

**COSEWIC**  
**Assessment and Update Status Report**

on the

**Great Basin Spadefoot**  
*Spea intermontana*

in Canada



**THREATENED**  
**2007**

**COSEWIC**  
COMMITTEE ON THE STATUS OF  
ENDANGERED WILDLIFE  
IN CANADA



**COSEPAC**  
COMITÉ SUR LA SITUATION  
DES ESPÈCES EN PÉRIL  
AU CANADA

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## COSEWIC Assessment Summary

### 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.



**COSEWIC**  
**Executive Summary**

**Great Basin Spadefoot**  
*Spea intermontana*

**Species information**

The Great Basin Spadefoot (*Spea intermontana*) is one of two species of spadefoots (family Scaphiopodidae, formerly Pelobatidae) that occur in Canada. Adults are about 40 – 65 mm long, and have a squat body form and relatively short legs for an anuran. The back is light grey, olive, or brown with lighter streaks and small raised dark blotches. Characteristic features include a black, keratinous ridge (“spade”) on the sole of each hind foot, used for burrowing, and a vertical, lens-shaped pupil.

**Distribution**

The Great Basin Spadefoot occupies the inter-montane region between the Rocky Mountains and Coastal Ranges from south-central British Columbia south to Arizona and Colorado. In Canada, the species is restricted to the arid and semi-arid zones of south-central British Columbia and occurs in the Okanagan Valley and in the Similkameen and Kettle-Granby river valleys in the south and in the Thompson and Nicola river valleys and the South Cariboo region in the north. Based on an estimation of about 235 discrete sites based on records from 1985 to 2006, the extent of occurrence is about 30,770 km<sup>2</sup>. The area of occupancy is about 619 km<sup>2</sup>, if calculated assuming a 1 km radius buffer around each discrete site, or 864 km<sup>2</sup>, if calculated using a 2 km × 2 km grid. From 1996 to 2006, the species continued to be found within all portions of its range. Most records are from the South Okanagan. Recent surveys in the North Okanagan, Nicola, and Kettle-Granby river valleys have established that the species is relatively widespread in these areas from where few previous records existed. In 2005 – 2006 it was found at 12 new sites in the South Cariboo, where it was previously known from two old records. Systematic surveys of historic sites have not been conducted, and local extinctions or range contractions cannot be determined.

**Habitat**

The Great Basin Spadefoot occupies grassland and open woodland habitats. It requires aquatic habitats for breeding and terrestrial habitats for foraging, hibernation, and aestivation. These habitats must be suitably connected to allow for seasonal movements. The species breeds in a variety of water bodies ranging from small pools to the margins of permanent water bodies and shallow areas of lakes but prefers

temporary ponds that hold water for only part of each year. Spadefoots shelter underground from unfavourable conditions and require terrestrial habitat all year. Loose, deep, and friable (crumbly) soils that allow for burrowing and rodent burrows are thought to be important. Anecdotal observations and movements of other species of spadefoots suggest that individuals use terrestrial habitat within about 500 m of breeding sites.

## **Biology**

Spadefoots respond rapidly to changing environmental conditions and breed explosively when temperatures are suitable and breeding sites are full of water. In British Columbia, adults begin to emerge from hibernation in early to mid-April and move quickly to breeding ponds where males begin to call. Females lay 300 – 800 black eggs in clusters of 20 – 40 in shallow water. Spadefoot tadpoles have among the shortest development times of all anurans, an adaptation that allows them to effectively exploit temporary pools. The entire development, from egg to toadlet, can be completed in as little as 5 weeks, but 6 – 8 weeks is more typical. In British Columbia, most metamorphosed toadlets appear in July and disperse from the breeding sites en masse. They attain reproductive maturity at 2 – 3 years and may live up to 10 years. Spadefoots have a variety of physiological adaptations for living in a dry environment, including the ability to survive relatively high water loss and absorb water directly from the soil while burrowed.

## **Population sizes and trends**

There is no accurate information on population sizes or trends. The maximum population is probably at least 10,000 individuals, but much uncertainty is associated with this number and it could be much larger. However, it is almost certain that populations fluctuate greatly in size; the population at its lowest ebb may well fall below the 10,000 individual threshold. Most breeding choruses appear to be small; large choruses, consisting of hundreds of adult males, have been reported from a few sites.

## **Limiting factors and threats**

The main threat to the Great Basin Spadefoot in British Columbia is from loss and degradation of habitat due to human activities. Dry grasslands, especially those in the South Okanagan, are under tremendous development pressures, from both intensive agriculture and urbanization, and habitat continues to be lost as the human population grows. Wetlands and temporary pools are naturally rare and continue to be lost and degraded. Other threats include habitat fragmentation, road mortality, pesticides, sport fish and bullfrog introductions, and degradation of breeding sites and their margins by livestock.

## **Special significance of the species**

The Great Basin Spadefoot is part of a suite of grassland and open woodland species that is restricted to the southern interior of British Columbia. Although not used for food or medicinal purposes, spadefoots are considered beneficial as they provide food for other animals, such as turtles.

## **Existing protection**

Most of the habitat suitable for the Great Basin Spadefoot is unprotected. Close to 70% of the species' range in British Columbia is either privately owned or within Aboriginal lands. Some populations occur within areas protected from development both in the south (Haynes' Lease Ecological Reserve, South Okanagan Wildlife Management Area, White Lake Grasslands Protected Area, South Okanagan Grasslands Protected Area) and in the north (Lac du Bois Grasslands Protected Area). The species is designated as an "Identified Wildlife" species under the BC *Forest and Range Practices Act* and is subject to mandatory implementation of management guidelines on provincial crown lands. It is listed as "Threatened" under Schedule 1 of SARA.



