Species at Risk Act
Recovery Strategy Series
Adopted under Section 44 of SARA

Recovery Strategy for the Great Basin Spadefoot (*Spea intermontana*) in Canada

Great Basin Spadefoot

2017

Government of Canada
Gouvernement du Canada

Canada

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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

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[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

RECOVERY STRATEGY FOR THE GREAT BASIN SPADEFOOT (*Spea intermontana*) IN CANADA

2017

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of British Columbia has given permission to the Government of Canada to adopt the *Recovery Plan for the Great Basin Spadefoot (*Spea intermontana*) in British Columbia* (Part 2) under Section 44 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the Great Basin Spadefoot in Canada consists of two parts:

Part 1 – Federal Addition to the *Recovery Plan for the Great Basin Spadefoot (*Spea intermontana*) in British Columbia*, prepared by Environment and Climate Change Canada.

Part 2 – *Recovery Plan for the Great Basin Spadefoot (*Spea intermontana*) in British Columbia*, prepared by the Southern Interior Reptile and Amphibian Working Group for the British Columbia Ministry of Environment.

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Part 1 – Federal Addition to the *Recovery Plan for the Great Basin Spadefoot (*Spea intermontana*) in British Columbia*, prepared by Environment and Climate Change Canada

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Great Basin Spadefoot and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Province of British Columbia, as per section 39(1) of SARA. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Province of British Columbia provided the attached recovery plan for the Great Basin Spadefoot (Part 2) as science advice to the jurisdictions responsible for managing the species in British Columbia. It was prepared in cooperation with Environment and Climate Change Canada.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Great Basin Spadefoot and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

Acknowledgements

The development of this recovery strategy addition was coordinated by Kella Sadler, Matt Huntley, and David Cunnington (Environment and Climate Change Canada, Canadian Wildlife Service (ECCC CWS) - Pacific Region. Kristiina Ovaska and Lennart Sopuck (Biolinx Environmental Research Ltd.) compiled information for the first draft of this recovery strategy under contract with Environment and Climate Change Canada. Substantial input and/or collaborative support was provided by Kim Borg (ECCC CWS – National Capital Region), Orville Dyer (B.C. Ministry of Forest, Lands and Natural Resource Operations), Dave Trotter (B.C. Ministry of Agriculture), Karl Larsen (Thompson Rivers University), Purnima Govindarajulu (B.C. Ministry of Environment), Natasha Lukey (Okanagan Similkameen Stewardship Society), and Dustin Oaten (SLR Consulting Ltd.). Sean Butler, Jeffrey Thomas and Danielle Yu (ECCC CWS-Pacific Region) provided additional assistance with mapping and figure preparation.

Additions and Modifications to the Adopted Document

The following sections have been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Recovery Plan for the Great Basin Spadefoot (*Spea intermontana*) in British Columbia* (Part 2 of this document, referred to henceforth as “the provincial recovery plan”) and/or to provide updated or additional information.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery plan referring to protection of survival/recovery habitat may not directly correspond to federal requirements. Recovery measures dealing with the protection of habitat are adopted; however, whether these measures will result in protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

1. Critical Habitat

This section replaces the “Section 7.1: Description of the Species’ Survival/Recovery Habitat” section in the provincial recovery plan.

Section 41 (1)(c) of SARA requires that recovery strategies include an identification of the species’ critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. The provincial recovery plan for Great Basin Spadefoot includes a description of the biophysical attributes of survival/recovery habitat. This science advice was used to inform the following critical habitat sections in this federal recovery strategy.

Critical habitat is partially identified in this recovery strategy. A schedule of studies (Section 1.2) has been included that identifies the activities required to complete the identification of critical habitat in supporting the population and distribution objectives.

Critical habitat for Great Basin Spadefoot is identified in this document to the extent possible; as responsible jurisdictions and/or other interested parties conduct research to address knowledge gaps, the existing critical habitat methodology and identification may be modified and/or refined to reflect new knowledge.

1.1 Identification of the Species’ Critical Habitat

Geospatial location of areas containing critical habitat

Critical habitat for Great Basin Spadefoot is identified in six geographic areas of southern interior British Columbia. These six geographic areas align with those described in the provincial recovery plan for Great Basin Spadefoot (i.e., Figure 4 of that document):

- Kettle (Figure 1)
- Granby (Figure 2)

- Okanagan/Similkameen (Figures 3-8)
- Nicola (Figures 9-10)
- Thompson (Figures 11-15)
- Cariboo (Figures 16-17)

Critical habitat for Great Basin Spadefoot is based on all available verified occurrence records[4] for the species. Within the six geographic areas where it occurs, Great Basin Spadefoot requires both aquatic breeding habitat and surrounding terrestrial habitat (for foraging, overwintering, and refuge) to complete life history functions. Together, the aquatic habitat and surrounding terrestrial habitat form the "core" critical habitat that is essential for the persistence of the local breeding population. Core critical habitat is identified to encompass these movements and regular seasonal migration routes between aquatic and terrestrial habitat. Longer movements of Great Basin Spadefoot beyond the core critical habitat occur across additional upland habitat. These dispersal movements are not part of regular seasonal habitat use but allow for colonization of new breeding sites, and/or recolonization of those that are not available each year; as such they are required to maintain long-term persistence and gene flow among populations. The additional terrestrial habitat required to meet this species' need is termed "connectivity" critical habitat.

There is limited information on the specific movement habits of the Great Basin Spadefoot in B.C. and other areas. The most pertinent data are from two telemetry studies conducted within the northern portion of the Great Basin Spadefoot's range in B.C. (Garner 2012; Richardson and Oaten 2013), which indicate that a band of 500 m of terrestrial habitat around breeding sites will encompass most movements of individuals and allow them to complete their life history functions. Further, the 500 m estimate aligns with NatureServe (2014) recommendation for habitat use by spadefoots, based on review by Hammerson (2005). The longest movement recorded for the Great Basin Spadefoot is 2350 m through telemetry (Richardson and Oaten 2013).

The area containing critical habitat for Great Basin Spadefoot is delineated based on sequential application of the following methods:

(1) application of a 500 m distance around all available verified occurrence records[5], delineated to represent the essential terrestrial areas required by the species for life history functions;

[4] All verified records of Great Basin Spadefoot with sufficient location accuracy (i.e., ≤ 100 m uncertainty distance) were used regardless of the life stage, date of collection, or method, including environmental DNA sampling, radio telemetry studies, auditory surveys, visual surveys of wetlands, incidental observations of live animals, and roadkills.

[5] The 500 m distance was applied to all occurrences owing to the facts that (a) many of the data points were from auditory surveys from roads (indicating breeding in nearby, but unspecified, sites), (b) the type of record (aquatic or terrestrial) was often not indicated, and because (c) spadefoots often use small, ephemeral ponds that may be dry in some years and may not be mapped (or visible on terrestrial photography, depending on date of imagery), such that most records (e.g., auditory surveys and roadkills) cannot be reliably matched or mapped to specific water bodies (i.e., for spatial identification of known/potential breeding sites).

(2) application of minimum convex polygons[6] around groups of overlapping essential terrestrial areas to create "**core**" critical habitat;

(3) selection of any occurrence records that were within 2.4 km of another occurrence record (i.e., to account for maximum movement capabilities), and identification of additional "**connectivity**" critical habitat between their essential terrestrial areas (identified in step (1)) wherever not already identified as "core" critical habitat; and,

(4) geospatial exclusion of any areas above 1230 m in elevation[7], and removal of any connectivity critical habitat areas where core critical habitat was separated by movement barriers (i.e., open water areas > 1 km in width, high elevation terrain).

Biophysical attributes of "core" critical habitat

The biophysical features and attributes required for Great Basin Spadefoot life history functions in core habitat areas (as outlined in the provincial recovery plan, and as summarized in Table 1) overlap biophysically, geospatially, seasonally, and across life history stages. Within the geospatial areas containing core critical habitat, only clearly unsuitable areas that do not support the species in any life history stage (i.e., do not contain any of the biophysical features or attributes required by the species at any time) are not identified as core critical habitat.

[6] A minimum convex polygon is the smallest shape, drawn with straight line segments, which will surround all essential terrestrial areas as identified in step 2. As an analogy, picture an elastic stretched around a group of pegs on a peg board.
[7] The highest elevation Great Basin Spadefoot has been reported in B.C. is 1230 m.

Table 1. Summary of essential functions, biophysical features, and key attributes of Great Basin Spadefoot core critical habitat, by life stage (including aquatic breeding and terrestrial/upland features).

Life stage	Function	Biophysical Feature(s)	Attributes
Adults; juveniles; eggs; tadpoles	Courtship, mating, egg-laying; foraging and development	Vernal Ponds (seasonal and temporary wetlands)	• wet areas at any time having these features: -shallow areas of less than 1 m depth, required for development of eggs and tadpoles -emergent vegetation (e.g., grasses, sedges, rushes), sticks, rocks, or other debris, required to provide egg attachment surfaces - algae, aquatic vegetation, and other organic matter, required as food for tadpoles • dry areas that become wet areas under the right conditions, identified at any time by: depressions with bare mud, sedges, rushes, or other hydrophilic plants
Adults; juveniles; eggs; tadpoles	Courtship, mating, egg-laying; foraging and development	Lakes, ponds, marshes, springs, sluggish streams, and seasonally wetted margins around permanent waterbodies	• shallow areas less than 1 m depth, required for development of eggs and tadpoles • emergent vegetation (e.g., grasses, sedges, rushes), sticks, rocks, or other debris, required to provide egg attachment surfaces • algae, aquatic vegetation, and other organic matter, required as food for tadpoles • optimally, an absence of predatory fish (sport fish, goldfish (*Carassius auratus)*, and fish used for mosquito control or other purposes)
Adults; juveniles (metamorphosed)	Foraging, refuge, overwintering, seasonal migrations	Grassland, shrub-steppe, open forest	• friable (easily crumbled) soils that permit burrowing (e.g., clay loam, fine gravel, clay, sandy soils), existing burrows (may include firmer soils), or naturally occurring holes or crevices • small vertebrate and invertebrate prey (e.g., earthworms, ants, beetles, flies, grasshoppers, etc.) • active-season refuges: self-made burrows, rodent burrows (ground squirrel, pocket gopher), surface cover objects such as flat rocks and coarse woody debris • overwintering refuges: self-made burrows, rodent burrows, crevices, or soil mounds that are sufficiently deep to permit access to frost-free areas (40–145 cm)

Biophysical attributes of “connectivity” critical habitat

The biophysical features and attributes required for Great Basin Spadefoot life history functions in connectivity habitat areas are outlined in the provincial recovery plan, and summarized in Table 2. Within the geospatial areas containing connectivity critical habitat, only clearly unsuitable areas that do not support the needs of adult and juvenile dispersal are not identified as connectivity critical habitat.

Table 2. Summary of essential functions, biophysical features, and attributes of Great Basin Spadefoot connectivity critical habitat.

Life stage	Function	Biophysical Feature(s)	Attributes
Adults, juveniles	Dispersal in between, and/or to new core aquatic and terrestrial habitats	Grassland, shrub-steppe, open forest, may include some human-modified habitats such as urban and agricultural areas	• friable (easily crumbled) soils that permit burrowing (e.g., clay loam, fine gravel, clay, sandy soils), existing burrows (may include firmer soils), or naturally occurring holes or crevices; may also move over patches of human-modified substrates such as pavement, lawns, etc. • small vertebrate and invertebrate prey (e.g., ants, beetles, flies, spiders, etc.) • refuges: self-made burrows, rodent burrows (ground squirrel, pocket gopher), rocks, logs, coarse woody debris, or other surface cover objects that provide shelter

The areas containing core and connectivity critical habitat for Great Basin Spadefoot are presented in Figures 1-17. Core critical habitat for Great Basin Spadefoot in Canada occurs within the shaded pink polygons shown on each map where the core habitat biophysical features and attributes described in this section occur. Connectivity critical habitat for Great Basin Spadefoot in Canada occurs within the shaded yellow polygons shown on each map where the connectivity habitat biophysical features and attributes described in this section occur. Within these polygons, only clearly unsuitable habitats are not identified as critical habitat. Examples of clearly unsuitable habitats include: (i) existing permanent infrastructure (buildings, extensive spans of artificial surfaces, running surface of major paved roads having high traffic volumes); (ii) large fast flowing rivers, portions of water bodies that are permanently over 1 m depth; and, (iii) elevations over 1230 m.

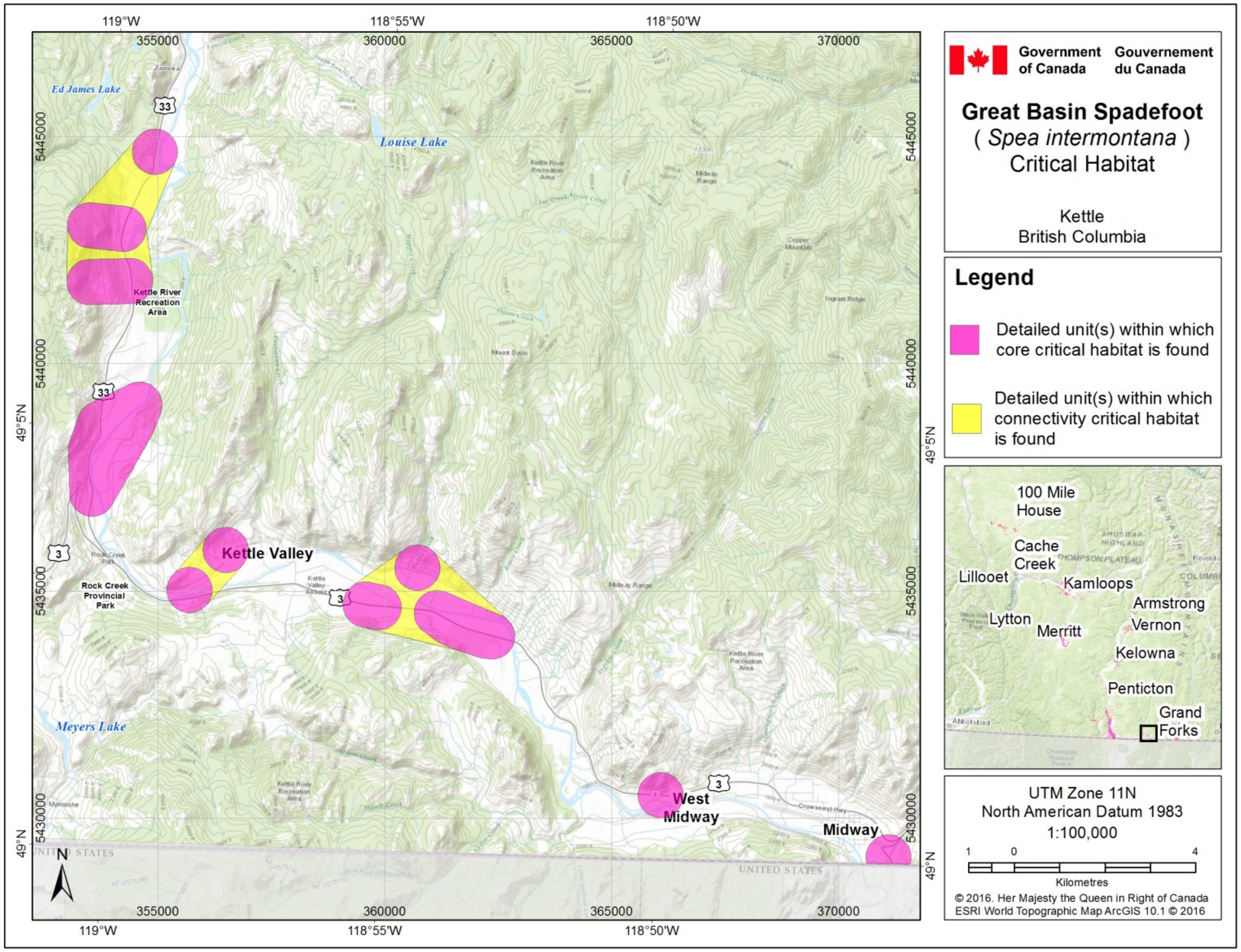

Figure 1. Critical habitat for the Great Basin Spadefoot in the Kettle area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

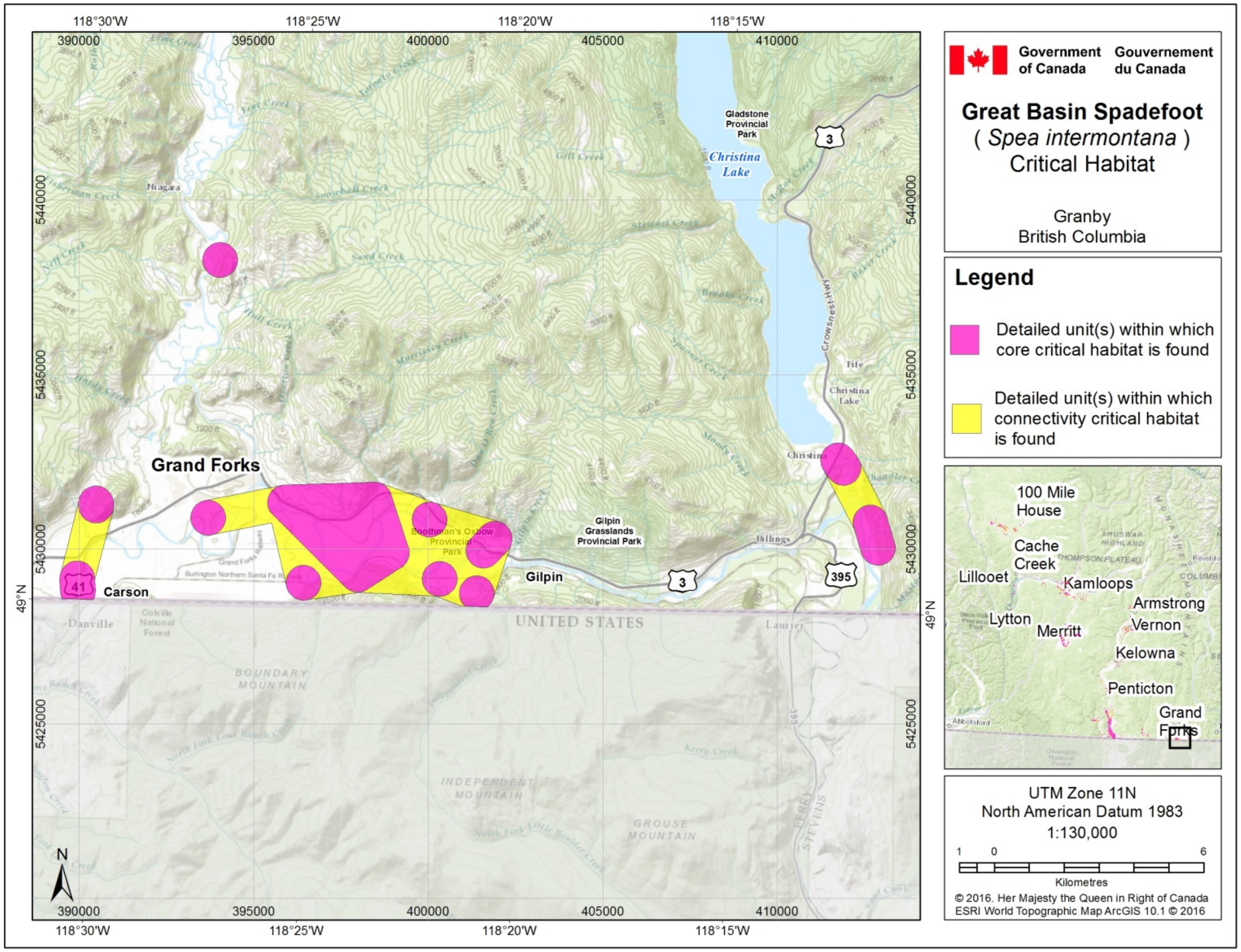

Figure 2. Critical habitat for the Great Basin Spadefoot in the Granby area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

