

Conservation Analysis
for the
Great Basin Gophersnake
(Pituophis catenifer deserticola)
in British Columbia

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EXECUTIVE SUMMARY

The Great Basin Gophersnake (*Pituophis catenifer deserticola*) inhabits most of the low and mid-elevation valleys in the southern interior of British Columbia. This snake is most at home in native, grassland-dominated ecosystems where it spends most of its time underground in small mammal burrows. Eggs often are laid on dry, warm slopes, sometimes with the clutches from other snakes. Gophersnakes are known to use deep fissures in rock and talus as well as deep mammal burrows as hibernacula.

The same valleys that provide optimal conditions in the northernmost extent of the gophersnake's range have attracted human settlement over the past 150 years. This sprawling change in the landscape displaces gophersnake populations by creating unsuitable habitats and threats to individuals, forming population sinks. The fire dynamics of natural areas have changed due to fire suppression, to produce infrequent hot fires, forest ingrowth and colonization of non-native plants. The culmination of habitat loss, numerous threats, and suspected population declines, resulted in the Committee on the Status of Endangered Wildlife listing the species as Threatened. A recovery team has prepared a draft recovery strategy and will be implementing recovery actions. The main challenge for recovery efforts is maintaining connectivity within each population and between populations. Four distinct populations are proposed for British Columbia, the Kettle, Thompson-Nicola, Fraser and Okanagan-Similkameen.

This report provides a spatial analysis of habitat suitability and land tenures within the potential range of the gophersnake. Conservation strategies are proposed with an emphasis on maintaining connectivity and promoting the most effective strategy for each population, depending on the dominating land tenure. One of the main questions which challenges recovery planning is whether sufficient lands with formal protection for the species and its habitat exists, and if not, can provincial Crown land that is part of the non-contributing land base (NCLB) be used as a surrogate.

Analysis showed that the majority of suitable habitat generally exists on unprotected Crown land, with relatively little formally protected lands (including Protected Areas, Wildlife Habitat Areas, private conservation). The Kettle population, however, is situated primarily on private lands, and virtually none of the habitat is protected. Although Crown land dominates the suitable habitat in the Thompson-Nicola population, more of the best habitat is on private land, and only about 6% of habitat is protected. The Fraser and Okanagan-Similkameen populations have the highest amounts of good habitat protected, at approximately 15% and 13%, respectively.

There is insufficient protected land to confidently recovery the species, unless there is a means to conserve gophersnake habitat on Crown lands in good condition throughout their range. The NCLB contains most of the high and moderate suitability habitat but these lands are often subject to a number of threats, including road construction and traffic, utility corridor construction and maintenance, intensive grazing, and recreational uses. Conservation tools like Wildlife Habitat Areas are considered the best mechanism to effectively protect these habitats. Conservation strategies may also be required on protected lands. Stewardship and applied best practices are seen as essential tools for conserving gophersnake habitat on private and First Nations' lands.

This analysis, and subsequent conservation strategies, is intended to be used at a landscape scale. Action plans and implementation will require more detailed information, such as accurate land tenure, within each population of gophersnakes.

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INTRODUCTION

The Great Basin Gophersnake is a large, non-venomous snake that is often mistaken for a rattlesnake, especially as it mimics their defensive behaviours. Gophersnakes den in two distinct conditions, one being in rocky fissures or deep talus, the other in deep soiled areas where small mammal burrows enable them to penetrate below the frost line. Movement to summer ranges is rapid, taking less than several days and directional (Waye and Shewchuk 2002). The summer ranges can be a kilometre or more from the hibernacula (Shewchuk 1996, Bertram et al. 2001). Therefore, barriers greater than two kilometres in width, likely prevent breeding between adjacent subpopulations. Summer home ranges are variable in size but appear to be between 5 and 15 hectares (Shewchuk 1996, Bertram et al. 2001), although there are discreet areas within the home range that are used for disproportionately longer periods (Waye and Shewchuk 2002, Rodriguez-Robles 2003). It is suspected that the same home ranges are used in consecutive years. This species of snake lays eggs in distinct areas, usually on warm, sandy slopes and gravid females engage in deliberate travel to get there (Shewchuk 1996). These snakes are long-lived, with their reproductive potential and familiarity with the landscape, increasing with age. Demographically, the older snakes contribute the greatest to the viability of the population.

Many species are becoming more at risk as humans continue to dominate the landscapes of the southern interior of the province. Fur trading, mining, selective timber harvesting and intensive cattle grazing dominated much of the 1800s. Agriculture boomed in the 1900s and cities were formed. The 2000s are experiencing rapid growth in housing, golf courses, and vineyards. The Great Basin Gophersnake is a species that is particularly vulnerable to threats associated with human activities. Gophersnakes are extremely limited in their ability to relocate, and are therefore affected as development occurs, and later, if individuals venture into developed areas. Their fossorial nature places them at risk as lands are tilled or excavated, and they may be at risk when vegetated areas are mowed or hayed. These snakes have been persecuted as well, due mainly to their resemblance to rattlesnakes. Like many smaller wildlife species, they are prone to predation by domestic animals. However, other than the broad loss of habitat, their greatest threat is thought to come from road traffic (Waye and Shewchuk 2002, Sarell et al. 2004).

The vulnerability of this species to human threats, coupled with apparent population declines, has placed it on the province's Blue List¹ and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has designated it as Threatened². A recovery team is currently developing a recovery strategy and action plan. The Federal government now has the capability to protect Residences³ (e.g. hibernacula and egg laying sites) on Federal lands through the Species at Risk Act (SARA). Descriptions of residences are currently being developed (Bertram

¹ **Blue List:** *List of indigenous species, subspecies and natural plant communities of special concern (formerly vulnerable) in British Columbia* (BC Conservation Data Centre 2005).

² **Threatened species:** *A wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction* (SARA 2003).

³ **Residence:** *A dwelling-place, such as a den, nest or other similar area or place that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* (SARA 2003).

2005 draft). In addition, SARA also has the ability to protect Critical Habitat⁴. Critical habitat is more likely to provide adequate protection for subpopulations. This recovery tool is unlikely to be available in the near future, as the recovery team must first describe the critical habitat that then must pass a number of procedural steps (Environment Canada 2004). The Province has also engaged in developing conservation strategies for the Gophersnake. The most effective tool on unencumbered provincial Crown lands is by designating spatially defined Wildlife Habitat Areas (WHA)⁵ through the Identified Wildlife Management Strategy (IWMS) established under the Forest and Range Practices Act of British Columbia. Wildlife habitat areas are made up of den sites and surrounding foraging habitat and summer range. Both measures attempt to protect important gophersnake habitat on Crown lands. Ultimately, the conservation of the species will depend on how well populations are maintained throughout their range, sustaining viable populations that have genetic connectivity.

Effective recovery for this species must look at issues on a landscape scale, which relate to land tenures and subsequent management of important habitat, and then on a local scale, where inventory and specific measures can be implemented. The rationale for this project was to provide the landscape perspective, in particular, to establish how lands with existing mandates for conserving gophersnake habitat contribute to the recovery objectives for the gophersnake and whether additional provincial Crown lands are necessary to achieve the recovery targets, established by the recovery team.

⁴ **Critical Habitat:** *The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or in an action plan for the species (SARA 2003).*

⁵ **WHA:** *An appropriate feature that triggers establishment of a WHA (e.g., active nest area, maternity colony or hibernacula). Typically these will be based on limiting habitats, significant concentrations or those habitats not addressed by coarse filter provisions that are currently occupied. The general design of WHAs is based on important life history characteristics such as home range size. In some cases, WHAs may be recommended for potentially or historically suitable sites for recovery or recruitment purposes. Generally these will be recommended or endorsed by established recovery teams to meet the requirements of the national Species at Risk Act (Paige 2003).*

METHODS

This project developed a variety of interpretive maps to help illustrate the current broad-scale conservation situation for the Great Basin Gophersnake in British Columbia. All mapping was conducted in ArcView 3.2a Geographic Information System (GIS). Existing base coverages were imported from a variety of sources and have varying levels of resolution and accuracy (Appendix I).

Maps and methods of initial range and habitat use models were reviewed by a number of species experts. Responses were received from Karl Larsen (University College of the Cariboo) and Jared Hobbs (MWLAP), whose vast knowledge and intensive effort was much appreciated. Response comments were incorporated into the final range map and suitability model. The Southern Interior Reptile Recovery Implementation Team had opportunities to contribute to this project and will be involved in the final analysis of the state of habitat protection in BC for gophersnakes.

Range

Although not a range map, the Reptiles of British Columbia (Gregory and Campbell 1984) was the first comprehensive source for all gophersnake observations in the province. Studies on local gophersnake populations have been conducted by Nelson (1992), Shewchuk (1996), and Bertram et al. (2001). Additional distribution and denning information has come from several studies (Sarell 1993, Hobbs 2001, Hobbs and Sarell 2001, Hobbs and Sarell 2002). Data has been gathered on incidental observations by a number of people, and compiled into an Okanagan wildlife sightings database (MWLAP 2004). All of this work contributed to an estimated known range of the Great Basin Gophersnake in British Columbia.

A map of the estimated known range of gophersnakes was sent for review, along with the habitat use models, and the range was revised based on recent observation records (Hobbs pers comm. 2004). A potential range map was created as well, based on contiguous, suitable habitat predicted by the suitability model, and comments from reviewers. It is anticipated that a number of further revisions to this map will be necessary as data gaps are resolved.

The four Gophersnake populations within the known and potential ranges were delineated based on relatively isolated geographic areas, and named by major watershed.

Habitat Use Models

Two models were developed to predict Great Basin Gophersnake habitats throughout their provincial range: capability and suitability. Capability is the ability of the habitat to support a species under optimal natural conditions, irrespective of the current condition of the habitat. Suitability is based on the current condition of the habitat. Methods specific to each model are described below, and are consistent with those methods described by the Resource Inventory Committee (1999).

The models were developed by constructing a ratings table, and applying the ratings to the spatial data in ArcView using an Ecosystem-based Resource Mapping (ERM) tool developed by MSRM (2004; see Appendix I for more detail). Ratings were initially assigned based on a 6-

class rating scheme (Table 1) to provide a higher level of differentiation, which was converted to a 4-class scheme for the final suitability model to be consistent with RIC standards and to reflect the level of inaccuracies associated with mapping at this scale.

Table 1: Habitat rating schemes for different knowledge levels of habitat requirements (RIC 1999).

Percent of Provincial Benchmark*	6-class (Substantial Knowledge of Habitat Use)		4-class (Intermediate Knowledge of Habitat Use)		2-class (Limited Knowledge of Habitat Use)	
76 - 100 %	High	1	High	H	Habitat Useable	U
51 - 75 %	Moderately High	2	Moderate	M		
26 - 50 %	Moderate	3	Low	L		
6 - 25 %	Low	4				
1 - 5 %	Very Low	5				
0%	Nil	6	Nil	N	Likely No Value	X

* The best habitat in the province. For example, high suitability (1 or H) is 76-100% as good as the provincial best.

Habitat Capability Model

The capability model used broad-scale Biogeoclimatic Ecosystem Classification (BEC), which includes ecosection and biogeoclimatic units. Biogeoclimatic (BGC) mapping has been conducted at varying scales across the range of gophersnakes in BC (Appendix II). Large-scale BGC mapping is scheduled for the Thompson-Okanagan in March of 2004 (but not yet available) and the Chilcotin in March 2005. This model should be rerun when this mapping is available.

Initially, BEC units occurring within 5 km of the known range were included in the ratings table to include suitable habitat to capture potential habitat that might have been overlooked by species experts. However, it was noticed that some areas potentially containing suitable habitat was still not included and these areas could provide linkages between populations (e.g. between Lillooet and Cache Creek / Ashcroft, and between Kamloops and Armstrong). In these cases, potentially suitable BEC units in these areas were manually selected to be included in the model, and the ratings table revised accordingly.

Habitat Suitability Model

The suitability model used a grassland coverage supplied by the BC Grasslands Conservation Council (GCC) as well as BEC mapping. The previously assigned BEC ratings were adjusted based on grassland-associated habitats portrayed by the GCC coverage.

This initial suitability model was compared to three existing gophersnake suitability models based on 1:20,000 scale Terrestrial Ecosystem Mapping (TEM): South Okanagan Conservation Strategy area (SOCS), Central Okanagan, and Bellavista - Goose Lake Range. The SOCS biophysical habitat mapping was actually conducted prior to provincial TEM standards being developed, but the methods, scale and accuracy are similar.

Revisions to the suitability model were made based on these comparisons and input from reviewers. The final suitability model used only BEC ratings, but with developed areas and water bodies from the GCC coverage clipped out. The developed areas identified by the GCC (urban area, cultivated or hayfield, and clearing) appeared to miss a large amount of land, particularly in the south Kelowna area. Therefore, a baseline thematic mapping (BTM) coverage was used as well. Areas identified by BTM that were clipped out of the suitability coverage

included: agriculture, recreation activities (e.g. golf course), residential/agriculture mixtures, and urban. It should be noted that this is not a true suitability model, as habitat type, condition, and structural stage are not considered. Only the removal of known unsuitable habitats differentiates it from the capability model.

Land Status

The land status layer was constructed from a variety of input coverages. Available provincial coverages for Protected Areas, IR and private lands were combined into a single coverage. This was then ‘unioned’ with the potential range coverage, and the resulting blank polygons assumed to be crown. Many sliver polygons, gaps and overlaps resulted. Polygons 0.001 ha or less in area were deleted. The provincial land status coverage appears to be very inaccurate; all analyses based on this are very approximate.

A more detailed and accurate land status coverage was available for part of the Okanagan-Similkameen population, within the area of the South Okanagan – Similkameen Conservation Program (SOSCP ownership coverage). The SOCS ownership was incorporated by clipping the corresponding area out of the land status coverage and then merging it to the provincial coverage.

Wildlife Habitat Areas (WHAs) were manually incorporated into the land status coverage and considered protected lands. A shapefile of six previously approved WHA was supplied for this project. Three recently approved WHAs were incorporated as well, based on an older shapefile of proposed WHAs; the extent may be inaccurate, as the proposed WHAs may have had boundaries changed before approval.

Old-growth management areas (OGMAs) were obtained from the Kamloops Region ftp site for the Kamloops and Merritt TSAs, and the Penticton, Vernon and Salmon Arm forest districts, and from the Cariboo Region ftp for the entire region. No coverage was available for the Boundary area. Therefore, there is no coverage for the Kettle and Fraser populations, and incomplete coverage for the Thompson-Nicola population and the Pavilion (Thompson / Fraser) potential connection. This layer was not used in the final analyses, as it was in various stages of development and ultimately would have little impact on any area outside of non-productive forests, which is already incorporated into the non-THLB.

The original intent was to incorporate non-contributing land base (NCLB) information, to assess whether this area could contribute to conservation of gophersnakes. NCLB is a theme derived from forest cover mapping and a variety of other GIS coverages, according to detailed instructions outlined in the Landscape Units Planning Guide (Forest Practices Code 1999). The guide is out of date in two large respects: it is based on the Forest Practices Act, which has been replaced by the Forest and Range Practices Act; and forest cover mapping has been converted to Vegetation Resources Inventory. Existing NCLB layers were not available, but draft timber harvesting land base (THLB) layers were obtained for most of the range of gophersnakes, except the 100 Mile House and Central Cariboo (Williams Lake) forest districts. The coverages varied by forest district/TSA in format and information contained. Non-THLB polygons were selected (Table 2) and clipped to Crown land from the land status coverage, which roughly approximates NCLB, except our coverage excludes Protected Areas and WHAs, which are included in a separate category.

Table 2: Landbase categories selected for non-THLB layer.

Forest District / TSA	Landbase Categories	Categories Selected
Boundary	X, N, P, C	X, N, P (<50% inclfact)
Okanagan	N, Y	N
Merritt	THLB, NON_THLB, THLB_REDUCT	NON_THLB, THLB_REDUCT
Kamloops	THLB, NON_THLB, THLB_REDUCT	NON_THLB, THLB_REDUCT
Lillooet	T, N	N

Codes in second and third columns are from a variety of databases and are not always defined; those selected are assumed to not be part of the timber harvesting land base.

Conservation Analysis

The suitability model was unioned with the land status coverage, to produce a coverage with the attributes of both inputs. Areas could then be portrayed by the combination of suitability value and land tenure, and area calculations performed. The non-THLB Crown land also was unioned to suitability, as a separate layer.

A 1 km buffer around protected lands was added as an additional layer, as this is the approximate maximum distance that gophersnakes will travel. This buffer was used to determine the amount of suitable habitat occurring within this distance of lands with some sort of conservation mandate.

RESULTS

Range

The range of the Great Basin Gophersnake in British Columbia was an integral base for conducting the conservation analysis. Analysis was conducted using both known and potential range (Figure 1). However, results are generally presented in the following sections only for potential range, as it likely captures all gophersnake habitat as opposed to missing any that has been overlooked by various inventory projects. It is anticipated that a number of further revisions to this map will be necessary as data gaps are resolved through inventory, the most likely to result from inventories associated with the Identified Wildlife Management Strategy or Species at Risk surveys.

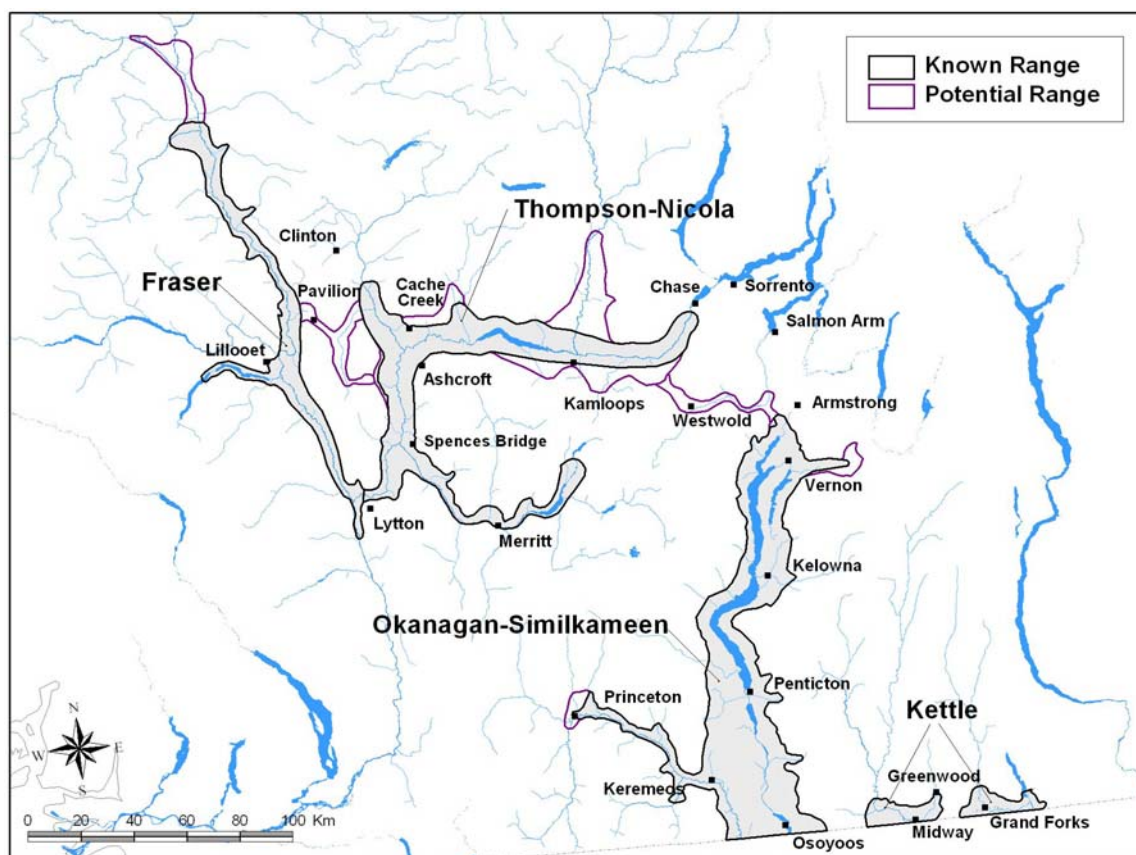


Figure 1: Estimated known and potential range of the gophersnake in BC.

The estimated known range of gophersnakes is about 800,000 ha, while the potential range is a little over 1 million. Approximately 75% of this range area occurs about equally between the Okanagan-Similkameen and the Thompson-Nicola populations. The Fraser population occupies around 15% of the total range area, and the Kettle population comprises about 4%. The remainder occurs in the two potential connections.

Habitat Use Models

The initial capability and suitability maps that were sent for review are presented in Figures 2 and 3. The files used to produce the maps are listed in Appendix III.

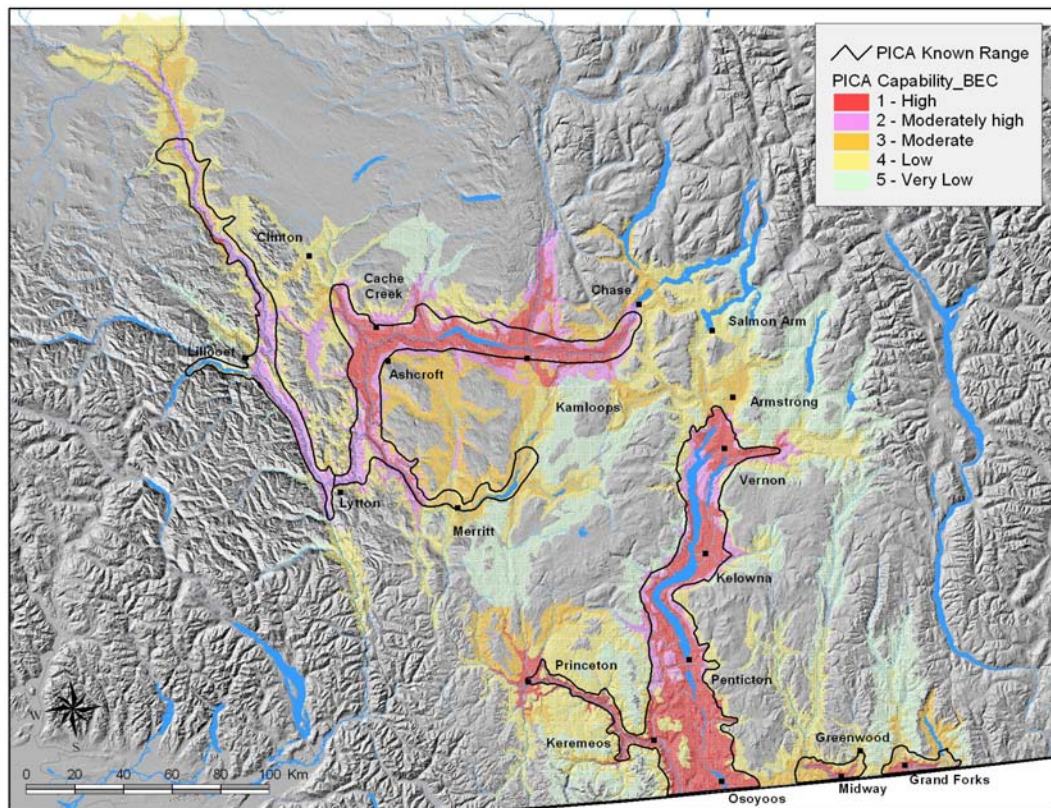


Figure 2: Initial gophersnake habitat capability model, based on BEC.

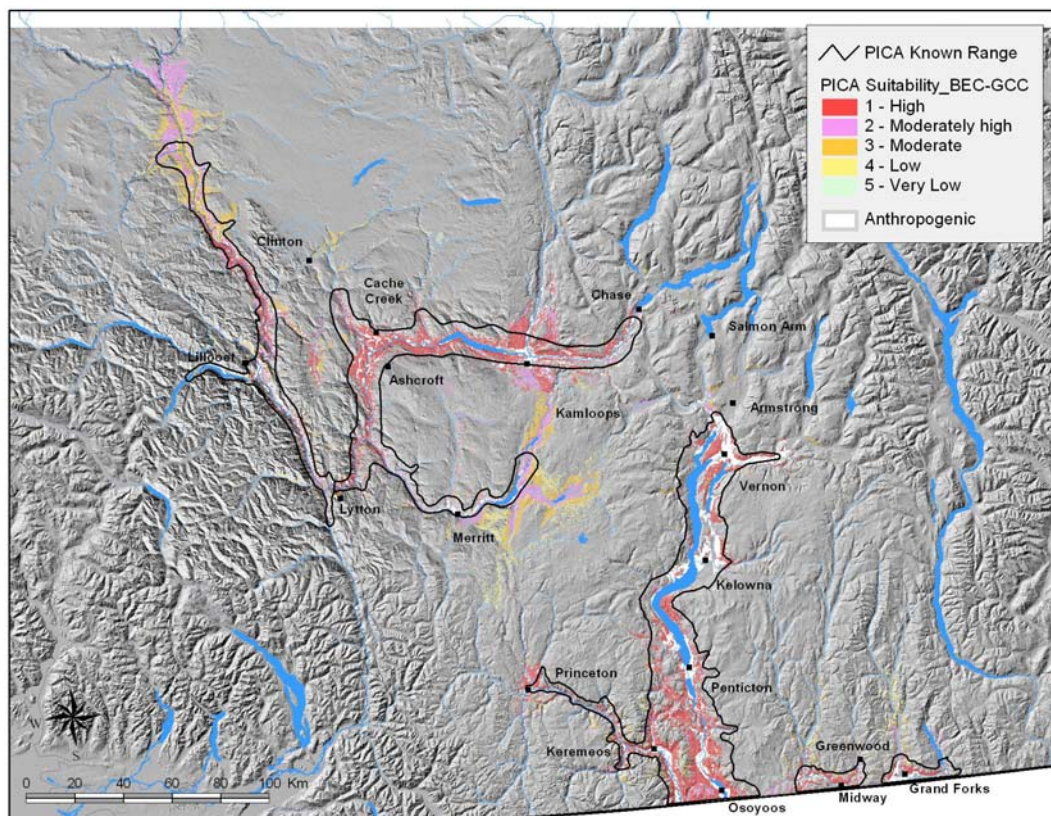


Figure 3: Initial gophersnake habitat suitability model, based on BEC and GCC.

Comparison of the habitat use models to existing TEM models revealed that the amount of habitat portrayed by the finer-scale and more detailed TEM models generally fell somewhere in between the suitability and capability models we developed.

The South Okanagan suitability model, based on pre-TEM biophysical habitat mapping ('Temsocs') portrays much more high and moderate habitat than the BEC-GCC model (Figure 4), and more closely resembles the BEC capability model.

The BEC-GCC suitability model in the Central Okanagan study area, which excludes most of the urban areas, showed very scant habitat compared to the existing TEM model. The BEC capability model appeared overly generous.

In the Bellavista – Goose Lake Range study area, the BEC-GCC suitability model tended to be more generous with high values and less generous with moderate and low values (more 'all or nothing') compared to the TEM model. The BEC capability model appeared to overestimate the amount of available habitat.

The variation between locally modelled gophersnake habitat and the BEC-GCC suitability model is in part due to the BEC-GCC coverage not capturing isolated grassland ecosystems and not having aspect taken into account. There also was less confidence using this system so manual ratings tended to be generous, rating habitat use higher.

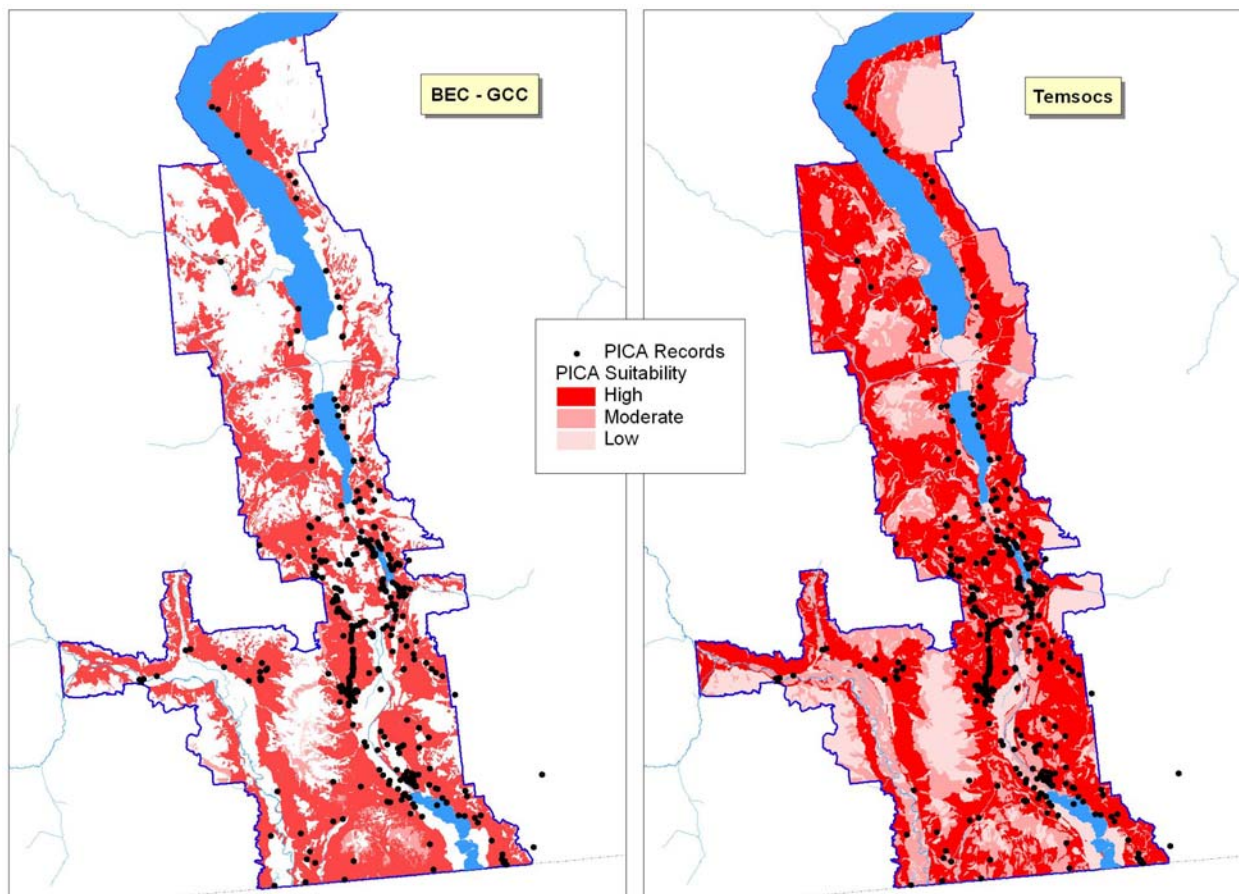


Figure 4: Gophersnake BEC-GCC suitability model compared to Temsocs suitability model.

The final suitability model is based on the initial capability model, with developed areas and water bodies removed (Figure 5). This seemed a reasonable compromise between the two initial models, which best reflected gophersnake habitat.

Almost all of the high suitability habitat (97%) is in the range of the Okanagan-Similkameen and Thompson-Nicola populations (Table 3). Moderate suitability habitat is more spread out, with the majority in the Thompson-Nicola (40%) and Fraser (30%) populations, followed by the Okanagan-Similkameen population (15%). The Fraser and Kettle populations, and the area of the two connections make up the remainder of moderate habitat about equally.

Table 3: Areas of suitable gophersnake habitat by population.

Population	Suitable Habitat (ha)				% of Population			% of Total Range			
	High	Mod.	Low	Total	High	Mod.	Low	High	Mod.	Low	Total
Kettle (Boundary)	7369	20371	4675	32415	23%	63%	14%	2%	6%	4%	4%
Okanagan - Similkameen	182503	58284	43225	284012	64%	21%	15%	54%	16%	41%	35%
Thompson - Nicola	143829	140800	26149	310778	46%	45%	8%	43%	39%	25%	39%
Fraser	1855	108796	28129	138780	1%	78%	20%	1%	30%	27%	17%
Westwold connection	0	16574	616	17190	0%	96%	4%	0%	5%	1%	2%
Pavilion connection	31	18387	3178	21596	0%	85%	15%	0%	5%	3%	3%
Total	335587	363212	105972	804771	42%	45%	13%	100%	100%	100%	100%

Within each population, high and moderate suitability habitat appears to be fairly contiguous and well connected, except in the Kelowna and Vernon areas, and to a lesser extent in the Kamloops area.

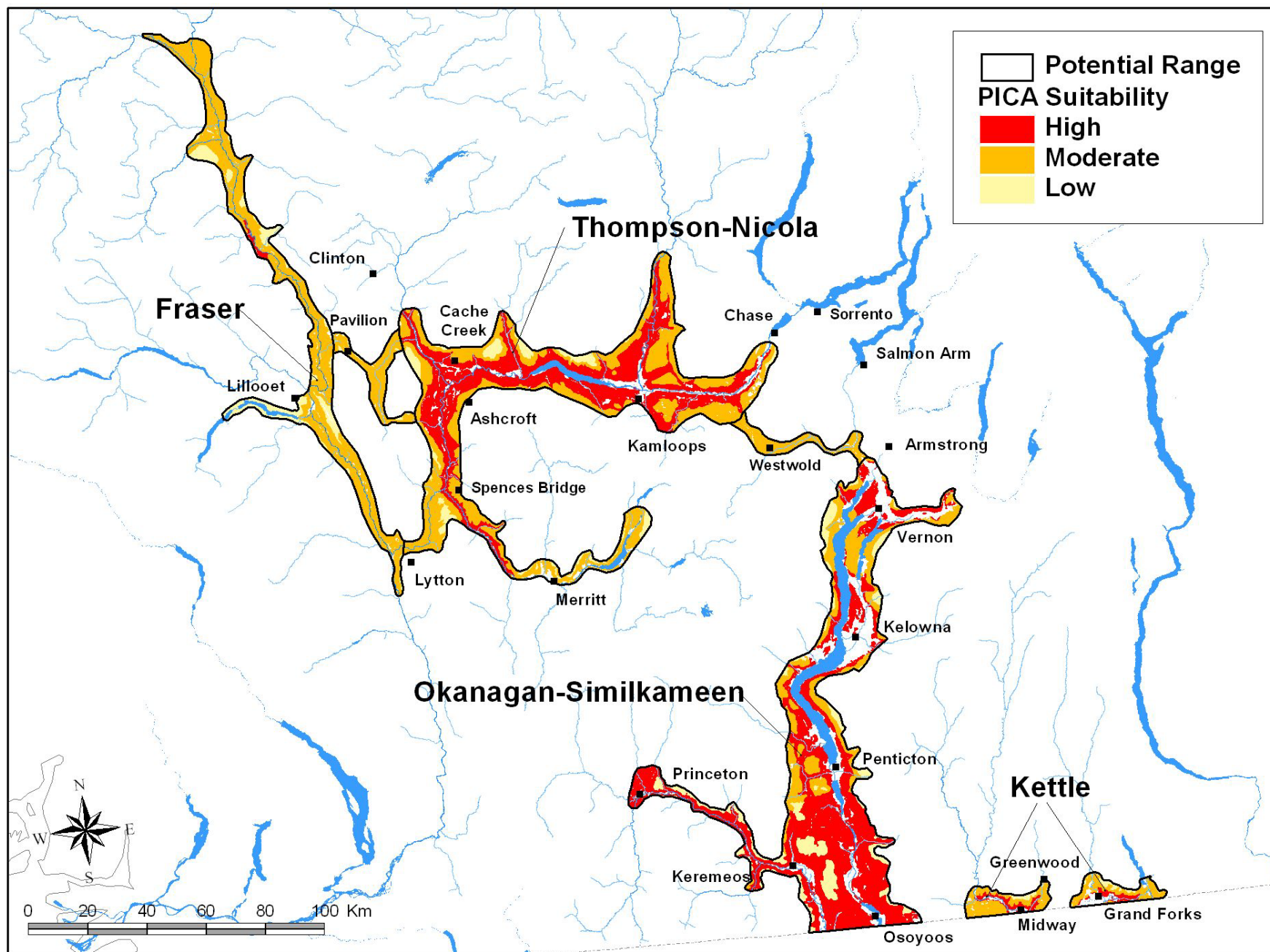


Figure 5: Final gophersnake suitability model.

Land Status

Land status within suitable habitat for gophersnakes is presented in Figure 6. All following analyses use the final suitability model, within the potential range.

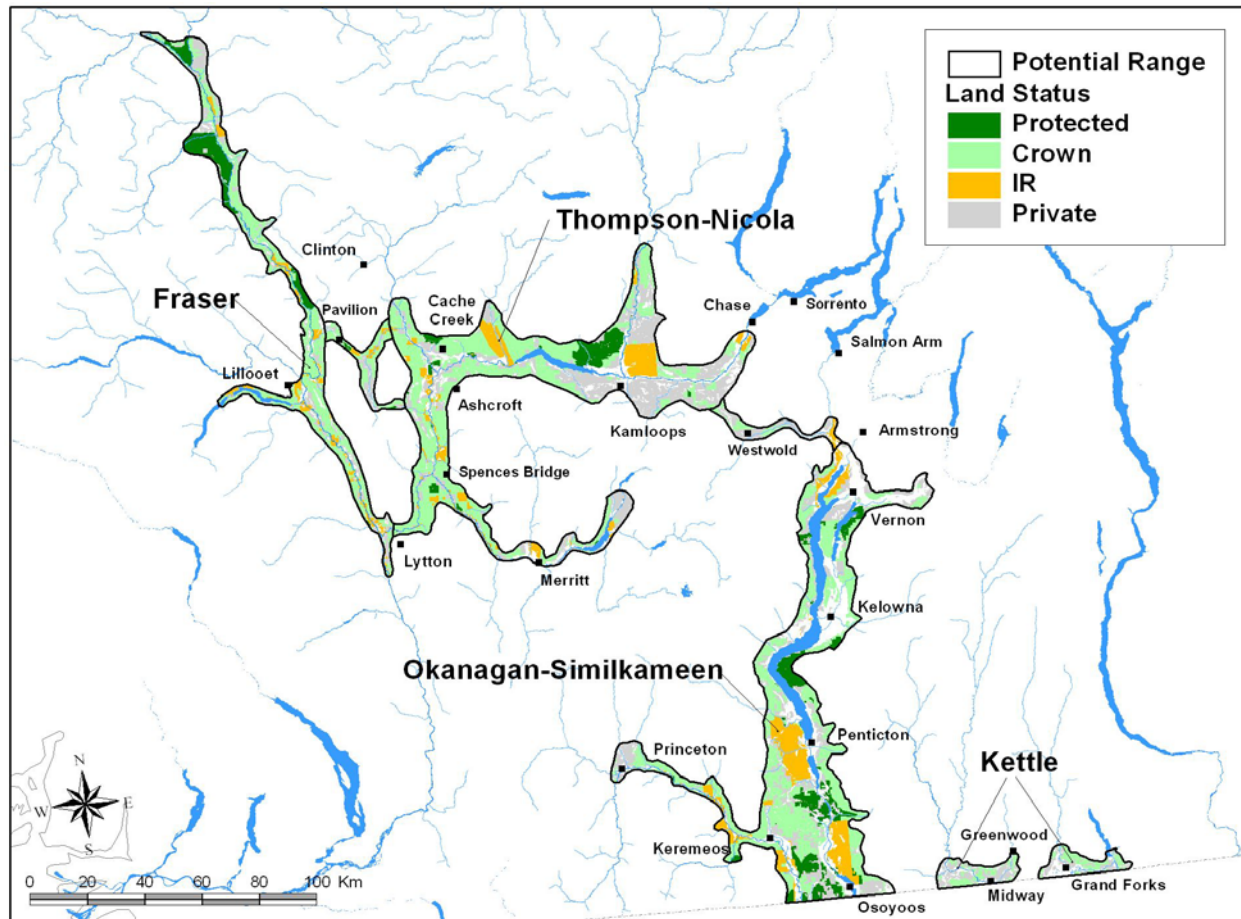


Figure 6: Land status of suitable habitat within the potential range of gophersnakes.

Almost half of all protected lands (all mapped land status with some level of protection for gophersnakes) within the potential range fall in the Okanagan-Similkameen population (45%), with most of the rest in the Fraser (30%) and Thompson-Nicola (24%) populations.

The Fraser population has the highest proportion of protected lands within suitable habitat (16%), followed by the Okanagan-Similkameen (12%) and the Thompson-Nicola (6%). The remaining areas have almost no land classified as protected (0-2%).

All populations have approximately 50% of the suitable habitat as unprotected Crown land, while the Pavilion connection (Thompson/Fraser) has 60% in Crown and the Westwold connection (Okanagan/Thompson) has only 30%. Indian Reserve constitutes approximately 10% of each population and connection, except the Okanagan-Similkameen that has 16%, and the Kettle that has none.

Private land makes up about 20 – 35% of most populations and connections, except the Kettle population and the Westwold connection that have more than 50%.

Conservation Analysis

Figure 7 presents the array of suitability and land status combinations. A table listing the amount of suitable habitat occurring within each land status category is available in Appendix IV.

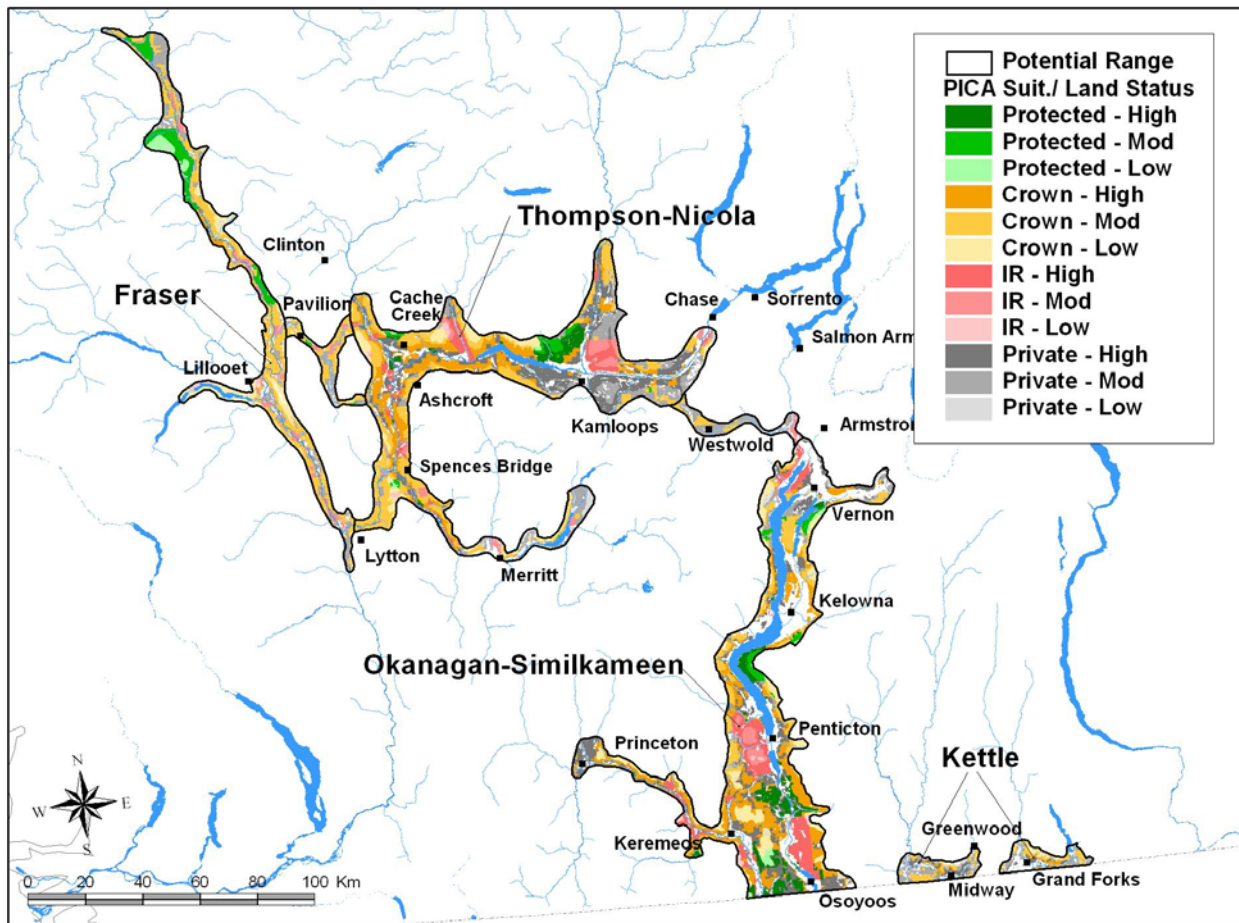


Figure 7: Gophersnake suitability portrayed by land status.

Overall, only 9% of suitable habitat occurs on protected lands. Half of all suitable habitat occurs on unprotected Crown land, and close to 30% on private land. The remainder occurs on IR.

In the Kettle (Boundary) population, virtually all suitable habitat is on private or unprotected Crown land, with the majority of high and moderate suitability on private land. The Okanagan-Similkameen and Thompson-Nicola populations have most of their high and moderate suitability area on unprotected Crown, with 10% and 6%, respectively, of the total suitable habitat occurring as high and moderate on protected land. The Fraser population has very little high suitability, but has the highest proportion of moderate habitat on protected land (12% of total suitable), but the majority of moderate on Crown. The two connections have no high suitability habitat, but most of the moderate habitat in the Westwold connection exists on private (0% of total suitable is on protected land). Most moderate habitat in the Pavilion connection is on Crown (2% of suitable is protected).

Because of the more detailed land status coverage for a portion of the Okanagan-Similkameen, it is likely that a more accurate percentage of the actual land tenure has been represented in this population compared to the other areas.

While gophersnakes do not generally travel more than 1 km from den sites, the vast majority of the suitable habitat occurs more than this distance from protected lands. In the most highly protected populations, the Okanagan and the Fraser, 76% of suitable habitat is greater than 1 km from protected lands (Table 4). In the Kettle it amounts to 98% of suitable habitat.

Table 4: Suitable habitat more than 1km from protected land.

Population	Suitable Habitat >1km from Protected (ha)	% of Suitable
Kettle	31678	98%
Okanagan - Similkameen	215235	76%
Thompson - Nicola	276569	89%
Fraser	105582	76%
Pavilion connection	19330	90%
Westwold connection	16888	98%
Total	665282	83%

Just over half of gophersnake populations' suitable habitat on Crown land appears to be included in the non-timber harvesting land base (non-THLB) layer. As previously discussed, the accuracy of this layer is questionable, however. The Fraser population is the only population with less than half of the suitable Crown habitat in the non-THLB layer, although 75% of the high suitability habitat is on non-THLB Crown land. Only partial THLB coverage is available for this population.

Lands with high conservation potential, due at least to some mandated protection through policy or legislated under SARA, include protected lands, Indian Reserve, and non-THLB Crown land. These areas combined account for almost half of the suitable habitat within gophersnake populations, with more than 25% contributed by non-THLB Crown land (Table 4).

Table 5: Gophersnake habitat (ha and %) on lands with high conservation potential.

Kettle (Boundary)	Suitable Habitat	High	Mod.	Total	High	Mod.	Total
	Protected	1	17	18	0%	0%	0%
	Crown (non-THLB)	2050	4950	8748	6%	15%	27%
	IR	0	0	0	0%	0%	0%
	Subtotal	2051	4967	8766	6%	15%	27%
	Total Suitable	7369	20371	32415			
Okanagan - Similkameen	Suitable Habitat	High	Mod.	Total	High	Mod.	Total
	Protected	23891	6486	34320	8%	2%	12%
	Crown (non-THLB)	47973	19172	76872	17%	7%	27%
	IR	35016	7097	44770	12%	2%	16%
	Subtotal	106880	32755	155962	38%	12%	55%
	Total Suitable	182503	58284	284012			
Thompson - Nicola	Suitable Habitat	High	Mod.	Total	High	Mod.	Total
	Protected	11455	5688	18438	4%	2%	6%
	Crown (non-THLB)	42112	40415	87612	14%	13%	28%
	IR	18343	12775	33335	6%	4%	11%
	Subtotal	71910	58878	139385	23%	19%	45%
	Total Suitable	143829	140800	310778			
Fraser	Suitable Habitat	High	Mod.	Total	High	Mod.	Total
	Protected	7	17066	22368	0%	12%	16%
	Crown (non-THLB) *	1443	21342	30170	1%	15%	22%
	IR	0	10581	12645	0%	8%	9%
	Subtotal	1450	48989	65183	1%	35%	47%
	Total Suitable	1855	108796	138780			
Total	Suitable Habitat	High	Mod.	Total	High	Mod.	Total
	Protected	35354	29257	75144	5%	4%	10%
	Crown (non-THLB)	93578	85879	203402	12%	11%	27%
	IR	53359	30453	90750	7%	4%	12%
	Subtotal	182291	145589	369296	24%	19%	48%
	Total Suitable	335556	328251	765985			

* THLB coverage incomplete for this population

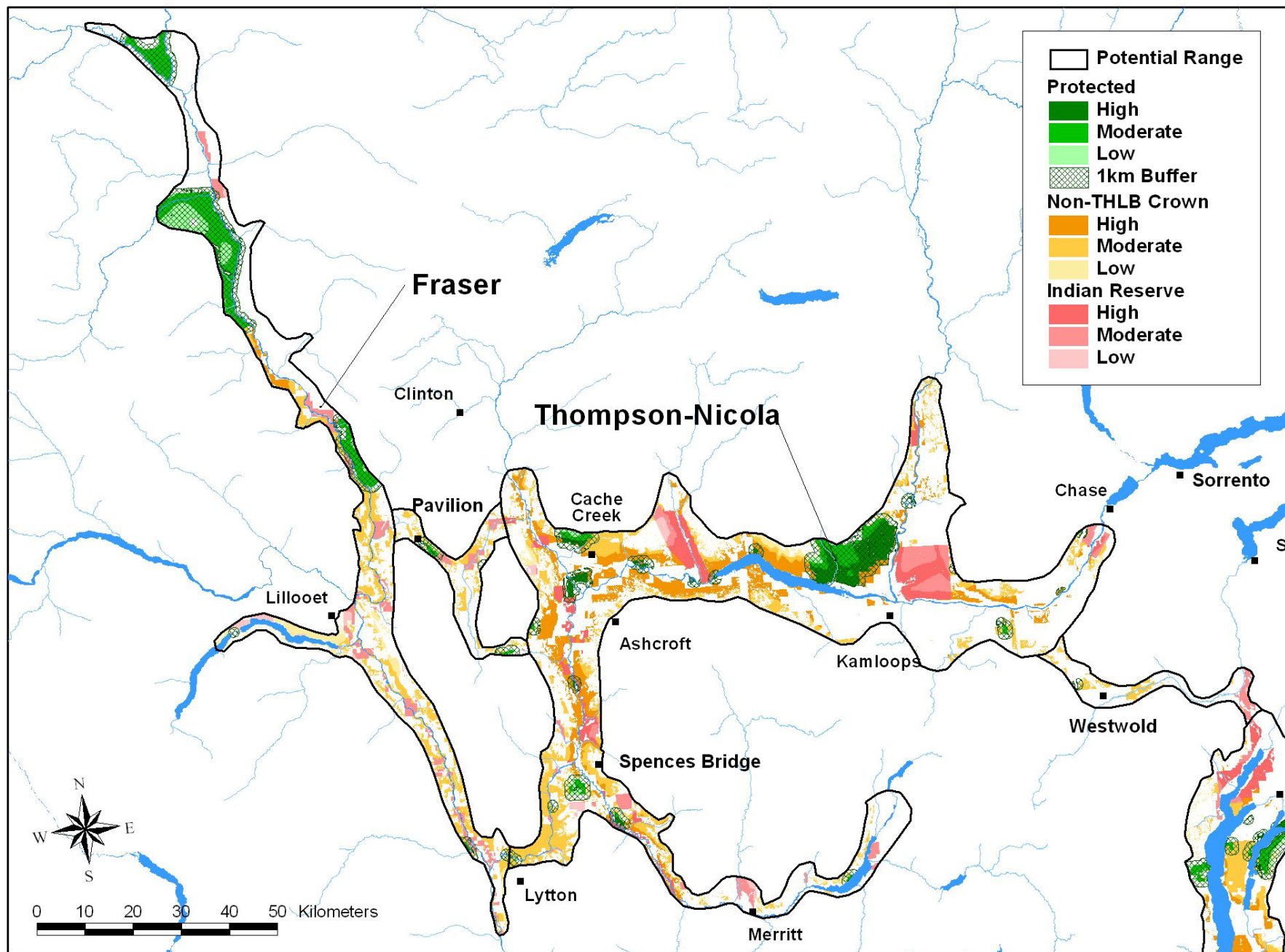


Figure 8: Habitat suitability on lands with high conservation potential in the western range of gophersnakes.

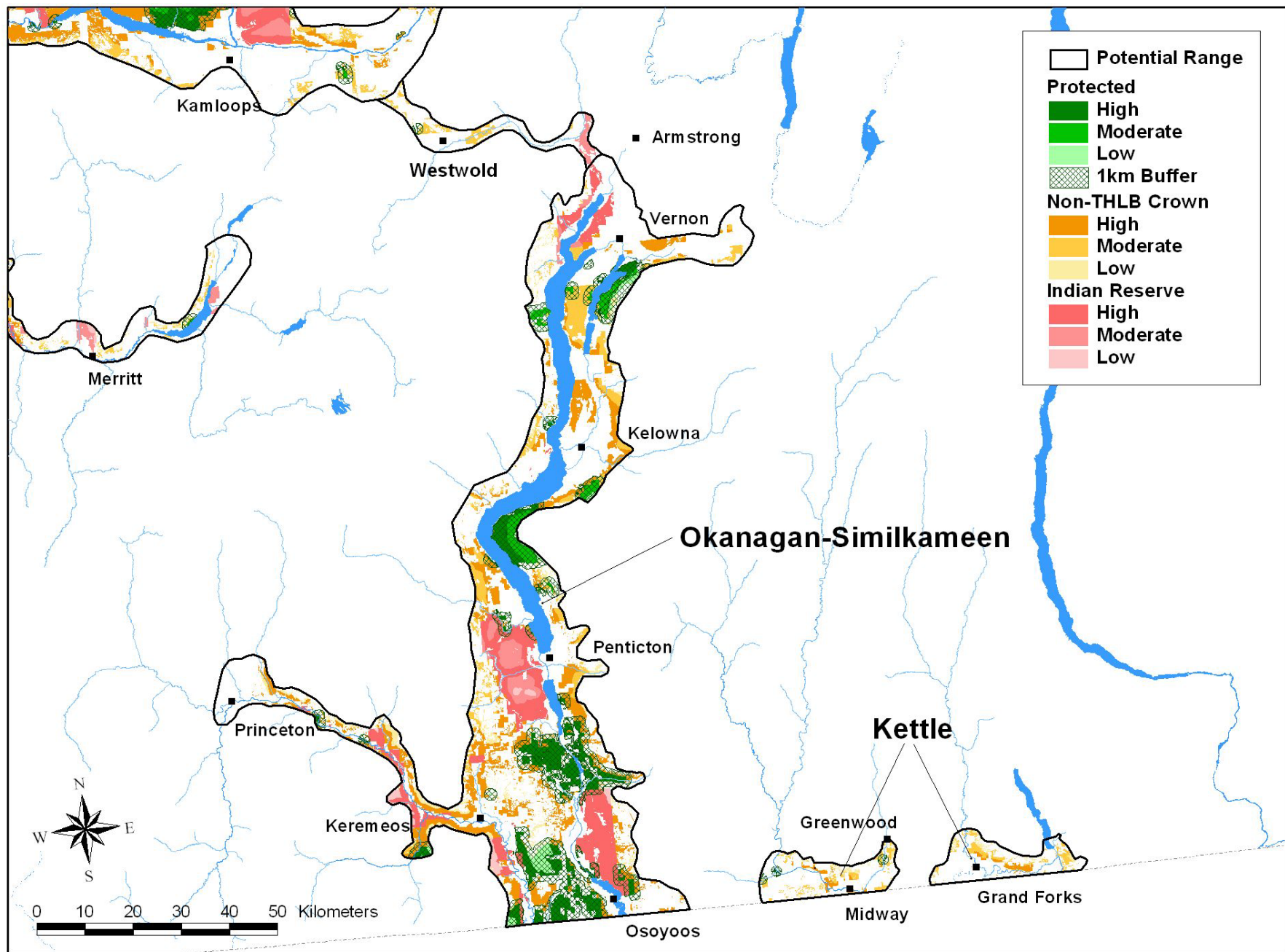


Figure 9: Habitat suitability on lands with high conservation potential in the eastern range of gophersnakes.

DISCUSSION

Populations and Connectivity

Four populations of gophersnakes are proposed for British Columbia (Figure 10). Two of these populations, the Kettle and the Okanagan-Similkameen, currently maintain connectivity with populations in the United States but are themselves disjunct within BC. Connectivity with the northern populations, the Thompson-Nicola and the Fraser, has not been established. It is conceivable that they were once joined from the Okanagan to the Thompson near Sorrento (Shuswap) and Westwold, and from the Similkameen to the Nicola in the Tulameen or Allison Lake area, during the hypsothermal period, about 8,000 years ago. The Westwold connection is the most likely to still maintain this connectivity. Only global warming is likely to re-establish any connectivity in the Similkameen-Nicola or Shuswap connections. The northern two populations are known to be connected at Lytton, and there is a possibility of connectivity through the Pavilion Valley, either through the Hat Creek or the Oregon Jack watersheds on the Thompson side. The Pavilion and the Westwold connections are included in the tenure analysis.

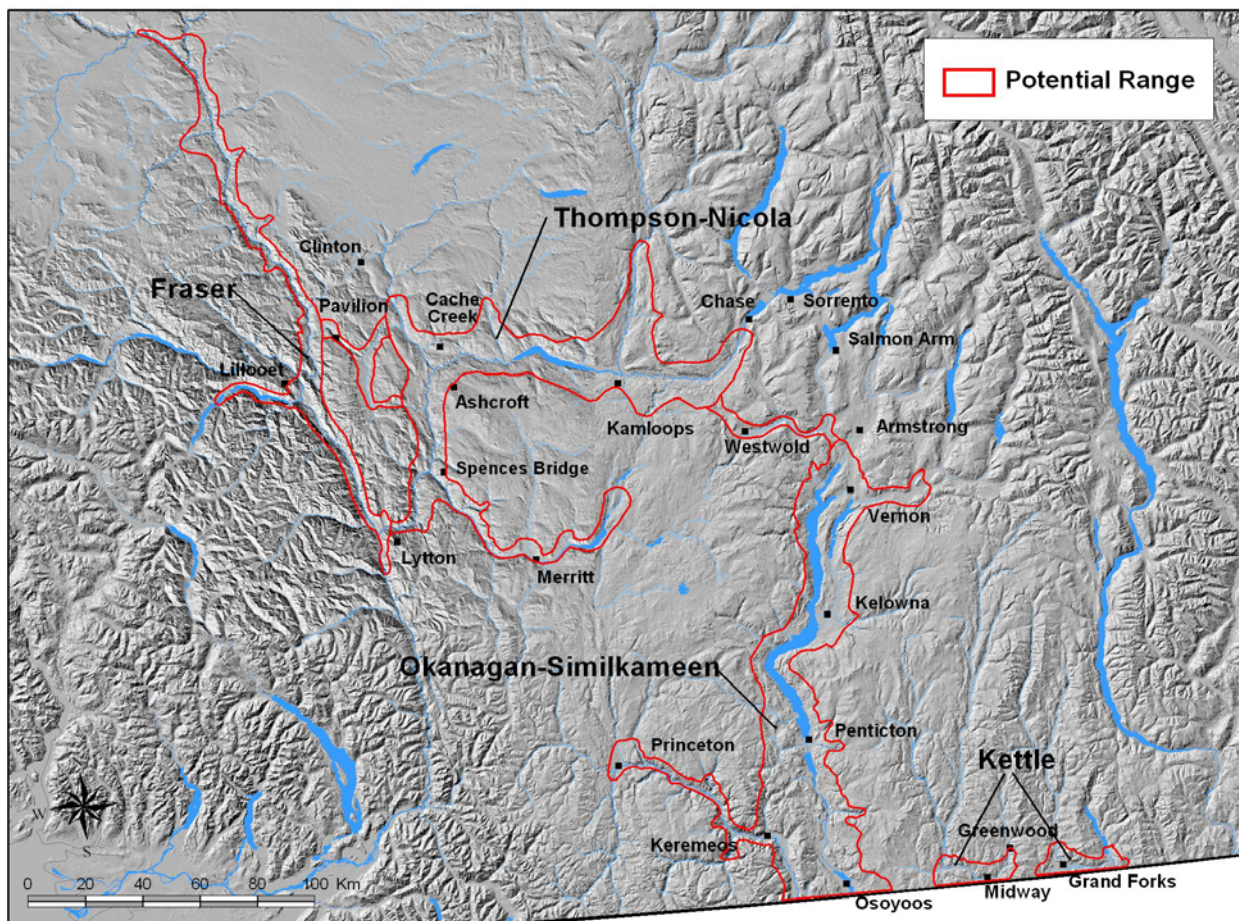


Figure 10: Gophersnake populations and potential corridors in BC.

Tenure of Gophersnake Populations

The following discussions examine the land tenure of gophersnake habitat within each population and suspected corridors. These analyses use high and moderate suitability values when considering 'good' habitat, and only high values when discussing 'best' habitat.

The Kettle (south Boundary) subpopulations are connected in the United States through the Mount Vulcan corridor (not shown on maps). The bulk of the good habitat in this population is on Private land (60%). Fortunately, most of these properties are large, and most owners or long-time residents can recognize a gophersnake from a rattlesnake. Nevertheless, stewardship, targeting landowners with large holdings, could be an effective conservation strategy. The Boundary also has a significant Crown portion (40%) of the high and moderate suitability habitat. Approximately 60% of suitable Crown habitat, and over 80% of the best Crown habitat, appears to be in the non-THLB layer. Much of the Crown lands have forest ingrowth and selective harvesting of smaller diameter stems could benefit gophersnake habitat, providing soil disturbance and soil compaction is minimized and rock outcroppings and areas with boulders are not disturbed.

The Okanagan-Similkameen population is considered a contiguous population, although there is considerable speculation whether the central Okanagan maintains metapopulation connectivity. Continuous human development across private lands along the valley floor, and progressing up the valley sides, threatens to sever the Okanagan subpopulation in the centre of the valley, and is causing increasing fragmentation elsewhere. Private lands make up over 50,000 ha (30%) of the high suitability (best) habitat. Land use planning, stewardship and outreach are essential to implement conservation of gophersnakes and their habitats. Most unprotected Crown land occurs at higher elevations, although in the Okanagan-Similkameen, this can still be very good habitat. Approximately 40% of the best habitat occurs on unprotected Crown lands (almost 70% of which is in the non-THLB layer), forming the bulk of the high suitability habitat. Therefore, establishing WHAs and promoting good resource uses is a high priority as well. Significant amounts of high quality habitat exist on Indian Reserve (20%). Despite the intense efforts of conserving natural landscapes, especially in the South Okanagan, only 13% of the best gophersnake habitat occurs on conservation lands. Conservation issues need to be boldly addressed and effectively implemented in the Okanagan subpopulation due to high development pressures, and the fact that the valley forms the only corridor to the northern populations.

The Thompson-Nicola population appears to be contiguous through the southern Nicola watershed to Spences Bridge. There is no corridor identified through the Stump Lake area in the north Nicola, although grasslands with ground squirrels provide potential habitat. The high and moderate suitability habitat in this area is dominated by Crown (47%) and private (36%), although private lands have a higher percentage of high versus moderate suitability habitat, resulting in more high-valued habitat (42%) than on Crown lands (37%). The first conservation emphasis should be a stewardship/outreach program to all landowners with large holdings (especially those with high-valued habitat). Concurrently, inventories could be conducted on Crown lands and WHAs established where appropriate. Almost 80% of the high suitability habitat on Crown land occurs on the non-THLB layer. Smaller amounts of good habitat occur within Indian Reserve (10%), although most of this represents high suitability habitat. Lands with a conservation mandate represent only 6% of the high and moderate habitat. Conservation strategies involving land use planning are essential in the Kamloops area due to urbanization pressures.

The Fraser population is dominated by moderate-value habitat and has little high suitability. Unprotected Crown land accounts for most of the good habitat (52%), and a very high proportion of the little amount of best habitat (78%). The proportion of this area occurring on non-THLB is unknown, as the THLB coverage for this area is incomplete. Establishing WHAs is the most important conservation activity for this population. Private lands contain the second largest representation with 23% of good habitat. Stewardship/outreach with landowners with large holdings would be effective if the message centred on incorporating best agricultural practices for hayfields and open range. A contact program could also be initiated with First Nations, who have 10% of the gophersnake habitat. Lands with existing conservation mandates only account for 15% of good gophersnake habitat in the Fraser, with none of it high suitability.

Corridors need to be maintained between the Thompson-Nicola and Fraser populations through Lytton. The potential corridor through Pavilion should be investigated. The eastern corridor to the Okanagan through Westwold is not verified and should be investigated as well.

Hypothermal corridors (existing 8000 yrs ago during hotter climes) may have occurred through Sorrento, and between the Similkameen and Nicola drainages, but this is even more speculative. No further analysis of the two potential corridors, Westwold and Pavilion, is warranted until inventories deem that these are useable metapopulation corridors.

Conservation Strategies

Provincial Crown Lands

The strongest protection of gophersnake habitat on provincial Crown lands is through Order-in-Council transfer of administration to create Protected Areas (Parks and Ecological Reserves) and Wildlife Management Areas. Protected Areas are usually established through higher level planning, such as Land and Resource Management Plans (LRMP). It is unlikely that any further Parks will be established unless they have already been identified within an LRMP. WMAs are also subject to higher-level plans but there is more flexibility to top up areas to fulfill conservation objectives. Although WMAs are primarily managed for wildlife, preceding land uses often continue, some of which can be inconsistent with managing habitats for gophersnakes.

Another mechanism for protecting gophersnake habitat is the establishment of Wildlife Habitat Areas (WHA) through the Identified Wildlife Management Strategy (<http://wlapwww.gov.bc.ca/wld/identified/index.htm>). This strategy is applied under the Forest and Range Practices Act (FRPA). A species account for the Great Basin Gophersnake has been prepared (Bertram 2004) and 12 WHAs have been established. It is important to note that only 4 WHAs are still candidates and 15 have been rejected. An interim measure is currently being pursued that can designate Wildlife Habitat Features (WHF). These can apply almost immediate protection to high and medium significance habitat features of Identified Wildlife and Species at Risk. However, WHAs are preferable as they protect the surrounding habitat of the local population, and not just the specific habitat feature.

A less direct means of managing gophersnake habitat is by incorporating good management practices of gophersnakes and their habitats in individual Range Use Plans and Forest Stewardship Plans. Types of prescriptions that could be incorporated are maintaining grass cover to reduce predation on basking and traveling gophersnakes, minimizing soil compaction to

facilitate subterranean access, and ensuring no disturbances occur to rock outcroppings that gophersnakes may use as hibernacula.

Incidental conservation could result within non-contributing land base (NCLB) of Provincial Forest lands. Gophersnake habitat within NCLB may occur in open range, non-productive forest, wildlife tree retention (WTR) areas, old-growth management areas (OGMA), existing forest ecosystem networks (FEN), community watersheds, and sensitive areas. One issue that counters effective conservation on NCLB is that most of the suitable gophersnake habitat is grazed, which has been cited as detrimental due to the collapse of nest sites, trampling of individuals, and increased predation resulting from reduced vegetative cover (Ovaska and Sopuck 2004). Managing towards the Potential Natural Community (PNC), as not only a range but a forestry objective, could provide an indirect means of measuring success of managing for gophersnakes, but there are many factors that contribute to effective management that are beyond the scope of just achieving PNC. Habitats within NCLB are also at risk of numerous disturbances such as the construction of roads and utility corridors, mineral exploration, recreation activities, and disposition of Crown land.

Gophersnake habitat on unprotected Crown land is an important conservation issue for all populations. However, there are no baseline conservation targets and therefore no monitoring to evaluate the success of managing for the maintenance or recovery of gophersnake habitat.

Federal Crown Lands

The strongest protection of gophersnake habitat on Federal lands is through the establishment of National Wildlife Areas (NWA), managed by the Canadian Wildlife Service (CWS). These are secure, and resource use is restricted or prohibited. Only the Vaseux Bighorn NWA lies within the range of the gophersnake.

Since the passing of the Species at Risk Act (SARA 2003), respective agencies of all Federal lands are now required to immediately protect the residences of Species at Risk. A description of gophersnake residence has been drafted (Bertram 2005draft) and will be posted on the public registry to increase public awareness of the species and its residences, promote compliance with prohibitions, and provide enforcement staff with information that will help to recognize infractions of the prohibitions. The greatest challenge will be to identify the specific locations of these residences. Examples of Federal agencies that occupy Federal lands within the range of gophersnakes are the National Research Council, Agriculture and Agri-Food Canada, and the Department of National Defense. All three of these agencies have begun Species at Risk management on their lands. Ultimately, these agencies are expected to enter into Stewardship Agreements, as outlined in SARA (Stratos Inc. 2003).

Transport Canada also may have gophersnake habitat at the Penticton, Kelowna, and Kamloops airports. There is no knowledge as to whether they have significant gophersnake habitat, as they were not a specific tenure in the tenure coverage. Nor is it known whether they have initiated any inventory for Species at Risk on their lands.

Indian Reserves fall under SARA as well. The department of Indian and Northern Affairs Canada (INAC) has initiated a First Nations Land Management Agreement, where Bands can opt out of the land administration sections of the Indian Act and establish their own regimes to manage their lands and resources. An environmental management agreement must be negotiated between each First Nation and the Government of Canada. Environmental protection laws must

be consistent with provincial legislation. Perhaps through this process, SARA can be incorporated in a manner that best suits the local conditions and community interests, while conserving important gophersnake habitat. Whether these land management plans are pursued or not, it is anticipated that each Band will enter into a Stewardship Agreement with Environment Canada, as recommended by SARA (2003).

Private Lands

The most secure manner to protect gophersnake habitat on private lands is through acquisition by private conservation organizations. Organizations that have holdings containing gophersnake habitat include The Nature Trust of British Columbia (TNT), The Land Conservancy (TLC), the Nature Conservancy of Canada (NCC), and Ducks Unlimited Canada (DUC). Although all of these organizations have strong conservation ethics, there are often no specific management provisions for Species at Risk, such as the gophersnake.

Conservation of gophersnake habitat on private lands can be achieved through land use planning that incorporates environmental values. This practice is now promoted in Environmental Best Management Practices, a series of draft publications prepared by the BC Ministry of Water, Lands, and Air Protection (Biodiversity Branch 2004a, 2004b). The best example of incorporating this strategy within the gophersnake's range is by the Central Okanagan Regional District (CORD), which has adopted Sensitive Ecosystem Inventory (SEI) into the Official Community Plans. Using SEI, in conjunction with habitat suitability models, it is possible to protect important habitats during the subdivision approval stage (www.regionaldistrict.com). Ultimately, CORD hopes to use SEI and habitat suitability mapping to develop a conservation strategy to guide both conservation and development, similar to what has been proposed in the Balanced Growth Scenario prepared for the Bella Vista – Goose Lake Range in the North Okanagan (Clarke et al. 2004).

While land use planning is important for the protection of habitats, residents can make a great difference in how habitats are managed on their own lands. Private landowner stewardship programs can increase landowners' awareness of gophersnake needs and threats, and they can modify their behaviours where appropriate. Community stewardship groups are the most effective way to achieve changes in private land management, a concept that has been adopted by the South Okanagan – Similkameen Stewardship Program.

CONCLUSIONS

Gophersnakes and their habitat in the southern interior of British Columbia are at risk from a number of sources. Effective conservation is dependent on correctly identifying and conserving core sub-populations that form corridors throughout each population. A more aggressive approach is required to conserve gophersnake habitat on Crown lands, especially in light of the large amount of suitable habitat on unprotected Crown land, and the recent rejection of 15 proposed WHAs. There also will need to be broad outreach programs initiated throughout their range, as well as stewardship that targets specific private lands. Ultimately, connectivity is most likely attainable at higher elevations, where gophersnake populations are likely smaller due to climatic conditions and poorer habitat quality, lack of deep soils, and ingressed forests. The Southern Interior Reptile Recovery Implementation Team will need to use detailed land tenure coverages to implement conservation activities, including ecosystem-based inventories to improve this broad-scale model and prioritize recovery activities.

RECOMMENDATIONS

1. Obtain accurate land tenure data throughout the range of the gophersnake to direct planning and conservation actions.
2. Inventory potential connections between populations to determine whether metapopulation connectivity exists.
3. Rigorously identify residences on Federal lands.
4. Work with First Nations to identify gophersnake residences and incorporate conservation objectives in land use plans and Stewardship Agreements.
5. Rigorously identify candidate WHAs for gophersnakes on Crown lands throughout their range and champion these until they are established. Establish Wildlife Habitat Features until WHAs are approved.
6. Determine other means to effectively protect gophersnake habitat on Crown lands through the Forest and Range Practices Act.
7. Work with local governments to promote gophersnake conservation through Sensitive Ecosystem Inventories and applying gophersnake habitat use models. Promote the inclusion of important habitats, including corridors, as Environmentally Sensitive Development Permit Areas.
8. Apply the Best Management Practices for Reptiles and Amphibians in Urban and Rural Environments in British Columbia (<http://www3.telus.net/public/leahmalk/BMP.pdf>) on private lands.
9. Promote the conservation of gophersnakes and their habitats on agricultural lands by integrating conservation objectives with Environmental Farm Plans (http://www.bcac.bc.ca/efp_programs.htm) and developing Best Management Practices for Reptiles and Amphibians on Agricultural Lands in British Columbia.
10. Update this conservation analysis within 5 years to incorporate better coverages and new data, as well as to accommodate changes to gophersnake habitat.

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APPENDICES

Appendix I: Detailed methodology for Habitat Use Models and sources of input coverages

Capability

Input coverages:

- 1) Provincial Ecoregion Ecosystem classification mapping (Version 2.01, last update March 2004) - Ministry of Sustainable Resource Management. Scale 1:250,000.
- 2) Provincial Biogeoclimatic Subzone/Variant mapping (Version 5, last update April 2003) – Ministry of Forests, Research Branch. Scale: 1:20,000 to 1:250,000 (see Appendix II).

Provincial Biogeoclimatic (BGC) and Ecoregion Ecosystem classification (ecosection) coverages were intersected in ArcView 3.2a GIS, to provide polygons with the attributes of both input coverages. This intersection resulted in numerous polygon slivers due to discrepancies in coverage linework. Resulting BEC units (Ecosection/BGC combinations) occurring only in polygons less than 0.5 ha were ignored. All other BEC units within 5 km of known gophersnake range (Hobbs and Sarell 2002) were selected, and a ratings table of these units generated. The ratings table was populated by assigning ratings to each BEC unit with the assistance of viewing the area of occurrence and observation records of gophersnakes in ArcView.

Suitability was modeled using the Ecosystem-based Resource Mapping (ERM) Tool (MSRM 2004), an ArcView extension specifically designed to model wildlife habitat or other ecosystem-based ratings. The spatial and ecosystem attribute databases, and the ratings table*, had to be formatted to specifications outlined in the ERM user's guide (MSRM 2004). See Appendix III for a description of the files required to use the ERM tool.

*ERM Note: When generating the user-defined ecosystem attribute table (containing BEC units), ArcView tends to truncate the longer Ecosection names (i.e. Southern Okanagan Highland and Northern Okanagan Highland). These will then not match the listing in the ratings table.

Ratings were initially assigned using a 6-class rating scheme, then modeled and reviewed. Although provincial standards suggest using a 4-class rating scheme based on the knowledge level of the species (RIC 1999), it was decided to use a 6-class rating scheme to provide a higher initial level of discrimination. The final ratings were later converted to a 4-class scheme.

In the first run of the model, it was noticed that some areas potentially containing suitable habitat had been omitted (e.g. between Lillooet and Cache Creek / Ashcroft, and between Kamloops and Armstrong). Although these areas are not within 5 km of the known range, it was suspected that suitable habitats within these areas might provide linkages between populations. Potentially suitable BEC units in these areas were manually selected to be included in the model, and the ratings table revised accordingly. The resulting suitable BEC units were then converted into an ArcView shapefile ('pica_cap_bec'). Based on these potentially suitable areas, a 'Potential Range' coverage was created.

Large-scale BGC mapping is scheduled for the Thompson-Okanagan in March of 2004 (but not yet available) and the Chilcotin in March 2005. This model should be rerun when this mapping is available. The updated BGC mapping should take precedence over the ecosection mapping, using a spatial join to assign the data, rather than intersecting or unioning the coverages. This should result in a much cleaner BEC coverage and avoid slivers.

Suitability (initial)

Input coverages:

- 1) Resulting capability based on BEC from above ('pica_cap_bec', last update 14 November 2004).
- 2) BC Grasslands Mapping ('tgrs_eco', last update November 2003) – Grasslands Conservation Council of BC. Scale and source: 1:20,000 Forest Cover mapping, verified by airphotos and discussions with local experts (see GCC metadata for details).

The Grasslands Conservations Council's grassland mapping (GCC) coverage provided habitat descriptions in the following fields:

- GRASSLANDS – open grasslands; open dry forest adjacent to open grasslands; open dry forest in NDT4; burned forest in PP or BG BGC zone
- GRS_ASSO_VEG – brush adjacent to open grasslands; burn adjacent to open grasslands; clearing adjacent to open grasslands; cultivated or hayfield adjacent to open grasslands; disturbed forest within open grasslands; meadow adjacent to open grasslands; open dry forest on broken terrain adjacent to open grasslands; open dry forest on broken terrain in NDT4
- GRS_ASSO_SPSVEG – clay bank adjacent to open grasslands; gravel bar adjacent to open grasslands; rock adjacent to open grasslands; rock in NDT4; urban area adjacent to open grasslands (includes roads)
- GRS_ASSO_CONIF – open, moist or wet coniferous forest adjacent to open grasslands; coniferous forest within open grasslands (>10% crown closure)
- GRS_ASSO_DECID – aspen forest adjacent to open grasslands; cottonwood forest adjacent to open grasslands; birch, maple or alder forest within open grasslands >10% crown closure); open birch, maple or alder forest adjacent to open grasslands
- GRS_ASSO_WET – lake; river or stream; wetland adjacent to open grasslands

These fields were combined into one field (GRASS_CLS) for the purposes of the model. Although the GCC coverage included BEC information, it was based on 1995 mapping, prior to the extensive recent updates. Only the information contained in the combined field GRASS_CLS was used for the model. Blank polygons were deleted.

Polygons consisting of 'lake' or 'river or stream' were deleted, as these are generally unsuitable habitats, and water features from the BC watershed atlas would be overlaid on the suitability model. Polygons consisting of anthropogenic habitats (urban area adjacent to open grasslands - includes roads; clearing adjacent to open grasslands; cultivated or hayfield adjacent to open grasslands) were selected out and converted into a separate shapefile to be overlaid on the suitability model. Note: none of these 'overlays' overlap.

The revised GCC coverage was then intersected with suitable BEC units from the first model, providing polygons with the attributes of both coverages. This again resulted in many sliver polygons. Polygons less than 0.25 ha were deleted.

A ratings table was generated from a unique list of occurring BEC / GRASS_CLS combinations. Each of these habitat types were rated using a 6-class rating scheme, and modeled using the ERM tool, as described above for capability.

Appendix II: Source and scale of mapping for Version 5 of the provincial digital Biogeoclimatic Subzone/Variant map



Appendix III: Files and format required to run Suitability Model using the ERM Tool

Suitability Based on BEC (resulting shapefile 'PICA_cap_bec'):

File Name	Description	Format
Bec_pica_em.dbf Bec_pica_em.shp Bec_pica_em.shx	Spatial Data	Must contain a field named ECP_TAG; character type and unique for each polygon.
Bec_pica_em.csv	'Standard' Ecosystem Map database	Must contain a field named ECP_TAG; one-to-one link with field in spatial data. Must contain fields SDEC_1, SDEC_2 and SDEC_3 (or TDEC_1 to 3).
Bec_pica_user-defined.csv	User-defined ecosystem database	Must contain a field named ECP_TAG; one-to-one link with field in spatial data. Used for data that does not fit into the standard (e.g. TEM) database.
PICA rating table_bec.csv	Ratings table	Field names must match appropriate fields in user-defined ecosystem database.

Suitability Based on BEC and Grasslands Mapping (resulting shapefile 'PICA_suit_bec-gcc'):

File Name	Description	Format
Bec-gcc_pica_em.dbf Bec-gcc_pica_em.shp Bec-gcc_pica_em.shx	Spatial Data	Must contain a field named ECP_TAG; character type and unique for each polygon.
Bec-gcc_pica_em.csv	'Standard' Ecosystem Map database	Must contain a field named ECP_TAG; one-to-one link with field in spatial data. Must contain fields SDEC_1, SDEC_2 and SDEC_3 (or TDEC_1 to 3).
Bec-gcc_pica_user-defined.csv	User-defined ecosystem database	Must contain a field named ECP_TAG; one-to-one link with field in spatial data. Used for data that does not fit into the standard (e.g. TEM) database.
PICA rating table_bec-gcc.csv	Ratings table	Field names must match appropriate fields in user-defined ecosystem database.

Note: All input and resulting shapefiles are in BC Albers projection.

Appendix IV: Amount of land (in hectares and percent) occurring in the various Suitability and Land Status categories.

Kettle (Boundary)	Suitable Habitat	High	Mod.	Low	Total	High	Mod.	Low	Total	% of H&M
	Protected ¹	1	17	0	18	0%	0%	0%	0%	0%
	Crown	2479	8990	3666	15135	8%	28%	11%	47%	41%
	IR	0	0	0	0	0%	0%	0%	0%	0%
	Private	4889	11364	1009	17262	15%	35%	3%	53%	59%
	Subtotal	7369	20371	4675	32415	23%	63%	14%	100%	100%
	Potential Range	42831				Suit% of Range		76%		
Okanagan - Similkameen	Suitable Habitat	High	Mod.	Low	Total	High	Mod.	Low	Total	% of H&M
	Protected ¹	23891	6486	3943	34320	8%	2%	1%	12%	13%
	Crown	70715	33011	34027	137753	25%	12%	12%	49%	43%
	IR	35016	7097	2657	44770	12%	2%	1%	16%	17%
	Private	52881	11690	2598	67169	19%	4%	1%	24%	27%
	Subtotal	182503	58284	43225	284012	64%	21%	15%	100%	100%
	Potential Range	407057				Suit% of Range		70%		
Westwold connection (Okanagan / Thompson)	Suitable Habitat	High	Mod.	Low	Total	High	Mod.	Low	Total	% of H&M
	Protected ¹	0	5	0	5	0%	0%	0%	0%	0%
	Crown	0	4862	289	5151	0%	28%	2%	30%	29%
	IR	0	1575	97	1672	0%	9%	1%	10%	10%
	Private	0	10132	230	10362	0%	59%	1%	60%	61%
	Subtotal	0	16574	616	17190	0%	96%	4%	100%	100%
	Potential Range	19214				Suit% of Range		89%		
Thompson - Nicola	Suitable Habitat	High	Mod.	Low	Total	High	Mod.	Low	Total	% of H&M
	Protected ¹	11455	5688	1295	18438	4%	2%	0%	6%	6%
	Crown	53578	81133	18734	153445	17%	26%	6%	49%	47%
	IR	18343	12775	2217	33335	6%	4%	1%	11%	11%
	Private	60453	41204	3903	105560	19%	13%	1%	34%	36%
	Subtotal	143829	140800	26149	310778	46%	45%	8%	100%	100%
	Potential Range	364586				Suit% of Range		85%		
Pavilion connection (Thompson / Fraser)	Suitable Habitat	High	Mod.	Low	Total	High	Mod.	Low	Total	% of H&M
	Protected ¹	0	466	48	514	0%	2%	0%	2%	3%
	Crown	3	10168	2843	13014	0%	47%	13%	60%	55%
	IR	28	1752	57	1837	0%	8%	0%	9%	10%
	Private	0	6001	230	6231	0%	28%	1%	29%	33%
	Subtotal	31	18387	3178	21596	0%	85%	15%	100%	100%
	Potential Range	23063				Suit% of Range		94%		
Fraser	Suitable Habitat	High	Mod.	Low	Total	High	Mod.	Low	Total	% of H&M
	Protected ¹	7	17066	5295	22368	0%	12%	4%	16%	15%
	Crown	1454	56176	18063	75693	1%	40%	13%	55%	52%
	IR	0	10581	2064	12645	0%	8%	1%	9%	10%
	Private	394	24973	2707	28074	0%	18%	2%	20%	23%
	Subtotal	1855	108796	28129	138780	1%	78%	20%	100%	100%
	Potential Range	152105				Suit% of Range		91%		
Total	Suitable Habitat	High	Mod.	Low	Total	High	Mod.	Low	Total	% of H&M
	Protected ¹	35354	29728	10581	75663	4%	4%	1%	9%	9%
	Crown	128229	194340	77622	400191	16%	24%	10%	50%	46%
	IR	53387	33780	7092	94259	7%	4%	1%	12%	12%
	Private	118617	105364	10677	234658	15%	13%	1%	29%	32%
	Subtotal	335587	363212	105972	804771	42%	45%	13%	100%	100%
	Potential Range	1008856				Suit% of Range		80%		

¹ Includes Protected Areas, WHAs, and in the South Okanagan WMAs, private conservation and NRC federal land.