## COSEWIC HISTORY

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

## COSEWIC MANDATE

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

## COSEWIC MEMBERSHIP

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

## DEFINITIONS

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

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

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

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



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**Update  
COSEWIC Status Report**

on the

**Great Basin Spadefoot**  
*Spea intermontana*

in Canada

2007

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## SPECIES INFORMATION

### Name and classification

The Great Basin Spadefoot (Anura: Scaphiropodidae: *Spea intermontana*, Cope, 1883) is one of four species of western North American spadefoots of the genus *Spea*; the other three species are *S. hammondii*, *S. bombifrons*, and *S. multiplicata* (Crother *et al.* 2000). The genus *Spea* was originally named by Cope (1875). For many years, *Spea* was widely considered only a subgenus of *Scaphiopus* (V.M. Tanner 1939). W.W. Tanner (1989a,b), Stebbins and Cohen (1995), Crother (2000), and others now consider *Spea* to be a valid genus. Species of *Spea* are smaller in body size compared to *Scaphiopus*, have wedge-shaped (rather than sickle-shaped) “spades”, and lack dermal plates of the skull. Garcia-Paris *et al.* (2003) examined phylogenetic relationships of North American and Eurasian spadefoots using mtDNA markers and concluded that the North American and Eurasian members of the nominal family Pelobatidae were not monophyletic. They revived the family Scaphiropodidae for the North American genera *Spea* and *Scaphiopus* and retained the remaining genera found in Europe and Asia in the family Pelobatidae.

Cope (1883) described *Spea intermontana* as a subspecies of the Western Spadefoot, *S. hammondii*. Tanner (1939) was the first to consider *S. intermontana* as a valid species separate from *S. hammondii*, a treatment that is now widely accepted (Collins 1990, Crother 2000). Reflecting changes in nomenclature, *Spea intermontana* is referred to as *Scaphiopus intermontanus* in much of the literature prior to 1990.

### Morphological description

*Spea intermontana* is a small to medium-sized anuran amphibian with adult body size (snout-vent length) about 40 – 65 mm (Tanner 1989b, Hallock 2005, Matsuda *et al.* 2006). Adults are grey-green with numerous dark brown or reddish tubercles and spots (Fig. 1). Limbs are relatively short and the snout is blunt and angled upwards slightly. Like all members of the family Pelobatidae, adults have a characteristic black, keratinous ridge (spade) on the sole of each hind foot. Great Basin Spadefoots have vertical, lens-shaped pupils, giving them a “cat’s-eye” appearance, and a glandular bump, termed boss, between the eyes. Males are somewhat smaller than females, have dark throats, and develop black pads on their inner three fingers during the breeding season (Hallock 2005, Matsuda *et al.* 2006). The advertisement call of males is a low, grating “gwaah”, repeated over and over and audible to the human ear from more than 200 m away. The loud calls and continuous chorus create a strong “assembly call”, typical of explosive breeders, i.e., amphibians that aggregate and breed in a very short period of time in response to environmental cues (Stebbins and Cohen 1995).



Figure 1. *Spea intermontana* adult, Penticton, BC. (Steve Cannings photo).

The egg masses consist of small (15 – 20 mm in diameter), grape-like clusters of about 20 – 40 eggs. Individual eggs are small (up to 5 mm in diameter, including the jelly layer) and loosely attached to each other. In dorsal view, tadpoles have a triangular-shaped head that appears distinct from the trunk. The closely set eyes are raised, and nostrils are prominent. The tail fin is high and terminates where the tail joins the trunk. The colour is dark with metallic flecking. Total length of tadpoles just before metamorphosis is about 30 – 70 mm (Hallock 2005, Matsuda *et al.* 2006).

### **Genetic description**

Allozyme analyses by Wiens and Titus (1991) indicate that populations of *S. intermontana* from Oregon and Colorado are more distinct from each other than the Colorado population is from *S. bombifrons*. Crother (2000) noted that geographic variation of *S. intermontana* remains poorly documented across its range and that the nominal species may be a composite of two or more species. No genetic studies have been conducted of populations of *S. intermontana* in British Columbia, and the distinctness of different geographic subpopulations remains unknown.

## **DISTRIBUTION**

### **Global range**

*Spea intermontana* is widely distributed in dry grasslands in western North America and occupies the intermontane region between the Rocky Mountains and coastal

ranges (Hallock 2005, Matsuda *et al.* 2006). Its range extends north from the Colorado River to southern British Columbia, west to the Sierra Nevada and Cascade ranges and east to the Rocky Mountain divide (Fig. 2). In Arizona, it occurs up to 2,800 m elevation (Stebbins 1985).

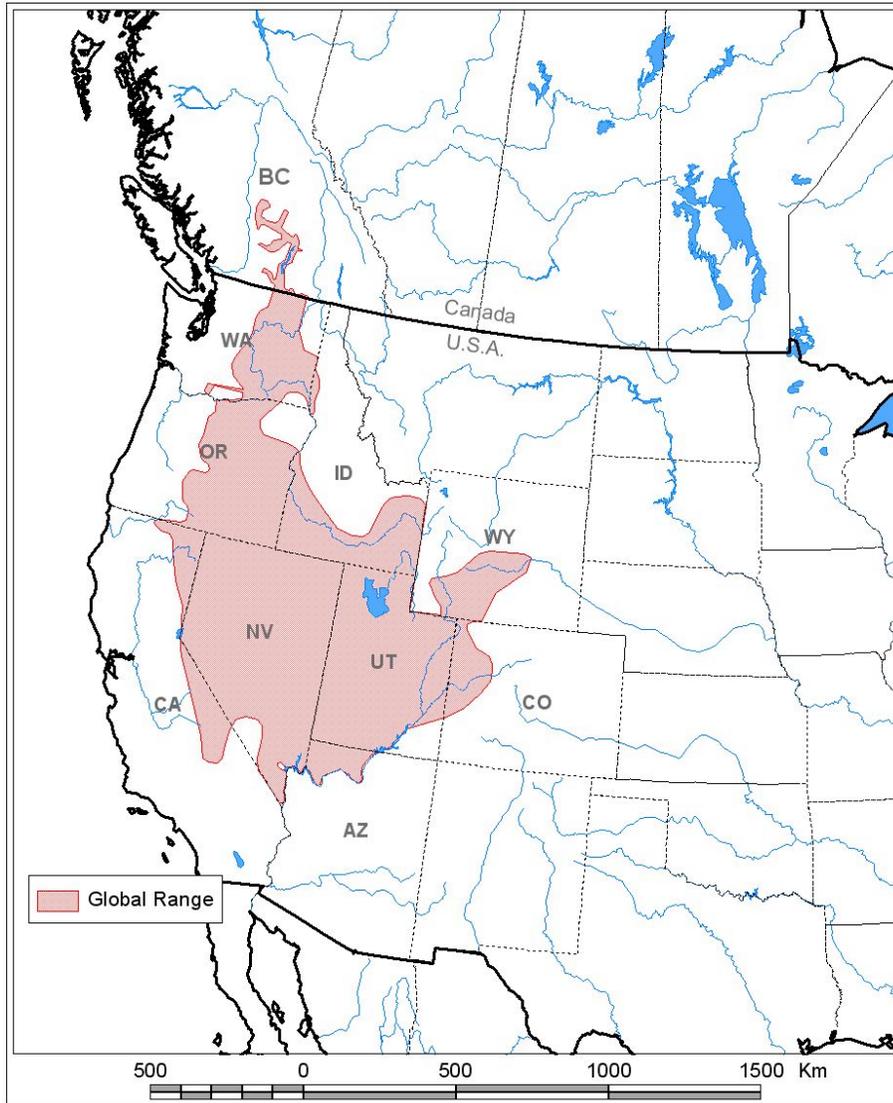


Figure 2. Global distribution of *Spea intermontana*. Map produced by Ophiuchus Consulting and printed courtesy of Mike Sarell.

### Canadian range

In Canada, *S. intermontana* occurs in arid areas of south-central British Columbia (Fig. 3). The species is found in the Okanagan Valley, in the Similkameen, Kettle-Granby, Thompson and Nicola river valleys, and the South Cariboo region, where the

species reaches the northernmost limit of its distribution (Sarell 2004, Matsuda *et al.* 2006; records collected for this report). It occurs primarily in the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir biogeoclimatic zones (see Meidinger and Pojar 1991 for descriptions). Additionally, there are limited records from the Engelmann Spruce-Subalpine-fir zone (tadpoles in three small lakes) and the Montane Spruce zone (Leupin *et al.* 1994, D. Low, pers. comm.). Canada has less than 5% of the species' global distribution.

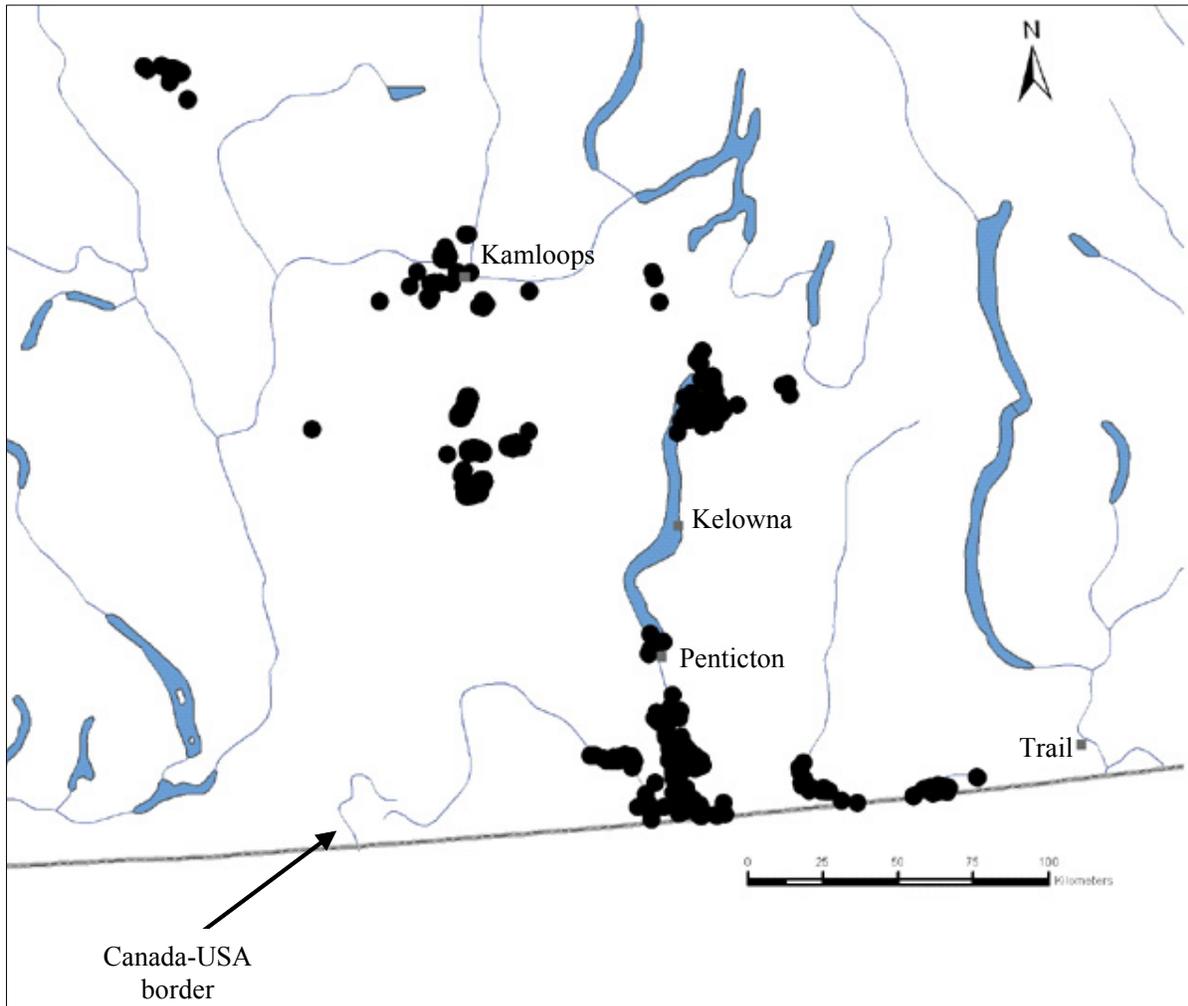


Figure 3. Canadian distribution of *Spea intermontana* in south-central British Columbia. Map prepared by Jenny Wu and Alain Filion (COSEWIC Secretariat), based on records compiled for this report.

The Canadian range of the species is discontinuous. The northern portion is centred in the Thompson River Valley and extends east from 70 Mile House to Barrière along the North Thompson River and west to Big Bar Creek along the Fraser River. The northernmost records, in the South Cariboo region, are about 100 km northwest from the nearest records in the Thompson River Valley. In the Nicola Valley, records exist from Quilchena to Douglas Lake; it is unclear whether this population is disjunct from

the Thompson Valley population or part of the northern population. The southern portion includes the Okanagan, Similkameen, and Kettle-Granby River valleys, extending north to past Vernon, west to Princeton, and east to the Grand Forks area.

Within the past 10 years (1996 to spring 2006), the species continues to be found within all portions its range in British Columbia. However, systematic surveys of historic sites have not been conducted in any areas, and local extinctions or range contractions cannot be determined from the available data.

There are 12 new records (1 from 2005 and 11 from 2006) from the extreme northwest of the species' range in the South Cariboo region, where the species was previously known from only two old records. During surveys in 2006 near Alberta and Meadow Lakes, west of 70 Mile House, the species was found at 11 of 17 sites surveyed (Verkerk *et al.* 2006). Verkerk *et al.* (2006) noted that numerous similar wetlands and lakes that might support spadefoots exist in the 100 Mile Forest District over an area of about 1,300 km<sup>2</sup>.

There are a few older records from the Cache Creek-Ashcroft area. Anecdotal observations by local residents suggest that the species continues to persist in this area (M. Sarell, pers. comm.). There are clusters of records, both historical and recent, from around Kamloops. In contrast, no recent records exist from the North Thompson River Valley, where historical records are available from the McLure and Barrière areas. Lack of recent records might reflect lack of search effort. In the Nicola River valley, there are a number of new records, and the species appears to be well distributed in the lowlands within the valley.

Most records, historical and recent, are from the southern portion of the species' range in the Okanagan and Similkameen valleys. The Okanagan Valley, in particular, appears to harbour the bulk of the Canadian population. Although there are only historical records from the Princeton area, anecdotal observations suggest that the species is locally common in the grasslands around Princeton in the Similkameen Valley (Jerry Herzig, pers. comm.). Both recent and old records are common from the southern Similkameen, from about 40 km south of Princeton to Keremeos and to the Canada-USA border. Numerous historical and recent records exist from the South Okanagan, especially from Okanagan Falls south to Osoyoos and the USA border. Recent surveys in the North Okanagan have established that the species is relatively widespread in the Vernon area; numerous new records exist from the Lumby/Blue Springs area west to Kalamalka Lake and to north of Okanagan Lake. There are three older (1994) records from small lakes just west of the Salmon River valley, which are isolated from the cluster of records in the North Okanagan. Surveys within the past 10 years have established that the species is relatively widespread within the southern part of the Kettle-Granby drainage. There are numerous new localities from the Grand Forks area, extending east to the south end of Christina Lake. In the Kettle River valley, there are new records from Zomora south and east through Midway to the Canada-USA border.

Based on records from 1985 to 2006, the species is known from about 235 sites, if localities closer than 500 m are considered the same site and each distribution record, whether a breeding chorus or a single animal, is treated equally. Sites vary from single observations to strings of many nearby localities separated from their nearest neighbours by less than 500 m. The extent of occurrence is about 30,770 km<sup>2</sup>. If the 235 sites are surrounded, conceptually, by a 1 km buffer zone to account for spadefoot dispersal (Hammerson 1995), the area of occupancy is about 619 km<sup>2</sup>. If a 2 km × 2 km grid is overlaid on the map, then the area of occupancy is 864 km<sup>2</sup>, according to the IUCN methodology.

Leupin *et al.* (1994) searched for the species on the Cariboo plateau north to Williams Lake but failed to detect the species in the northern part of this area. Anna Roberts (pers. comm.) has not come across the species in the Williams Lake or Riske Creek areas despite many hours of nocturnal surveys for bats and owls. Although suitable habitat exists in the East Kootenay region of southeastern British Columbia, that area is separated from the Thompson and Okanagan valleys by a broad swath of moist forest and high mountains.

## HABITAT

### Habitat requirements

*Spea intermontana* inhabits semi-arid grasslands and open forests. In British Columbia, it is commonly found from valley floors to about 800 – 1,200 m (St. John 1993, Leupin *et al.* 1994) and rarely as high as 1,800 m (Leupin *et al.* 1994). In the South Okanagan, St. John (1993) found most breeding sites to be below 600 m.

Spadefoots require aquatic habitats for breeding and terrestrial habitats for foraging, hibernation, and aestivation. These habitats must be suitably connected to allow for seasonal movements. Breeding habitats of *S. intermontana* range from ephemeral pools to wetted margins of lakes to shallow water areas of permanent water bodies, but sites that fill with water and dry up each year seem to be preferred (Hallock 2005, Sarell 2004). Wright and Wright (1949) listed the following aquatic habitats for *S. intermontana*: “canyon pools, desert springs and pools, intermittent and permanent, irrigation ditches, stream edges, rain puddles, water pockets, water depressions made by cattle.” Breeding sites often, but not always, contain abundant emergent and riparian vegetation (Leupin *et al.* 1994). Spadefoots readily use human-made spawning sites and have been recorded from dug-out ponds, plastic pools, and ditches in the Okanagan valley (C. Bishop, pers. comm.). Breeding sites must last long enough for larval development to take place; given a period of at least six weeks for breeding and development, a usable breeding site in British Columbia must retain ample water from about mid-April until the end of May.

Spadefoots shelter underground from unfavourable conditions and require terrestrial habitat year-round (Hallock 2005, Matsuda *et al.* 2006). Loose, deep, and

friable (crumbly) soils that allow for burrowing are thought to be important (Sarell 2004) (see General Biology: Terrestrial Ecology). Clustering of over-wintering burrows in areas that contain suitable soils and close to breeding sites has been reported for *S. hammondii* (Ruibal *et al.* 1969).

## Habitat trends

Grasslands in the arid southern interior of British Columbia are among Canada's most endangered ecosystems (Scudder 1980) and cover less than 1% of the land area of the province (662,872 ha; MOE 2004a). Pitt and Hooper (1994) emphasize both the rarity and lack of protection for grasslands in British Columbia. These naturally rare habitats have been reduced drastically since European settlement, especially in productive and biologically rich valley bottom habitats and continue to be lost due to expanding urban development, agriculture, and other land conversions (MOE 2004a). In the Okanagan Basin and Boundary District, about one third of grasslands have been lost, whereas in the North Okanagan, about 50% of grasslands have been lost (MOE 2004a). Fire suppression, invasive species, livestock grazing, intensive recreation, and other human-mediated activities further continue to degrade and diminish these habitats.

Wetlands cover a small proportion of the arid southern interior of British Columbia, comprising about 0.3% to 0.7% of grassland and Ponderosa Pine ecosystems (MOE 2004b), but are exceedingly important for *S. intermontana*. At least half of the wetlands in the area have probably been lost since European settlement (Ted Lea, pers. comm.). Accurate information on historical rates of wetland loss is lacking. Much of the valley bottom habitat was already modified by agriculture in 1938, when air-photos first became available. In the southern Okanagan valley, 85 – 90% of larger marshes have been lost (MOE 2004b). Rates of recent wetland losses are difficult to calculate because small, seasonal wetlands that *S. intermontana* frequently uses for breeding are often not mapped. Small wetlands and ponds are often the first to be filled in for development or modified for cattle water holes. Many of the remaining wetlands are degraded as a result of invasive plants and animals, livestock use, channelization, contamination with agricultural chemicals and fertilizers, and withdrawal of water for irrigation, domestic, and other uses (MOE 2004b). In the Okanagan, major changes in irrigation practices and water conservation are expected to reduce agricultural ponds used by spadefoots for breeding. For example, many farm operations are switching to drip irrigation, which reduces the need for irrigation ponds (C. Bishop, pers. comm.).

The water table has dropped significantly at many sites in the Canadian range of *S. intermontana* in the past two to three decades. On the southern Cariboo Plateau, at the northern end of the species' range, the water table dropped 4 m between 1978 and 1988 (Northcote 1992), and it dropped a similar amount at Mahoney Lake, an alkaline lake in the South Okanagan Valley, between 1982 and 1994 (Lowe *et al.* 1997). Although these drops are at least partly due to reduced precipitation, the accelerating human development in these areas and associated increase in water consumption are probably lowering the water table as well. Predicted increases in droughts associated

with climate change will further diminish and alter wetland habitats in the area (Cohen *et al.* 2004).

Land alienation of grasslands in British Columbia has accelerated since the 1970s, particularly in the Okanagan Valley (Hlady 1990). Redpath (1990) calculated that less than 9% of grassland habitat remained undisturbed by 1990 in the South Okanagan and Similkameen valleys. The human population grew exceedingly rapidly throughout the Canadian range of *S. intermontana* from 1986 to 1996; the growth slowed down somewhat in 1996 – 2005 but is predicted to continue to increase steadily over the next decades, putting pressure on already scarce land and water resources (Government of British Columbia 2006; Table 1). Within the past two decades, population growth has been greatest in the south, particularly in the Okanagan-Similkameen region, and lowest in the Cariboo region in the north. Over the next two decades, the greatest growth rates are predicted for the Central Okanagan. Concomitant with increasing human population, terrestrial and wetland habitats will continue to be lost as more of the land base is converted into housing developments and other human uses and as demand for water increases.

**Table 1. Human population growth in regions of British Columbia inhabited by *Spea intermontana* (rates calculated from Government of Canada 2006).**

Region	Change (%); calculated from census estimates			Projected change (%)
	1986-1995	1996-2005	2006-2016	2016-2026
Okanagan-Similkameen	28.8	5.6	10.2	8.6
Central Okanagan	52.7	18.6	18.4	15.3
North Okanagan	30.4	8.5	12.3	9.9
Thompson-Nicola	21.4	4.3	8.3	5.5
Cariboo	10.5	0.7	10.4	4.7

Extensive habitat loss has also occurred within the range of *S. intermontana* in the United States. For example, more than 90% loss of native shrub-steppe grassland in Oregon and in southwestern Washington has been lost (The Nature Conservancy 1992); more than 99% of basin big sagebrush (*Artemisia tridentata tridentata*) habitat in the Snake River plain of Idaho has been converted to agriculture (Hironaka *et al.* 1983); 99.9% of Palouse prairie throughout the species' range in Idaho, Oregon, and Washington have been lost to agriculture (Tisdale 1961); 52% loss of wetlands in Nevada and 30% loss of wetlands in Utah occurred from 1780s to 1980s (Dahl 1990).

### Habitat protection/ownership

Most of the habitat suitable for *S. intermontana* is unprotected. About 68% (40,000 ha) is within Indian Reserves or is privately owned (Sarell 2004). Two of the largest known populations are partially protected. The Haynes' Lease Ecological Reserve (ER#100) provides 100 ha of secure habitat for part of the large population of *S. intermontana* breeding and foraging in the marsh and shrub steppe habitats at the north end of Osoyoos Lake. The adjacent South Okanagan Wildlife Management Area

provides additional habitat for that population as well, but at a lower level of protection. Lac du Bois Grasslands Protected Area (15,000 ha) near Kamloops in the Thompson area provides protection for another population. The Nature Trust of British Columbia has acquired a number of properties with suitable habitat for the species, including the White Lake Ranch west of Okanagan Falls, providing protection for several smaller populations. Two provincial parks with suitable habitat for the species were established in 2001: White Lake Grasslands Protected Area (3,741 ha), which is contiguous with other protected areas around Vaseux Lake, and South Okanagan Grasslands Protected Area (9,364 ha). These areas are protected from development, but livestock grazing occurs at least at the White Lake and South Okanagan grasslands protected areas (C. Bishop, pers. comm.). In the 100 Mile House District, South Cariboo, all recent records and majority of ponds that provide potential habitat are from provincial Crown lands that are under grazing licences (R. Packham, pers. comm.).

Habitat for a large population of *S. intermontana* at the Osoyoos sewage lagoon (about 1,000 breeding males in early the 1990s; St. John 1993) remains unprotected, and much of the terrestrial habitat surrounding the lagoon has been converted to housing and golf course expansion within the past 10 years (Sarell 2004).

## BIOLOGY

Little specific information exists on the biology of *S. intermontana* in British Columbia, and the account below is supplemented with anecdotal observations and by studies in the United States on this and related species of spadefoots. Extrapolations to *S. intermontana* in British Columbia, however, must be carried out with caution, as habitats and conditions at the northern limits of their range are different from those farther south. In British Columbia, Leupin *et al.* (1994) reported on the distribution and life history of the species in the Thompson-Nicola regions and St. John (1993) in the South Okanagan Valley. Since 1998, work on the species has focused mainly on inventories within various parts of the species' range (Sarell *et al.* 1998, Sarell and Alcock 2004, Rebellato 2005, Tarangle and Yelland 2005, Ashpole *et al.* 2006a, R. Weir, pers. comm.). Oaten (2003) conducted a laboratory study on burrowing behaviour. Ashpole *et al.* (2006a,b) studied species occurrence, early embryonic development, and pesticide exposure in the South Okanagan; this study is ongoing.

### Life cycle and reproduction

Like other northern anurans, spadefoots have a biphasic lifecycle, consisting of aquatic eggs and tadpoles and terrestrial adults and juveniles. In British Columbia, adults begin to emerge from hibernation in early to mid-April and move quickly to breeding ponds where males begin to call (St. John 1993, Leupin *et al.* 1994). Females soon follow or may move to ponds at the same time as males (M. Sarell, pers comm.). Brown (1989) states that the breeding season in the northern parts of the species' range lasts from April to June. At any given site, the length of the breeding season, as measured by the presence of calling males, can vary from one month to less than a

week (St. John 1993). Sites occupied earlier in the season had calling spadefoots longer than those occupied later in the summer (St. John 1993). Females lay 300 – 800 black eggs (Stebbins 1951, Leonard *et al.* 1993) in clusters of 20 – 40 (Nussbaum *et al.* 1983), attached to sticks, pebbles, or aquatic vegetation in shallow water. Leupin *et al.* (1994) reported clusters of 4 – 5 eggs attached to submerged stems of foxtail barley (*Hordeum jubatum*) and alkali grass (*Puccinellia nuttalliana*) in the Thompson-Nicola regions, British Columbia. Surveys by Ashpole and Canadian Wildlife Service in 2003-2006 found clusters of 10 – 110 eggs, usually attached to sticks (C. Bishop, pers. comm.).

Spadefoot tadpoles have the shortest developmental time of all anurans (Buchholtz and Hayes 2002), an adaptation that allows them to effectively exploit ephemeral pools of water. Eggs of *S. intermontana* hatch in 2 – 3 days during warm conditions but can take 7 days or more in cool water (Nussbaum *et al.* 1983). Eggs in Nevada successfully hatched despite overnight low air temperatures of 0 – 7°C (Nussbaum *et al.* 1983). Under laboratory conditions, development of *S. intermontana* from egg to complete metamorphosis took 36 days at 23°C, but toadlets could leave the water at just over 28 days of age (Brown 1989). Other sources, probably referring to field data, give the larval development time as 6 to 8 weeks (Nussbaum *et al.* 1983, Green and Campbell 1984). Bragg (1961) observed eggs of *Scaphiopus holbrookii*, *Bufo terrestris*, and *Rana pipiens* laid simultaneously in a pond. The *Scaphiopus* eggs hatched in three days, the *Bufo* eggs in five days and the *Rana* eggs in seven, while the entire aquatic phase took 35 days, 55 days, and about 60 to 70 days, respectively. Environmental factors shown to accelerate development in at least some species of spadefoots include a reduction in water volume or food availability (Boorse and Denver 2003).

In British Columbia, most tadpoles are seen in May and most metamorphosed toadlets appear in July. If a pond begins to dry up, older tadpoles can accelerate metamorphosis to some extent but at the expense of attaining larger body size; small spadefoots (*Scaphiopus couchii*) lose water more quickly than larger ones (Newman and Dunham 1994). Young *S. intermontana* averaged 20.5 mm in snout-vent length at metamorphosis (Brown 1989) and often still have a substantial tail (18 mm) when they leave the water (Nussbaum *et al.* 1983). Bragg (1964) stated that *Scaphiopus* larvae “always emerge in nature before the tail has been visibly changed at all.” There is much variability in age and body size of *S. intermontana* at metamorphosis, and body size increases with increased larval food levels (Morey and Reznick 2004). Body size at metamorphosis affects survival of *S. hammondi* over the first year of life; in enclosures, larger metamorphs were more likely to survive to 1 yr of age than smaller juveniles (Morey and Reznick 2001). However, the size difference of surviving juveniles from different tadpole densities was negligible after one year and did not affect growth rates of older juveniles. There are no data on survivorship of *S. intermontana*.

Males become sexually mature at about 40 mm and females at about 45 mm SVL; they can reach this size in their second or third year (Nussbaum *et al.* 1983, Green and Campbell 1984). *Spea intermontana* may not breed each year if conditions are

unsuitable (Leupin *et al.* 1993), but no information on frequency of breeding is available for British Columbia populations. The maximum longevity of *S. intermontana* is unknown, but for *Scaphiopus couchii* it is about 13 years for females and 11 years for males (Tinsley and Tocque 1995).

## Physiology

Spadefoots have a variety of physiological adaptations for living in a dry environment, including the ability to survive the loss of up to 48% of their body mass in water, compared to a tolerance of only 31% in the frog genus *Rana* (Nussbaum *et al.* 1983). While the permeability of the amphibian integument is often thought of as a detriment to life in an arid environment, it does allow spadefoots to absorb water directly from the soil while burrowed (Ruibal *et al.* 1969). This is accomplished by accumulating urea in the blood plasma, thus reducing the water potential of body fluids to allow absorption of water through the skin.

Water quality is often highly variable in the small ponds used by spadefoots. While temperature tolerances have not been studied in *Spea intermontana*, Brown (1967) found that eggs of *Spea hammondi* near hatching could withstand temperatures of up to 39 or 40°C, but freshly laid eggs died at 37°C. Leupin *et al.* (1993) reported that while water temperature in small breeding ponds fluctuated greatly within a 24-hour period (from 33°C to 12°C on some occasions), there were no apparent effects on tadpole survival of *S. intermontana*. The species has been recorded at breeding sites with pH of 7.2 – 10.4 (Hovingh *et al.* 1985, Leupin *et al.* 1993). Anecdotal evidence suggests that *Spea intermontana* may be intolerant of the very high pH levels common to many ponds within the Canadian range of the species. In the Thompson-Nicola area, Dave Low (pers. comm.) has found spadefoots clustered around seepage areas where fresh water was entering small ponds. The pH was around 8.5 at the seepage sites and about 10 elsewhere in the pond where the species was absent. The plasma osmolarity of *Spea hammondi* tadpoles was consistently higher than that of bullfrog (*Rana catesbeiana*) tadpoles, an apparent adaptation to osmotic concentrations found in drying pools (Funkhouser 1977).

## Terrestrial ecology and hibernation

Spadefoots occupy open, semi-arid to arid habitats not normally associated with aquatic anurans. They cope with this lack of water by burrowing underground and remaining dormant through dry and/or cold periods. They emerge when a combination of warm weather and wet soil (either the result of rainfall or snowmelt) provides suitable conditions for survival above ground, although Wright and Wright (1949) noted that they will emerge in the absence of rain if conditions are otherwise suitable.

Foraging occurs at night, especially during rain or when humidity is high (Hallock 2005, Matsuda *et al.* 2006). Spadefoots shelter underground during the day, thereby minimizing water loss. Svihla (1953) described diurnal retreats of *Spea intermontana* around breeding ponds in central Washington. Adults dug backward away from the

pond in sand, leaving tracks and “pretzel-shaped ridges” marking their temporary burrows. Svihla also found many *Spea intermontana* that had burrowed under flat rocks, about 30 cm<sup>2</sup>, and within 0.6 to 6 m from the breeding pond. Wright and Wright (1949) stated that adults could be surveyed by stamping on the ground near their breeding grounds, causing the animals to emerge from their shallow burrows. Homing to specific burrows has been reported for the Eastern Spadefoot, *Scaphiopus holbrookii* (Pearson 1955).

In laboratory experiments, *Scaphiopus holbrookii* burrowed most easily in sand and were unable to burrow in sod; recently metamorphosed juveniles were unable to burrow in gravel or sod (Jansen *et al.* 2001). Experiments with a small number of juvenile *Spea intermontana* from British Columbia, showed they could burrow into sandy clay loam, fine gravel, sand, and Brown Chernozemic soils prevalent in the grassland habitats, but tended to prefer sandy clay loam and gravel over clay and sand (Oaten 2003). The toadlets showed no preferences for substrates with pre-existing holes (Oaten 2003), but rodent burrows and crevices may be important in areas with coarse or compact substrates (Sarell 2004).

Not surprisingly, hibernating individuals probably burrow to relatively great depths. In other species of spadefoots, Ruibal *et al.* (1969) found that hibernating *Spea hammondi* burrowed to an average depth of 54 cm (n=6) in February in southeastern Arizona; the maximum depth observed was 91 cm. Some spadefoot species can obtain enough energy in as few as seven feedings (*Spea multiplicata*) or even just one feeding (*Scaphiopus couchii*) to survive a year of dormancy (Dimmit and Ruibal 1980), but similar data are not available for *Spea intermontana*. *Scaphiopus couchii* and *Spea hammondi* can remain dormant for two or more years waiting for suitable foraging and breeding conditions (Seymour 1973), but it is unknown whether *Spea intermontana* has this ability.

## **Dispersal and migration movements**

Spadefoots undertake seasonal migrations between terrestrial foraging and hibernation habitat and aquatic breeding habitat. There is very little information on movement distances of *S. intermontana* in British Columbia or other areas. Based on anecdotal information on spadefoots in general, Hammerson (2005) noted that spadefoots will move several hundred m or more from breeding sites and thus, in the absence of more specific information, it can be assumed that spadefoots use terrestrial habitat up to a minimum of 500 m around breeding sites and probably up to 1 km, depending upon the terrain.

Dispersal from natal ponds occurs en masse (Hallock 2005). For example, in British Columbia hundreds of small, newly metamorphosed spadefoots were seen crossing Inkaneep Road near Oliver on a wet night in late July 1990 (pers. obs. by R. Cannings). In the Eastern Spadefoot (*Scaphiopus holbrookii*) movements of metamorphs from natal ponds was rapid and completed within a week from transformation (Greenberg and Tanner 2004). There are no data on dispersal distances at any life history stage.

## Diet and predation

Adults of *Spea intermontana* feed on a variety of invertebrates, including earthworms, ants, beetles, crickets, grasshoppers, and flies (Nussbaum *et al.* 1983, M. Sarell, pers. comm.). Bragg (1956) found that adults of the similar *Spea bombifrons* ate a wide variety of insects, including flies, small wasps, moths and beetles.

Larvae are voracious feeders on algae and aquatic plants and scavenge dead fish and even their own feces (Green and Campbell 1984). Bragg (1960) successfully raised *Spea bombifrons* tadpoles on boiled lettuce. Martha Hett (pers. comm.) found that *S. intermontana* tadpoles living in a garden pool in Vernon readily ate boiled lettuce and frozen bloodworms (midges).

In the South Okanagan, cannibalism among tadpoles of *S. intermontana* was frequently observed in ponds where densities were high (C. Bishop, pers. comm.). A specialized carnivorous morph has been described for tadpoles of other spadefoot species (*Spea bombifrons*: Orton 1954, Bragg 1956, 1964, 1965, Bragg and Bragg 1959; *Spea multiplicata*: Pfennig 1990) but has not been documented for *S. intermontana*. Carnivorous *S. bombifrons* tadpoles are characterized by larger heads and more serrated beaks, enlarged jaw muscles, and modifications of the labial denticles. This morph apparently eats other tadpoles, including conspecifics (Orton 1954), and fairy shrimp, *Artemia* (Farrar and Hey 1997). Carnivorous *S. multiplicata* tadpoles have larger heads and mouths and specialize in eating fairy shrimp. This morph has an extremely rapid development (12 days) and is favoured in ephemeral water bodies with high densities of fairy shrimp (Pfennig 1990).

Adults are eaten by snakes (such as the Western Garter Snake, *Thamnophis elegans*) and burrowing owls (*Athene cunicularia*; Leupin *et al.* 1994), and likely by larger predators such as great blue heron (*Ardea herodias*) and coyotes (*Canis latrans*; Leupin *et al.* 1994, Leonard *et al.* 1993). Mike Sarell (pers. comm.) observed an adult Tiger Salamander (*Ambystoma mavortium*) eating an adult *S. intermontana* in captivity.

Tadpoles are likely eaten by ducks, and killdeer and ravens have been seen feeding on dying larvae in a drying pond (Leupin *et al.* 1994). Carp have been observed consuming tadpoles in the South Okanagan (C. Bishop, pers. com.). Black (1970) suggested that aggregations of *Spea bombifrons* tadpoles were an adaptation to avoid predation by cannibalistic tadpoles and water beetles, which attacked tadpoles at the periphery of the aggregations but not those in the centre of the group. Painted turtles (*Chrysemys picta*) may be important predators of tadpoles (St. John 1993). Adults have noxious skin secretions that appear to deter some predators (Stebbins and Cohen 1995, Matsuda *et al.* 2006).

## Interspecific interactions

Leupin *et al.* (1994) noted a complementary pattern of breeding site occupancy between the Pacific Treefrog, *Pseudacris regilla*, and *S. intermontana* in the Thompson-

Nicola area: at several sites containing suitable habitat for both species, only one species was abundant, while the other was either absent or occurred in very low numbers. They suggested that this pattern might have resulted from interspecific competition and possibly from acoustic interference by the louder treefrogs. Surveys in the South Okanagan by Ashpole and the Canadian Wildlife Service found a similar negative association of the two species in breeding ponds (C. Bishop, pers. comm.). