COSEWIC
Assessment and Status Report

on the

Bullsnake
Pituophis catenifer sayi

in Canada

SPECIAL CONCERN
2017

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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Previous report(s):

COSEWIC 2002. COSEWIC assessment and status report on the Gophersnake *Pituophis catenifer* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 33 pp.

Waye, H., and C. Shewchuk. 2002. COSEWIC status report on the Gophersnake *Pituophis catenifer* in Canada *in* COSEWIC assessment and status report on the Gophersnake *Pituophis catenifer* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-33 pp.

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Bullsnake (*Pituophis catenifer sayi*); photo by Jonathan Wright

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COSEWIC
Assessment Summary

Assessment Summary – April 2017

Common name
Bullsnake

Scientific name
Pituophis catenifer sayi

Status
Special Concern

Reason for designation
Like other large snakes, this species is affected by habitat loss and roadkill and may become Threatened if threats are not mitigated. The species relies on communal wintering dens, which may be scarce on the landscape. Although the severity of threats across the species' range is not fully understood, the impact of those threats is potentially significant. The species is especially vulnerable to increased mortality because of its low abundance, late maturity, and low rate of productivity.

Occurrence
Alberta, Saskatchewan

Status history
Species considered in May 2002 and placed in the Data Deficient category. Status re-examined and designated Special Concern in April 2017.

COSEWIC
Executive Summary

Bullsnake
Pituophis catenifer sayi

Wildlife Species Description and Significance

Bullsnake is one of three subspecies of gophersnakes in Canada. It is one of the largest species of snake in Canada, occasionally exceeding 2 m in length, and it has inspired countless reptile enthusiasts. Adults are yellowish with black, brown, or reddish-brown blotches on their dorsal and lateral scales. Distinguishing features include a narrow scale at the tip of the snout that is raised above the nearby scales, a dark line that crosses the head in front of the eyes, a dark band from the eye to the angle of the jaw, and a dark vertical spot below the eye. Bullsnake is non-venomous.

Distribution

Bullsnake's range in North America extends from Alberta and Saskatchewan in the north, through central United States to northeastern Mexico in the south. In Alberta, Bullsnake occurs from north and west of Drumheller along the Red Deer River coulee system, distributed mainly in the mixed grassland region in the Lower Red Deer, South Saskatchewan, and Milk river valleys. In Saskatchewan, the Bullsnake's range extends east to the Big Muddy Valley and north to the South Saskatchewan River.

Habitat

In Canada, Bullsnake occurs in short- and mixed-grass prairie, commonly in association with brushy and sandy areas and around badlands along major river valleys. The snakes often use mammal burrows for foraging, protection from predators, moulting of the skin, temperature regulation, and as hibernation sites. Bullsnakes hibernate communally, often with other snake species, in mammal burrows, slump blocks, meander scarps and fissures, sinkholes, and rocky outcrops on slopes with warm exposure. For nesting, female Bullsnakes excavate burrows or modify existing mammal burrows in sandy or friable soils on south-facing bluffs within the coulees and gorges of river valleys.

Biology

Mating generally occurs in May, soon after the snakes emerge from hibernation. Females may reproduce annually or every other year, laying an average of 16 eggs in June or July, with hatchlings emerging from mid-August to mid-September. The age at sexual maturity is unknown; however, the closely related Great Basin Gophersnake probably does not reproduce until four years of age. Generation time for Bullsnakes in Canada is probably approximately eight years. Bullsnakes are active during the day, foraging mainly on small mammals. They are adept climbers and will also eat birds and bird eggs.

Population Sizes and Trends

Insufficient data exist to document abundance or population trends. Declines from historical levels are inferred from road mortality and habitat loss. Habitat in the grassland regions has been lost and degraded throughout the range of the Bullsnake in Alberta and Saskatchewan. However, the snakes appear to persist across their wide Canadian range.

Threats and Limiting Factors

Threats to the Bullsnake include road mortality, certain types of agricultural practices and overgrazing, and alteration of prairie habitat from oil and gas drilling. The impact of these threats on Bullsnakes overall is considered to be low. Additional threats determined to have overall negligible, but potentially important local impacts on Bullsnakes include the following: persecution; human disturbance in the form of recreational and military activities; natural system modifications such as wildfires; residential and commercial development; and pollution, specifically from rodent control measures. Potential threats with unknown impacts on Bullsnake include landslides (slumping) and habitat alteration by invasive plants.

Protection, Status and Ranks

Globally, NatureServe lists the Bullsnake as secure (G5T5), with subnational rankings of S3 (vulnerable) for Alberta and S4 (apparently secure) for Saskatchewan. In Alberta, Bullsnake is designated as a sensitive species by Alberta Environment and Parks, with the population described as stable or possibly declining. Bullsnakes are afforded general protection as native wildlife under the Alberta and Saskatchewan wildlife acts; hibernation sites are seasonally protected under the provincial *Wildlife Act* in Alberta. In national and provincial parks, the species and its habitats are protected under the *Canada National Parks Act*, *The Provincial Parks Act* (Alberta), and *The Parks Act* (Saskatchewan).

TECHNICAL SUMMARY

Pituophis catenifer sayi

Bullsnake

Couleuvre gaufre de Say

Range of occurrence in Canada: Alberta, Saskatchewan

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	ca. 8 yrs See **Life Cycle and Reproduction** for description of generation time used.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred from habitat trends and threats
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. no b yes, partly c. no
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	119,005 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	All Records: 952 km² Only records from 1990 to 2015: 900 km². Only records from 2001 to 2015: 820 km²

Is the population "severely fragmented" ie. is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. probably not b. unknown; some clusters of occurrences, especially in Saskatchewan, are widely separated and appear to be isolated
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Probably >>10 based on road mortality as the most plausible threat
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown; IAO calculations since 1990 and 2001 show a declining trend, but it could not be ascertained whether this trend reflects shifts in the distribution of search effort or an actual decline.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred decline; quality of habitat has decreased largely because of modifications to road network (e.g., new roads and increases in traffic volumes)
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals (see Abundance section)**
	Subpopulation structure is unknown
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Analysis not completed due to lack of data

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

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

i. Transportation and Service Corridors (impact low)
ii. Agriculture
iii. Energy Production and Mining

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

Yes, on March 9, 2016

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	*Status of outside population(s)?* **USA:** Unknown NatureServe Rank for *Pituophis catenifer* in Montana: S5
Is immigration known or possible?	Possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Unknown
Are conditions deteriorating in Canada?[+]	Possibly
Are conditions for the source population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	Possible, but it would be slow and limited to the southern extremity of the Canadian range

Data Sensitive Species

Is this a data sensitive species? No (only the locations of hibernation sites are sensitive)

Status History

COSEWIC:
Species considered in May 2002 and placed in the Data Deficient category. Status re-examined and designated Special Concern in April 2017.

Status and Reasons for Designation:

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

Reasons for designation:
Like other large snakes, this species is affected by habitat loss and roadkill and may become Threatened if threats are not mitigated. The species relies on communal wintering dens, which may be scarce on the landscape. Although the severity of threats across the species' range is not fully understood, the impact of those threats is potentially significant. The species is especially vulnerable to increased mortality because of its low abundance, late maturity, and low rate of productivity.

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

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Does not meet criteria; the magnitude of decline is unknown.
Criterion B (Small Distribution Range and Decline or Fluctuation): Does not meet criteria; although IAO is below the threshold value for threatened, only one sub-criterion is met (biii; decline in habitat quality or quantity); the population is unlikely to be severely fragmented, there are >10 locations, and extreme fluctuations do not apply.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable; population size and subpopulation structure are unknown.
Criterion D (Very Small or Restricted Population): Does not meet criteria; the population is neither very small not restricted.
Criterion E (Quantitative Analysis): Not applicable; PVA not done due to lack of data

PREFACE

The previous COSEWIC status report (Waye and Shewchuk 2002) included three subspecies of *P. catenifer*: *P. c. deserticola* (Great Basin Gophersnake), *P. c. catenifer* (Pacific Gophersnake), and *P. c. sayi* (Bullsnake). This update status report addresses one of these subspecies, *P. c. sayi*, whereas *P. c. deserticola* was addressed in COSEWIC (2013; assessed as threatened) and *P. c. catenifer* in COSEWIC (2012; assessed as extirpated).

The Bullsnake was previously assessed as "data deficient". While new information has been obtained over the past ten years, significant data gaps remain pertaining to population size, subpopulation structure, population and habitat trends, and significance of threats, especially from road mortality but also from oil and gas development. In addition, the distribution of the species in a large part of the range remains poorly documented.

New information since the 2002 report includes the following: literature review and mailed request for observations of the species in Alberta (Kissner and Nicholson 2003); detailed documentation of a communal nesting area in Alberta over five years (Wright 2008); study of road mortality patterns in and around Dinosaur Provincial Park, Alberta (Martinson 2009); and a series of studies and publications on populations in and around Grasslands National Park, Saskatchewan (Martino 2010; Gardiner and Sonmor 2011; Gardiner 2012; Fortney *et al.* 2012; Martino *et al.* 2012; Gardiner *et al.* 2013). A study of habitat and space use in Bullsnakes at the northern limits of the species' range in Saskatchewan (Edkins *et al*. 2016) is ongoing. The above information was deemed sufficient to warrant a new assessment.

No Aboriginal Traditional Knowledge was accessible at the time of the preparation of this report (Jones pers. comm. 2015).

COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS
(2017)

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

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

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

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

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

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

COSEWIC Status Report

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Bullsnake

Pituophis catenifer sayi

in Canada

2017

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Bullsnake (couleuvre à nez mince) *Pituophis catenifer sayi* (Schlegel 1837; Crother 2012) is one of three subspecies of gophersnakes in Canada. Great Basin Gophersnake (*P. c. deserticola*) occurs in southern British Columbia, whereas Pacific Gophersnake (*P. c. catenifer*) on the southern coast and Gulf Islands of British Columbia is now considered extirpated (COSEWIC 2002, 2012). All three were formerly classified as subspecies of the Pinesnake (*P. melanoleucus*), but currently the western and central North American populations of *Pituophis* are considered to be *P. catenifer* and eastern populations are *P. melanoleucus* (Crother 2012).

The classification of Bullsnake is as follows:
Class: Reptilia
Order: Squamata
Family: Colubridae
Genus: *Pituophis*
Species: *P. catenifer*
Subspecies: *P. c. sayi*

Morphological Description

Bullsnake is one of the largest species of snake in Canada and can exceed 2 m in length (Powell *et al.* 2016). Adult males are generally larger than females (Kapfer 2009). Adults are yellowish, with black, brown, or reddish-brown blotches on their dorsal and lateral scales. The ventral scales are yellow or yellow-white with brown to black spots (Waye and Shewchuk 2002). The dorsal scales are keeled (Conant and Collins 1998). Other distinguishing features include a narrow rostral scale raised above the nearby scales, a dark line that crosses the head in front of the eyes, a dark band from the eye to the angle of the jaw, and a dark vertical spot below the eye (Conant and Collins 1998; Waye and Shewchuk 2002).

Population Spatial Structure and Variability

Given the large spatial extent of Bullsnake's geographic distribution in Canada, as well as the large distances between some of the documented occurrences in Saskatchewan (e.g., distances between occurrences in the Big Muddy, Frenchman, and South Saskatchewan river valleys appear to be separated by 10s of km), it seems likely that there are numerous disjunct subpopulations.

Genetic analyses of microsatellite DNA loci from over 100 Bullsnakes in Saskatchewan strongly support the existence of genetically discrete subpopulations corresponding to the Big Muddy, Frenchman, and South Saskatchewan river valleys (Somers pers. comm. 2016). Dispersal and gene flow among subpopulations in the valleys is likely negligible. The subpopulation in the South Saskatchewan River Valley is highly differentiated from the other two. Finer-scale subdivision within river valleys may occur based on den sites, but cannot be resolved with existing data. Genetic analyses from Alberta populations have not been conducted.

Designatable Units

Bullsnake's geographic range in Canada occurs within the Prairie/Western Boreal faunal province as per the boundaries developed for COSEWIC in 2003 for terrestrial amphibians and reptiles. Although there is evidence of genetically discrete subpopulations, it is currently unknown whether the level of genetic differentiation has been sufficient to generate local adaptations that would warrant multiple designatable units. A single designatable unit is therefore recognized.

Special Significance

Bullsnake is one of the largest snakes in Canada and as such has inspired countless reptile enthusiasts. The northern extent of the species' distribution in Alberta is at the highest latitude of any egg-laying snake in Canada. Bullsnake may also be economically important given that its primary prey is small mammals, and some of the species that it preys upon cause damage to agricultural crops (COSEWIC 2002). Some landowners in Alberta relocate snakes to areas of high squirrel and pocket gopher activity as a means of pest control (Kissner and Nicholson 2003). Additionally, some landowners in Saskatchewan protect Bullsnakes found on their lands because of the perceived benefit of reducing rodent populations (Edkins pers. comm. 2016).

DISTRIBUTION

Global Range

Bullsnake's distribution extends from Alberta and Saskatchewan in the northwest, through Montana, North Dakota, Wyoming, South Dakota, Minnesota, Wisconsin, Illinois, Iowa, Nebraska, Colorado, Kansas, Missouri, Oklahoma, New Mexico, and Texas, and into northeastern Mexico: Coahuila, Nuevo León, and Tamaulipas (Figure 1).

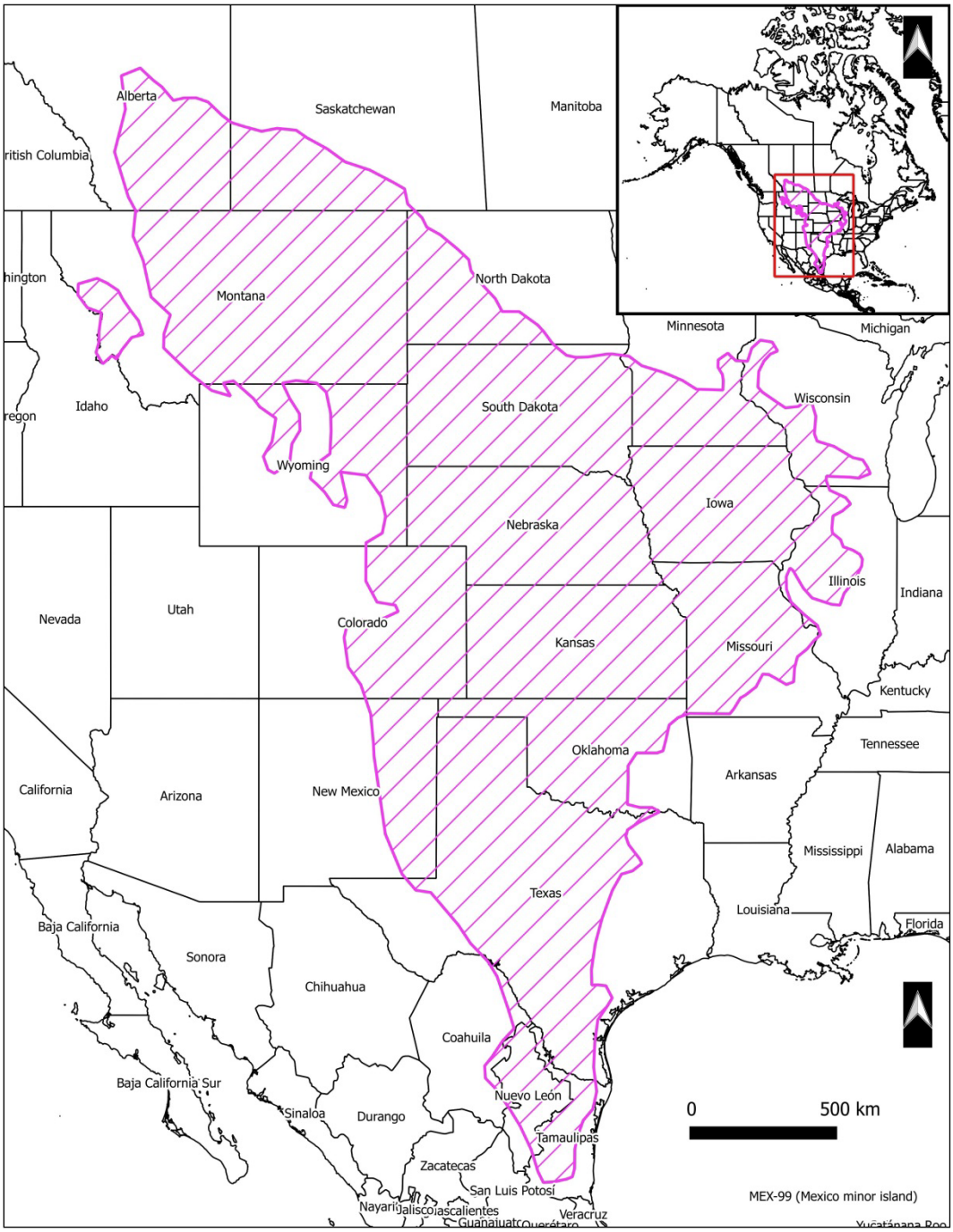

Figure 1. North American range of Bullsnake (*Pituophis catenifer sayi*). Adapted from Conant and Collins (1998) and Kissner and Nicholson (2003).

Canadian Range

In Canada, Bullsnake occurs in Alberta and Saskatchewan, where it exists at the northern extent of its global range (Figure 2). The northwestern extent of Bullsnake's range in Alberta occurs just north and west of Drumheller along the Red Deer River coulee system (Wright 2008). From Drumheller the range extends south to Montana and east to Saskatchewan. Within Alberta, Bullsnake mostly occurs in the mixed grassland region, in the lower Red Deer, South Saskatchewan, and Milk river valleys. In Saskatchewan, Bullsnake's range extends from the Alberta border to the Big Muddy Valley and north to the South Saskatchewan River.

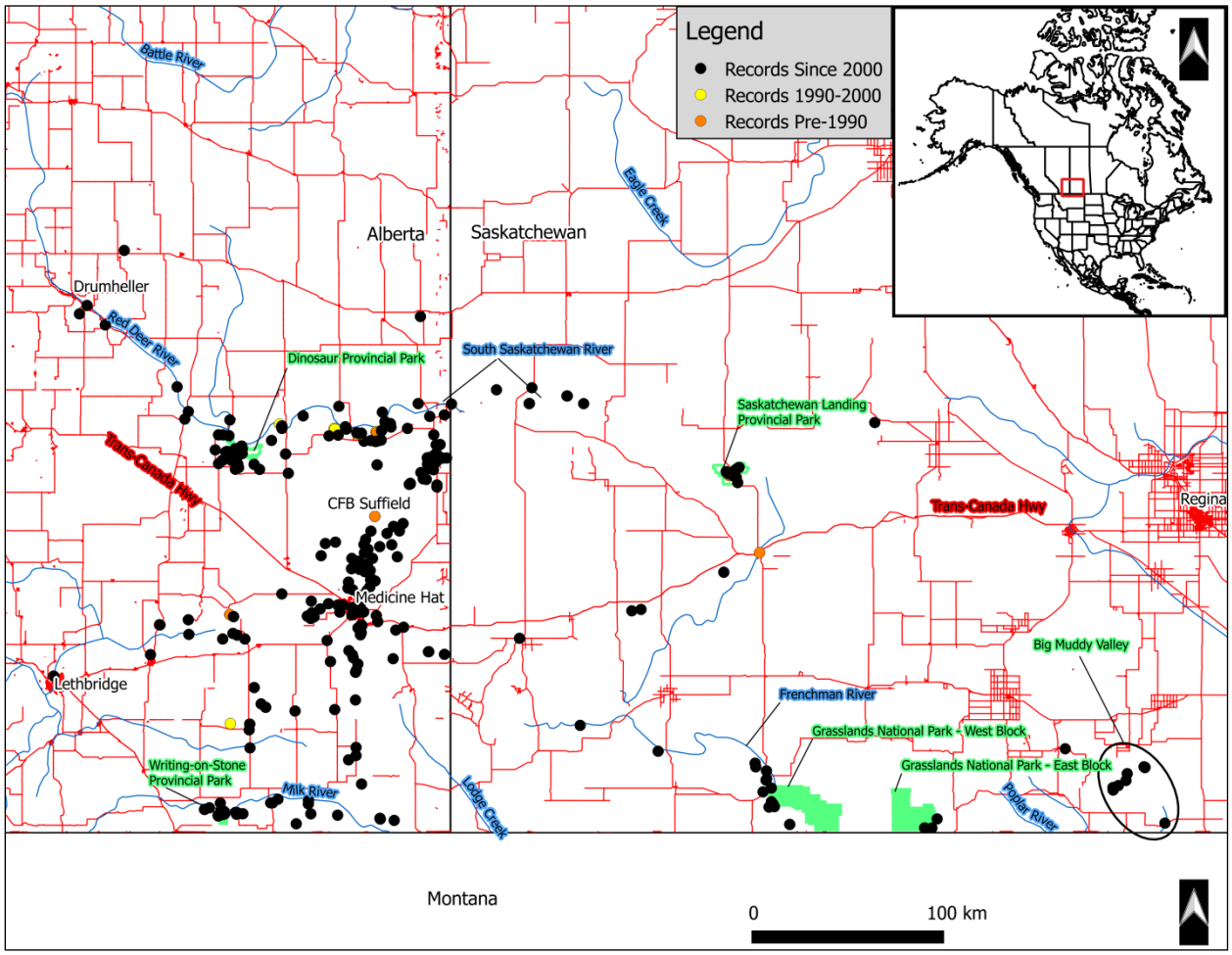

Figure 2. Occurrence records for Bullsnake (*Pituophis catenifer sayi*) in Alberta and Saskatchewan. Records obtained from Conservation Data Centres in Alberta and Saskatchewan and from Poulin (pers. comm. 2016). Green polygons illustrate National and Provincial parks where Bullsnakes occur.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) of Bullsnake in Canada is estimated to be 119 005 km^2 (Appendix 1) The value of the EOO is similar when historical records (i.e., prior to 1990) are removed from the calculation, suggesting that the species continues to persist across its known range. The index of area of occupancy (IAO) was calculated by superimposing a grid of 2x2 km squares over the occurrence records in Alberta and Saskatchewan (Appendices 2, 3). The calculated value based on all compiled records was 952 km^2. When only occurrence records from 1990 to 2015 were included, the IAO value was 900 km^2 (5.5% decline). When the dataset was further restricted to occurrence records from 2001 to 2015, the period after the previous COSEWIC report on the species, the IAO value was 820 km^2 (13.9% decline). It is assumed that newly discovered occurrences represent existing undocumented occurrences rather than range expansion. The calculated change in IAO could be an artefact of the distribution of recent search effort, which has not been systematic across the species' range.

Search Effort

Early surveys for Bullsnakes in Alberta were conducted by Cottonwood Consultants Ltd. (1986, 1987; cited in COSEWIC 2002), Didiuk at Suffield National Wildlife Area (Didiuk 1999), and Alberta Environmental Protection (1996, 1998; cited in COSEWIC 2002). Most search effort for Bullsnakes has focused on hibernacula, but Wright (2008) also monitored nesting areas in the Drumheller region from 1998 to 2002. In 2003, Kissner and Nicholson (2003) acquired Bullsnake records in Alberta by examining observation databases and the literature, as well as soliciting records from museums and individuals potentially having relevant information. In 2008, road surveys and drift-fence surveys were conducted in and around Dinosaur Provincial Park (Martinson 2009).

Search effort in Saskatchewan has largely focused on the west block of Grasslands National Park and surrounding area, which includes the Frenchman River Valley (Martino 2010; Gardiner and Sonmor 2011; Gardiner 2012; Martino *et al.* 2012; Fortney *et al.* 2012; Gardiner *et al.* 2013). Efforts have included road surveys and hibernacula surveys, as well as radio-telemetry studies, which have often led to records of new occurrences. Additional studies are being conducted (2016, ongoing) in the Big Muddy Valley and South Saskatchewan River Valley (in Saskatchewan Landing Provincial Park) (Figure 2) by Somers, Poulin, and Edkins using similar methods (Gardiner pers. comm. 2016). Many of the distribution records obtained from museums are the result of incidental observations, and road-killed individuals are often found opportunistically or during informal surveys.

HABITAT

Habitat Requirements

At a landscape scale, Bullsnakes in Canada are found in short- and mixed-grass prairie, commonly in association with brushy and sandy areas and around badlands along major river valleys (Waye and Shewchuk 2002; Kissner and Nicholson 2003). Although Bullsnakes may be found in farmland and fields in Alberta (Kissner and Nicholson 2003) and in Saskatchewan Landing Provincial Park (Edkins pers. comm. 2016), they were not found in crop fields or irrigated hay fields in the Saskatchewan River Valley (Martino *et al.* 2012). Bullsnakes were not found in mudflats or colonies of the Black-tailed Prairie Dog (*Cynomys ludovicianus*) at a study area in southern Saskatchewan (Martino *et al.* 2012); however, Bullsnakes are regularly documented in Black-tailed Prairie Dog colonies in other parts of their range (Shipley and Reading 2006). Martino *et al.* (2012) observed that Bullsnakes tended to be on or near slopes in their study area in southern Saskatchewan.

Hibernation Habitat

Hibernation habitat is critically important for snakes in Alberta and Saskatchewan, where they occur at the northern limits of their geographic distribution. Both intra- and interspecific communal hibernacula have been documented in Canada, with Bullsnakes hibernating with Prairie Rattlesnakes (*Crotalus viridis*), Eastern Yellow-bellied Racers (*Coluber constrictor flaviventris*), Plains Gartersnakes (*Thamnophis radix*), Wandering Gartersnakes (*Thamnophis elegans vagrans*), and occasionally with Plains Hog-nosed Snakes (*Heterodon nasicus*), and Red-sided Gartersnakes (*Thamnophis sirtalis parietalis*) (Didiuk 1999; Waye and Shewchuk 2002; Kissner and Nicholson 2003; Gardiner 2012; Martino *et al.* 2012; Gardiner *et al.* 2013).

In Alberta, hibernacula have been found in stable slump blocks, meander scarps and fissures, sinkholes, rocky outcrops, and mammal burrows (Didiuk 1999; Waye and Shewchuk 2002; Kissner and Nicholson 2003). These habitat features are usually associated with major river valleys, and many hibernacula have been located along the breaks and coulees of the South Saskatchewan, Red Deer, Bow, Oldman, and Milk rivers (Kissner and Nicholson 2003). The aspect of most of the slopes with Bullsnake hibernacula is south, east, and southeast; however, sites on southwest facing slopes have also been occasionally documented (Kissner and Nicholson 2003).

In Saskatchewan, most hibernacula have been located in unstable slump zones along the slopes of river valleys (e.g., Frenchman River Valley; Gardiner and Sonmor 2011; Martino *et al.* 2012; Gardiner *et al.* 2013). Unstable slopes are subject to landslides that create terraces containing slight depressions or sinkholes, fissures, or small faults; the loosely packed soil in these areas attracts burrowing mammals (Gardiner and Sonmor 2011). Hibernacula within these areas most often consisted of large burrow systems that were occasionally shared with mammals such as the Mountain Cottontail (*Sylvilagus nuttallii*) (Martino *et al.* 2012). In the Big Muddy Valley, Bullsnakes were documented hibernating in large rock formations in the valley, and in Saskatchewan Landing Provincial

Park hibernacula were found within hillsides where mammal burrows were prevalent (Edkins pers. comm. 2016).

It is unknown whether neonatal (first year) and immature Bullsnakes use the same hibernacula as adults. Didiuk (pers. comm. in Kissner and Nicholson 2003) rarely encountered these age classes at hibernacula.

Nesting Habitat

Eggs are typically laid in sandy or friable soils where females are able to excavate burrows either by creating their own holes (Wright 2008) or by modifying the burrows of other animals (Kissner and Nicholson 2003; Wright 2008). In Alberta, most Bullsnake nests have been located on south-facing bluffs within the coulees and gorges of river valleys (e.g., South Saskatchewan and Red Deer rivers; Kissner and Nicholson 2003; Wright 2008). As is typical for most nesting habitat of snakes at northern latitudes, solar exposure at the sites is high (i.e., minimal canopy cover).

Communal nesting appears to be common, and Wright (2008) documented a minimum of 15 females using nesting sites within a 190 x 90 m bluff over 5 years in Alberta. Several nesting sites were located within this bluff, and females showed annual fidelity to the bluff and also to the specific nesting site, although not every year (i.e., females were documented using the same nest site in a series of consecutive years, but later selected a different nest site within the bluff; Wright 2008). A single nesting site may have several chambers containing eggs from different females (Wright 2008).

Other Types of Habitat (Shelter, Foraging, Mating, Movement)

In Saskatchewan, the mammal burrows that Bullsnakes used were often created and/or occupied by species that Bullsnakes prey upon (e.g., Richardson's Ground Squirrel, *Urocitellus richardsonii*; Sagebrush Vole, *Lemmiscus curtatus*; Meadow Vole, *Microtus pennsylvanicus*; Mountain Cottontail; Martino *et al.* 2012). At Suffield National Wildlife Area, Bullsnakes were often found in Northern Pocket Gopher (*Thomomys talpoides*) burrows (Didiuk 1999). Bullsnakes likely use mammal burrows for foraging as well as for shelter and protection from predators. As observed by Wright (2008) and Edkins (pers. comm. 2016), Bullsnakes often use burrows for ecdysis (moulting of the skin), which occurs several times during the active season. Sites used for ecdysis are often used by multiple Bullsnakes, as evidenced by the presence of multiple shed skins (Kissner and Nicholson 2003). Bullsnakes are also undoubtedly using these burrows and other subterranean cavities for thermoregulatory purposes; a temperature gradient varying with depth would be available in burrows, as well as higher thermal stability than at the surface. Given the number of functions of burrows and cavities for Bullsnakes, this type of habitat feature is undoubtedly important (Martino *et al.* 2012).

The distance between hibernacula and the habitat used by Bullsnakes for most of the active season varies with the area and individual (see **Dispersal and Migration**). It is unknown whether Bullsnakes move along or within specific features of the landscape (e.g.,

hedgerows, linear vegetation features) during long-distance movements; however, it seems unlikely that well-defined movement corridors are not present.

Habitat Trends

A general decline in habitat quality and quantity may be inferred from the availability and condition of native grassland within Bullsnake's range in Alberta and Saskatchewan, but no quantitative measures of habitat loss on the spatial and temporal scales relevant to status assessment (e.g., the past three Bullsnake generations) were available.

In Alberta, the prairie region covers approximately 24% (156,318 km^2) of the land base (ABMI 2016). According to most recent estimates, 63.1% of prairie landscapes have been altered by agriculture, industry, and urbanization (ABMI 2016). Agriculture is responsible for the largest human footprint (55.2%), followed by transportation corridors (2.7%), energy development (2.5%), and urban, rural, and industries (2.3%). The human footprint on grasslands continues to increase, with a proportionally large increase within lands considered high value to biodiversity, i.e., relatively large and intact parcels of land. Human footprint on these high biodiversity value lands showed a 2.4% increase from 1999 to 2013, while the increase outside these areas was 1.6% within the same period (ABMI 2016). An assessment of land-use change in Alberta between 1971 and 2001, summarized by the Alberta NAWMP Partnership (2008), is shown in Figure 3 with Bullsnake's EOO and IAO overlaid. There was no obvious change in cultivated acres throughout most of Bullsnake's range in southeastern Alberta, whereas increases in cultivated acres were documented in the western portion of the range. Hay-land increased and natural land declined within Bullsnake's range in the grasslands and eastern parklands (Figure 3b,c; Alberta NAWMP Partnership 2008). Because of the greater than 50,000 km of highways, roads, and wellsite roads within the Grassland Natural Region of Alberta (Alberta Environmental Protection 1997), the quality of habitat for Bullsnakes has undoubtedly declined due to the negative impacts that roads have on snakes (e.g., intersecting habitats causing fragmentation and vehicle mortality; see **THREATS AND LIMITING FACTORS**). As of 2007, the footprint of human development within the Grassland Natural Region of Alberta was 57%, composed of cultivation and irrigation infrastructure (50%); residential, commercial, and energy infrastructure (4%), and transportation infrastructure (2%) (ABMI 2011). Within the Prairie Region of Alberta (which encompasses the Grassland Natural Region where Bullsnake is found, as well as the Parkland Region), the percent area covered by human footprint increased from 61.3% to 63.1% between 1999 and 2013 (ABMI 2016).

An assessment of land use change in Saskatchewan between 1971 and 2001, summarized by the Saskatchewan NAWMP Partnership (2008), is shown in Figure 4 with Bullsnake's EOO and IAO overlaid. As can be seen by examining the overlaid IAO grid squares in Figure 4a, tilled land increased in several areas where Bullsnakes occur; however, it decreased in other areas. Hayland increased throughout most of Bullsnake's range in Saskatchewan (Figure 4b), whereas natural land decreased in most of the counties where the grid squares occur (Figure 4c).

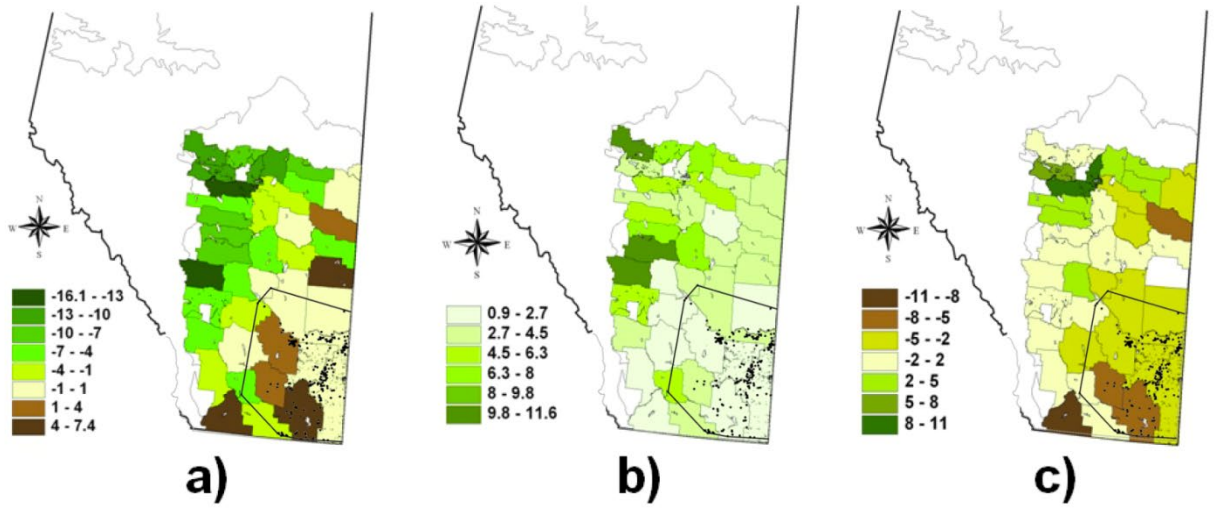

Figure 3. Percent of landscape change by county in a) cultivated acres, b) hayland, and c) natural land from 1971 to 2001 in southern Alberta. Extent of occurrence (dark line) and index of area of occupancy grid squares (black dots) for Bullsnake (*Pituophis catenifer sayi*).. Adapted from Alberta NAWMP Partnership (2008).

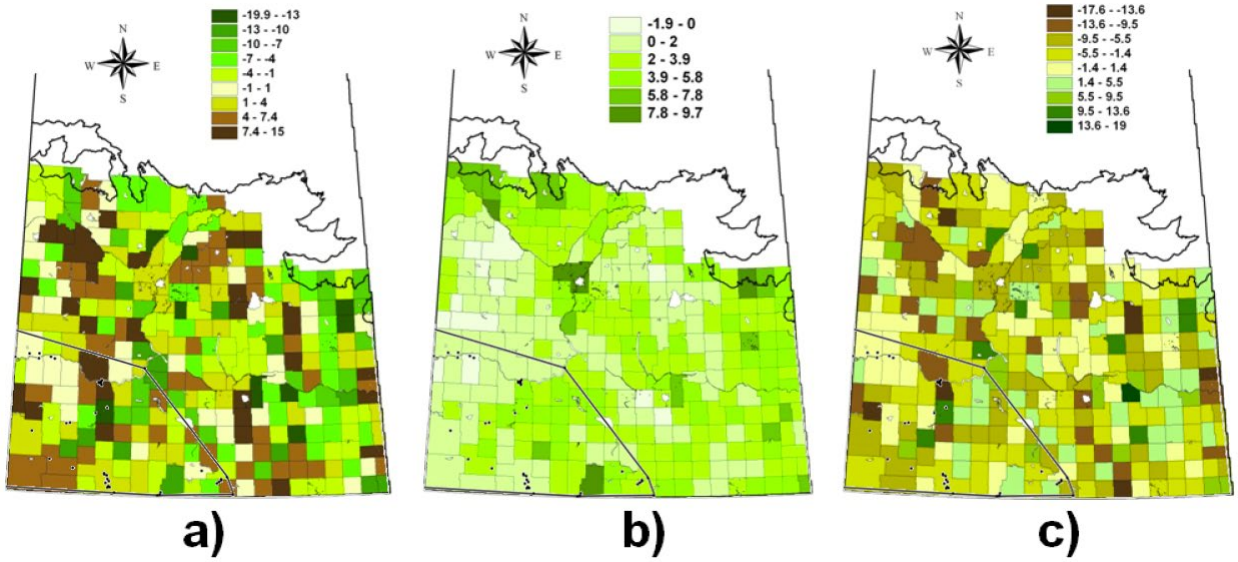

Figure 4. Percent of landscape change by county in a) tilled land, b) hayland, and c) natural land from 1971 to 2001 in southern Saskatchewan. Extent of occurrence (dark line) and index of area of occupancy grid squares (black dots) for Bullsnake (*Pituophis catenifer sayi*). Adapted from Saskatchewan NAWMP Partnership (2008).

BIOLOGY

Life Cycle and Reproduction

Bullsnake is an egg-laying snake with an average clutch size of 16 (range: 8 – 26 eggs; n = 11 snakes) for a site at the northern extent of its range in Alberta (Wright 2008). Egress from hibernacula occurs in late April, mating in May, often in close proximity to hibernacula, and nesting in June and July with hatchlings emerging from mid-August to mid-September; ingress to hibernacula occurs in September and early October (Didiuk 1999; Kissner and Nicholson 2003; Wright 2008). Although most adults probably do not forage until after the mating season (Kissner and Nicholson 2003), immature individuals and non-reproductive females likely start to search for prey as soon as their metabolic rates have returned to active-season levels. Annual reproduction by females has been documented in Canada (Kissner and Nicholson 2003), but biennial cycles also occur (Wright unpubl. data in Kissner and Nicholson 2003). Of 25 females encountered over a 5-year period at an Alberta site, the smallest gravid female was 112 cm SVL, its age was unknown (Wright 2008). The age of maturity for Bullsnakes in Canada may be similar to Great Basin Gophersnakes in British Columbia, which may not reproduce until at least 4 years of age (COSEWIC 2013).

Following the estimated generation time for the Great Basin Gophersnake in COSEWIC (2013), a value of 8 years is considered a reasonable approximation for Bullsnake. The estimate for that subspecies was based mainly on parameters derived from a population of Great Basin Gophersnakes in northern Utah (Parker and Brown 1980).

Dispersal and Migration

The maximum distances dispersed from hibernacula during the course of the active season by 16 radio-tracked adult Bullsnakes ranged from 493 m to 3946 m (mean = 1709 m ± 257 m) in the wide Frenchman River valley in Saskatchewan (Martino 2010). At Suffield National Wildlife Area, Bullsnakes were reported to move in contiguous grassland plains up to 12 km from hibernacula along the South Saskatchewan River (Didiuk pers. comm. 2016a). In the Big Muddy Valley and South Saskatchewan Provincial Park, the maximum distances from hibernacula documented for radiotracked Bullsnakes was 1297 m and 2427 m respectively (Edkins pers. comm. 2016). The configuration of habitat features around the hibernacula likely has a substantial influence on the distances moved by Bullsnakes.

Physiology and Adaptability

The defensive behaviours of Bullsnakes (e.g., hissing, tail vibrating, occasionally biting) coupled with their large size and superficial resemblance to rattlesnakes increase the likelihood of intentional persecution. Additionally, Bullsnakes tend to remain motionless on roads when they are approached or passed by vehicles (Martinson 2009; Fortney *et al*. 2012). These defensive behaviours increase the likelihood of negative interactions with humans and vehicles.

Interspecific Interactions

Bullsnakes share hibernacula with several other snake species (see **Hibernation Habitat**). They also occasionally share nest sites with sympatric Eastern Yellow-bellied Racers (Didiuk pers. comm. 2016b).

Bullsnakes feed primarily on small mammals, but are adept climbers and will also feed on birds and their eggs (Ernst and Ernst 2003).

Predators of Bullsnakes include raptors, North American Badger (*Taxidea taxus*), Striped Skunk (*Mephitis mephitis*), Coyote (*Canis latrans*), and foxes (e.g., Red Fox, *Vulpes vulpes*; Waye and Shewchuk 2002). Domestic cats and dogs may also kill juvenile snakes where the snakes occur near populated areas (Whitaker and Shine 2000).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

The most intensive studies of Bullsnake in Canada have been conducted in the Frenchman River Valley in southern Saskatchewan. Although captured snakes were marked as part of this research (Martino 2010), population sizes were not estimated (Fortney *et al.* 2012). Didiuk (1999) captured Bullsnakes by setting up drift fences in the Suffield area, but not for the purpose of population estimation. Martinson (2009) similarly used drift fencing and traps to capture 84 Bullsnakes in and around Dinosaur Provincial Park; however, the focus of his study was road mortality. Wright (2008) conducted surveys at known and potential hibernacula in Alberta. Many of the surveys conducted at hibernacula focus on confirming use rather than estimating numbers of individuals. Radiotelemetry and mark-recapture studies on Bullsnakes are currently in progress in Saskatchewan (Edkins *et al*. 2016).

Abundance

Although a number of studies on Bullsnake in Canada have been conducted, it is currently not possible to generate abundance estimates for the species. Generating population estimates is difficult given the typically low recapture rates (Kapfer *et al.* 2008), a difficulty that has been recognized for Great Basin Gophersnakes in British Columbia as well (COSEWIC 2013). Additionally, the studies that have been conducted on Bullsnakes in Canada have not focused on estimation of numbers. Kapfer *et al.* (2008) estimated a density of 0.42 adult Bullsnakes/ha for a 72-ha area in the Midwest of USA, but this was based on a small sample size (n = 30 adults captured). Given the extensive range of Bullsnake in Alberta and Saskatchewan, as well as the variation in habitat quantity and quality, the density estimate cannot be extrapolated to the species' Canadian range, and the population size remains unknown.

Fluctuations and Trends

Sufficient data have not been collected to document trends or fluctuations in subpopulations of Bullsnakes in Canada. Indirect evidence of declines comes from documentation of road mortality, an increase in the number of roads, as well as intermittent increases in traffic volume throughout portions of Bullsnake's range in Canada (Alberta Environmental Protection 1997), and declines of Prairie Rattlesnakes in Alberta (ESRD and ACA 2012), as both species often use the same hibernacula (Kissner and Nicholson 2003). As indicated in Habitat Trends, natural land declined and the footprint of human development increased within Bullsnake's range in the grasslands of Alberta, and natural land decreased in most of the counties where Bullsnake occurs in Saskatchewan. Given the increase in human activities, it is probable that Bullsnake numbers have declined from historical levels, but no data are available due to lack of systematic monitoring efforts.

The trends in IAO, calculated over the past three (since 1990) and two (since 2001) generation periods, shows a decrease of 5.5% and 13.9%, respectively. However, there are no obvious spatial patterns for these possible losses; they appear to be from local rather than from broad areas and with continuing observations in nearby grid cells (Appendices 2 and 3). Furthermore, recent search effort in these grid cells is unknown. Given that there have been no systematic surveys and incidential observations may not be regularly documented, these potential changes in IAO should be interpreted with extreme caution and cannot be taken as evidence of a decline in IAO.

The threats calculator assessment resulted in a "low" overall threat impact (Appendix 4), indicating a 0.1 – 10% suspected population decline over the next 3 generation periods or 24 years from threats operating over the next 10 years. However, the significance of road mortality, in particular, for this species remains uncertain and is suspected to be similar to that for other large snakes, especially Prairie Rattlesnake, which occupies similar areas. Localized impacts of road mortality, together with incremental habitat loss across the species' range, contribute to a suspected continuing decline of the Bullsnake population.

Population Fragmentation

The distribution of the species in Alberta and Saskatchewan, as currently understood, suggests a degree of fragmentation based on habitat availability. While many occurrences in Saskatchewan appear to be separated by distances that are beyond normal movement capabilities of Bullsnakes (e.g., 10s of km separating Big Muddy, Frenchman, and South Saskatchewan river valleys), others, particularly in eastern Alberta are relatively close together (within a few km or closer), suggesting habitat connectivity. Most occurrences fall into the latter category, suggesting that the population is probably not severely fragmented, assuming that the number of occurrences shows a relationship to abundance across the landscape. In addition, most occurrences are associated with drainages and adjacent grassland habitat, which would allow for habitat connectivity and movements of Bullsnakes. However, the delineation of subpopulations and assessment of the degree of habitat fragmentation could not be done reliably across the species' Canadian range, given the paucity of available information.

Rescue Effect

There is habitat connectivity across the international border to Montana along the many drainages of the Milk River (Didiuk pers. comm. 2016b), which potentially allow for movements of Bullsnakes back and forth. Additionally, there are documented occurrences within the last 15 years in Montana in areas that abut areas of occurrence in Saskatchewan (i.e., Big Muddy and Frenchman river valleys; Montana Field Guide 2016), suggesting that immigration from the United States may be possible. However, rescue of Canadian subpopulations from the US would be confined to the southern extremity of the species' Canadian range and be slow.

THREATS AND LIMITING FACTORS

The IUCN Threats Calculator was applied to Bullsnake by a panel of experts. The overall threat impact was calculated as "low", based on three low level threats (Appendix 4). The applicable threats are discussed below in approximate perceived order of importance.

Transportation and Service Corridors (overall threat impact "low")

Most authorities consider road mortality to be the most serious threat to Bullsnake in Canada (Kissner and Nicholson 2003; Martinson 2009). Since the 2002 COSEWIC report, two surveys of road mortality focusing on snakes, including the Bullsnake, have been conducted in Alberta (Martinson 2009) and in Saskatchewan (Fortney *et al.* 2012). A number of factors make Bullsnakes susceptible to road mortality, namely their use of road-side features as habitat (Fortney *et al.* 2012; Gardiner 2012), their tendency to move slowly across roads (Martinson 2009), and their habit of remaining stationary when threatened (e.g., when passed by a motor vehicle; Martinson 2009). Additionally, individuals are known to stop or move slowly on paved roads, when temperatures on the road surface are seemingly preferable to surrounding substrates (e.g., Martinson 2009). At sites where communal hibernacula are in close proximity to roads, the majority of individuals from these hibernacula are likely to cross one or several roads during the course of the active season as documented by Gardiner *et al*. (2013). In Alberta, increased traffic levels from industry associated with resource extraction (e.g., coalbed methane) can intermittently result in high roadkill levels (Wright pers. comm. 2016). It has been demonstrated that a subset of snakes killed by motor vehicles on roads are run over intentionally (e.g., Jochimsen 2005; Ashley *et al.* 2007), and deliberate targeting of snakes by drivers undoubtedly occurs in portions of Bullsnake's range in Alberta and Saskatchewan. Using a modelling approach, Martinson (2009) predicted a probability of 0.04 to 0.35 for road mortality for Bullsnakes with traffic densities of 100 and 1000 vehicles per day, respectively; corresponding values for Prairie Rattlesnakes were 0.05 and 0.43. His field data resulted in a higher probability (0.14) for road mortality for Bullsnakes, but the sample size was small (3 of 22 snakes were found dead on a 12 km stretch of Prairie Road 130 in southeast Alberta). Based on field studies and the model, Martinson (2009) concluded that the proportion of Bullsnakes and Prairie Rattlesnakes subjected to road mortality can be high even at relatively low traffic

densities but noted that population effects of this threat are poorly understood and require further quantification.

Although the aforementioned studies have documented Bullsnakes being killed on roads, and localized sites and/or subpopulations could be adversely affected, large areas of the species' range have few roads, particularly in Saskatchewan, and many of these roads have low traffic levels (Didiuk pers. comm. 2016a). Consequently, the threat impact of road mortality on Bullsnake was determined to be low overall (see Appendix 4); however, road mortality can be important locally to subpopulations. Furthermore, there is much uncertainty about the significance of road mortality on the Canadian population.

Throughout the Bullsnake's range in Alberta and Saskatchewan, the creation and maintenance of service corridors likely has some adverse effects on individuals and habitat. Construction activities such as grubbing, clearing, and trenching for pipelines and other linear infrastructure projects can accidentally kill Bullsnakes. However, suitable shelter habitats for Bullsnakes, such as rock piles, are often created inadvertently, as has been reported for Great Basin Gophersnakes in British Columbia (COSEWIC 2013). Because most pipelines are underground, the threat impact is largely limited to the construction period and considered negligible (Appendix 4).

Agriculture (overall threat impact "low")

As indicated in **Habitat Trends**, hay-land has increased across portions of the Bullsnake's range, but the overall impact on the Bullsnake due to new and ongoing activities was determined to be low (Appendix 4). Free-ranging cattle occur across much of the Bullsnake's range, but the effects from this land use on the species or its habitat are probably only negative where overgrazing occurs (Didiuk pers. comm. 2016a). The impact on Bullsnake habitat resulting from recent cancellation of public Saskatchewan Pastures Programs is unknown. The program includes 51 pastures (780,000 acres) across the province, and the sale of lands is a possibility. However, the level of scrutiny for land use changes is likely high, and it is probable that the lands will be maintained as grazing areas (Didiuk pers. comm. 2016a). Potential impacts of increasing potato farming in Alberta are deemed to be limited to degradation of the foraging and movement habitats and to have negligible effects on hibernacula.

Energy Production and Mining (overall threat impact "low")

Alteration of prairie habitat from oil and gas drilling was identified by Kissner and Nicholson (2003) as a threat to Bullsnake in Alberta. Overall, however, this activity by itself (i.e., not including road construction and use) was determined to have a low impact on Bullsnake across the species' Canadian distribution (Appendix 4). Impacts on foraging habitat would be largely limited to within the 100 m x 50 m footprint of individual well sites. There might be a potential increase in prey availability in the vicinity of the well sites due to taller grass. Furthermore, new well monitoring technology has reduced the frequency of on-site maintenance visits (Didiuk pers. comm. 2016a). While the effects of oil and gas exploration and drilling on the snakes were thought to be low overall, there have been no studies.

Threats with "Negligible" Impacts:

Seven threat categories were identified as having negligible overall impacts on the Canadian population at present, but they could be locally important or could become more important in the future.

Biological Resource Use

Persecution of snakes is a well-documented phenomenon, and the defensive display that Bullsnakes can exhibit when threatened (e.g., flattening their bodies and hissing) as well as their superficial resemblance to rattlesnakes undoubtedly results in individuals being killed in areas where they come into contact with humans. Aggregations of individuals at hibernacula in the spring are most vulnerable to persecution.

Human Intrusion and Disturbance

Off-road vehicles are known to cause mortality in snakes (Willson pers. obs. 2006). Burger *et al.* (2007) demonstrated that continued off-road vehicle activity in an area had adverse effects on Pinesnakes (*Pituophis melanoleucus*). However, large areas in southwestern Saskatchewan and Alberta are private lands, and trespassers are actively discouraged, and thus many areas are not visited by recreational users (Didiuk pers. comm. 2016a).

Natural System Modifications

Wildfires have the potential to directly cause mortality in Bullsnakes; however, fires within the range of Bullsnake are controlled to minimize extent, and habitat quality of burned areas can be enhanced within a few years as vegetation regenerates (Didiuk pers. comm. March 2016).

Residential and Commercial Development

The potential for this type of development to have adverse effects on Bullsnake is limited to occurrences of the species on the periphery of population centres. The effects are therefore local and overall impacts were determined to be negligible.

Threats with "Unknown" Impacts:

Pollution

Bullsnakes may be at risk from indirect poisoning via rodenticides that are ingested when consuming rodents considered to be agricultural pests (Martino *et al*. 2012). However, it was recognized that Bullsnakes largely avoid crop lands and most rodent control occurs at the edges of prairies with only local applications within grasslands (Didiuk pers. comm. 2016a).

Geological Events

Landslides or terrain slumping in steeply sloped areas have been documented to have adverse effects on the structural integrity of snake hibernacula and mortality of snakes (Gardiner and Sonmor 2011). However, these types of events probably also create new hibernacula and thus have beneficial effects as well (Didiuk pers. comm. 2016a; Gardiner pers. comm. 2016).

Natural System Modifications

A number of invasive plant species occur within the Bullsnake's range that might have adverse effects on the species through habitat alteration (e.g., White Sweet Clover, *Melilotus albus*; Crested Wheatgrass, *Agropyron cristatum*; Smooth Brome, *Bromus inermis*). The likelihood and severity of the effects of these plant species on Bullsnake are largely unknown. At some sites the effects may even be beneficial given the potential for providing shelter habitat and/or increasing prey populations.

Invasive Species: Snake Fungal Disease

Snake Fungal Disease (SFD) affects wild snakes in eastern North America and is caused by the fungus *Ophidiomyces ophiodiicola* (CWHC 2016). The disease has not been reported in Bullsnakes; however, numerous species have been confirmed as being affected (CWHC 2016). It is unknown whether Bullsnake populations could be adversely affected if SFD becomes established in Alberta or Saskatchewan because population level effects that have so far been reported have been variable (CWHC 2016).

Number of Locations

The most plausible threat for determining the number of threat-based locations for Bullsnake is road mortality. A large increase in traffic volume would adversely affect many Bullsnake subpopulations. As for Great Basin Gophersnake in B.C. (COSEWIC 2013), the number of locations based on road mortality as the most plausible threat is deemed to be large and greatly exceed 10. That subspecies has a smaller geographic range in Canada than Bullsnake, and the distribution of communal hibernacula for Great Basin Gophersnake is much better documented. Given the estimate of the number of threat-based locations for Great Basin Gophersnake, as well as the current road network in Alberta and Saskatchewan in relation to the areas where Bullsnakes are known to currently persist, it is reasonable to presume that the number of locations for Bullsnake is also large and greater than 10.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

In Canada, Bullsnake is not listed under the *Species at Risk Act*.

In Alberta, Bullsnakes are protected as a non-game animal under the provincial *Wildlife Act*, which makes it illegal to kill, possess, buy or sell snakes native to Alberta. Additionally, the species is protected when it is hibernating, as hibernacula of all snakes are protected annually from 1 September to 30 April in Alberta under the *Wildlife Act* (Kissner and Nicholson 2003). Because the hibernacula are not protected for the entire year, this protection primarily benefits individual snakes, as opposed to protection of the habitat feature. In Saskatchewan, general protection afforded to all native wildlife applies to Bullsnake under the provincial *Wildlife Act*, but because the species is not listed as a designated species under the *Act*, no specific measures apply.

In national parks, the species is protected under the *Canada National Parks Act*. Protection within provincial parks in Alberta is afforded via the *Provincial Parks Act* and in Saskatchewan through the *Parks Act* (see **Habitat Protection and Ownership** for the parks where the species occurs).

Non-Legal Status and Ranks

NatureServe (2016) indicates the following status designations for Bullsnake: Global—G5T5; National for U.S.A—N5; National for Canada—N4; Subnational for Alberta—S3 (Vulnerable); Subnational for Saskatchewan—S4 (Apparently Secure). The state of Montana borders the range of Bullsnake in Canada wherein the species is ranked S5 (Secure).

In Alberta, Bullsnake is listed as a sensitive species (2000, 2005, 2010; Alberta Wild Species General Status Listing). Sensitive species are defined in Alberta as “Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.” Comments for the listing of Bullsnake are as follows: “Population stable or possibly declining. Most vulnerable at winter dens. Requires conservation of prairie grassland, protection of hibernacula, and better population information. Threatened by traffic mortality, direct persecution, and habitat loss.”

Habitat Protection and Ownership

Bullsnake habitat within national and provincial parks in Alberta and Saskatchewan receives protection from development. The only national park where Bullsnakes are known to occur is Grasslands, whereas they occur in several provincial parks: Dinosaur and Writing-on-Stone Provincial Parks in Alberta and Saskatchewan Landing Provincial Park. Bullsnake habitat within the National Wildlife Area of CFB Suffield is also protected. An examination of the grid squares used to calculate Bullsnake’s IAO indicates that approximately 12% of Bullsnake’s range is in national or provincial parks.

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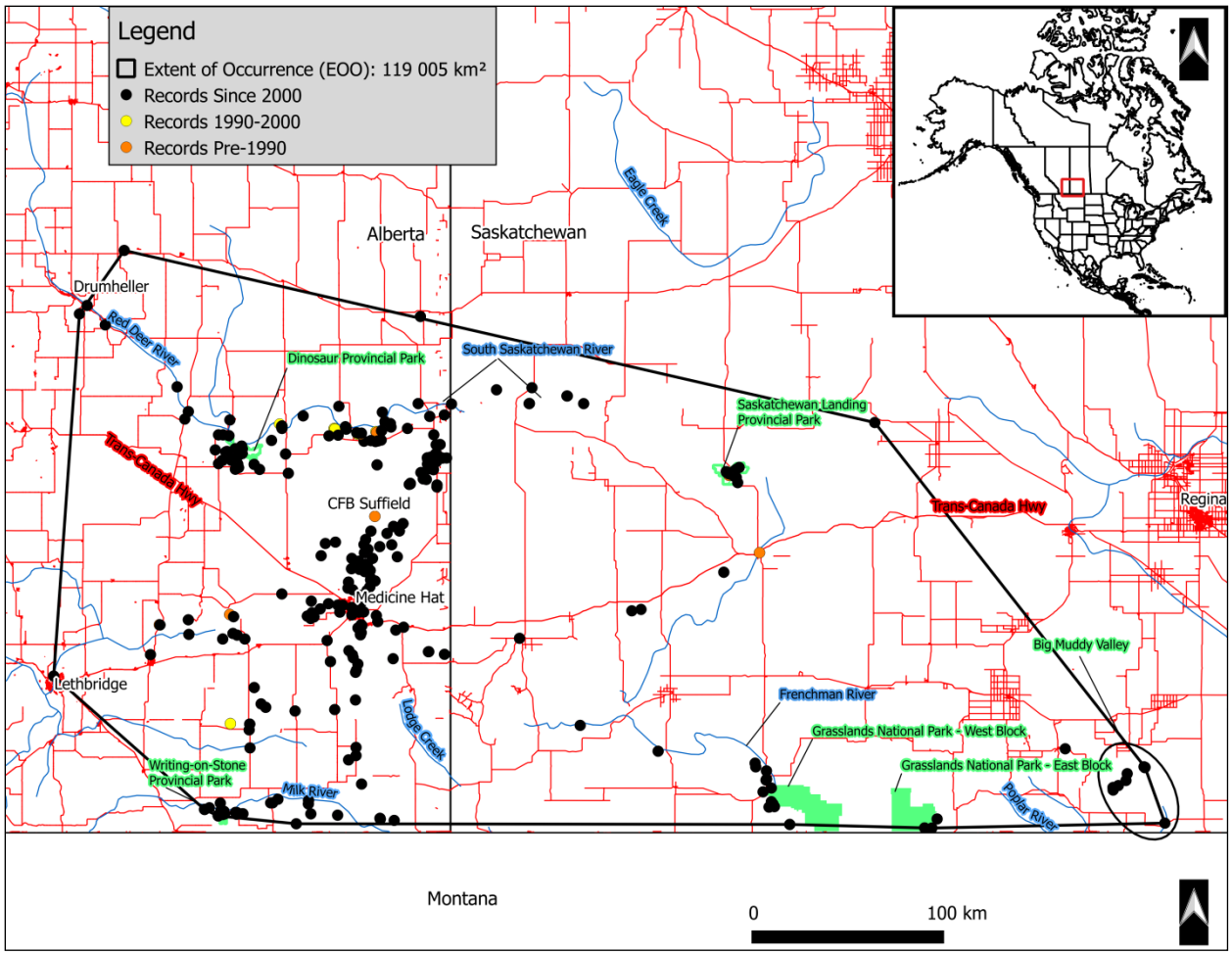
BIOGRAPHICAL SUMMARY OF REPORT WRITER

Rob Willson obtained his BSc and MSc from the University of Guelph. He conducted research on Pelee Island's snakes from 1994 to 2004. Additional investigations of snake ecology and conservation include eight years working on Eastern Massasaugas and Eastern Hog-nosed Snakes in Ontario. Rob has written COSEWIC reports and recovery strategies for several snakes. He currently works as an ecological consultant in Ontario.

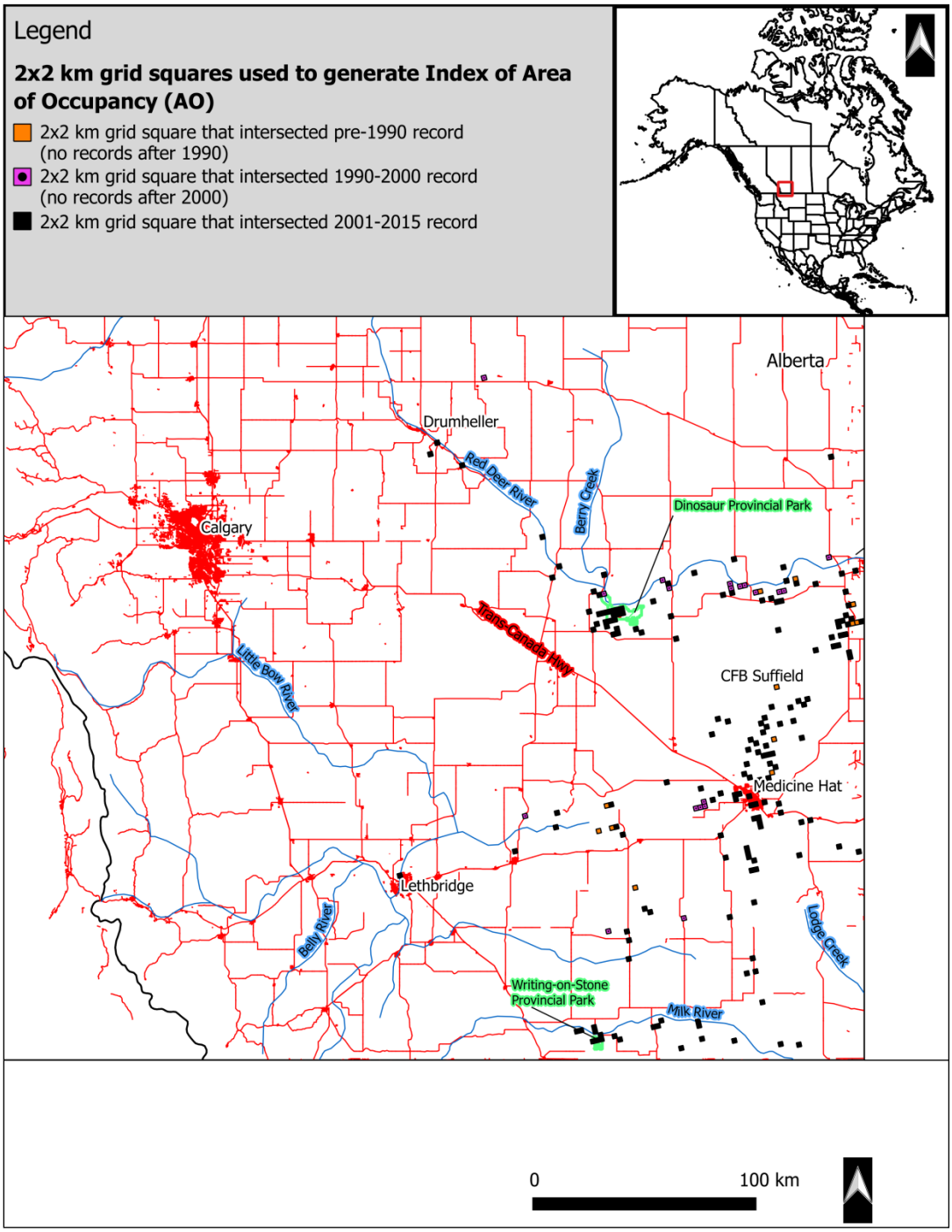
COLLECTIONS EXAMINED

No collections were examined.

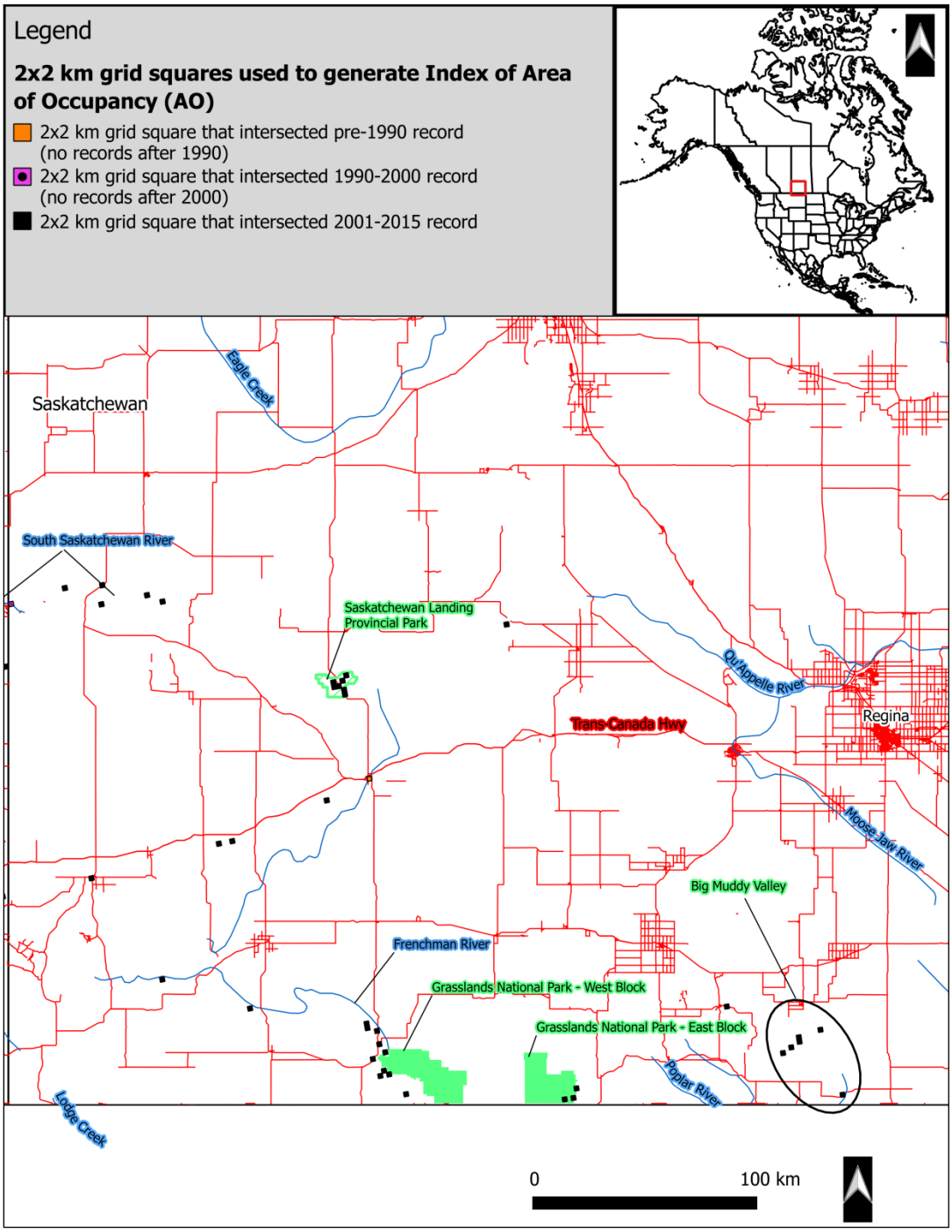
Appendix 1. Estimated extent of occurrence (EOO) of Bullsnake (*Pituophis catenifer sayi*) in Canada. Green polygons illustrate National and Provincial parks where Bullsnakes occur.



Appendix 2. Index of area of occupancy (IAO) of Bullsnake (*Pituophis catenifer sayi*) in Alberta, Canada. Green polygons illustrate National and Provincial parks where Bullsnakes occur.



Appendix 3. Index of area of occupancy (IAO) of Bullsnake (*Pituophis catenifer sayi*) in Saskatchewan, Canada. Green polygons illustrate National and Provincial parks where Bullsnakes occur.



Appendix 4. IUCN threats calculator results for Bullsnake. Only those threats that affect the species and were scored are shown.

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	Bullsnake, *Pituophis catenifer sayi*
Element ID	**Elcode**
2016-03-09	
Kristiina Ovaska (facilitator; Amphibians and Reptiles Specialist Subcommittee co-chair), Rob Willson (status report writer), Andrew Didiuk (Canadian Wildlife Service), Laura Gardiner (Parks Canada), Cynthia Paszkowski (Amphibians and Reptiles Specialist Subcommittee). COSEWIC Secretariat: Bev McBride (notes, non-assessor)	
Draft COSEWIC status report (Nov 2015)	

		Level 1 Threat Impact Counts	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	3	3
Calculated Overall Threat Impact:		Low	Low

Assigned Overall Threat Impact:	**D = Low**
Impact Adjustment Reasons:	
Overall Threat Comments	***Assumptions: Generation time ~8 years (24 years for 3 generations); IAO 952 km2, EOO 119 005 km²; total population size is unknown.***

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	Negligible	Negligible (<1%)	Serious - Moderate (11-70%)	High (Continuing)	
1.1	Housing & urban areas	Negligible	Negligible (<1%)	Serious - Moderate (11-70%)	High (Continuing)	Probably not significant for the total population, but local impacts are likely in some areas. Impact of urban expansion is mainly restricted to around major population centres. Scope is therefore negligible.
1.2	Commercial & industrial areas	Negligible	Negligible (<1%)	Serious - Moderate (11-70%)	High (Continuing)	See comment above. Footprint will likely be smaller than that for housing and urban expansion.
2	Agriculture & aquaculture	D Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Mostly a historical threat. While the extent and intensity of agricultural activities have increased in general within the Bullsnake's range, call participants thought that the impact would have been historically higher in Saskatchewan (e.g., due to conversion to row agriculture), but more recently higher in Alberta because of conversion of grassland to potatoes. Although some public pasture programs have been cancelled, the risk to Bullsnake habitat in grasslands from the pasture transfer from PFRA are likely negligible because of high level protection measures to maintain the lands as grazing areas. Increased grazing intensity and poorer range management could potentially be a problem in Alberta. Potato farming in Alberta (1/4 section or larger) is a threat to foraging habitat and movement habitat; studies (e.g., Big Muddy in Saskatchewan) have shown snakes tend to avoid croplands. Negligible to no impacts on hibernacula are expected from these changes. Some uncertainty about impact of potato farming on severity rating led to wavering between slight and moderate-slight.
2.3	Livestock farming & ranching		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Free-ranging cattle occur across much of the snake's range. Over-grazed areas are harmful for snakes, but most areas (e.g., in parks) are managed reasonably well avoiding over-grazing. Across the range, severity is considered negligible, but it may be an issue locally if over-grazing occurs.
3	Energy production & mining	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
3.1	Oil & gas drilling	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Alteration and loss of prairie habitat from oil and gas activities continue to be a threat to Bullsnake populations. There is loss of foraging habitat (for example the 100 x 50 m footprint of a well site), but this does not affect hibernacula. Some participants felt that well sites may increase prey abundance via taller grass growth around the platforms. New monitoring technology means there are now fewer site visits by vehicles. Severity is probably slight.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	No examples are known, but sand and gravel extraction is ongoing and widespread enough that there is a reasonable probability of an impact to some snakes. Provincial protection exists for hibernacula, and they are unlikely to be affected. Mining was recognized as a future possibility, but call participants knew of no examples.
4	Transportation & service corridors	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	The number of vehicles on roads that intersect habitat used by Bullsnakes has undoubtedly increased with agriculture and oil and gas activity in Alberta. Monitoring programs by Didiuk (1999) and Alberta Fish and Wildlife in 2001 documented road-killed Bullsnakes in several areas in Alberta (Kissner and Nicholson 2003). Bullsnake populations are likely vulnerable to the effects of road mortality where roads are in close proximity to communal hibernacula (Fortney *et al.* 2012), and many individuals from these hibernacula will cross one or several roads during the course of the active season (Gardiner *et al*. 2013). However, especially in Saskatchewan, large areas of the Bullsnake's range have few roads and most of these roads have little traffic. The scope of the threat is large but uncertainty is high and requires analysis. Most secondary roads in the grasslands have low traffic volumes. Local effects are likely in areas adjacent to highways and busy rural roads, but overall the severity was deemed slight. Bullsnakes use roadsides more often than expected, likely because they forage in ditches. As big, slow snakes they are more susceptible to road mortality, but they are also relatively fecund (when compared with rattlesnakes). While the severity was considered slight across the entire Canadian range, roads can be an important contributor to mortality at the local level and are thus a problem for subpopulations.
4.2	Utility & service lines		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	The scope is closer to the high end of restricted and the severity is negligible because most pipelines are underground. Call participants were uncertain of any future development plans. The 1,659-kilometre pipeline (Line 3) that carries oil from Alberta through Saskatchewan to the United States is located north of the main range of the Bullsnake (twinning of the pipeline is approved, in principle, by the federal government).
5	Biological resource use		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Includes deliberate killing of snakes. As recognized for other communally hibernating snakes (e.g., Great Basin Gophersnakes; COSEWIC 2013), aggregations of individuals at hibernacula in the spring are most vulnerable to persecution. However, as indicated in COSEWIC 2015 (Prairie Rattlesnake), there are several reasons why hibernacula usually remain undisturbed. The scope would be at the low end of the 'small' range. Landowners might kill snakes if they happen to encounter them. Local effects are possible.
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Off-road vehicle recreation occurs within the Bullsnake's range; however, large areas in southwestern Saskatchewan and in Alberta have restricted access and are not visited by recreationalists.
6.2	War, civil unrest & military exercises	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Activities within Canadian Forces Base Suffield are not considered a threat, because most of the military training area occurs outside of the range of the species that is mostly within the National Wildlife Area. Only a small portion of the snakes would be affected by military traffic and activities.
7	Natural system modifications	Negligible	Restricted - Small (1-30%)	Negligible (<1%)	High (Continuing)	
7.1	Fire & fire suppression	Negligible	Restricted - Small (1-30%)	Negligible (<1%)	High (Continuing)	Only wildfires were considered applicable to the Bullsnake. Given current fire suppression practices, the scope was determined to be somewhere near the middle or lower end of range. Habitat quality was considered to be enhanced by a fire event within a few years; thus overall habitat improvement can occur within 3 generations. There was a large fire event in 2013 in Grasslands National Park. At Suffield, fires are controlled to minimize their extent. Direct mortality is possible in the short term, but subsequent habitat enhancement via vegetation regeneration can be rapid. Net severity was considered negligible with the recognition that local effects may be higher.
7.3	Other Ecosystem modifications	Unknown	Small (1-10%)	Unknown	High (Continuing)	This category scored invasive plants that alter habitat. The extent and coverage of Sweet Clover was thought to be extensive, but the effect on snakes was unknown. Crested Wheatgrass is used as a reclamation seed source in uplands and has become invasive. Brome occurs extensively, usually along roads, and although it is thought to have some negative effects on snakes, it also has positive effects such as improved thermal shelter and increased prey (note: the above was originally scored under 8.1).
8	Invasive & other problematic species & genes	Unknown	Small (1-10%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species	Unknown	Unknown	Unknown	High (Continuing)	Snake fungal disease is now in Minnesota, and although it is not yet known within the Bullsnake's range, its spread was considered a possibility.
9	Pollution	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.3	Agricultural & forestry effluents	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Bullsnakes may be at risk from indirect poisoning via rodenticides that are ingested when consuming rodents considered to be agricultural pests (Martino *et al*. 2012). This threat was assessed to be a risk for Great Basin Gophersnakes in the Okanagan Valley B.C. through a modelling exercise (Williams and Bishop 2011). Call participants noted that Bullsnakes avoid crop lands and so would be less likely to encounter agricultural chemicals. Most rodent control takes place at the edges of prairies, with some local applications within grasslands.
10	Geological events	Unknown	Small (1-10%)	Unknown	High (Continuing)	
10	Avalanches/landslides	Unknown	Small (1-10%)	Unknown	High (Continuing)	Landslides occur sporadically throughout the Bullsnake's range in steeply sloped areas where hibernacula are located. Such events may be increasing in frequency due to climate change and habitat deterioration. Slumping also creates hibernation habitat. The scope was considered to be towards the low end of small. There was a slumping event at a large den in Grasslands National Park (Gardiner and Sonmor 2011). Bullsnake was thought to be less vulnerable than some other species of snakes.
11	Climate change & severe weather	Not calculated	Pervasive	Unknown	Low (Possibly in the long term, >10 yrs)	Potential impact but unknown as the species occurs in a wide climatic range.