct destruction of denning sites, road mortality, contamination of food supply by pesticide application, mortality from farm machinery, and forest/grass fires. Although overwinter mortality is naturally high, the indirect effects of habitat loss can lead to higher overwinter mortality if suitable hibernacula are lost or if food supply is compromised. Additionally, Racers show a high degree of den site fidelity and may not be able to find a suitable replacement den for overwintering. Nesting sites are also vulnerable to disturbance.

Wright and Wright (1957: 140) suggest that annual burning of grasslands might be detrimental to populations of *C. c. flaviventris*. Recent forest fires in British Columbia may have serious effects on Racers, but in either case, no detrimental effects have been documented. Similarly, Racers often share their habitat with cattle, but negative effects of grazing have not been demonstrated. Racers have persisted on lands that have been grazed by cattle for many decades. There certainly has been habitat alteration due to overgrazing but the impact this may be having on Racers is unknown (Macartney, unpublished observations as cited in Campbell and Perrin, 1991). Increased use of pesticides in the south Okanagan region could affect insect populations and thus may reduce food availability for *C. c. mormon* (Shewchuk and

Waye 1995). The effect of ingesting insects that have been contaminated with pesticides should also be a concern. As well, many Racers are killed incidentally by farm machinery in rural and agricultural areas. Fitch (1963: 455) suggested that *C. c. flaviventris* in Kansas declined by 95% between 1911 and 1960 as a result of mechanized farming activities. Racer populations have declined markedly in rural Missouri since 1893 (Wright and Wright 1957: 140).

Direct human persecution of snakes has occurred throughout history, particularly for rattlesnakes. Juvenile Racers, with their blotched patterning superficially resemble a juvenile rattlesnake, and could be mistakenly killed. There are few reports of deliberate killing of Racers (e.g. Campbell and Perrin 1991), but such killings are unlikely to be reported or detected particularly in less populated areas. Road mortality is high for many snake species in certain areas of both the Okanagan and Similkameen valleys (Macartney, personal observations as cited in Campbell and Perrin, 1991). Road mortality is often higher for adult females during egg-laying migrations and for newly hatched young while they disperse (Bonnet *et al.* 1999). High mortality of sexually mature females is more significant than losses of males or neonates because the loss of reproductive females will be more likely to limit population growth. This constraint on population growth might be further exacerbated by late age of maturity in females (3 to 4 years) and biannual reproduction (for *C. c. flaviventris,* Fitch 1963). The latter is likely a factor in population decline in Canadian populations.

As noted earlier (Behaviour/adaptability), Racers do not survive in urban settings. Therefore, the rapid expansion of housing developments in the Okanagan Valley and other areas of interior British Columbia is a serious threat to the Racer's centre of distribution in the province and likely causes population declines and fragmentation.

SPECIAL SIGNIFICANCE OF THE SPECIES

The Racer, *Coluber constrictor*, is the only species in the genus, *Coluber*, Family Colubridae, in North America. All three Canadian subspecies are at the most northern extent of their range, where their populations are small and limited by habitat and constraints on reproduction. *Coluber c. flaviventris* and *C. c. mormon* occur in the mixed-grass prairie in Saskatchewan and in the Great Basin in British Columbia. Peripheral populations often have high conservation value because they can be genetically divergent from the southern/central populations (Lesica and Allendorf 1995). Both subspecies may show adaptive traits that are unique to Canada's colder climate. As predators of grasshoppers and other insects, Racers could dampen population increases of these insects. It is the fastest snake in Canada.

EXISTING PROTECTION OR OTHER STATUS

Coluber constrictor flaviventris is protected under the Saskatchewan Wildlife Act. Its legal status was changed in 1988 from the designation of "wildlife for which there is no

closed season" to "wildlife for which there is no open season". *Coluber constrictor flaviventris*' provincial heritage status rank is S3 – indicating that the subspecies is vulnerable to extirpation or extinction (NatureServe 2003). Federally, *C. c. flaviventris* was designated as a species of Special Concern (Vulnerable) by COSEWIC in April 1991. *Coluber constrictor flaviventris* is not protected under the Alberta Wildlife Act.

Coluber constrictor mormon is protected by the British Columbia Wildlife Act, which protects it from being killed, collected or held in captivity. *Coluber constrictor mormon* is listed as Identified Wildlife under the *Forest and Range Practices Act*, which can provide protection on Crown Lands. Because of its habitat requirements, *C. c. mormon* has a restricted range in British Columbia, being found only in the Okanagan, Thompson, Nicola, and middle Fraser drainages north to Churn Creek (Shewchuk and Waye 1995, CDC 2003). Thus, in British Columbia, *Coluber c. mormon* is 'Blue listed', because it is restricted to dry grassland which is currently under threat. Federally, *C. c. mormon* assessed as 'Not at Risk' in Canada (COSEWIC 1991) thus it is not currently protected under the Species at Risk Act (SARA). The provincial heritage status rank of *C. c. mormon* is S3S4 – indicating that the subspecies may be vulnerable to extirpation or extinction (NatureServe 2003).