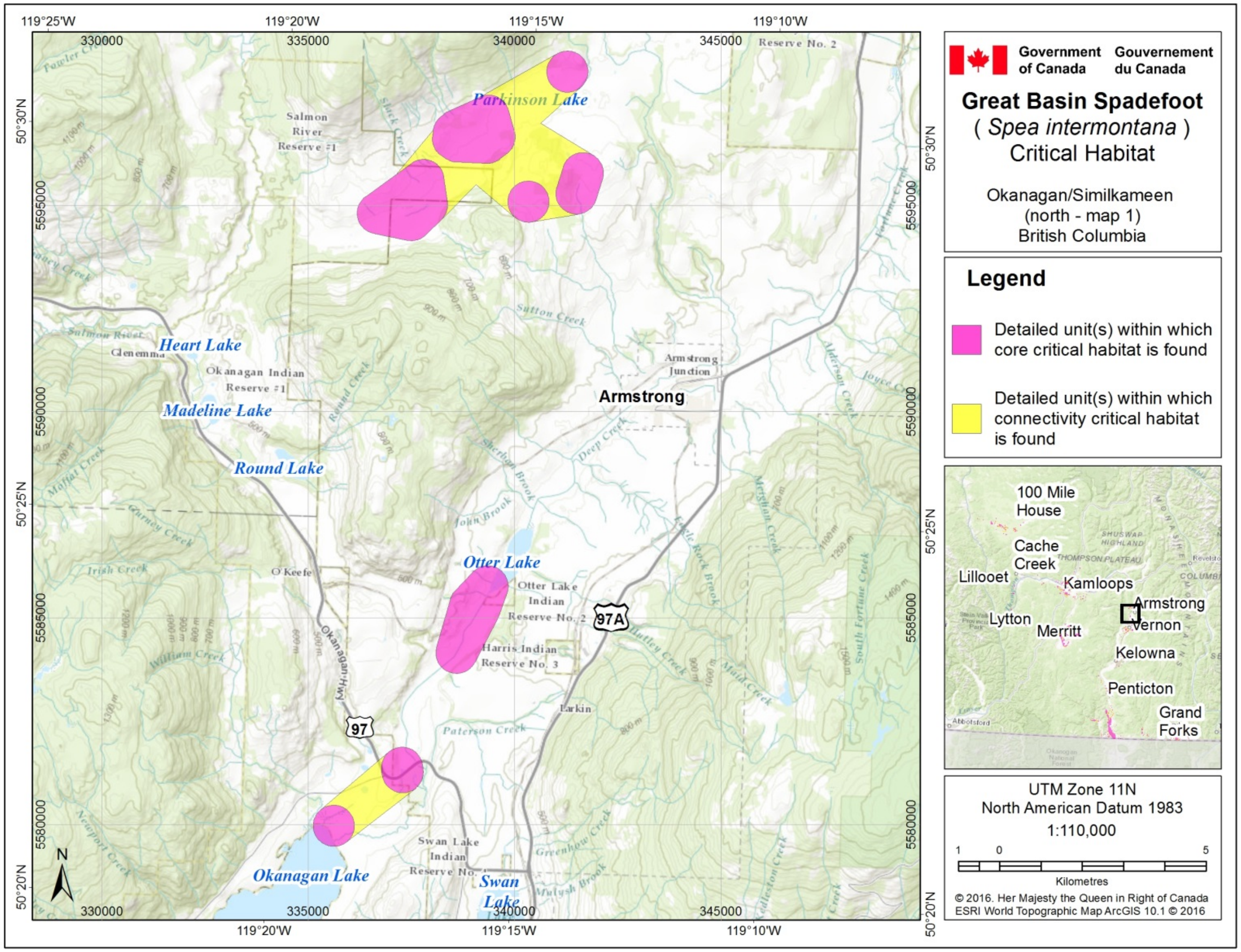

Figure 3. Critical habitat for the Great Basin Spadefoot in the Okanagan/Similkameen (north-map 1) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

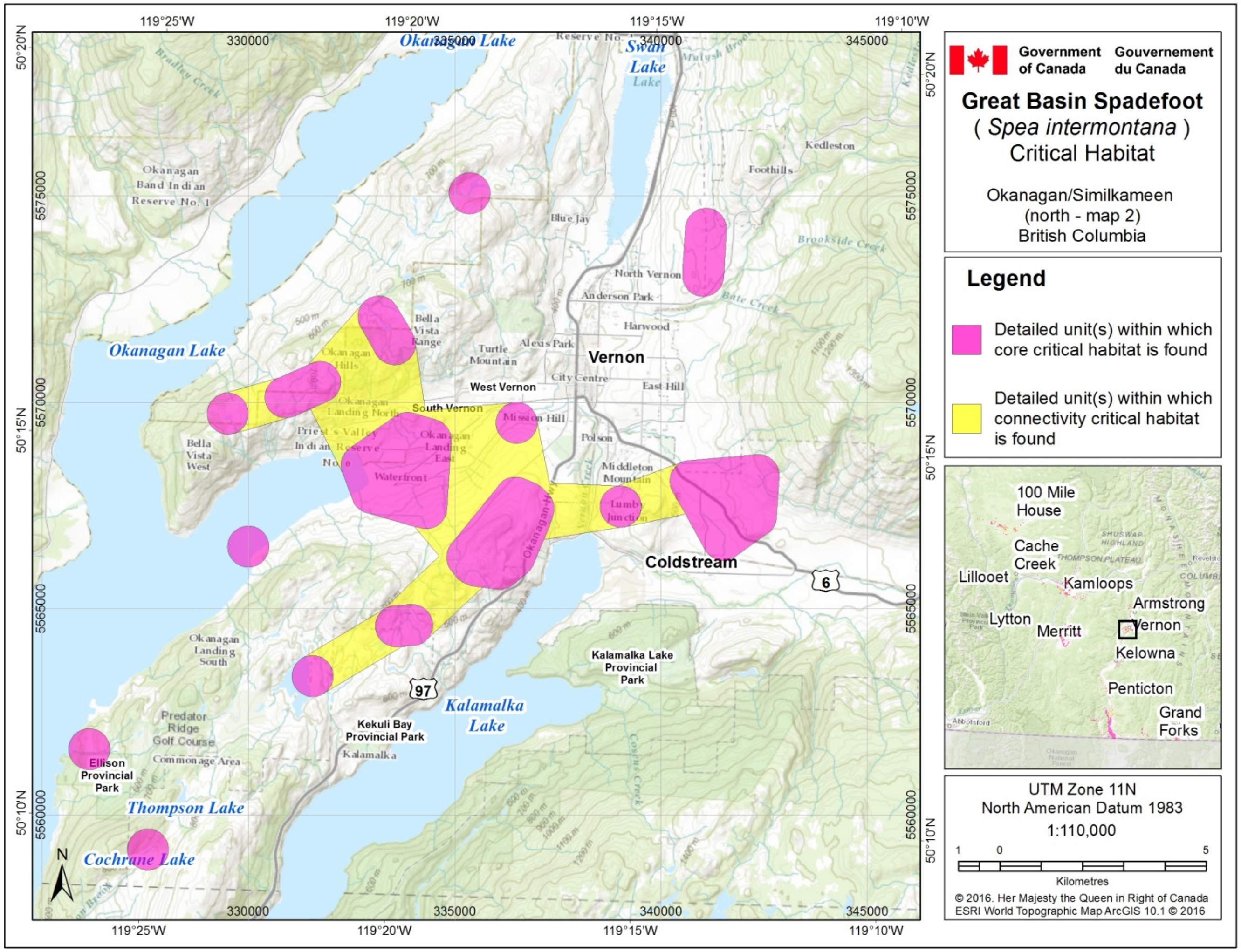

Figure 4. Critical habitat for the Great Basin Spadefoot in the Okanagan/Similkameen (north – map 2) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

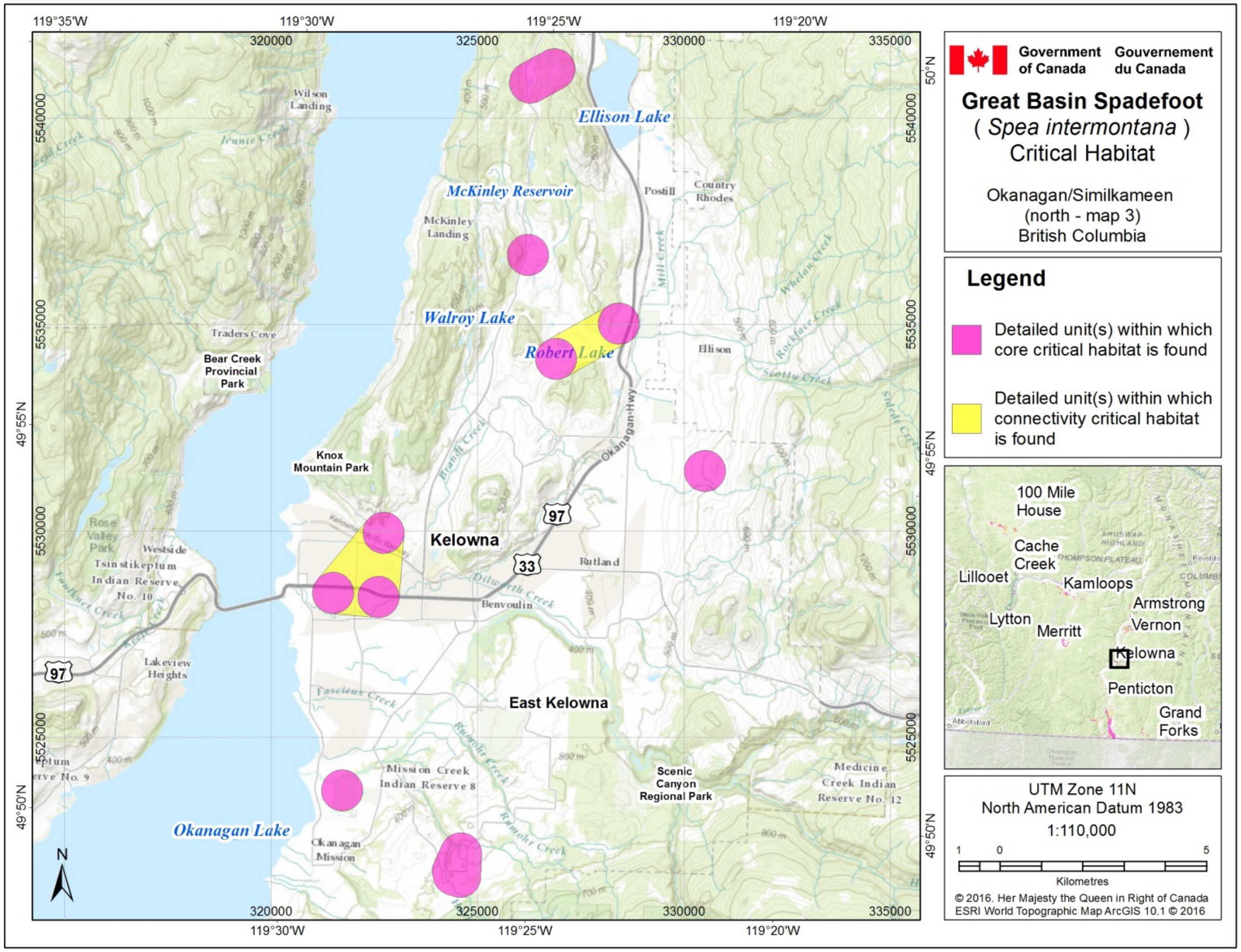

Figure 5. Critical habitat for the Great Basin Spadefoot in the Okanagan/Simikameen (north – map 3) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

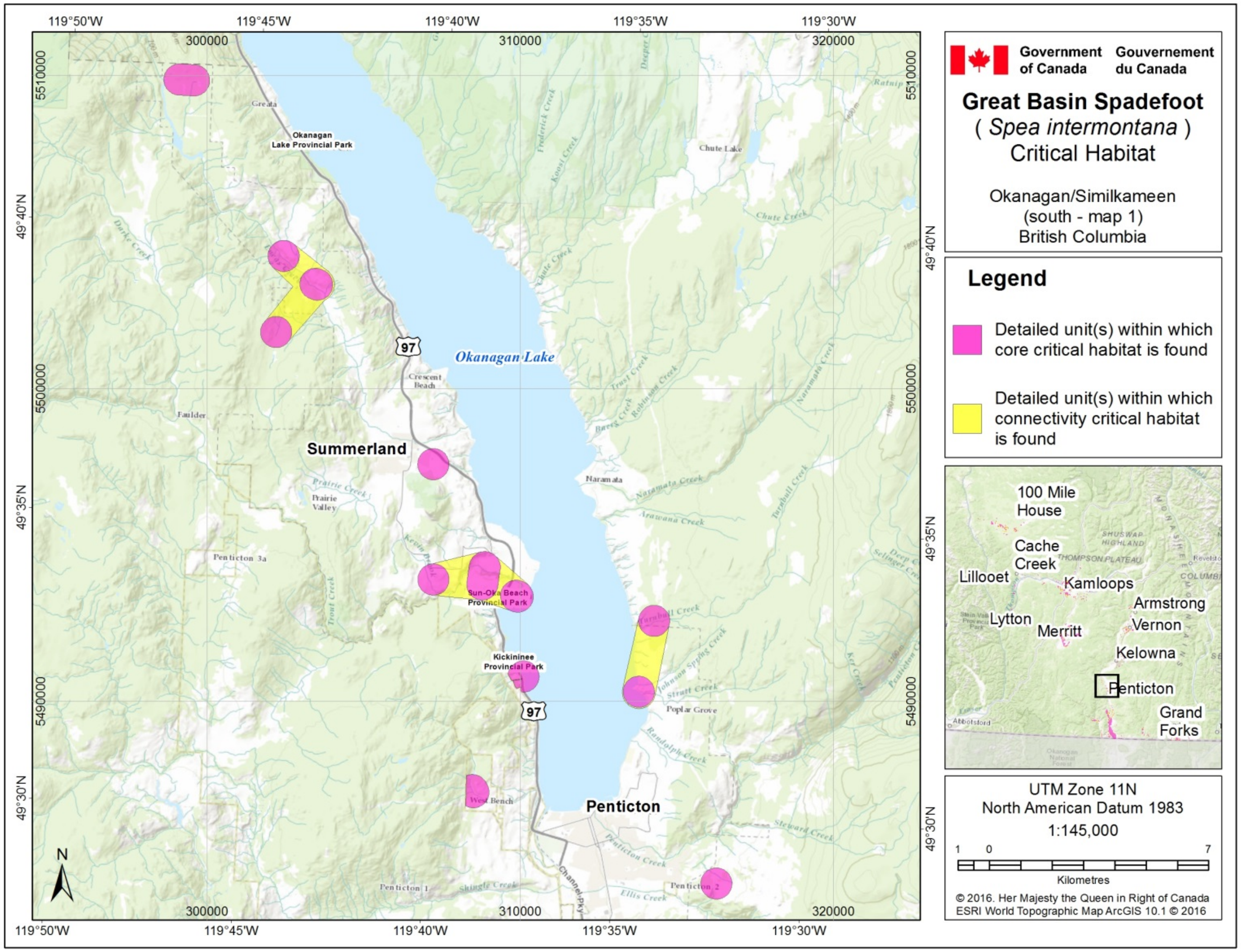

Figure 6. Critical habitat for the Great Basin Spadefoot in the Okanagan/Simikameen (south – map 1) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

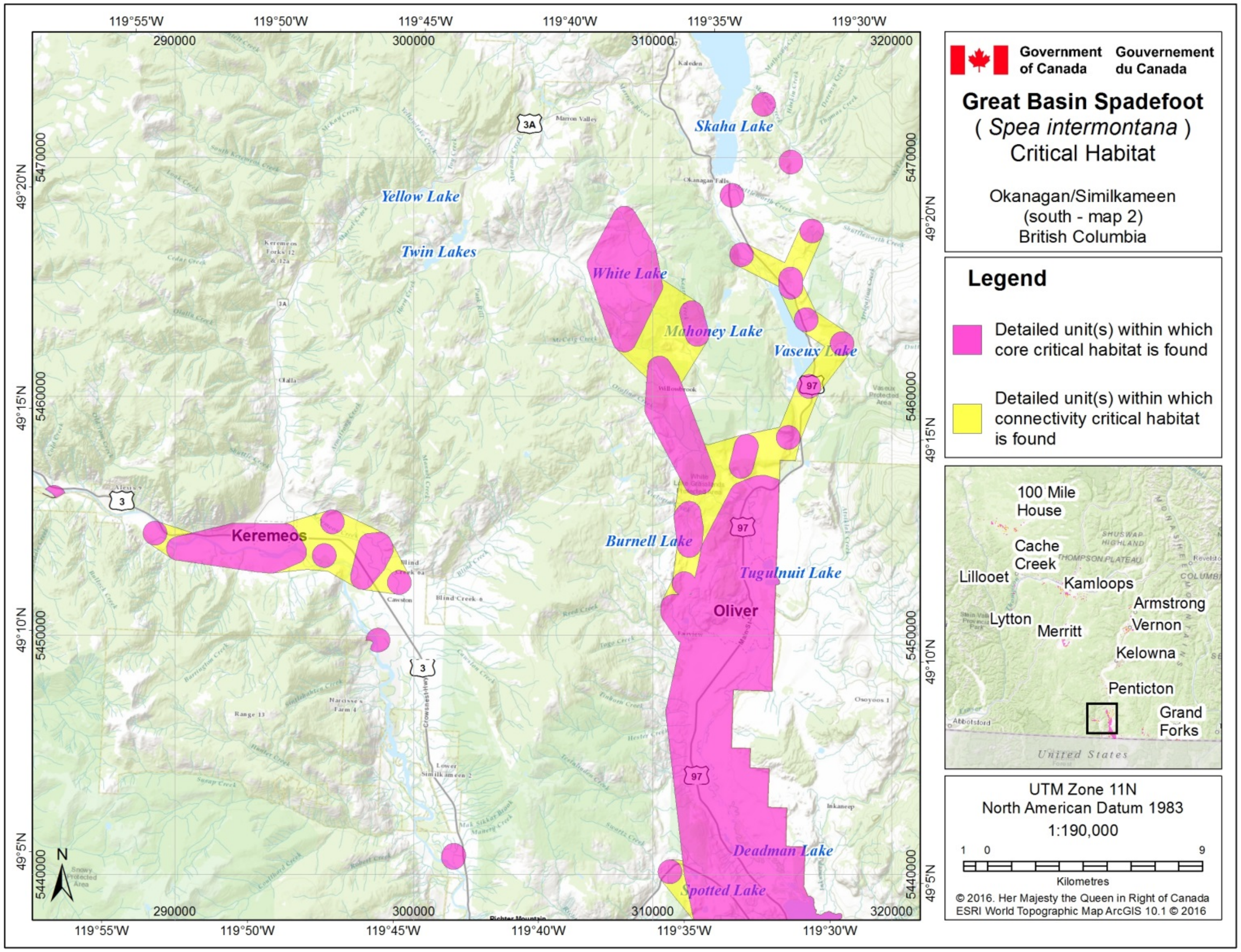

Figure 7. Critical habitat for the Great Basin Spadefoot in the Okanagan/Simikameen (south – map 2) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

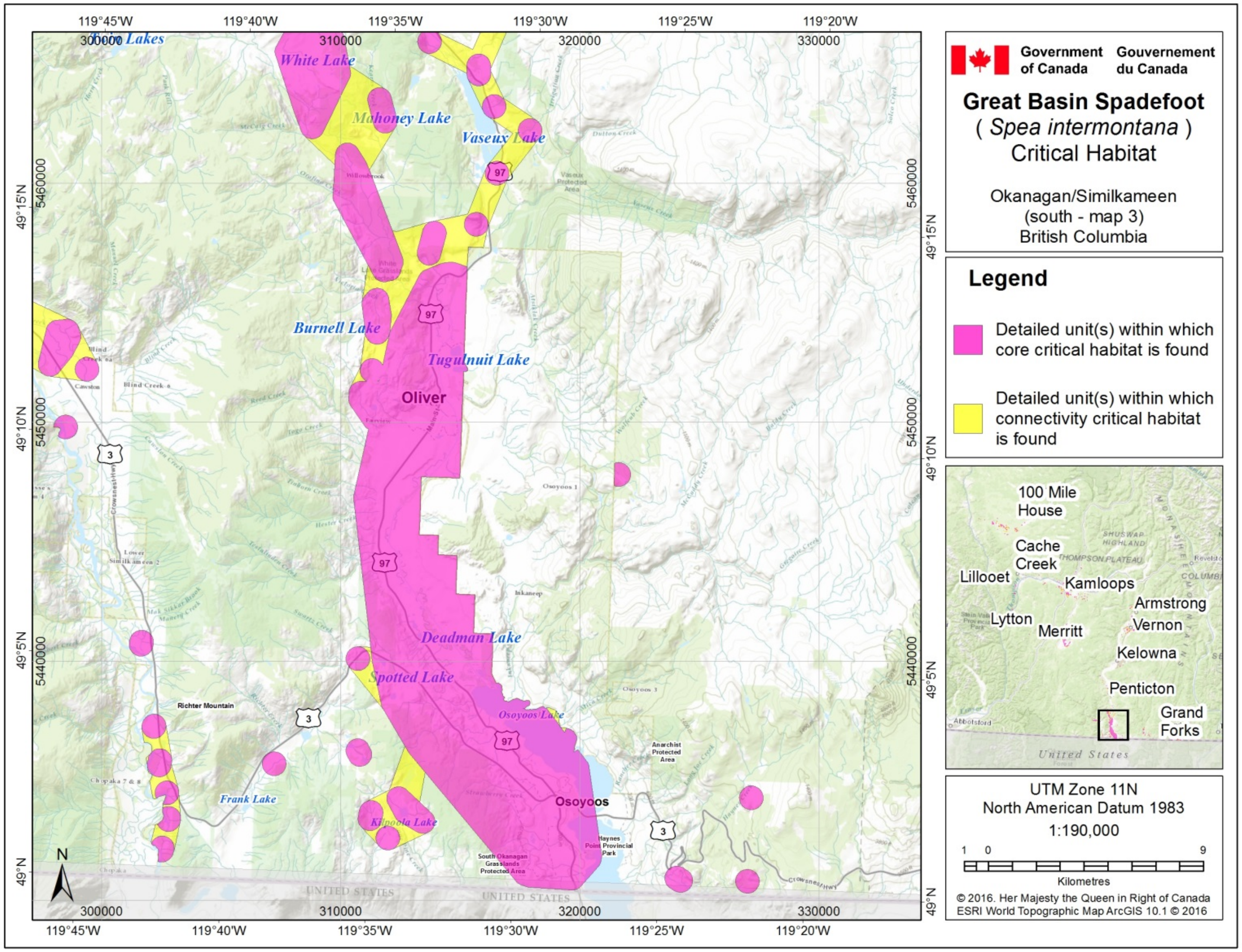

Figure 8. Critical habitat for the Great Basin Spadefoot in the Okanagan/Simikameen (south – map 3) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

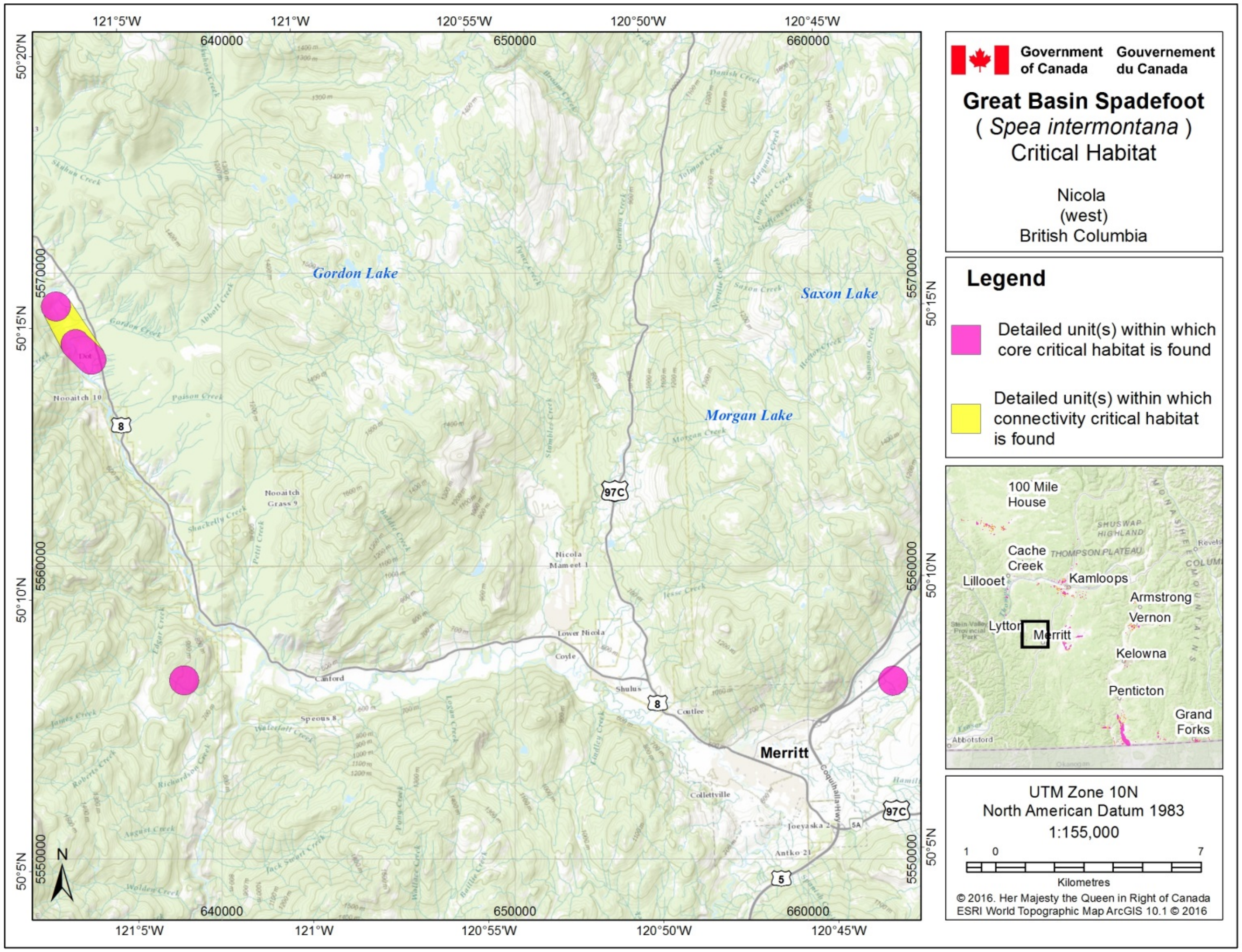

Figure 9. Critical habitat for the Great Basin Spadefoot in the Nicola (west) area of B.C. is represented by the shaded pink polygons (areas containing "core" critical habitat) and the shaded yellow polygons (areas containing "connectivity" critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

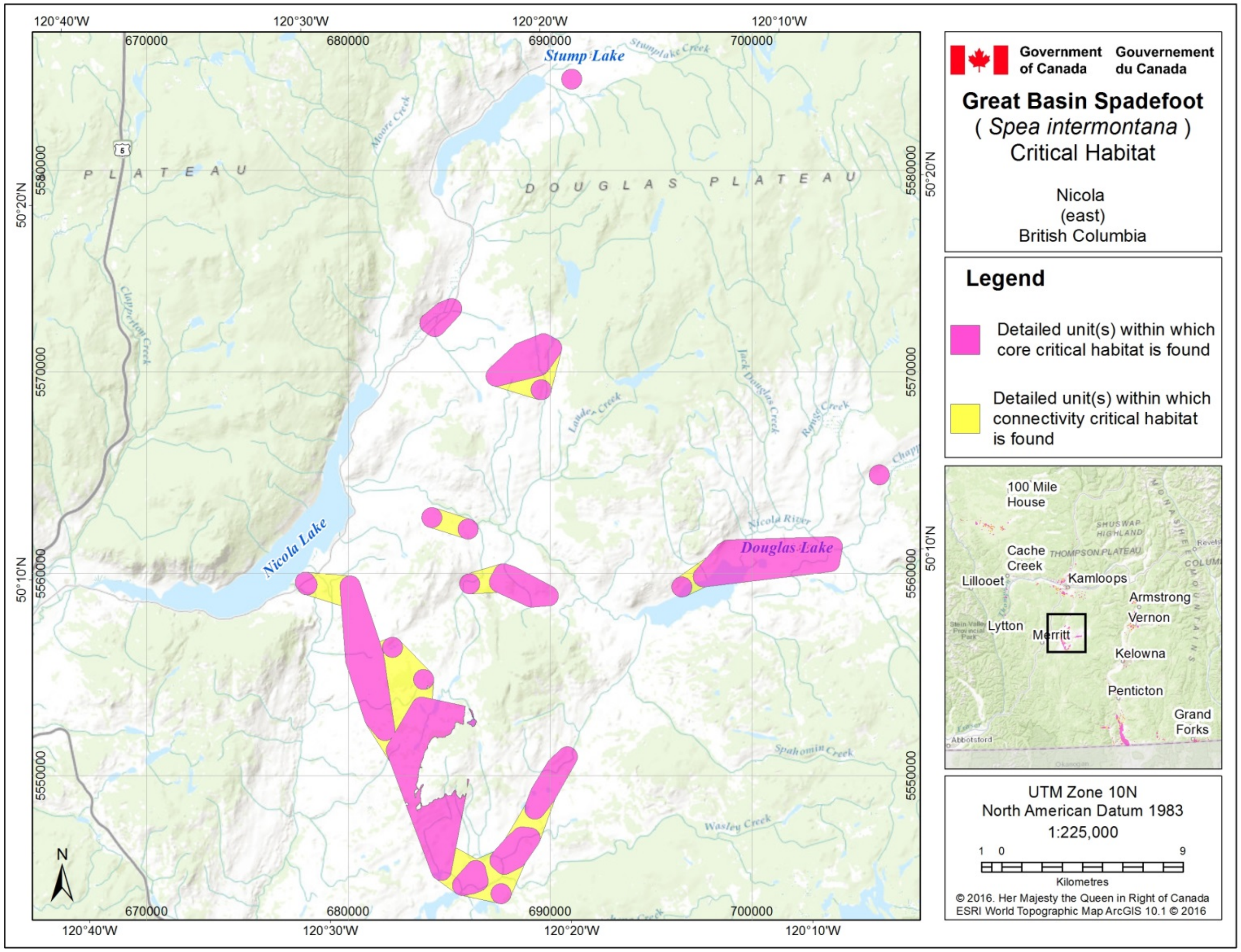

Figure 10. Critical habitat for the Great Basin Spadefoot in the Nicola (east) area of B.C. is represented by the shaded pink polygons (areas containing "core" critical habitat) and the shaded yellow polygons (areas containing "connectivity" critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

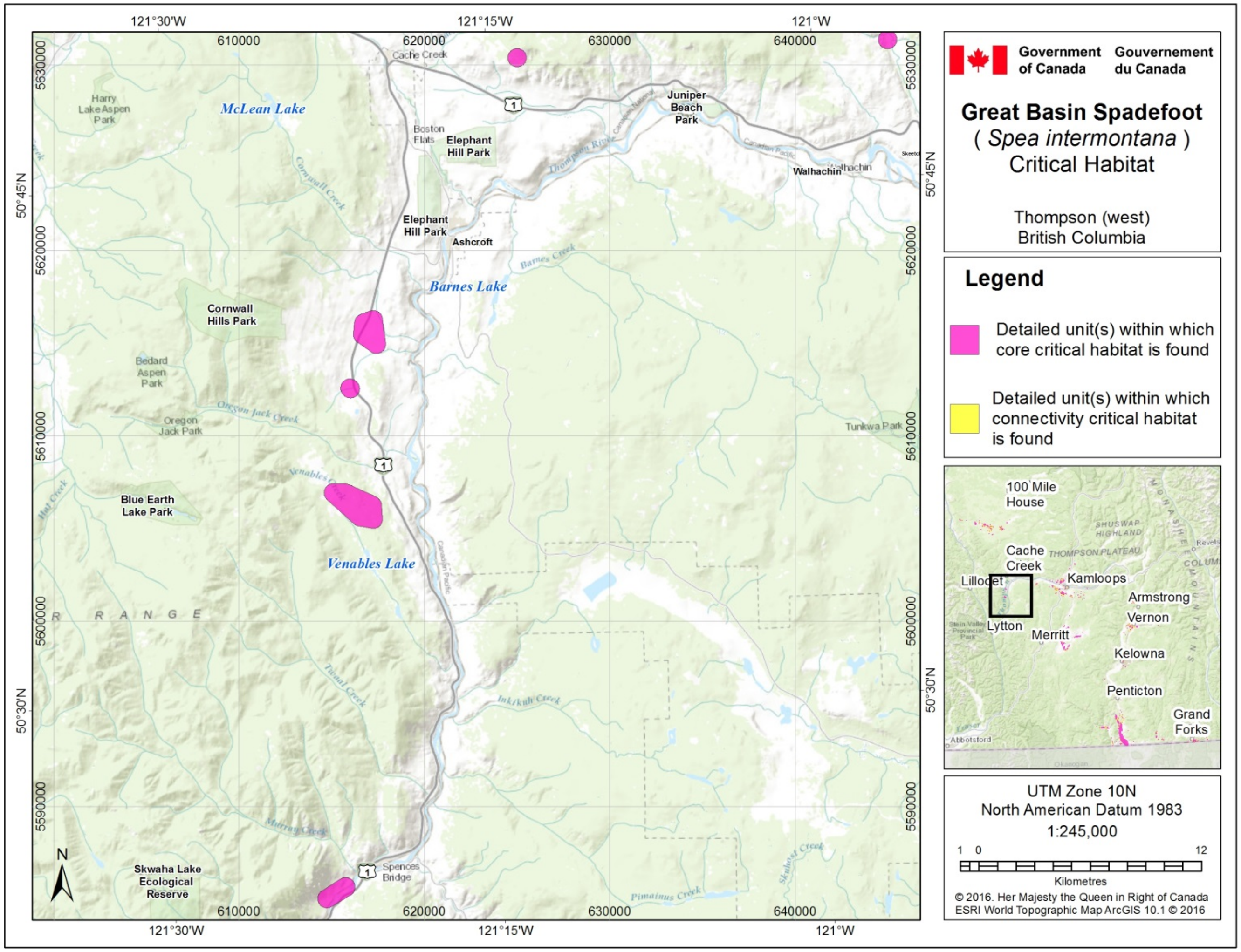

Figure 11. Critical habitat for the Great Basin Spadefoot in the Thompson (west) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

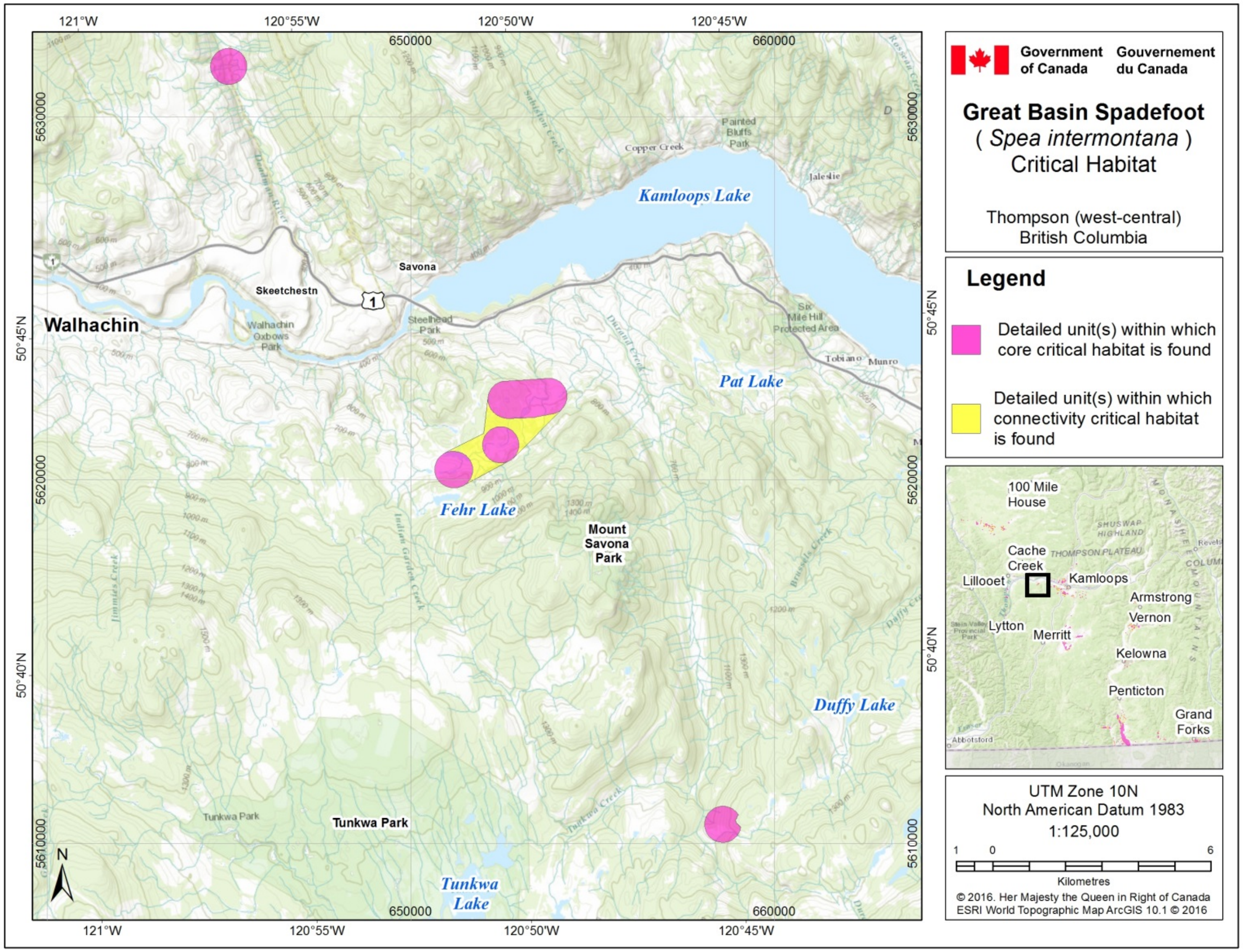

Figure 12. Critical habitat for the Great Basin Spadefoot in the Thompson (west-central) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

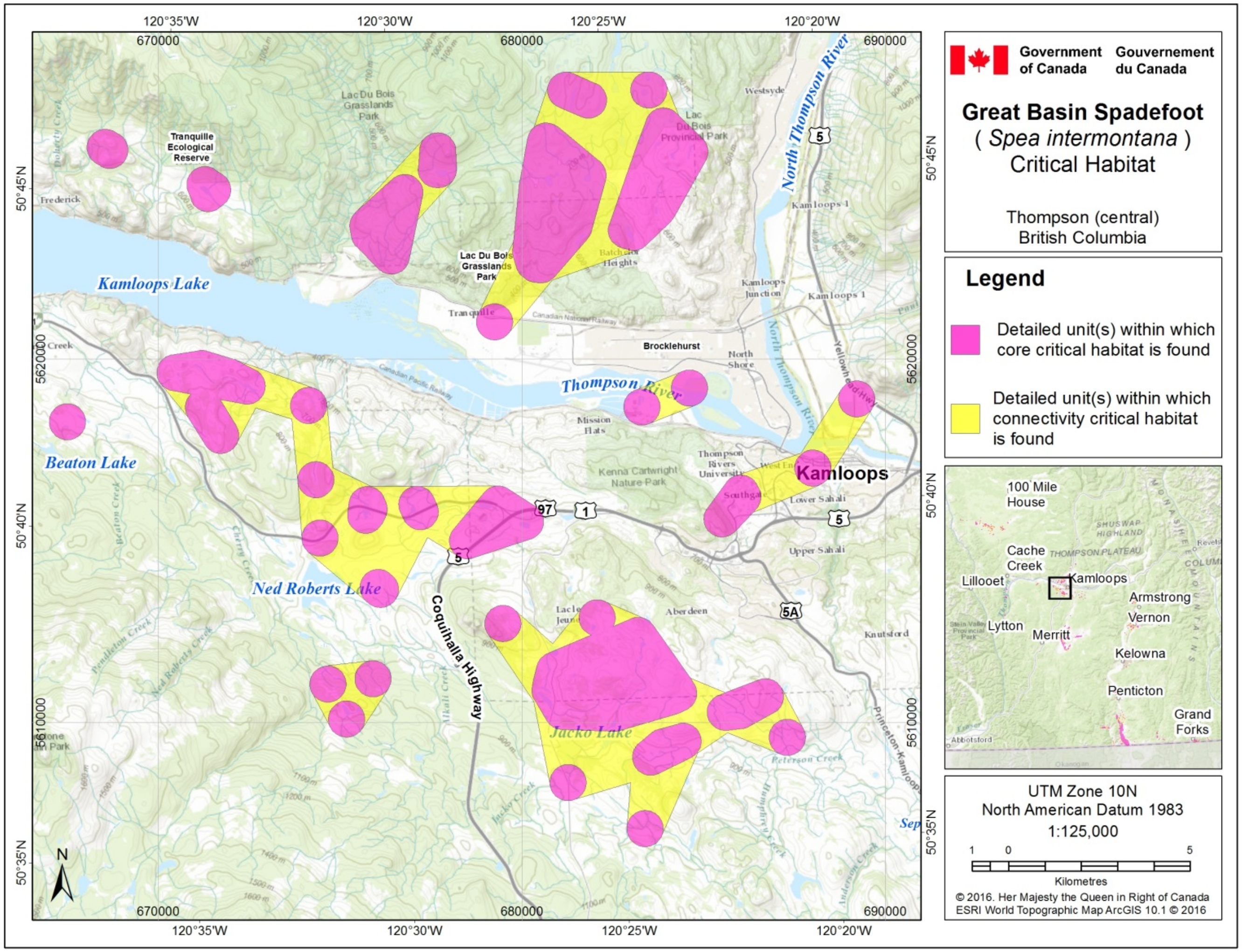

Figure 13. Critical habitat for the Great Basin Spadefoot in the Thompson (central) area of B.C. is represented by the shaded pink polygons (areas containing "core" critical habitat) and the shaded yellow polygons (areas containing "connectivity" critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

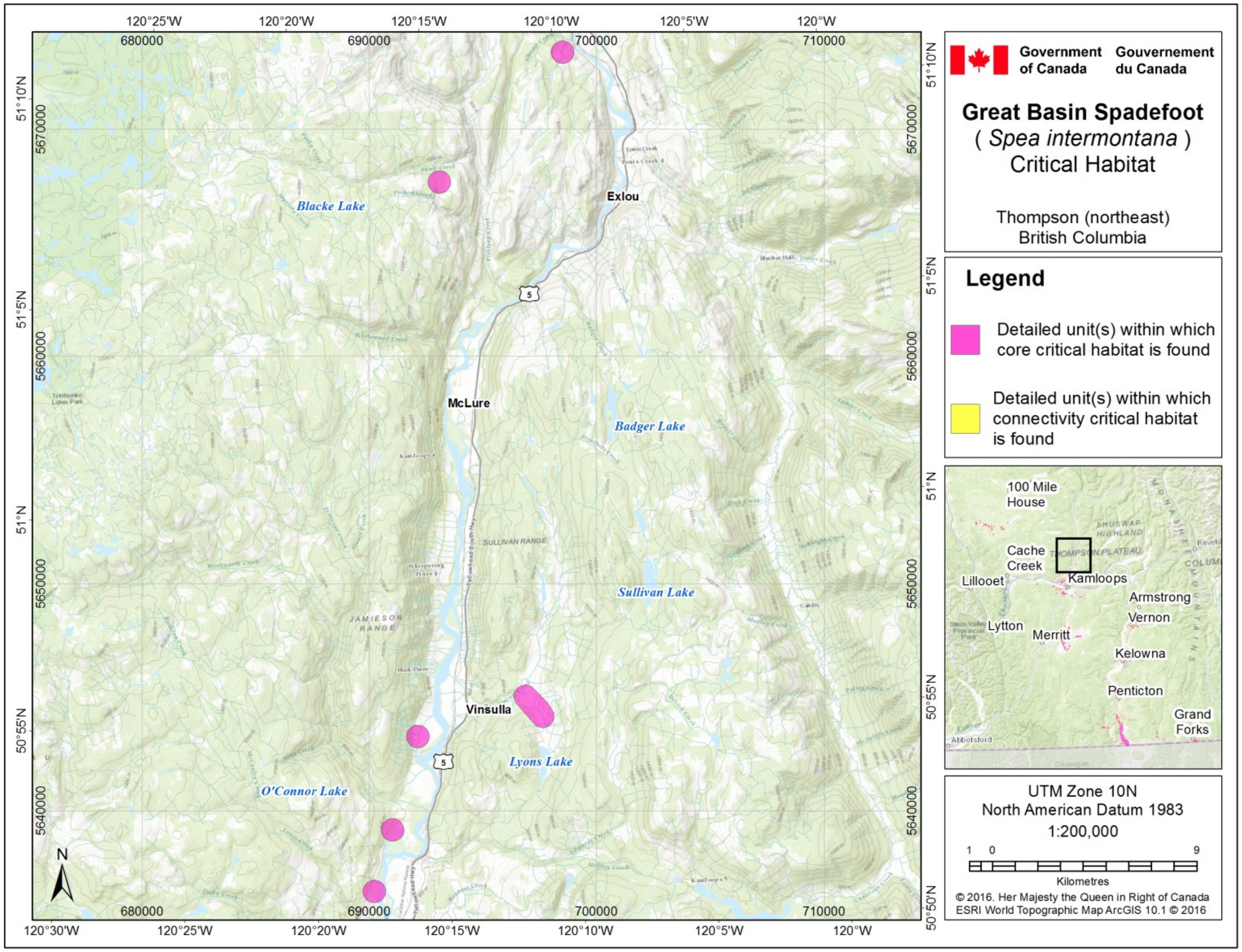

Figure 14. Critical habitat for the Great Basin Spadefoot in the Thompson (northeast) area of B.C. is represented by the shaded pink polygons (areas containing "core" critical habitat) and the shaded yellow polygons (areas containing "connectivity" critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

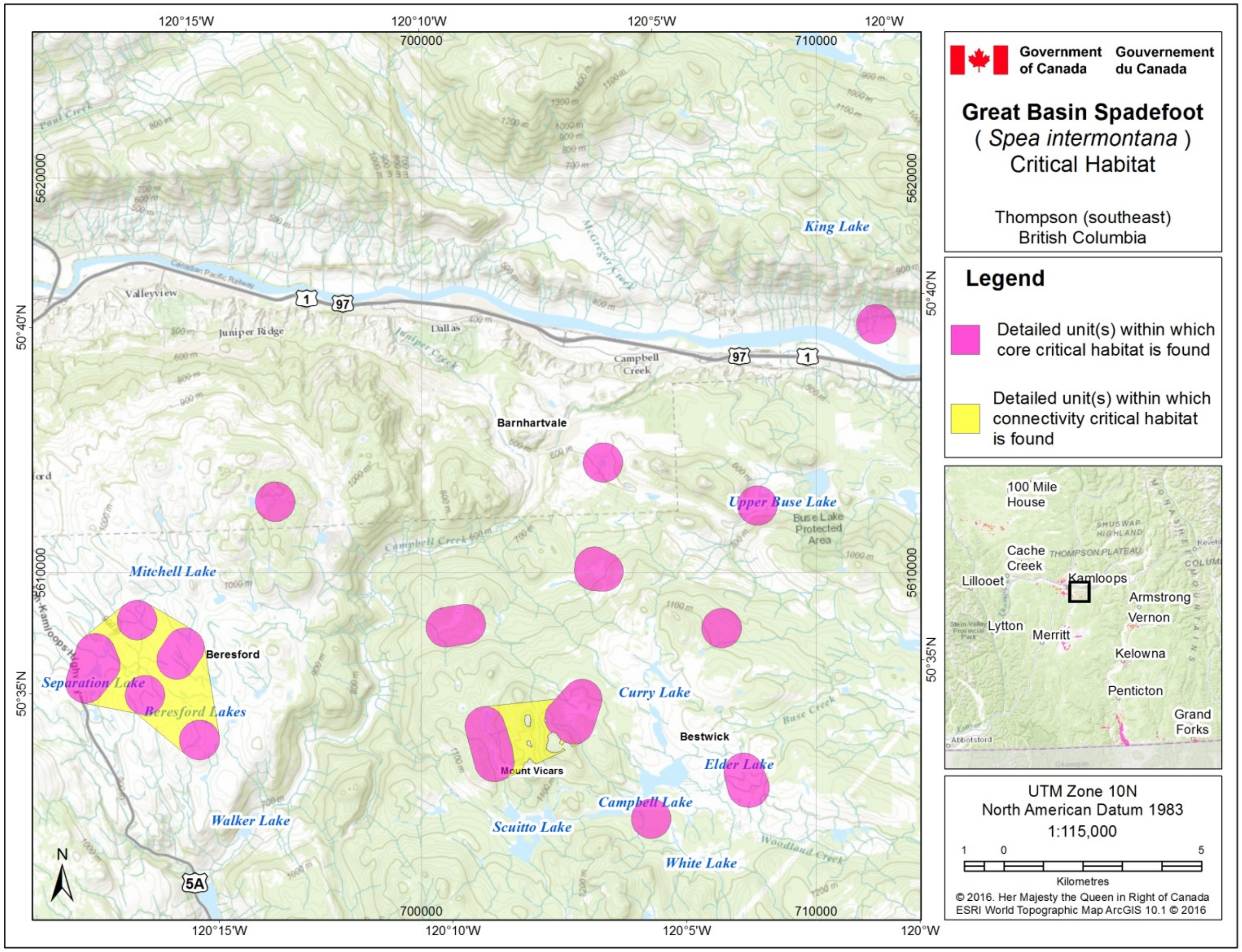

Figure 15. Critical habitat for the Great Basin Spadefoot in the Thompson (southeast) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

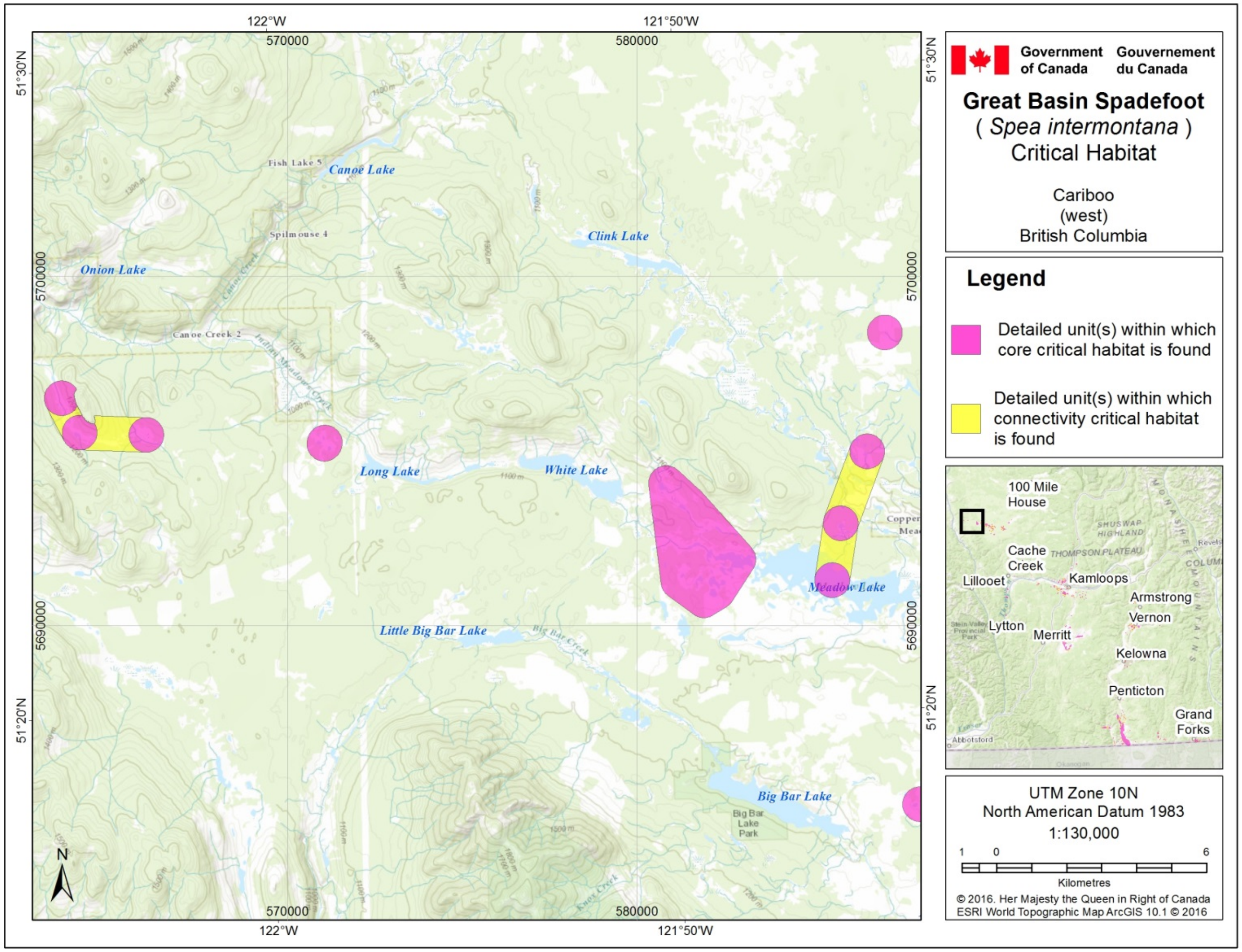

Figure 16. Critical habitat for the Great Basin Spadefoot in the Cariboo (west) area of B.C. is represented by the shaded pink polygons (areas containing "core" critical habitat) and the shaded yellow polygons (areas containing "connectivity" critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

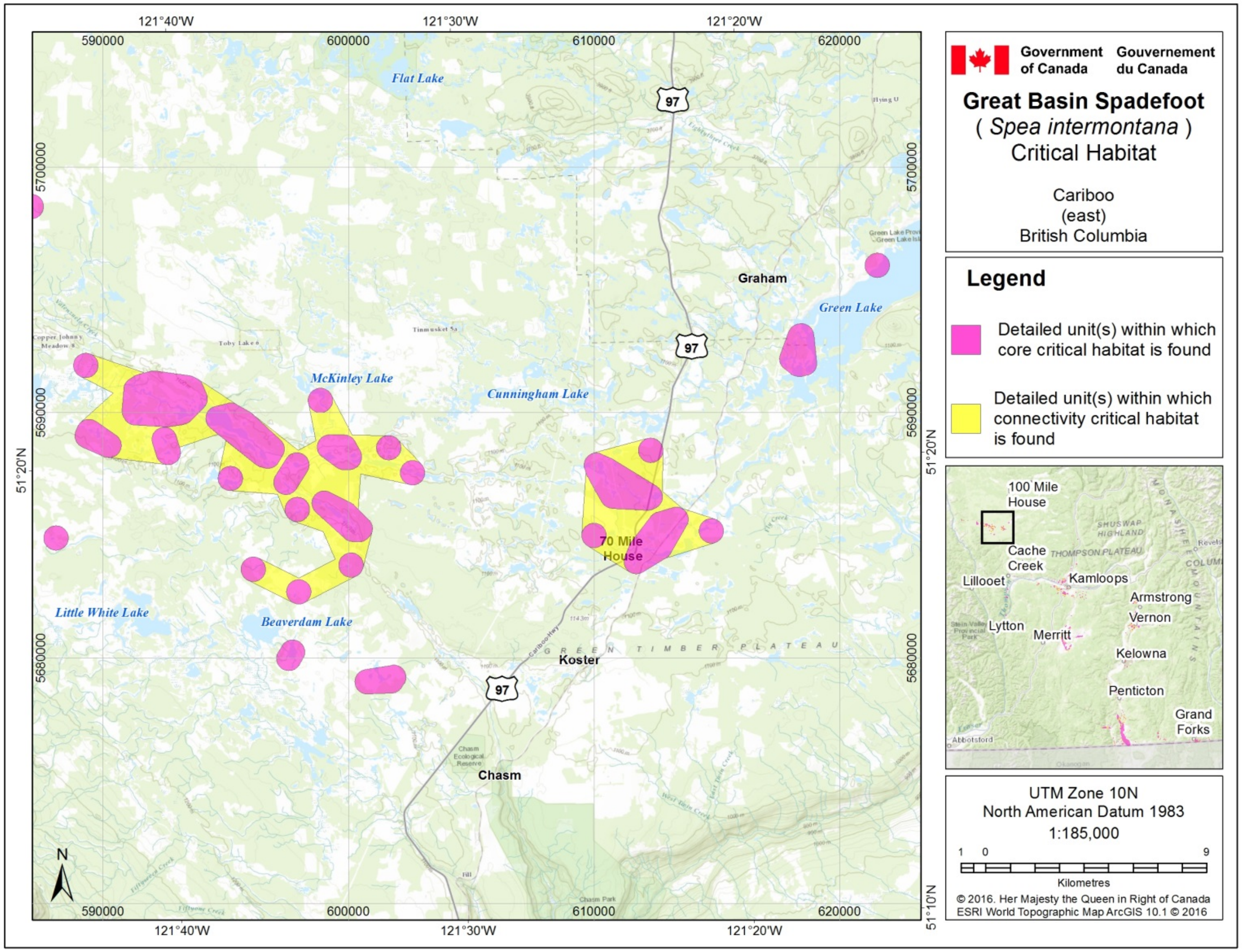

Figure 17. Critical habitat for the Great Basin Spadefoot in the Cariboo (east) area of B.C. is represented by the shaded pink polygons (areas containing “core” critical habitat) and the shaded yellow polygons (areas containing “connectivity” critical habitat), except where clearly unsuitable habitats (as described in Section 1.1) occur.

1.2 Schedule of Studies to Identify Critical Habitat

The following schedule of studies (Table 3) outlines the activities required to complete the identification of critical habitat for Great Basin Spadefoot. This section addresses parts of critical habitat that are known to be missing from the identification based on information that is available at this time. Actions required to address future *refinement* of critical habitat (such as fine-tuning boundaries, and/or providing greater detail about use of biophysical attributes) are not included here. Priority recovery actions to address these kinds of knowledge gaps are outlined in the recovery planning table in the adopted provincial recovery plan.

Table 3. Schedule of Studies to Identify Critical Habitat for Great Basin Spadefoot

Description of activity	Rationale	Timeline
Conduct survey/inventory in areas with occurrence records that were not included in the critical habitat identification owing to location uncertainty distance.	Critical habitat has not been identified for 87 documented occurrence records because the location uncertainty distance (>100 m) prevents an accurate identification of critical habitat. This activity is required such that sufficient critical habitat is identified to meet the population and distribution objectives.	2017-2022
Work with applicable organizations to complete the identification of critical habitat for Great Basin Spadefoot.	Critical habitat has not been identified for a portion of lands in the south Okanagan. This activity is required such that sufficient critical habitat is identified to meet the population and distribution objectives.	2017-2022

1.3 Activities Likely to Result in Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. The provincial recovery plan provides a description of limitations and potential threats[8] to Great Basin Spadefoot. Activities described in Table 4 include those likely to cause destruction of critical habitat for the species; destructive activities are not limited to those listed.

[8] Threat classification is based on the IUCN-CMP (International Union for Conservation of Nature – Conservation Measures Partnership) unified threats classification system (www.conservationmeasures.org).

Table 4. Activities likely to result in destruction of Critical Habitat for Great Basin Spadefoot.

Description of activity	Description of Effect	Additional Information; related IUCN threat
Land conversion for human development (e.g., housing and urban areas, logging, agriculture) in core or connectivity critical habitat	This activity can result in the direct loss of core critical habitat, or could degrade habitat to a point where it no longer meets the needs of the species. This could occur through soil compaction and/or the alteration of moisture regimes (e.g., impounded drainage, or reduced water flow to wetlands through ditching or diversion of subsurface water by built structures) in core critical habitat; see also next row. Can destroy connectivity critical habitat by fragmentation of habitats needed for dispersal.	Related IUCN-CMP Threat 1.1, 2.1, 2.3, 4.1, 5.3, 7.2 Urbanization and agricultural development (annual and perennial non-timber crops, livestock farming and ranching) is ongoing and is most notable in the Okanagan and Similkameen valleys, as well as Kamloops, B.C. The threat of logging currently appears to be confined to the northern limits of the species' range in the Cariboo region.
Activities such as: filling in wetlands; diversion of water; and operation of water control devices or irrigation practices that result in rapid water level changes	Results in habitat loss or degradation of core critical habitat for Great Basin Spadefoot by altering hydrological patterns thereby disrupting natural ecological processes and destroying wetland breeding sites, e.g., premature drying (prior to metamorphosis) during the breeding period.	Related IUCN-CMP Threat 1.1, 2.1, 2.3, 4.1, 5.3, 7.2 Alterations in hydrological characteristics can be caused by housing developments and associated urbanization, agriculture, logging, roads, or management of water/dams. Does not need to occur within the bounds of critical habitat to cause destruction. Although activities during the breeding period (generally April to July) are most likely to result in direct destructive impacts, destruction of core habitat attributes can be caused at any time of year.
Development and/or maintenance or modification of transportation and service corridor infrastructure, including: road building, expansion, upgrading, or installation of other types of barriers to Great Basin Spadefoot movement without installation of mitigations such as safe movement passages and fencing in core and/or connectivity critical habitat	Can destroy core and/or connectivity critical habitat outright; can reduce and/or destroy habitat needed to maintain dispersal within or between core habitat areas.	Related IUCN-CMP Threat 4.1 Road densities are high, and increasing, throughout much of the Great Basin Spadefoot range in B.C., therefore road maintenance and construction activities are likely to result in destruction of critical habitat.

Description of activity	Description of Effect	Additional Information; related IUCN threat
Damaging recreational use (e.g., mudbogging and other off-road vehicle use) in <u>core</u> critical habitat	Off-road use of vehicles in core critical habitat can compact soils, making them unsuitable for burrowing. In and around wetlands, this activity reduces emergent vegetation, alters the shoreline, and degrades substrates of the water body, making them less suitable for Great Basin Spadefoot breeding and development. Recreational use can increase the risk of invasive plant introductions via uncleaned footwear, vehicles and other equipment.	Related IUCN-CMP Threat 6.1, 8.1 Mudbogging and other intensive use of off-road vehicles for recreational purposes is widespread across the species' range, especially near human population concentrations. Although activities during the breeding period (generally April to July) are most likely to result in direct destructive impacts, destruction of core habitat attributes can be caused at any time of year.
Inappropriate level and concentration of livestock use, i.e., that results in significant adverse effects[9] [10] in <u>core</u> critical habitat	Overgrazing in core critical habitat by livestock can result in loss of suitable habitat for Great Basin Spadefoot. Trampling of habitat can lead to the loss of emergent vegetation, soil compaction that makes habitat unsuitable for burrowing and/or create deep hoof prints that make the habitat unsuitable for movements (including seasonal migrations and dispersal) , to the extent that the habitat is no longer suitable. Indirect impacts may include hydrological changes and increased influx of pollutants and/or sedimentation	IUCN-CMP Threat 2.3, 9.3 Allowing cattle access to shallow wetland areas in core critical habitat is most likely to result in destructive impacts. Although activities during the breeding period (generally April to July) are most likely to result in direct destructive impacts, destruction of core habitat attributes can be caused at any time of year.

[9] Significant adverse effects are those that negatively impact the species' survival and recovery. Success of the species' survival and recovery will be assessed against the adopted population and distribution (recovery) objective and associated performance measures, in that the abundance of Great Basin Spadefoot is maintained as stable or increasing within each of the six geographic areas where it occurs.

[10] Additional research is required to determine what level of livestock use is considered destructive to Great Basin Spadefoot, i.e. the level at which the features and attributes necessary for long-term persistence are destroyed. However, it is clear that intensive stocking rates would be likely to result in destruction of critical habitat.

Description of activity	Description of Effect	Additional Information; related IUCN threat
Introduction of predatory fish in core critical habitat and/or introduction of American Bullfrogs (*Lithobates catesbieanus*) into water bodies within the species' range.	Predatory influence of introduced fish or American Bullfrogs can cause waterbody habitats to be unsuitable for breeding Great Basin Spadefoots	Related IUCN-CMP Threat 6.1, 8.1. The threat from introduced fish is widespread, current and severe. American Bullfrogs were introduced to localized areas of the South Okanagan but are currently believed to be eradicated. Introduced species can result in the prevalence of diseases associated with introductions (such as Chytridiomycosis caused by the chytrid fungus *Batrachochytrium dendrobatidis*).

Activities related to the control of invertebrate pests or invasive plant species, or to improve crop production, that are not in accordance with provincial best management practices[11], where available.	Great Basin Spadefoots are sensitive to pollutants; thus, activities within or outside the area of critical habitat that cause contaminants to enter the wetland are likely to result in damage or destruction. Release of pollutants can result in loss of the water quality required for survival, growth, and successful reproduction in core critical habitat. Pollutants known to be of concern for Great Basin Spadefoot include atrazine, endosulfan, chlorpyrifos and diazinon based pesticides (Bishop et al. 2010; De Jong Westman et al. 2010). Note: Depending on the location, and timing/frequency of application, in some very specific circumstances (e.g., invasive plant removal, and/or restoration of habitat for the species), the targeted application of herbicides may result in a neutral or potential net benefit to Great Basin Spadefoot. Appropriate application (i.e., in line with best management practices, and with consideration of the species' life history) is essential to avoid destruction.	Related IUCN-CMP Threat 9.3. Use/application of agricultural chemicals is prevalent, particularly in the Okanagan-Similkameen valleys. Effects can be direct or cumulative. The cumulative threat from pollution is likely more serious at lower elevations, where human developments are concentrated. Does not need to occur within the bounds of critical habitat to cause destruction (e.g. may include on-site activities, and/or drift from adjacent areas).

[11] E.g. see "Best Management Practices for Invasive Plants in Parks and Protected Areas of British Columbia"

2. Statement on Action Plans

One or more action plans for Great Basin Spadefoot will be posted on the Species at Risk Public Registry by 2022.

3. Effects on the Environment and Other Species

This section replaces the "Effects on Other Species" section in the provincial recovery plan.

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[12]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[13] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

Many other species occupy habitats that are used by the Great Basin Spadefoot in the arid interior of British Columbia. In particular, Great Basin Spadefoot habitats overlap with *SARA*-listed species at risk such as the Western Tiger Salamander (*Ambystoma mavortium*– Southern Mountain Population; Endangered) and the Western Toad (*Anaxyrus boreas*; Special Concern) at some sites. Other species at risk may benefit from Great Basin Spadefoot recovery activities through grassland or shrub-steppe habitat protection. Those species include the Burrowing Owl (*Athene cunicularia*; Endangered), American Badger (*Taxidea taxus*; Endangered), Sage Thrasher (*Oreoscoptes montanus*; Endangered), Great Basin Gophersnake (*Pituophis catenifer deserticola*; Threatened); Behr's Hairstreak butterfly (*Satyrium behrii*; Threatened), Pallid Bat (*Antrozous pallidus*; Threatened), Showy Phlox (*Phlox speciosa*; Threatened), Rusty Cord-moss (*Entosthodon rubiginosus*; Endangered), and Alkaline Wing-nerved Moss (*Pterygoneurum kozlovii;* Threatened). Western Tiger Salamanders are natural predators of Great Basin Spadefoot larvae, but habitat overlaps are incomplete and predation impacts are expected to be low. Recovery planning activities for Great Basin

[12] www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[13] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1

Spadefoot will be implemented with consideration for co-occurring species, such that inadvertent negative impacts to these species and their habitats are minimized.

4. References

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Part 2 – *Recovery Plan for the Great Basin Spadefoot (*Spea intermontana*) in British Columbia*, prepared by the Southern Interior Reptile and Amphibian Working Group for the British Columbia Ministry of Environment

Recovery Plan for the Great Basin Spadefoot (*Spea intermontana*) in British Columbia

Prepared by the Southern Interior Reptile and Amphibian Working Group

September 2016

Updated – January 2017

About the British Columbia Recovery Series

This series presents the recovery documents that are prepared as advice to the Province of British Columbia on the general approach required to recover species at risk. The Province prepares recovery documents to ensure coordinated conservation actions and to meet its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada* and the *Canada–British Columbia Agreement on Species at Risk*.

What is recovery?

Species at risk recovery is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a provincial recovery document?

Recovery documents summarize the best available scientific and traditional information of a species or ecosystem to identify goals, objectives, and strategic approaches that provide a coordinated direction for recovery. These documents outline what is and what is not known about a species or ecosystem, identify threats to the species or ecosystem, and explain what should be done to mitigate those threats, as well as provide information on habitat needed for survival and recovery of the species. The provincial approach is to summarize this information along with information to guide implementation within a recovery plan. For federally led recovery planning processes, information is most often summarized in two or more documents that together make up a recovery plan: a strategic recovery strategy followed by one or more action plans used to guide implementation.

Information in provincial recovery documents may be adopted by Environment and Climate Change Canada for inclusion in federal recovery documents that federal agencies prepare to meet their commitments to recover species at risk under the *Species at Risk Act*.

What's next?

The Province of British Columbia accepts the information in these documents as advice to inform implementation of recovery measures, including decisions regarding measures to protect habitat for the species.

Success in the recovery of a species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this document. All British Columbians are encouraged to participate in these efforts.

For more information

To learn more about species at risk recovery in British Columbia, please visit the B.C. Recovery Planning webpage at:

<http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning>

Recovery Plan for the Great Basin Spadefoot (*Spea intermontana*) in British Columbia

Prepared by the Southern Interior Reptile and Amphibian Working Group

September 2016

Updated – January 2017

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Cover photograph

Great Basin Spadefoot, near Merritt, May 2011; photo by Lennart Sopuck

Additional copies

Additional copies can be downloaded from the B.C. Recovery Planning webpage at:

<http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning>

Publication information

This is an updated version of the September 2016 first edition of this document.
See **Updates** for specific changes to the document.

Updates

Updated December 2016 - Changes to the original posting (September 2016) include: correction of the overall province-wide threat impact for this species (Section 4.2, pg.17).

Disclaimer

This recovery plan has been prepared by the Southern Interior Reptile and Amphibian Working Group, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The B.C. Ministry of Environment has received this advice as part of fulfilling its commitments under the *Accord for the Protection of Species at Risk in Cana*da and the *Canada–British Columbia Agreement on Species at Risk.*

This document identifies the recovery strategies and actions that are deemed necessary, based on the best available scientific and traditional information, to recover the Great Basin Spadefoot population in British Columbia. Recovery actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and recovery approaches may be modified in the future to accommodate new findings.

The responsible jurisdictions and all members of the working group have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals on the working group.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this plan. The B.C. Ministry of Environment encourages all British Columbians to participate in the recovery of Great Basin Spadefoot.

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WORKING GROUP MEMBERS

Co-Chairs

Christine Bishop, Environment and Climate Change Canada, Science and Technology Branch, Delta, BC
Purnima Govindarajulu, B.C. Ministry of Environment, Victoria, BC

Working Group Members

Lindsay Anderson, B.C. Ministry of Forests, Lands and Natural Resource Operations, Nelson, BC
Sara Ashpole, St. Lawrence University, NY
David Cunnington, Environment and Climate Change Canada, Canadian Wildlife Service, Delta, BC
Orville Dyer, B.C. Ministry of Environment, Penticton, BC
Bevan Ernst, B.C. Ministry of Forests, Lands and Natural Resource Operations, Kamloops, BC
Jared Hobbs, Consultant, Victoria, BC
Karl Larsen, Thompson Rivers University, Kamloops, BC
Natasha Lukey, Consultant, Kelowna, BC
Matt Huntley, Environment and Climate Change Canada, Canadian Wildlife Service, Delta, BC
Dustin Oaten, Consultant, Kamloops, BC
Kella Sadler, Environment and Climate Change Canada, Canadian Wildlife Service, Delta, BC Mike Sarell, Ophiuchus Consulting, Oliver, BC
Julie Steciw, B.C. Ministry of Forests, Lands and Natural Resource Operations, Williams Lake, BC
Lisa Tedesco, B.C. Ministry of Forests, Lands and Natural Resource Operations, Nelson, BC

EXECUTIVE SUMMARY

The Great Basin Spadefoot (*Spea intermontana*) is a small, greyish amphibian (adult size 4–6 cm in snout–vent length) with a squat body, short limbs, and a short, upturned snout. Characteristic features include eyes with a vertical pupil and a sharp-edged dark ridge (“spade”) on the inner side of each hind foot, used for burrowing. Tadpoles have a grey, globular body with gold flecks, raised, close-set eyes on the top of the head, and a high tail fin.

The Great Basin Spadefoot was designated as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) because of its small area of occupancy, in conjunction with a continuing decline in the extent and quality of habitat, severely fragmented total population in British Columbia, and extreme fluctuations in numbers of adults. It is listed as Threatened in Canada on Schedule 1 of the *Species at Risk Act*. In British Columbia, the Great Basin Spadefoot is ranked S3 (special concern, vulnerable to extirpation or extinction) by the B.C. Conservation Data Centre and is on the provincial Blue list. It is protected from capture and killing under the provincial *Wildlife Act*. It is also listed as a species that requires special management attention to address the impacts of forest and range activities under the *Forest and Range Practices Act* on provincial Crown land (as described in the Identified Wildlife Management Strategy). Recovery is considered to be biologically and technically feasible.

In Canada, the species is restricted to relatively low elevations (up to 1230 m) in dry valleys of the south-central interior of British Columbia, where it occurs in grasslands, shrub–steppe, and open pine and Douglas-fir forest. The species occurs in six geographic areas within the province: Kettle, Granby, Okanagan-Similkameen, Nicola, Thompson, and Cariboo. Great Basin Spadefoots require both aquatic breeding habitat and suitably connected upland terrestrial habitat to complete their life-cycle functions. They breed in a wide variety of temporary and permanent waterbodies. Adults and metamorphosed juveniles require terrestrial habitat year-round, sheltering in underground burrows during the day and dry periods from spring to summer, and hibernating in deeper burrows in winter. Soils that facilitate burrowing are important, including deep friable, sandy, loamy soils or fine gravel. Their active season is from April to September.

The overall province-wide threat impact for this species is High to Very High. Primary threats include direct mortality from roads and lower reproductive success due to climate change (drought). Lower-ranked threats include habitat loss/alteration and direct mortality from residential and agricultural development, all-terrain vehicles, water management, non-native species (fish, bullfrogs), pollution and salvage logging.

The recovery goal is to maintain or increase the abundance of Great Basin Spadefoot in each of the six geographic areas where it occurs and to ensure connectivity within these areas.

The recovery objectives are to:

1. secure Great Basin Spadefoot core habitats (i.e., breeding sites and associated terrestrial habitat) within each of the six geographic areas that it occupies;

2. maintain or increase connectivity across the landscape within and among adjacent subpopulations;[1] and
3. address knowledge gaps related to the distribution, breeding, terrestrial and connectivity habitat requirements, population dynamics across the landscape, impacts of priority threats, and effectiveness of recovery actions.

RECOVERY FEASIBILITY SUMMARY

The recovery of the Great Basin Spadefoot in British Columbia is considered technically and biologically feasible based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility.

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.
   YES. Reproductive subpopulations are still present in each of the six geographic areas in the species' provincial range. Individual females can produce large numbers of eggs each year (up to 800, Matsuda *et al*. 2006; 1000 or more, Ashpole *et al*. 2014), contributing to the ability of subpopulations to recover quickly under suitable conditions.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.
   YES. Although suitable wetland breeding sites and associated terrestrial habitats are decreasing, such habitats still exist in each of the six geographic areas in the species' provincial range and are deemed sufficient to support the species. New wetland breeding sites could be made available through habitat creation, if needed.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.
   YES. Primary threats can be avoided or mitigated through habitat protection, habitat restoration, land stewardship, and best management practices. Primary threats include direct mortality from roads and lower reproductive success due to climate change (drought). Lower-ranked threats include habitat loss/alteration and direct mortality from residential and agricultural development, all-terrain vehicles, water management, invasive non-native species (fish, bullfrogs), pollution and salvage logging.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.
   YES. Recovery techniques (i.e., habitat protection, habitat restoration, stewardship, land management) are available to help achieve the provincial recovery goal (population and distribution objectives).

[1] Subpopulations are defined as geographically or otherwise distinct groups in the total population between which little demographic or genetic exchange occurs.

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1 COSEWIC* SPECIES ASSESSMENT INFORMATION

Assessment Summary – April 2007
Common Name: Great Basin Spadefoot
Scientific Name: *Spea intermontana*
Status: Threatened
Reason for Designation: This small, rotund, toad-like amphibian has under each hind foot a prominent tubercle, or "spade", which it uses for burrowing. The species has a restricted distribution in Canada in the semi-arid and arid areas of southern interior British Columbia. Parts of this region are experiencing rapid loss and alteration of critical habitats for the spadefoot, including loss of breeding sites, because of urban and suburban expansion, increased agriculture and viticulture, and the introduction of alien fish species and disease. The protected areas it inhabits are losing surrounding natural buffer habitats due to encroaching agricultural and housing developments. In consequence, available habitat in some parts of the range is becoming fragmented, resulting in increased local extinction probabilities for the sites that remain. Although spadefoots may use artificial habitats for breeding, there is evidence that such habitats may be ecological traps from which there may be little or no recruitment.
Occurrence: British Columbia

Status History: Designated Special Concern in April 1998. Status re-examined and designated Threatened in November 2001 and in April 2007. Last assessment based on an update status report.

* Committee on the Status of Endangered Wildlife in Canada.

2 SPECIES STATUS INFORMATION

Great Basin Spadefoot[a]		
Legal Designation:		
FRPA:[b] Species at Risk OGAA:[b] Species at Risk	B.C. *Wildlife Act:*[c] Schedule A	SARA:[d] Schedule 1 – Threatened (2003)
Conservation Status[e]		
B.C. List: Blue B.C. Rank: S3 (2010) National Rank: N3 (2011; Nature Serve 2014) Global Rank: G5 (2002)		
Other Subnational Ranks:[f] Arizona (S3), California (SNR), Colorado (S3), Idaho (S4), Nevada (S4), Oregon (S5), Utah (S5), Washington (S5), Wyoming (S3)		
B.C. Conservation Framework (CF)[g]		
Goal 1: Contribute to global efforts for species and ecosystem conservation.		Priority:[h] 6
Goal 2: Prevent species and ecosystems from becoming at risk.		Priority: 1
Goal 3: Maintain the diversity of native species and ecosystems.		Priority: 2
CF Action Groups:[g]	Monitor Trends; Compile Status Report; Planning; Send to COSEWIC; Habitat Protection; Private Land Stewardship; Habitat Restoration; Species and Population Management.	

[a] Data source: B.C. Conservation Data Centre (2016) unless otherwise noted.
[b] Species at Risk = a listed species that requires special management attention to address the impacts of forestry and range activities on Crown land under the *Forest and Range Practices Act* (FRPA; Province of British Columbia 2002) and/or the impacts of oil and gas activities on Crown land under the *Oil and Gas Activities Act* (OGAA; Province of British Columbia 2008) as described in the Identified Wildlife Management Strategy (Province of British Columbia 2004).
[c] Schedule A = designated as wildlife under the B.C. *Wildlife Act*, which offers it protection from direct persecution and mortality (Province of British Columbia 1982).
[d] Schedule 1 = found on the List of Wildlife Species at Risk under the *Species at Risk Act* (SARA; Government of Canada 2002).
[e] Blue: Includes any indigenous species or subspecies considered to be of Special Concern (formerly Vulnerable) in British Columbia. S = subnational; N = national; G = global; 1 = critically imperiled; 2 = imperiled; 3 = special concern, vulnerable to extirpation or extinction; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure; NA = not applicable; NR = unranked; U = unrankable.
[f] Data source: NatureServe (2014).
[g] See B.C. Ministry of Environment (2009) for information regarding current Conservation Framework prioritization and action sorting tools.
[h] Six-level scale: Priority 1 (highest priority) through to Priority 6 (lowest priority).

3 SPECIES INFORMATION

3.1 Species Description

The Great Basin Spadefoot, *Spea intermontana* (Figure 1), is a small amphibian (adult size 4–6 cm in body length) with a squat body, short limbs, and a short, upturned snout (Hallock 2005). Although sometimes incorrectly referred to as “toads,” spadefoots are distinct in appearance and not closely related to true toads (family Bufonidae). The colour of the back is light grey, brown, or greenish with indistinct light streaks or dark spots (bumps), often with orange centres; the underside is whitish. Characteristic features include eyes with a vertical pupil and a sharp-edged, sickle-shaped, dark, keratinized ridge (“spade”) on the inner side of each hind foot, used for burrowing. Spadefoots are nocturnal and secretive, spending much of the year burrowed under the soil. During the breeding season in spring and early summer, their presence is revealed by the loud, grating, snore-like advertisement calls that males produce, especially on wet nights.

Figure 1. Great Basin Spadefoot, Merritt 2013 (Christian Engelstoft).

The Great Basin Spadefoot has a complex life cycle. Females lay small, loose clusters of black eggs (up to 800–1000 eggs/year per female) and attach them to vegetation or on the bottom substrate of aquatic breeding sites (Matsuda *et al*. 2006; Ashpole *et al*. 2014). Tadpoles are grey with gold-coloured speckling, have a high tail fin, and can be up to 70 mm long (Figure 2). The head is as wide as or wider than the globular body and the eyes are up-raised and on the top of the head (Matsuda *et al*. 2006). Tadpoles develop rapidly and are able to transform and leave the breeding site within 1–2 months from egg-laying (Hallock 2005; Matsuda *et al*. 2006). In Kamloops, larval development averaged 42 days, with a minimum of 32 days and a maximum 52 days (Oaten, pers. comm., 2016). The young mature in their second or third year (Matsuda *et al*. 2006). Adults may not reproduce each year, if conditions are unfavourable (i.e., low precipitation, dry breeding ponds, low physical condition). The life span is unknown but may be up to 10 or more years, based on other species of spadefoot (COSEWIC 2007).

Figure 2. Great Basin Spadefoot tadpole (Jared Hobbs).

3.2 Populations and Distribution

3.2.1 Global Distribution and Abundance

The Great Basin Spadefoot is widely distributed within arid regions of western North America. Its range extends from south-central British Columbia south to the Colorado River, west to the Sierra Nevada and Cascade ranges, and east across the Rocky Mountain divide (Hallock 2005) (Figure 3). Canada has less than 5% of the species' global distribution as estimated from the global distribution map.

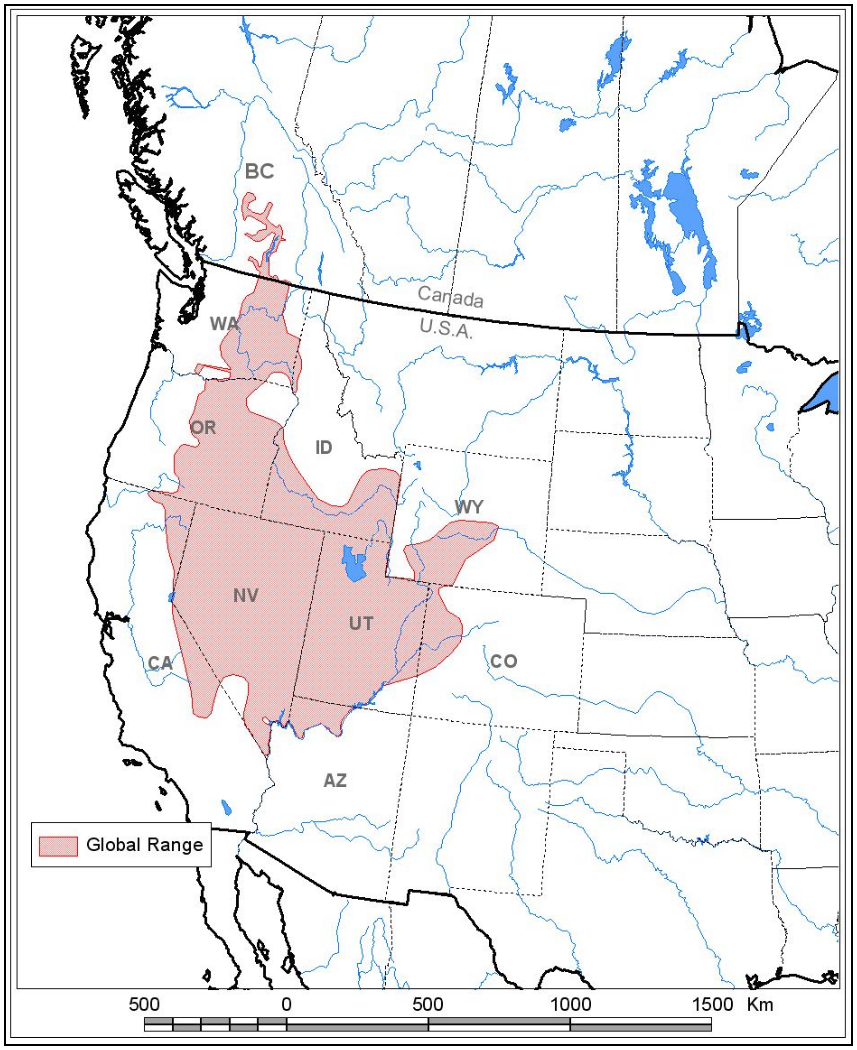

Figure 3. Global distribution of the Great Basin Spadefoot (*Spea intermontana*) (COSEWIC 2007; originally produced by Mike Sarell).

3.2.2 Provincial Distribution and Abundance

The Great Basin Spadefoot occupies six geographic areas in British Columbia: Kettle, Granby, Okanagan-Similkameen, Nicola, Thompson, and Cariboo (Figure 4). The extent of gene flow between these geographic areas is probably minimal and they "may constitute distinct management units consistent with their reported disjunct range distribution" (Russello and Hollatz 2011). The species is restricted to relatively low elevations (< 1230 m) in dry valleys of the province's Southern Interior and plateau areas of the Central Interior (COSEWIC 2007; Southern Interior Reptile and Amphibian Recovery Team 2008). The southern portion of its distribution includes the Okanagan-Similkameen and Kettle-Granby river valleys and extends north to Vernon, west of Keremeos, and east to Grand Forks. There also is one historical record from from Princeton (1955). The northern portion includes the Nicola and Thompson river drainages and extends from Barriere, along the North Thompson River, through the Kamloops area, west to Cache Creek and north to the 70 Mile House area in the Cariboo Region.

No total population trend data exist, but the species is probably in decline based on widespread loss and fragmentation of arid grassland habitats (COSEWIC 2007; B.C. Conservation Data Centre 2016). The number of adults is unknown but likely greater than 10 000 (B.C. Conservation Data Centre 2016); total population numbers fluctuate greatly (COSEWIC 2007). The number of subpopulations[2] is not known due to incomplete data. However, the B.C. Conservation Data Centre (2016) reported more than 100 element occurrences based on a 1 km separation distance between element occurrences in unsuitable habitat and 5 km in suitable habitat. In addition, the Committee on the Status of Endangered Wildlife in Canada (2007) reported 235 sites based on a 500 m separation distance.

[2] Subpopulations are defined as geographically or otherwise distinct groups in the total population between which little demographic or genetic exchange occurs.

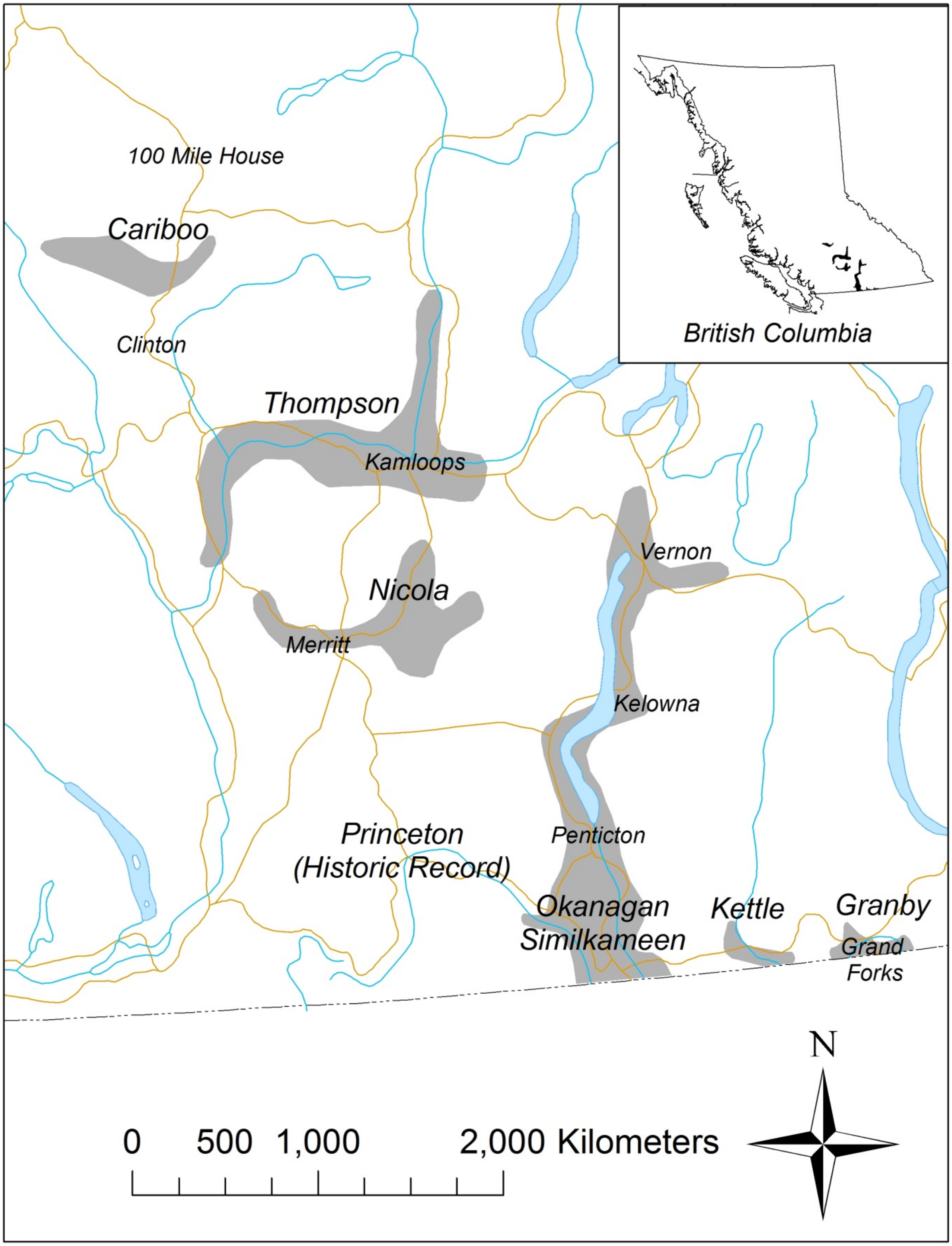

Figure 4. Distribution of Great Basin Spadefoot (*Spea intermontana*) in British Columbia (B.C. Ministry of Environment, 2016).

3.3 Habitat and Biological Needs of the Great Basin Spadefoot

Similar to other semi-aquatic amphibians, the Great Basin Spadefoot requires both aquatic breeding habitat (Tables 1–3) and surrounding terrestrial habitat (Tables 4–5) to complete its life-cycle functions. Together, the aquatic habitat and surrounding terrestrial habitat form the core habitat essential for the persistence of the population (Semlitsch and Bodie 2003). This habitat encompasses movements associated with foraging and other functions, as well as seasonal migration routes (Semlitsch and Bodie 2003; Rittenhouse and Semlitsch 2007).

The Great Basin Spadefoot occurs in various semi-arid habitats, including grasslands, shrub–steppe, and open ponderosa pine (*Pinus ponderosa*) and Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) forest (Matsuda *et al*. 2006; COSEWIC 2007). The species is usually found from valley bottoms up to about 1200 m (St. John 1993; Leupin *et al*. 1994). The highest elevation record in the province is east of Merritt at 1230 m (Ernst, pers. comm., 2015).

3.3.1 Aquatic Breeding Habitat

Function: Courtship, mating, egg-laying, development of eggs and tadpoles

Great Basin Spadefoots use aquatic breeding habitats seasonally from spring (early April in the south Okanagan) to late summer (mid-July) (B.C. Ministry of Environment 2008). Breeding has occasionally occurred in August after rainstorms, but larvae may not survive if frosts come early (Oaten, pers. comm., 2016). Migration to breeding sites varies by area: early April to mid-May in the South Okanagan; mid-April to end May in the north Okanagan and Thompson; and just after ice-off to mid-July in the Cariboo (B.C. Ministry of Environment 2008).

Aquatic habitat is used for courtship, egg-laying, and tadpole development (B.C. Ministry of Environment 2008). Spadefoots breed in a wide variety of temporary and permanent waterbodies but seem to prefer small vernal pools that fill and dry up each year (Hallock 2005; COSEWIC 2007). Seasonally wetted margins of larger waterbodies can also provide high-quality breeding habitat. Human-made sites, such as irrigated depressions, dugout watering holes, and ditches, are also used. Ephemeral breeding sites typically have relatively few predators and contribute large numbers of recruits to the subpopulation during years when conditions are optimal. Permanent waterbodies support breeding during drought years when vernal breeding sites either are unavailable or produce few or no recruits. A mosaic of breeding sites of different water depths distributed across the landscape is important for long-term maintenance of subpopulations (Gibbs 2000). Eggs hatch in 2–7 days (Nussbaum *et al*. in COSEWIC 2007). Larvae metamorphose in 4–8 weeks, but the average is about 6 weeks (Matsuda *et al*. 2006; COSEWIC 2007); Lukey, pers. comm., 2016). In Kamloops, larval development averaged 42 days, with a minimum of 32 days and a maximum 52 days (Oaten, pers. comm., 2016).

A summary of functions (Table 1), features, and attributes (Tables 2–3) for aquatic breeding habitat is presented below.

Table 1. Summary of essential functions and features of the Great Basin Spadefoot aquatic habitat in British Columbia.

Life stage(s)	Function[a]	Feature(s)[b]
Adults	Courtship, mating, egg-laying	These two features apply to adult, egg, and tadpole life stages:
Eggs	Development	• Vernal ponds (seasonal and temporary wetlands)
Tadpoles	Foraging and development	• Lakes, ponds, and other permanent wetlands with stationary or very slowly moving water

[a] Function: a life-cycle process of the species (e.g., courtship, mating, egg-laying, foraging, tadpole development).
[b] Feature: the essential structural components of the habitat required by the species.

Table 2. Attributes and descriptions for the feature: Vernal ponds (seasonal and temporary wetlands).

Attribute [a]	Description
Availability	Retains water at least 4–8 weeks, between early April and late July, to allow development from egg to metamorphosis
Elevation	Less than 1230 m above sea level
Habitat Type	May be dry for several years but can be identified from wetland basin (depression with bare mud or sedges, rushes, or other hydrophilic plants), which continues to provide a breeding site in some years; important for subpopulation persistence across the landscape over time
Depth	Shallow areas less than 1 m deep are present in which warm water allows for rapid development of eggs and tadpoles
Shoreline	Gently sloping in at least one or more portions of the waterbody, creating shallows (see above); presence of emergent vegetation or, alternatively, sticks, rocks, or other objects used for egg attachment
Food	Availability of algae, aquatic vegetation, and other organic matter as food for tadpoles
Other	Optimally, an absence of predatory fish (sport fish, goldfish [*Carassius auratus*], and fish used for mosquito control or other purposes)

[a] Attribute: the building blocks or *measurable* characteristics of a feature.

Table 3. Attributes and descriptions for the feature: Lakes, ponds and permanent wetlands.

Attribute [a]	Description
Availability	Retains water at least 4–8 weeks, between early April and late July, to allow development from egg to metamorphosis
Elevation	Less than 1230 m above sea level
Habitat Type	Lakes, ponds, marshes, springs, sluggish streams, and seasonally wetted margins around permanent waterbodies
Depth	Shallow areas less than 1 m deep are present in which warm water allows for rapid development of eggs and tadpoles
Shoreline	Gently sloping in at least one or more portions of the water body, creating shallows (see above); presence of emergent vegetation or, alternatively, sticks, rocks or other objects used for egg attachment
Food	Availability of algae, aquatic vegetation and other organic matter as food for tadpoles
Other	Optimally, an absence of predatory fish (i.e., sport fish, invasive alien fish, gold fish, other fish used for mosquito control or other purposes) and suitable water quality (i.e., without high levels of pollutants that impair reproductive success)

[a] Attribute: the building blocks or *measurable* characteristics of a feature.

3.3.2 Terrestrial (Upland) Habitat Surrounding Wetlands

Function: Foraging, overwintering, seasonal migrations

Outside of the breeding period, metamorphosed juveniles and adults use grassland, shrub–steppe, and open forest habitats for foraging, seasonal migration, and overwintering (COSEWIC 2007). These terrestrial habitats are therefore required year-round. Adults and juveniles forage where they can dig burrows for diurnal refuges, aestivation (dormancy to avoid dryness or heat), and hibernation (COSEWIC 2007).

Seasonal migration: Characteristics of habitat features and the extent of terrestrial habitat in which these activities take place are not completely understood. Based on information on other spadefoot species, Hammerson (2005) reported that spadefoots in general move several hundred metres or more from breeding sites and suggested that a band of at least 500 m radius around breeding sites would encompass their seasonal movements and terrestrial habitat requirements. This distance is generally supported by telemetry studies of Great Basin Spadefoot in the northern portion of the species' provincial distribution. Garner (2012) used telemetry to track 19 adult spadefoots in grassland and open forest habitat near 70 Mile House. After breeding, study animals moved a mean distance of 100.1 m from aquatic habitat (95% confidence interval = 85.3–111.7), with an average maximum of 135.9 m ± 98.2 m and a maximum of 371 m. Richardson and Oaten (2013) found two types of life-history strategies in shrub–steppe habitat near Kamloops. Twenty-one of 32 (66%) telemetered adults stayed within 500 m of an aquatic breeding site; 10 (48%) of these were between 250 m and 500 m of the wetland. Ten individuals made longer movements (750–2350 m) away from wetlands; it is unclear whether these longer movements represented dispersal to other wetlands or to more distant foraging areas from the pond by non-breeding individuals. Hales (pers. comm., 2016) monitored 33 telemetered adults in grassland habitat near Kamloops over a 2-year period and reported average and maximum movements of 180 m and 500 m, respectively. The effect of telemetry equipment (weight) on movement is unknown and, as a result, movement distances may be conservative. Movement within core habitat needs to be free of insurmountable barriers (e.g., large fast rivers and large lakes, dense urban centres, extensive spans of artificial surfaces, major roads with high traffic volumes, cliffs, and blocky talus).

Foraging: During the active season from April–September (Richardson and Oaten 2013), the Great Basin Spadefoot forages for small invertebrates (e.g., earthworms, ants, beetles, flies, grasshoppers, spiders, etc.) during nights when humidity is high. They shelter in refuges during the day and during dry, hot periods in the summer (i.e., aestivation). Refuges typically consist of shallow, self-constructed burrows (Sarell 2004; Morey 2005; Garner 2012). Small mammal burrows, other existing crevices, or surface cover objects are also used but usually to a lesser extent (Svihla 1953; Sarell 2004; Garner 2012; Richardson and Oaten 2013); however, Hales (pers. comm., 2016) found 40% (n = 111) of daytime retreats were in rodent burrows (pocket gopher, mice) in heavily compacted, silty clay soils near Kamloops. Soils at this site likely were relatively difficult to burrow into, and this may have contributed to an increased use of rodent burrows. Hales also found that cover objects were used near breeding ponds in spring but not much in other habitats or other times of the year. Soil types that facilitate burrowing are necessary. Spadefoots are unlikely to burrow in substrates such as sod or coarse gravel, as shown for the Eastern Spadefoot (*Scaphiopus holbrookeii*; Jansen *et al*. 2001). Deep, loose, friable soils are considered important (COSEWIC 2007); however, Oaten (pers. comm., 2016) observed

Great Basin Spadefoots burrowing in various soil types and fairly hard textures. In laboratory tests, juvenile Great Basin Spadefoots preferred sandy clay loam soils and fine gravel over clay and sand (clay and sand were used at lower rates) (Oaten 2003). Great Basin Spadefoots focus their activities around burrow sites within several small (~ 0.5 ha) activity centres (Garner 2012; Richardson and Oaten 2013). Burrows are more often in bare ground in open, rather than in vegetated, microsites (Garner 2012). Daytime burrows near Kamloops were under sagebrush (41%) or in the open (36%) and sometimes in existing burrows or under coarse woody debris or rocks (Richardson and Oaten 2013). Some individuals do not establish activity centres but move frequently and over relatively long distances (> 500 m) away from wetlands and repeatedly used new burrow sites (Richardson and Oaten 2013). The significance of this behaviour, and the circumstances that might promote it, are unknown.

Overwintering and aestivation (torpor during hot weather): Great Basin Spadefoot are adapted to survive long periods (i.e., 1–2 years in similar species) of unsuitable conditions by burrowing underground (Hallock 2005; COSEWIC 2007). In British Columbia, overwintering occurs from October to March, but exact timing depends on local conditions. Aestivation may occur any time outside this period in response to dry conditions. Self-dug burrows similar to those used for diurnal retreats probably serve during periods of summer inactivity, but no specific information is available. At the northern part of the species' provincial range, overwintering took place in the same areas that were used in summer for foraging (Garner 2012; Richardson and Oaten 2013). Suitable soils (see above) that facilitate burrowing to below the frost line are required. Overwintering burrows were at depths of 40–145 cm near the northern limits of the species' range near 70 Mile House (n = 3; Garner 2012). Richardson and Oaten (2013) found a mean hibernation depth of 54 cm near Kamloops (n = 12) and maximum depths up to 1.5 m (Oaten, pers. comm., 2016). It is unclear what effect transmitters may have on burrowing depth. In one case, the self-dug burrow was immediately adjacent to a badger burrow into which the spadefoot burrow probably joined (Garner 2012).

A summary of functions (Table 4), features, and attributes (Table 5) for terrestrial habitat is presented below.

Table 4. Summary of essential functions and features of Great Basin Spadefoot terrestrial habitat in British Columbia.

Life stage(s)	**Function**[a]	**Feature(s)**[b]
Adults and juveniles	Foraging, refuge, overwintering, and seasonal migrations between waterbodies and proximal terrestrial locations	Grassland, shrub–steppe, open forest

[a] Function: a life-cycle process of the species (e.g., foraging, refuge, overwintering, seasonal migrations).
[b] Feature: the essential structural components of the habitat required by the species.

Table 5. Attributes and descriptions for the feature: Grassland, shrub–steppe, open forest.

Attribute [a]	Description
Availability	All year
Elevation	Less than 1230 m above sea level
Habitat type	Grassland, shrub–steppe, open forest and may include some agricultural areas
Distance from breeding habitat	Most terrestrial habitat occurs within a band of about 500 m around breeding wetlands
Substrate	Contains friable (easily crumbled) soils, clay loam, fine gravel, clay, and sandy soils that permit burrowing, existing burrows (may include firmer soils), naturally occurring holes or crevices, and cover objects (e.g., coarse woody debris and larger rocks) that provide refuge; sod and coarse gravel are unsuitable
Food	Small vertebrate and invertebrate prey (e.g., earthworms, ants, beetles, flies, grasshoppers, etc.)
Corridor (seasonal migrations)	Absence of insurmountable barriers to movement (e.g., large fast rivers and large lakes, dense urban centres, extensive spans of artificial surfaces, major roads with high traffic volumes, cliffs, and blocky talus)
Refuge (foraging and seasonal migration)	Self-made burrows, rodent burrows (ground squirrel, pocket gopher), surface cover objects such as flat rocks and coarse woody debris (particularly important for recently metamorphosed juveniles)
Refuge (over-wintering)	Self-made burrows, rodent burrows, crevices, or soil mounds that are sufficiently deep to permit access to frost-free areas (40–145 cm, Garner 2012; Richardson and Oaten 2013)

[a] Attribute: the building blocks or *measurable* characteristics of a feature.

3.3.3 Dispersal/Connectivity Habitat

Function: Dispersal

Connectivity between breeding sites across the landscape is required by aquatic-breeding amphibians for dispersal among waterbodies, colonization of new or irregularly used sites, and persistence of subpopulations (Trenham and Shaffer 2005; Semlitsch 2008). Connectivity through upland habitat is especially important for Great Basin Spadefoots, which rely on ephemeral breeding sites that might not be available each year because of environmental fluctuations. Dispersal may take place when adults are moving to breeding sites in spring and/or when metamorphosed juveniles are leaving these sites in summer. More than 1 year may be required for dispersal movements to new ponds across the landscape (Semlitsch 2008). Characteristics of dispersal habitat are poorly understood, but patches of bare ground with suitable soils for burrow construction are most likely required over at least a portion of the area, as well as other refuges from the elements and predators. On wet nights, amphibians may travel across various habitats relatively rapidly (Marsh and Trenham 2001). The Great Basin Spadefoot is suspected of using a broader range of habitats during dispersal movements compared to characteristic aquatic and terrestrial core habitat used for breeding and foraging. These movements are likely influenced by habitat types and physical barriers. However, features that would prevent dispersal of Great Basin Spadefoot are poorly understood.

Aquatic-breeding amphibians of many species can travel several kilometres across terrestrial habitat under optimal conditions (see reviews in Marsh and Trenham 2001; Rittenhouse and Semlitsch 2007). Inter-pond movements have not been specifically studied in the province, but telemetry data from one study near Kamloops detected movements up to 2350 m from breeding ponds by adults (Richardson and Oaten 2013). In the absence of specific information, NatureServe (2014; following a review by Hammerson [2005]) suggested separation distances of 1 km in unsuitable habitat and 5 km in suitable habitat to delineate subpopulations of spadefoots. Insurmountable barriers listed by Hammerson (2005) include: busy major highways, especially at night when Great Basin Spadefoots generally travel, such that they rarely cross successfully; urban development dominated by buildings and pavement; large, wide, fast-flowing rivers, cliffs, blocky talus.

A summary of functions (Table 6), features, and attributes (Table 7) for dispersal habitat is presented below.

Table 6. Summary of essential functions and features of Great Basin Spadefoot dispersal/connectivity habitat in British Columbia.

Life stage(s)	Function[a]	Feature(s)[b]
Adults and juveniles	Longer-distance dispersal between core habitat areas (i.e., breeding habitat and proximal terrestrial seasonal migration areas); foraging, refuge, overwintering, and seasonal migrations	Grassland, shrub–steppe, open forest and may include some human-modified habitats such as urban and agricultural areas

[a] Function: a life-cycle process of the species (e.g., dispersal).
[b] Feature: the essential structural components of the habitat required by the species.

Table 7. Attributes and descriptions for the feature: Grassland, shrub–steppe, open forest.

Attribute [a]	Description
Availability	All year
Elevation	Less than 1230 m above sea level
Habitat type	Grassland, shrub–steppe, open forest and may include some human-modified habitats such as agricultural areas and low-density urban areas.
Distance from breeding habitat	Most dispersal habitat occurs between approximately 500 m and 2400 m from a breeding wetland.
Substrate	Contains friable soils, clay loam, fine gravel, clay, and sandy soils that permit burrowing, existing burrows (may include firmer soils), naturally occurring holes or crevices, and cover objects (e.g., coarse woody debris and larger rocks) that provide refuge; sod and coarse gravel are unsuitable. May also move over human-modified substrates such as pavement, lawns, etc.
Food	Food includes invertebrate and small vertebrate prey (e.g., ants, beetles, flies, spiders, etc.)
Corridor	Absence of insurmountable barriers to movement (e.g., large fast rivers and large lakes, dense urban centres, extensive spans of artificial surfaces, major roads with high traffic volumes that intersect dispersal routes, cliffs, and blocky talus
Refuge	Self-made burrows, rodent burrows (ground squirrel, pocket gopher), rocks, logs, and surface cover objects that provide shelter

[a] Attribute: the building blocks or *measurable* characteristics of a feature.

3.4 Ecological Role

The Great Basin Spadefoot is part of the food web of the threatened grassland and shrub–steppe ecosystems of British Columbia's Southern Interior. It is potential prey for a number of animals, including Coyote (*Canis latrans*), various snakes, and other species at risk such as Burrowing Owl (*Athene cunicularia*), Blotched Tiger Salamander (*Ambystoma mavortium*), and Great Blue Heron (*Ardea herodias*). In turn, it preys on a wide variety of invertebrates (COSEWIC 2007). Juveniles transport nutrients from aquatic breeding sites to terrestrial uplands after they leave ponds and adults transport nutrients from the terrestrial habitat to the breeding pond, performing an important ecosystem function.

3.5 Limiting Factors

Limiting factors generally are not human-induced and include characteristics that make the species or ecosystem less likely to respond to recovery/conservation efforts (e.g., inbreeding depression, small population size, and genetic isolation; dispersal limitations that prevent recolonization).

Great Basin Spadefoots often use vernal pools for breeding. Although the life history strategy of Great Basin Spadefoot allows for opportunistic exploitation of ephemeral breeding sites as they become available, it can also result in attraction to unsuitable sites, such as water-filled depressions of cattle hoof prints, swimming pools, ditches, or other human-made "sink" habitats, in which the completion of the life cycle to metamorphosis is unlikely or precarious (Sarell 2004; COSEWIC 2007). In addition, the suitability of vernal breeding sites fluctuates widely over time because of variability in precipitation, sometimes resulting in many years or even decades of reproductive failure. Although this can result from natural climate variation, it is most likely exacerbated by climate change. Spadefoots are relatively long lived compared to other amphibians (up to 10+ years), but even this may not be sufficient for population viability during droughts that extend beyond the maximum lifespan of the species. Dispersal capabilities are limited to only a few kilometers in a lifetime, and therefore recolonization of locally extirpated breeding sites also may limit population viability.

Great Basin Spadefoot are habitat specialists that require suitably connected aquatic and associated terrestrial habitats in grassland, shrub–steppe, and open forest at relatively low elevations (up to 1230 m) with soils suitable for burrowing. This habitat is naturally limited in British Columbia. Range expansion to alternate habitats is unlikely.

4 THREATS

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational) (adapted from Salafsky *et al.* 2008). For purposes of threat assessment, only present and future threats are considered.[3] Threats presented here do not include limiting factors,[4] which are presented in Section 3.5.

For the most part, threats are related to human activities, but they can also be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., introduction of invasive species). Effects of natural phenomena (e.g., fire, flooding) may be especially important when the species is concentrated in one location or has few occurrences, which may be a result of human activity (Master *et al.* 2012). As such, natural phenomena are included in the definition of a threat, though they should be considered cautiously. These stochastic events should only be considered a threat if a species or habitat is damaged from other threats and has lost its ability to recover. In such cases, the effect on the population would be disproportionately large compared to the effect experienced historically (Salafsky *et al.* 2008).

4.1 Threat Assessment

The threat classification below is based on the IUCN–CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system and is consistent with methods used by the B.C. Conservation Data Centre. For a detailed description of the threat classification system, see the Open Standards website (Open Standards 2014). Threats may be observed, inferred, or projected to occur in the near term. Threats are characterized here in terms of scope, severity, and timing. Threat "impact" is calculated from scope and severity. For information on how the values are assigned, see Master *et al.* (2012) and table footnotes for details. Threats for the Great Basin Spadefoot were assessed for the entire province (Table 8).

[3] Past threats may be recorded but are not used in the calculation of threat impact. Effects of past threats (if not continuing) are taken into consideration when determining long-term and/or short-term trend factors (Master *et al.* 2012).
[4] It is important to distinguish between limiting factors and threats. Limiting factors are generally not human-induced and include characteristics that make the species or ecosystem less likely to respond to recovery/conservation efforts (e.g., inbreeding depression, small population size, and genetic isolation).

Table 8. Threat classification table for the Great Basin Spadefoot in British Columbia.
Note: a description of the threats included in this table are found in section 4.2.

Threat #[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]
1	Residential & commercial development	Low	Small	Serious	High
1.1	Housing & urban areas	Low	Small	Serious	High
1.2	Commercial & industrial areas	Negligible	Negligible	Extreme	High
1.3	Tourism & recreation areas	Negligible	Negligible	Extreme	High
2	Agriculture & aquaculture	Low	Pervasive	Slight	High
2.1	Annual & perennial non-timber crops	Low	Small	Moderate	High
2.3	Livestock farming & ranching	Low	Pervasive	Slight	High
2.4	Marine & freshwater aquaculture	Negligible	Negligible	Extreme–Serious	High
3	Energy production & mining	Negligible	Negligible	Unknown	High
3.2	Mining & quarrying	Negligible	Negligible	Unknown	High
4	Transportation & service corridors	Medium–Low	Large	Moderate–Slight	High
4.1	Roads & railroads	Medium–Low	Large	Moderate–Slight	High
5	Biological resource use	Low	Small	Slight	High
5.3	Logging & wood harvesting	Low	Small	Slight	High
6	Human intrusions & disturbance	Low	Small	Moderate–Slight	High
6.1	Recreational activities	Low	Small	Moderate–Slight	High

Threat #[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]
7	Natural system modifications	Low	Small	Extreme–Serious	High
7.2	Dams & water management/use	Low	Small	Extreme–Serious	High
8	Invasive & other problematic species & genes	Low	Pervasive	Slight	High
8.1	Invasive non-native/alien species	Low	Pervasive	Slight	High
9	Pollution	Low	Small	Moderate–Slight	High
9.3	Agricultural & forestry effluents	Low	Small	Moderate–Slight	High
11	Climate change & severe weather	Medium–Low	Large–Restricted	Moderate–Slight	High
11.2	Droughts	Medium–Low	Large–Restricted	Moderate –Slight	High

[a] Threat numbers are provided for Level 1 threats (i.e., whole numbers) and Level 2 threats (i.e., numbers with decimals).
[b] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on severity and scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment time (e.g., timing is insignificant/negligible [past threat] or low [possible threat in long term]); Negligible: when scope or severity is negligible; Not a threat: when severity is scored as neutral or potential benefit.
[c] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).
[d] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation time frame. For this species a 10-year time frame was used. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).
[e] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or three generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2 Description of Threats

The overall province-wide threat impact for this species is Medium to High.[5] This overall threat considers the cumulative impacts of multiple threats. Primary threats include direct mortality from roads and lower reproductive success due to climate change (drought). Lower-ranked threats include habitat loss/alteration and direct mortality from residential and agricultural development, all-terrain vehicles, water management, non-native species (fish, bullfrogs), pollution and salvage logging (Table 8). Details are discussed below under the Threat Level 1 headings.

Threat 1. Residential & commercial development (threat impact Low)

Residential development is the greatest contributor to this threat, augmented by industrial and shoreline recreational developments. The threat applies to the Okanagan and Similkameen valleys and locally in other areas experiencing urban expansion, such as Kamloops. Historically, the infilling of wetlands associated with residential development has resulted in breeding loss for the Great Basin Spadefoot. (COSEWIC 2007) and direct mortality of eggs and tadpoles, depending on the time of year. The province's *Water Sustainability Act* (Province of British Columbia 2014) makes it illegal to infill wetlands without authorization, but the practice does continue occasionally (Harrison and Moore 2013; Dyer, pers. comm., 2016). Nevertheless, the Act may not provide protection for vernal pools, which do not persist for long and may not fill with water annually and therefore may not meet the definition of a "stream." The probability of substantial infilling of breeding sites is thought to be relatively low over the next 10 years; however, development continues to affect upland foraging, overwintering, and dispersal habitat. The footprint of buildings, roads, and turf grasses prevent spadefoots from digging burrows for thermal and predator protection and foraging above ground. Commercial & industrial areas and tourism & recreation areas have a Negligible impact.

Threat 2. Agriculture & aquaculture (threat impact Low)

Impacts of annual and perennial non-timber crops accrue primarily from habitat loss and degradation at lower elevations. The Agricultural Land Reserve provides some protection of habitat from conversion for urban development (see Threat #1); however, it also encourages agricultural developments that can affect this species. Infilling wetland breeding sites makes them unusable for egg-laying and tadpole development. The impact on terrestrial habitat likely depends on the type of crop and management approach, although no information on the relative impact from different crops was found. Spadefoots are unlikely to be able to burrow into sod grasses (Jansen *et al*. 2001). They also choose bare ground rather than vegetated microsites (Garner 2012) and use coarse woody debris (Richardson and Oaten 2013). Crops that are sod-forming, have sod grasses between rows, or have little bare ground or coarse woody debris likely receive little use by spadefoots. Farm vehicles can cause accidental mortality. Accidental trapping in irrigation system control pits also can increase mortality (Ashpole, pers. comm.,

[5] The overall threat impact was calculated following Master *et al.* (2009), using the number of Level 1 threats assigned to this species, where timing = High or Moderate, which included two Medium–Low, and seven Low (Table 2). The overall threat impact considers the cumulative impacts of multiple threats.

2012). The rate of natural land conversion for agricultural purposes in the Okanagan Valley has decreased over the past decade (Dyer, pers. comm., 2016).

Livestock farming and ranching occurs over much of the species' range. The effect of cattle on amphibians is thought to be mostly through disturbance of breeding sites, including trampling (compaction) of shoreline vegetation and bottom substrate, loss of cover, and direct mortality of tadpoles through creation of deep hoof prints in mud (pug marks), which trap and dry out eggs and tadpoles (Sarell 2004). Hales (pers. comm., 2016) also found large numbers of recent metamorphs that were trapped in deep cattle hoof prints and died. In addition, one of Hales' 33 telemetered adults (3%) was stepped on by a cow and killed. Mortality of breeding adults, especially females, has a much greater population impact than juvenile mortality. Oaten (pers. comm., 2016) and Richardson and Oaten (2013) found that adult Great Basin Spadefoots concentrated in shallow (5–10 cm) burrows within 10–20 m of breeding ponds from April to late May. During this time, adults likely are more vulnerable to direct trampling mortality or becoming trapped in shallow burrows, if the soil above them is compacted by livestock. Livestock drinking of limited water in drought years may also affect spadefoots at some shallow sites. Livestock trampling may also compact soils in terrestrial habitat and collapse small mammal burrows, which are used by spadefoots for aestivation (Sarell 2004). The severity of the threat likely depends on stocking density and duration of grazing season and is likely more damaging in drought years when water levels are low.

Nevertheless, light grazing by livestock may be beneficial to spadefoots, opening up heavily shaded shorelines and introducing nutrients (Bull and Wales 2001); however, this would not apply during the breeding season. The creation or enhancement of livestock watering sites may provide breeding sites but may also create sink habitat with high mortality of eggs or young. Research is needed to determine livestock stocking rates that are compatible with the maintenance of Great Basin Spadefoot habitats.

Aquaculture (fish farming) has affected a small number of sites in the Okanagan, owing to direct predation on eggs and larvae but the impact is Negligible.

Threat 3. Energy production & mining (threat impact Negligible)

The scope of mining and quarrying is Negligible and the severity is Unknown, resulting in a Neglible threat.

Threat 4. Transportation & service corridors (threat impact Medium–Low)

The threat of direct mortality on Great Basin Spadefoots caused by vehicles on existing and new roads is ongoing and exists over a widespread area. Spadefoots are vulnerable when moving across roads or using roads as travel routes during seasonal migrations between aquatic breeding sites and upland foraging and overwintering sites. Great Basin Spadefoots also appear to use paved surfaces for thermoregulation and water absorption (Crosby 2014 and references therein), which may increase mortality by increasing the time spent on roads. Approximately 80% of the species' provincial range is within 500 m of roads, and almost all is within 3 km (calculated from

Hectares BC[6] using compiled distribution records up to 2014). Road mortality for this species has been recorded from several areas in the province (Sarell 2004; COSEWIC 2007; Crosby 2014). Great Basin Spadefoots represented 87.4% of all amphibians and 46.5% of roadkill along 52 km of paved roads (including 31 km on Highway 97) surveyed from 2010 to 2012 in the South Okanagan (Crosby 2014). In Crosby's study (2014), spadefoot roadkill occurred throughout the extent of roads surveyed and were encountered most often in May (adults) and end of June to mid-July (juveniles), corresponding to migration events. Crosby suggested that mitigation using underpasses and drift fences reduced mortality; however, most roads within the species' range are devoid of structures that would allow safe passage for amphibians. The impact of this threat is variable across the species' range but is likely severe at some local sites. Population effects have seldom, if ever, been determined. The degree of population impact likely depends on the number and age structure of road killed animals. For example, metamorph mortality in a good reproduction year will have a lower population impact than loss of a few breeding females after a long drought when population numbers are low.

Threat 5. Biological resource use (threat impact Low)

The threat of logging seems currently confined to the northern limits of the species' range in the Cariboo region, where spadefoots occur primarily on forestry lands and salvage harvesting associated with Mountain Pine Beetle damage is taking place. Salvage harvesting has been extensive over the past few years (up to 2014) and may continue at a lower rate in the future (Packham, pers. comm., 2014). In other areas of the Great Basin Spadefoot range, the overlap of its habitat with logging is limited to higher elevations. Impacts from logging accrue mostly from disturbance to wetland breeding habitats and from inadvertent road mortality, if activities are carried out during the active period of Great Basin Spadefoots. Over the long term, some effects of tree removal may be positive, as they reduce encroachment of forest into grasslands (see

Threat 6. Human intrusions & disturbance (threat impact Low)

Mudbogging and other intensive use of off-road vehicles for recreational purposes are widespread across the species' range, especially near human population concentrations. A relatively small portion of the Great Basin Spadefoot population is regularly exposed to mudbogging at breeding sites; however, this can be a serious local issue. For example, human intrusion affected 10% of breeding sites in a study area near Kamloops, and mudbogging trucks heavily impacted one site, which supported more than 5000 tadpoles in 2011 (Oaten, pers. comm., 2016). Other examples of mudbogging activities on Great Basin Spadefoot breeding sites are known from the Okanagan and Thompson (Liepens, pers. comm., 2013; Ashpole, pers. comm., 2014) and likely occur throughout the range. Impacts are from direct mortality and from tire ruts that trap tadpoles, isolating them from the remainder of the wetland and causing them to die when the ruts dry up. Impacts may increase seasonally because Great Basin Spadefoots concentrate in shallow (5–10 cm) burrows within 10–20 m of breeding ponds from mid-April to late May (Richardson and Oaten 2013; Oaten, pers. comm., 2016). The effects of off-road vehicles on Great Basin Spadefoots terrestrial habitat containing burrows are not well known, but soil compaction and burrow collapse are of concern. Garner (pers. comm., 2015) found one of

[6] Hectares BC <http://www.hectaresbc.org/app/habc/HaBC.html> [Accessed October 2014].

her 19 telemetered spadefoots dead, in a shallow burrow that had been run over by a vehicle. A wide severity range was used because the type of impact depends on number of vehicles and the frequency and timing of activities at particular sites, resulting in much uncertainty in the average impact across the species' range.

Threat 7. Natural system modifications (threat impact Low)

Natural system modifications include dams and water management/use. Impacts can occur from water withdrawal for irrigation or other purposes (e.g., water removal by helicopters or pumps for firefighting), as well as from alteration of natural water regimes, which can result in early drying of ponds, rapid drops in water levels, or creation of sink habitats in which larvae die before metamorphosing. Human use or water diversion can interact or exacerbate the impact of multi-year droughts associated with climate change and severe weather (see Threat 11.2). The severity of this threat depends on the type of water management practice deployed; the wide range in the scoring reflects this uncertainty across the species' provincial range.

If burrowed underground, Great Basin Spadefoot might survive fires, unless the fire is very hot. Over the long term, fire suppression may result in encroachment of forest into grassland and open woodland habitats, but conifer encroachment is not currently an issue.

Threat 8. Invasive & other problematic species & genes (threat impact Low)

Introduced fish and disease organisms, particularly the amphibian chytrid fungus *Batrachochytrium dendrobatidis*, pose widespread and serious threats.

American Bullfrogs (*Lithobates catesbeianus*) have been a localized threat in the South Okanagan, but this threat has reduced dramatically because of a 7-year eradication effort, with no frogs detected since 2010 (Govindarajulu, pers. comm., 2014). Monitoring continues and plans are in place to eradicate new occurrences, if detected.

Epidemic disease must be considered a serious threat to all amphibian populations, with the amphibian chytrid fungus geographically widespread across British Columbia (Govindarajulu *et al*. 2013; Richardson *et al*. 2014). Although no disease outbreaks have been reported for Great Basin Spadefoots, 5/ 35 (14%) Great Basin Spadefoot tadpoles tested positive for chytrid in 2008 (Richardson *et al*. 2014); whether this leads to mortality is unknown (Govindarajulu, pers. comm., 2014). The prevalence of chytrid fungus across the species' range resulted in a pervasive scope for this threat.

Introduced fish represent a widespread and ongoing threat of direct predation to aquatic-breeding amphibian populations in the province (see reviews and references in Wind 2005). Spadefoots are somewhat protected from predatory fish introductions because of their extensive use of shallow, temporary waterbodies, which generally do not support fish owing to winter die-off. However, introductions of trout, bass, carp, and perch affect Great Basin Spadefoot habitat in the South Okanagan (Ashpole, pers. comm., 2014) and likely throughout the species' range. Introductions of goldfish and other fish used for mosquito control or other purposes also continue in Great Basin Spadefoot breeding ponds.

Threat 9. Pollution (threat impact Low)

This threat includes pollution from agricultural herbicides, pesticides, and fertilizers, as well as pesticide use for mosquito control. It applies mainly to agricultural areas in the Okanagan and Similkameen river valleys, and hence the scope is small (1–10% of the Great Basin Spadefoot population affected). The application of magnesium chloride to desiccate gravel road surfaces for dust abatement during road maintenance poses an additional, potential threat that requires clarification (Packham, pers. comm., 2014).

Impaired reproduction and abnormal development of amphibians can occur as a result of exposure to toxic and teratogenic substances, which are released through escalating human developments in valley bottoms and accumulate in aquatic habitats (see reviews and references in Harfenist *et al*. 1989; Bishop 1992; Pauli *et al*. 2000; Crump 2001). Bishop *et al*. (2010) detected low concentrations of 17 chemicals at amphibian breeding sites located in organic and treated orchards in the South Okanagan River valley. Hatching success of Great Basin Spadefoots was highly variable but was lower overall in the treated orchards compared to organic orchards or reference sites away from the agricultural areas (0–92% in sprayed orchards; 48–98.6% in organic orchards; 51–95.5% at reference sites). The herbicide atrazine by itself, and atrazine combined with total nitrate and chlorpyrifos, accounted for approximately 80% of the variation in spadefoot hatching success. The effects of reduced survivorship for developmental stages in the local Great Basin Spadefoot population were not examined and are unknown. Widespread applications of Vectobac® as part of mosquito control programs to reduce the potential impacts of West Nile virus is a developing issue that may affect Great Basin Spadefoots and requires additional research. Substantial uncertainty surrounds population-level impacts and the combined effects of pollutants from various sources.

Threat 11. Climate change & severe weather (threat impact Medium–Low)

Under projected climate change scenarios, the impacts of drought are expected to be widespread and increase in significance over the long term. Over the past 20 years, the water table has dropped substantially across the species’ range in British Columbia (Cohen 2004; Sarell 2004; COSEWIC 2007). Higher temperatures and summer droughts associated with climate change are expected to increase evaporation rates and further lower the water table. A decrease in the water table is likely to either eliminate temporary shallow waterbodies or shorten their hydro-period and accentuate effects of periodic droughts (Bunnell *et al*. 2010). This is expected to increase mortality of eggs and tadpoles. The Great Basin Spadefoot relies largely on small temporary wetlands that are most at risk. Over the past decade or so, a substantial number of small wetlands across the species’ provincial range have been dry or almost dry (Okanagan: Dyer, pers. comm., 2014; Cariboo: Packham, pers. comm., 2014). Coelho (2008) found that the total number and surface area of ponds at eight sites in the Southern Interior decreased by 63% and 54%, respectively, between 1992 and 2012. Although all areas of the range are affected, not all habitats are affected equally; deeper wetlands will remain available. Clusters of wetlands with different depths are needed to maintain long-term population viability (Gibbs 2000). The cumulative effects generated by the other threats described above will likely exacerbate the threat posed by climate change.

5 RECOVERY GOAL AND OBJECTIVES

5.1 Recovery (Population and Distribution) Goal

The recovery goal is to maintain or increase the abundance of Great Basin Spadefoot in each of the six geographic areas where it occurs and to ensure connectivity within these areas.

5.2 Rationale for the Recovery (Population and Distribution) Goal

The Great Basin Spadefoot has a naturally restricted distribution within grassland and open forest habitats in British Columbia's Southern and Central Interior, where its distribution overlaps extensively with human-modified landscapes and is subjected to habitat loss and degradation. Developments reduce or eliminate habitat and connectivity between remaining subpopulations, further exacerbating spadefoot population loss in the province. Insufficient baseline data on historical distributions and abundance, as well as data gaps regarding current subpopulation sizes and trends, have thwarted efforts to quantify long-term total population and distribution/habitat targets for spadefoot survival and recovery.

With its small index of area of occupancy[7] (619–864 km^2), severely fragmented total population, and observed declines in the area and quality of its habitat, the Great Basin Spadefoot is likely to undergo extreme fluctuations in number of adult individuals COSEWIC (2007). Among other considerations, these quantitative criteria led to its assessment as Threatened[8] in Canada. More than one-half of the total population in British Columbia is deemed to occur in habitat patches smaller than required to support viable subpopulations over the long term. The threshold separating designations of Threatened and of Special Concern include an area of occupancy greater than 2000 km^2, or an absence of (a) severe fragmentation, (b) continuing declines, and (c) extreme fluctuations (COSEWIC 2007).

Future improvements to the species' condition may be possible by substantially reducing threats to habitat and individuals and increasing habitat connectivity so that habitat patches are sufficiently large to support viable subpopulations over the long term. For example, connectivity among subpopulations in each geographic area could be increased by restoring or protecting habitat in the intervening areas and/or facilitating safe movements across roads; such actions could be used to reduce fragmentation and maintain a "rescue effect" between breeding wetlands.

The immediate recovery goal is to prevent further loss and fragmentation of the species' small distribution range. If additional naturally occurring subpopulations are discovered (within or outside of the six known geographic areas), their habitat should also be maintained. More information about subpopulation sizes and trends across the landscape, and opportunities to mitigate threats, is needed to clarify what is biologically and technically feasible for recovery, and to develop an appropriate long-term recovery goal for the species that includes specific

[7] COSEWIC index of area of occupancy is calculated as the number of occupied 2 x 2 km grid cells.
[8] Assessed as "Threatened" based on COSEWIC criteria: B2ab(ii,iii)c(iv).

targets. Restoring and protecting dispersal habitat lost due to human-induced fragmentation will be important for maintaining viable subpopulations within each of the six geographic areas occupied by Great Basin Spadefoot in B.C.

5.3 Recovery Objectives

The recovery objectives focus on reducing threats to the species and its habitats, and increasing connectivity, so that the total provincial population will no longer suffer from severe fragmentation. Habitat connectivity across terrestrial habitat is essential for the persistence of subpopulations of this species, which have adapted to take advantage of ephemeral breeding sites. The objectives also tackle knowledge gaps related to threats and needs associated with the species, so that factors influencing the viability of subpopulations can be addressed more rigorously.

1. Secure Great Basin Spadefoot core habitats (i.e., breeding sites and associated terrestrial habitat) within each of the six geographic areas that the species occupies.
2. Maintain or increase connectivity across the landscape within and among adjacent subpopulations.[9]
3. Address knowledge gaps related to the distribution, breeding, terrestrial and connectivity habitat requirements, population dynamics across the landscape, impacts of priority threats, and effectiveness of recovery actions.

“Secure” habitat is defined as that which is managed to maintain the species long term (i.e., at the time scale of at least 100 years), includes suitably connected breeding and terrestrial habitat, and where primary threats have been addressed. Habitat securement will require a stewardship approach that engages the voluntary cooperation of landowners and managers on various land tenures to protect this species and the habitat it relies on. It may include stewardship agreements, conservation covenants, ecological gifts, voluntary sale of private lands by willing landowners, land use designations, protected areas, management agreements, and existing legislation.

6 APPROACHES TO MEET RECOVERY OBJECTIVES

6.1 Actions Already Completed or Underway

The action groups of the B.C. Conservation Framework (B.C. Ministry of Environment 2009) have categorized the following actions. Status of the action group for this species is given in parentheses.

Monitor Trends (in progress)

[9] Subpopulations are defined as geographically or otherwise distinct groups in the total population between which little demographic or genetic exchange occurs.

Monitoring has occurred in several areas, including the South Okanagan (Ashpole, pers. comm., 2016); Grand Forks (Tedesco 2014); Cariboo (Nicholson and Packham 2008; Kline and Packham 2009); Lac du Bois Grasslands Protected Area (Richardson and Oaten 2013); and White Lake Grasslands Protected Area (Ashpole, pers. comm., 2014; Safford, pers. comm., 2016).

Compile Status Report (complete)

COSEWIC report completed (COSEWIC 2007). Update due in 2017.

Planning (complete)

British Columbia Recovery Plan completed (Southern Interior Reptiles and Amphibians Recovery Team 2008); update 2016 (this report).

Inventory (in progress)

- Inventory throughout various portions of the species' range (e.g., Orchard 1989; St. John 1993; Leupin *et al*. 1994; Sarell *et al*. 1998; P. McAllister, unpubl. data[10]; K. Larsen, unpubl. data[11]; Sarell and Alcock 2004; Rebellato 2005; Nicolson and Packham 2008; Kline and Packham 2009; Ovaska *et al*. 2011–2014; Richardson and Oaten 2013; Hobbs and Werden 2012; Hobbs and Vincer 2015).

Habitat Protection (in progress)

- Occupied habitat is protected from destruction on provincial Crown land. Some examples include: South Okanagan Grasslands Protected Area, White Lake Grasslands Protected Area, Lac du Bois Grasslands Protected Area, Sun-Oka Beach Park, Boothman's Oxbow Park, South Okanagan and Dewdrop–Rosseau Creek Wildlife Management Areas.
- The Dominion Radio Astrophysical Observatory (National Research Council), the Vaseux Bighorn National Wildlife Area (Canadian Wildlife Service), and the Vernon Army Cadet Summer Training Centre (Department of National Defence) protect important habitats.
- Private land conservancies conserve substantial spadefoot habitat (e.g., The Nature Trust of British Columbia's Twin Lakes, White Lake, and Kilpoola properties; Ducks Unlimited Canada's Bobolink Meadows; Nature Conservancy of Canada's Sage and Sparrow Conservation Area, South Block, Kit Carr, and Bobolink Meadows; Osoyoos Desert Centre; and Southern Interior Land Trust).
- The Great Basin Spadefoot is listed as a "Species at Risk" by the Identified Wildlife Management Strategy; 18 Wildlife Habitat Areas, totalling 1078 ha, have been approved to manage Great Basin Spadefoot habitat (B.C. Ministry of Environment 2016).
- Thirty-one Crown Land Map Reserves protect spadefoot habitat.

[10] McAllister, P., unpubl. data, cited in Southern Interior Reptile and Amphibian Recovery Team (2008).
[11] Larsen, K., unpubl. data, cited in Southern Interior Reptile and Amphibian Recovery Team (2008).

- British Columbia's new *Water Sustainability Act* has expanded definitions of a stream and associated aquatic ecosystem (including wildlife) that provide increased protection for spadefoot breeding sites (Province of British Columbia 2014).

Private Land Stewardship (in progress)

- Private land stewardship agreements totalling 773 ha of spadefoot habitat have been established through Okanagan Similkameen Stewardship Society.
- South Okanagan–Similkameen Conservation Program and Okanagan Collaborative Conservation Program completed "Keeping Nature in our Future," a biodiversity strategy for the Okanagan (South Okanagan–Similkameen Conservation Program 2014). The strategy includes detailed Conservation Ranking maps, analyses by local government area, and recommendations for Environmentally Sensitive Development Permit Areas (White, pers. comm., 2016). A companion document on designing and implementing ecosystem connectivity in the Okanagan is also available (Latimer and Peatt 2014).
- The Okanagan Basin Water Board initiated the Okanagan Wetlands Strategy in 2014, designed to identify and protect or restore Okanagan wetlands.
- Guidelines for amphibian and reptile conservation during urban and rural land development in British Columbia were updated (Province of British Columbia 2014).
- Two habitat stewardship agreements to protect Great Basin Spadefoots were developed in cooperation with the City of Vernon and Municipality of Coldstream in 2011.

Habitat Restoration (in progress)

- Underpasses (large culverts and directional fencing) were installed at the Highway 97 twinning project south of Oliver to partially restore connectivity (Crosby 2014).
- Fourteen artificial wetlands have been created for spadefoots in the south Okanagan; of these, 13 have been occupied by the target species (Ashpole, pers. comm., 2016).

Species and Population Management (in progress)

- Habitat suitability models were developed for the Okanagan and Similkameen area (Warman *et al.* 1998; Sarell *et al*. 2002; Sarell and Haney 2003; Haney and Sarell 2005).
- Toxicology studies were completed at selected breeding sites in the South Okanagan (Ashpole 2004; Bishop *et al.* 2010).
- Laboratory research on pesticide exposure was conducted (de Jong Westman 2008)
- Research on movements and habitat use is ongoing (Oaten 2003; Garner 2012; Richardson and Oaten 2013; Oaten, PhD thesis, in prep.; Hales, Master's thesis, in prep.).
- Research on sensitivity to temperature changes under climate change was accomplished (O'Regan 2013).
- A 7-year bullfrog eradication project in the South Okanagan has had good success, with no confirmed sightings since 2010 (Ashpole, pers. comm., 2014).
- Road mortality effectiveness research was conducted at the Highway 97 twinning project south of Oliver (Crosby 2014) and research is underway at Grand Forks (Tedesco 2014) and White Lake (Winton, pers. comm., 2015).

- Development and monitoring of experimental, artificial amphibian breeding sites in the South Okanagan is continuing through the “Ponds for Peepers Project” (Ashpole, pers. comm., 2016); artificial wetland construction in ongoing in the Kamloops area (Ernst, pers. comm., 2015).
- Best management practices for amphibian and reptile salvages in British Columbia have been developed (B.C. Ministry of Forests, Lands and Natural Resource Operations 2016).
- The Alberta Lake Badger and Spadefoot Enhancement Project was completed (2007–2008) in the Cariboo area.

6.2 Recovery Planning Table

Table 9 summarizes the recommended recovery actions for the Great Basin Spadefoot.

Table 9. Recovery actions for the Great Basin Spadefoot.

Objective	Conservation Framework action group	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
1, 2, 3	Monitor Trends	Continue to monitor trends at several sites throughout the species' range to clarify the effectiveness of habitat to support the species, population variability, and invasive alien species.	1.2, 2.1, 2.3, 4.1, 7.2	Necessary
1, 2	Habitat protection	Continue to inventory potential breeding sites, record sightings in terrestrial habitat, and road mortality to identify locations for habitat protection. Focus on gaps (i.e., Kettle-Granby, Spences Bridge to 14 mile, Lillooet to Churn Creek). Monitor sites to quantify and improve habitat protection effectiveness. Environmental DNA (eDNA) may increase cost effectiveness.	2.3, 4.1, 7.2	Essential
		Continue to improve habitat protection through existing land use designations and management agreements on Crown land (e.g., Wildlife Habitat Areas, Section 16 *Land Act* reserves, Protected Area management, Range Use Plans).	1.2, 2.1, 2.3, 4.1, 7.2	Essential
		Continue working with First Nations to identify and implement opportunities for cooperative habitat conservation projects both on and off reserve land. Incorporate Traditional Ecological Knowledge into recovery actions.	1.1, 2.1, 4.1	Essential
		Continue to work with local governments to incorporate habitat stewardship and protection into planning processes such as Official Community Plans, Environmentally Sensitive Development Permit Areas, zoning, bylaws, and park/recreation plans (e.g., South Okanagan–Similkameen Conservation Program biodiversity strategy implementation).	2.3, 7.2, 11.2	Essential
		Continue to improve connectivity at priority sites in the province and with adjoining populations in the United States, if necessary.	1.2, 2.1, 2.3, 4.1, 7.2	Essential
		Identify sites where water use affects spadefoot tadpoles and develop options for protecting environmental flow needs.	2.3, 4.1,7.2	Beneficial

Objective	Conservation Framework action group	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
1, 2	Private land stewardship	Continue to acquire and manage important habitat through purchase of private lands from willing vendors (e.g., acquisitions by The Nature Trust; The Nature Conservancy of Canada; Southern Interior Land Trust).	1.1, 2.1, 2.3, 7.2	Essential
		Continue to implement stewardship agreements, conservation covenants, and best management practices on private lands through voluntary agreements (e.g., Okanagan–Similkameen Stewardship Society and local government stewardship agreements).	1.1, 2.1, 7.2, 8.1, 9.3	Essential
2	Habitat restoration	Develop a prioritized strategy to eliminate predatory fish and other invasive species at key sites (where feasible) and reduce the likelihood of continued, illegal introductions through targeted outreach.	8.1	Essential
		Develop a prioritized strategy for restoration projects, including wetland construction guidance, key restoration locations, fencing options, etc. Identify and strategically restore or enhance breeding sites where loss of habitat and connectivity is seriously impacting subpopulation viability.	1.1, 2.1, 11.2	Necessary
		Identify and strategically reduce movement barriers in terrestrial habitat where loss of habitat and connectivity is seriously impacting subpopulation viability.	1.1, 2.1, 4.1	Necessary
		Identify “hot spots” where a high level of road mortality occurs and implement mitigation where required; use adaptive management to identify effective actions to reduce or eliminate mortality and restore habitat connectivity.	4.1	Necessary
1, 2, 3	Species and population management	Develop a prioritized research strategy to address knowledge gaps, including implementation options. Include evaluation of constructed wetlands.	1.1, 2.1, 2.3, 4.1, 7.2, 8.1, 9.3, 11.2	Essential
		Clarify threats from climate change and severe weather, including drought, on breeding ponds and identify priorities and options for addressing impacts, if necessary.	11	Essential
		Monitor for emerging infectious diseases (e.g., Ranavirus, Chytrid) and contain their spread, if identified. Explore eDNA monitoring methods.	8.1	Essential
		Continue research to quantify threats from pollution, particularly agricultural chemicals, magnesium chloride on roads, and effects of West Nile Virus control strategies.	9.3	Essential
		Continue efforts to monitor for invasive American Bullfrogs and eliminate introduced populations throughout Great Basin Spadefoot range, if detected.	8.1	Necessary
		Clarify the impacts of urban and agricultural development, including impacts of specific crops and connectivity barriers.	1.1, 2.1	Necessary
		Develop and implement a strategy to eliminate or reduce impacts from habitat disturbance by off-road vehicles at priority sites.	6.1	Necessary
		Clarify potential impacts from livestock on breeding and terrestrial habitat; identify mitigation measures, and implement priority actions.	2.3	Necessary

Objective	Conservation Framework action group	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
		Develop a prioritized and targeted outreach strategy to inform and support key stakeholders. Continue to develop and deliver outreach materials to priority target audiences to increase understanding, support for and implementation of other actions	1.1, 2.1, 2.3, 4.1, 7.2, 8.1, 9.3, 11.2	Necessary
		Address knowledge gaps regarding distribution, movements, population structure, metapopulation dynamics, and landscape connectivity requirements.	1.1, 2.1, 2.3, 4.1, 7.2, 8.1, 11.2	Necessary
		Develop a population viability analysis to quantify specific targets required for recovery.	1.1, 2.1, 2.3, 4.1	Beneficial

[a] Threat numbers according to the IUCN–CMP classification (see Table 8 for details).
[b] Essential (urgent and important, needs to start immediately); Necessary (important but not urgent, action can start in 2–5 years); or Beneficial (action is beneficial and could start at any time that was feasible).

6.3 Narrative to Support Recovery Action Table

6.3.1 Introduction

The recovery activities in Table 9 will be accomplished using a landscape conservation approach, mainly through provincial Crown land designations and partnerships with local government and non-government groups such as the South Okanagan–Similkameen Conservation Program, Okanagan Collaborative Conservation Program, Grasslands Conservation Council of British Columbia, The Nature Trust of British Columbia, and The Nature Conservancy of Canada. Whenever possible, an ecosystem approach (ecological communities or groups of similar ecological communities) will be used to protect and manage habitat for multiple species. Species at risk with overlapping habitat use in wetlands include the Blotched Tiger Salamander, Painted Turtle (*Chrysemys picta*), and Western Toad (*Anaxyrus boreas*), and many other species overlap in terrestrial habitat use (see Section 9). Recommended actions are categorized by the action groups of the B.C. Conservation Framework (B.C. Ministry of Environment 2009).

6.3.2 Monitor Trends

Monitoring subpopulation trends helps to identify the highest priority sites for habitat protection and threat mitigation. Monitoring also provides information on whether management or habitat protection measures are adequate. Follow-up monitoring should be incorporated in all projects that involve manipulations, such as installation of road-crossing structures and amphibian salvage.

Monitoring may consist of determining continued presence to obtaining more detailed trend information on subpopulation size. Although intensive population monitoring with mark-recapture methods provides detailed demographic information, it also requires a lot of effort and can be costly. Nevertheless, intensive population monitoring carried out at selected sites in different parts of the species' range is valuable, and it also provides information on habitat use and movements (see Section 6.3.5, Species and Population Management). Relative abundance measures and persistence monitoring (e.g., revisiting occupied/sentinel sites every 3–5 years) may be the most cost-effective method to take the pulse of population health over the long term and to alert us of range-wide declines.

6.3.3 Habitat Protection, Restoration, and Private Land Stewardship

Conducting inventory work is important to identify new sites for habitat protection, both within and outside of the six known geographic areas that the species occupies in British Columbia. This work should focus on potentially suitable wetlands within areas that have received low survey effort, so that possible undocumented breeding sites are located and managed appropriately. In addition, it is necessary to systematically revisit historical sites across the species' range along with the surrounding wetlands to establish whether subpopulations continue to occur at these or adjacent sites within the landscape. The new environmental DNA (eDNA) method greatly facilitates the probability of detecting the species through sloughed off skin, mucus, or feces in water samples (Pilliod *et al.* 2013). However, because the small temporary wetlands favoured by Great Basin Spadefoots may not be available or used each year, survey efforts should span breeding seasons in multiple years, unless eDNA methods are used on sediments.

Habitat protection will be accomplished largely through land use designations and management on Crown lands, and stewardship activities on private lands. To ensure recovery activities are successful, a strong need exists to encourage and support voluntary cooperation by landowners and stewardship managers on all land tenures. This stewardship approach includes following guidelines or best management practices; conservation agreements and covenants; Ecological Gifts and sale of high-priority sites by willing landowners. To be useful, protected habitat needs to be large enough and maintained in adequate condition for this species to carry out its seasonal activities and life cycle.

Habitat restoration and enhancement can be a useful tool in some cases and in areas where wetlands and associated terrestrial habitats are degraded by human activities. Great Basin Spadefoots readily use human-made waterbodies (Ashpole *et al*. 2014), but creation of such habitats should be conducted sparingly and with extreme care to avoid creating mortality sinks. Habitat creation should not preclude the protection of existing natural habitat, which is always the preferred option. Restoration aimed at improving terrestrial habitat connectivity should consider mitigation activities to reduce the effects of road mortality.

6.3.4 Species and Population Management

Actions related to species and population management focus on mitigating the impacts of significant threats, and include: developing strategies to detect and confine disease outbreaks (e.g., chytrid fungus), should these occur; clarifying the impacts associated with agricultural practices, and developing effective management measures for livestock use and to alleviate the pollution of breeding sites; and proactively addressing the potential threats posed by control efforts for emerging diseases such as the West Nile virus. Threat mitigation and clarification can often be conducted in the context of an adaptive management approach; this approach should be deployed whenever feasible to ensure timely initiation of mitigation efforts.

Targeted outreach activities are needed to gain support and collaboration from landowners and other stakeholders. This action includes the development and dissemination of best management practices to mitigate threats from various land use practices.

To help quantify targets for habitat protection, recovery activities should address existing knowledge gaps related to terrestrial movements, habitat use, population structure across the landscape, and dispersal. The needed information includes the amount and type of upland habitat required for seasonal migration and dispersal movements, the optimal spatial configuration of breeding habitats in the landscape, and how these factors affect the viability of subpopulations over the long term. Various methods, ranging from mark-recapture studies to genetic analyses and population modeling, are available to tackle these issues.

7 SPECIES SURVIVAL AND RECOVERY HABITAT

Survival/recovery habitat is defined as the habitat that is necessary for the survival or recovery of the species. This is the area in which the species naturally occurs or depends on directly or indirectly to carry out its life-cycle processes or formerly occurred on and has the potential to be reintroduced.

7.1 Biophysical Description of the Species' Survival/Recovery Habitat

A description of the known biophysical features and their attributes of the species' habitat that are required to support these life-cycle processes (functions) are provided in Section 3.3. Additional work required to fulfill habitat knowledge gaps is included in the Recovery Action Table (Table 9).

7.2 Spatial Description of the Species' Survival/Recovery Habitat

The area of survival/recovery habitat required for a species is guided by the amount of habitat needed to meet the recovery goal. Although no maps are included with this document, it is recommended that locations of survival/recovery habitat be spatially delineated to support threat mitigation and avoidance, and to facilitate the actions for meeting the recovery (total provincial population and distribution) goals.

8 MEASURING PROGRESS

The following performance measures provide a way to define and measure progress toward achieving the recovery (total provincial population and distribution) goal and recovery objectives. Performance measures are listed below for each objective.

- The abundance of Great Basin Spadefoot is maintained or increased in each of the six geographic areas that it occupies.
- Additional core habitat (breeding habitat and associated terrestrial habitat) is secured in each of the six geographic areas that the species occupies.
- Dispersal/connectivity habitat is maintained or improved within each of the six geographic areas that the species occupies.
- A research strategy is developed by 2017 and research on priority knowledge gaps is taking place.

9 EFFECTS ON OTHER SPECIES

Many other endangered or threatened species occupy habitats that are used by the Great Basin Spadefoot in the arid interior of British Columbia. In particular, Great Basin Spadefoot habitats overlap with the Blotched Tiger Salamander – Southern Mountain Population (endangered) and the Western Toad (special concern) at some sites. Similar recovery strategies will benefit these three species. Other species at risk may benefit from Great Basin Spadefoot recovery activities through grassland or shrub–steppe habitat protection. These include the Burrowing Owl (endangered), American Badger (*Taxidea taxus*; endangered), Sage Thrasher (*Oreoscoptes montanus*; endangered), Great Basin Gophersnake (*Pituophis catenifer deserticola*; threatened), Western Rattlesnake (*Crotalus oreganus*), Behr's Hairstreak butterfly (*Satyrium behrii*; endangered), Pallid Bat (*Antrozous pallidus*; threatened), showy phlox (*Phlox speciosa*; threatened), rusty cord-moss (*Entosthodon rubiginosus*; endangered), and alkaline wing-nerved moss (*Pterygoneurum kozlovii*; threatened). Recovery conflicts between species are unlikely to occur, as the Great Basin Spadefoot is not known to prey upon, or directly compete with, any other species at risk.

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Personal Communications

Sara Ashpole, Environmental Studies, St. Lawrence University, Canton, NY.

Orville Dyer, Ecosystem Biologist, B.C. Ministry of Environment, Penticton, BC.

Bevan Ernst, Ecosystem Biologist, B.C. Ministry of Forests, Lands and Natural Resource Operations, Kamloops, BC.

Jocelyn Garner, Consultant, Kamloops, BC.

Purnima Govindarajulu, Amphibian/Reptile/Small Mammal Specialist, B.C. Ministry of Environment, Victoria, BC.

Jo-Anne Hales, Consultant, Kamloops, BC.

Sarma Liepens, Conservation Specialist, B.C. Ministry of Environment, Kamloops, BC.

Natasha Lukey, Consultant. Kelowna, BC.

Dustin Oaten, Consultant, Kamloops, BC.

Roger Packham, Senior Ecosystems Biologist (retired). B.C. Ministry of Environment, 100 Mile House, BC.

Kirk Safford, Conservation Specialist, BC Parks, B.C. Ministry of Environment, Penticton, BC.

Bryn White, Program Manager, South Okanagan Similkameen Conservation Program, Penticton, BC.

Stephanie Winton, Master’s candidate, Thompson Rivers University, Kamloops, BC.