Neither *C. c. flaviventris* nor *C. c. mormon* are listed as Threatened or Endangered in the United States of America, and thus are not protected under the US Endangered Species Act (USFWS 1999). The status of *C. c. mormon* is considered secure in Nevada, vulnerable in Colorado and critically imperilled in Texas. Other states do not list it except as *C. constrictor*. It is N5 in the US (Natureserve 2003). *Coluber constrictor* is also secure in the states that border Canada, Washington (S5), Idaho (S5), Montana (S5).

Globally the species is considered secure (G5; NatureServe 2003). The World Conservation Union Red List does not list *C. c. flaviventris* or *C. c. mormon* (IUCN 2003). CITES does not list any snakes from the Genus *Coluber* (UNEP-WCMC 2003).

SUMMARY OF STATUS REPORT

Coluber constrictor flaviventris is at risk in Canada for the following reasons:

1. The range of *C. c. flaviventris* is limited to only a small portion of the southern part of Saskatchewan.
2. Populations are likely very small and isolated from each other making them more vulnerable to demographic and environmental stochasticity and extirpation.
3. It is likely that the *C. c. flaviventris* has experienced range-wide declines due to loss of habitat. These declines have not been quantified nor documented due to a lack of monitoring and research.
4. The limited availability and the restrictive requirements of adequate hibernation sites make Racers particularly vulnerable to human activities. Also, *C. c. flaviventris* shares denning sites with rattlesnakes that have been the

targets of human persecution. Juvenile Racers may be mistaken for rattlesnakes because of their similar colouration and may also be persecuted.
5. Populations in Saskatchewan are likely continuous with populations in Montana. Future developments along this border might inhibit movement, if any occurs at present.
6. *The* provincial heritage status rank of *C. c. flaviventris* is S3 for Saskatchewan - indicating that the subspecies is rare or uncommon (NatureServe 2003). This subspecies has not been ranked in Alberta

Coluber constrictor mormon is at risk in Canada for the following reasons:

1. The limited availability and the restrictive requirements of adequate hibernation sites make Racers particularly vulnerable to human activities, especially because this snake does not persist in developed areas.
2. A significant amount of suitable Racer habitat has been lost, especially in the Okanagan Valley, where the core population is located.
3. At least one population, and likely 3 more, of the 5 known populations in British Columbia are fragmented, and isolated from any other populations. With small population sizes and habitat, these populations are susceptible to demographic and environmental stochasticity.
4. The main population is likely continuous with Racers in Washington State, but the northern (Thompson/Fraser) population has no rescue effect and 3 of the 4 southern populations have low potential for rescue effect.
5. Recruitment of *C. c. mormon* may be limited by road mortality, which most strongly affects dispersing juveniles and reproducing females during egg-laying migrations.
6. It is likely that the *C. c. mormon* has experienced range-wide declines due to loss of habitat but these declines have not been quantified or documented due to a lack of monitoring and research.
7. The Great Basin Gophersnake (*Pituophis catenifer deserticola*) and Western Rattlesnake (*Crotalus oreganus*) are sympatric with *C. c. mormon*, and occupy the same habitat and areas. Great Basin Gophersnakes and Western Rattlesnakes are both listed as Threatened by COSEWIC for reasons similar to those for which Racers would be listed, particularly declines in habitat quality and quantity that would lead to population declines. Racers have additional threats in that they do not survive where urban development occurs and that they probably are more exposed to the negative impacts of pesticide application and farm machinery. However, gophersnakes appear to be much less common than racers in British Columbia and resemble rattlesnakes whereas racers do not. Also, racers mature earlier and are more fecund than gophersnakes.
8. The provincial heritage status rank of *C. c. mormon* is S3S4 – S3 indicates rare or uncommon, may be susceptible to large-scale disturbances such as loss of peripheral populations. S4 indicates frequent to common, apparently secure but may have restricted distribution or there may be perceived future threats.

TECHNICAL SUMMARY

Coluber constrictor flaviventris
Eastern Yellow-bellied Racer — Couleuvre agile à ventre jaune de l'Est
Saskatchewan

Extent and Area information	
• *extent of occurrence (EO)(km²)*	~3,000 km^2
• *specify trend (decline, stable, increasing, unknown)*	Stable?
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)*	< 10 km^2 (area occupied by hibernacula)
• *specify trend (decline, stable, increasing, unknown)*	Declining
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No
• *number of extant locations*	5-7 in Saskatchewan
• *specify trend in # locations (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	No
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Declining
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	~ 7 years (female)
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	Unknown But likely <<10,000
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Probably declining
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	unknown
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	No
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	unknown but may be fragmented between two small regions
• *list each population and the number of mature individuals in each*	2 populations # individuals unknown; 2 populations in SK (Big Muddy Lake and Val Marie). Or there could be 5-7 populations across these two regions
• *specify trend in number of populations (decline, stable, increasing, unknown)*	Unknown, decline likely in association with habitat loss
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No
Threats (actual or imminent threats to populations or habitats)	
- small populations confined to small number of hibernacula (~7 locations) - habitat loss – due to agricultural encroachment, cattle ranching - road mortality - direct human persecution, destruction of dens (little direct evidence of this threat)	

Rescue Effect (immigration from an outside source)	Moderate
• *does species exist elsewhere (in Canada or outside)?*	Yes in Montana, USA
• *status of the outside population(s)?*	stable
• *is immigration known or possible?*	Possible
• *would immigrants be adapted to survive here?*	Probably
• *is there sufficient habitat for immigrants here?*	Unknown
Quantitative Analysis	No

Status and Reasons for Designation

Status: Threatened	**Alpha-numeric code:** Met criteria for Endangered, B1ab(iii)+2ab(iii), but designated Threatened, B1ab(iii)+2ab(iii), because a large part of the subspecies' habitat is in Grasslands National Park, and there is rescue potential from the state of Montana.

Reasons for Designation:
This snake is restricted to two small areas in extreme southern Saskatchewan. It is at risk due to loss of habitat from agriculture, mortality on roads, loss of den sites and perhaps from effects of small population size. There may be a rescue effect from immigration from the United States, but this effect has not been observed.

Applicability of Criteria

Criterion A (Declining Total Population): Not applicable as percent decline is unknown.

Criterion B (Small Distribution, and Decline or Fluctuation): Endangered B1 (EO < 5,000 km^2) 2(AO < 500 km^2) a(< 5 locations) b(decline inferred from loss of habitat) iii.

Criterion C (Small Total Population Size and Decline): Not applicable, total population unknown, though very likely fewer than 10,000 adults.

Criterion D (Very Small Population or Restricted Distribution): Not applicable.

Criterion E (Quantitative Analysis): Not applicable.

TECHNICAL SUMMARY

Coluber constrictor mormon
Western Yellow-bellied Racer — Couleuvre agile à ventre jaune de l'Ouest
British Columbia

Extent and Area information	
• *extent of occurrence (EO)(km²)*	~ 8300
• *specify trend (decline, stable, increasing, unknown)*	Probably declining
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	no
• *area of occupancy (AO) (km²)*	<210 km^2 if only hibernacula are considered
• *specify trend (decline, stable, increasing, unknown)*	Declining
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	no
• *number of extant locations (considering each valley a location)*	204 or unknown or 5 if each valley were considered a population
• *specify trend in # locations (decline, stable, increasing, unknown)*	decline
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	no
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Declining in extent and quality of habitat
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	~ 7 years (female)
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	Unknown (likely fewer than 10,000)
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Declining
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	unknown
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	no
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	1 northern population isolated, 4 southern populations fragmented from each other (3 are small Trail, Grand Forks and Midway). There are 20+ locations in these valleys but degree of fragmentation is unknown
• *list each population and the number of mature individuals in each*	5 "populations" # individuals unknown Trail (small), Grand Forks (small), Midway (small), Okanagan/Similkameen (largest), Thompson/Fraser. The two larger populations are likely fragmented to some degree by development and habitat degradation

• *specify trend in number of populations (decline, stable, increasing, unknown)*	Declining?
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	no
Threats (actual or imminent threats to populations or habitats)	
- habitat loss – urban and agricultural encroachment and accompanying expansion of road system - road mortality - risk of pesticide accumulation, effects of direct spray, contaminated insect prey - incidental mortality due to automated farm equipment, farm machinery, hay balers - direct human persecution	
Rescue Effect (immigration from an outside source)	Moderate
• *does species exist elsewhere (in Canada or outside)?*	Yes in US
• *status of the outside population(s)?*	Stable
• *is immigration known or possible?*	possible
• *would immigrants be adapted to survive here?*	probably
• *is there sufficient habitat for immigrants here?*	Unknown
Quantitative Analysis	**no**

*1 Based on GIS data provided by Hobbs and Sarell, calculations by Jared Hobbs.

*2 Based on the number of hibernacula and known sites.

Status and Reasons for Designation

Status: Special Concern	**Alpha-numeric code:** not applicable

Reasons for Designation:
This snake occurs in five valleys in south-central British Columbia. It is susceptible to habitat loss and fragmentation from agriculture and urban development, especially as this species is particularly intolerant of urbanization. The ongoing expansion of the road network and traffic volumes increases mortality and further fragments the habitat. Pesticide applications in agricultural areas may impact the snakes both directly and via contamination of their insect prey. It is unlikely that there is a significant rescue effect because of extensive loss of habitat contiguous to the United States border.

Applicability of Criteria

Criterion A (Declining Total Population): Not applicable because no data on size of decline.

Criterion B (Small Distribution, and Decline or Fluctuation): Not applicable because there are more than 10 locations and there is not severe fragmentation.

Criterion C (Small Total Population Size and Decline): Not applicable because total numbers may exceed 10,000 adults and populations are not severely fragmented.

Criterion D (Very Small Population or Restricted Distribution): Not applicable as there are > 1000 mature individuals.

Criterion E (Quantitative Analysis): Not applicable.

*1 Based on GIS data provided by Hobbs and Sarell, calculations by Jared Hobbs.

*2 Based on the number of hibernacula and known sites.

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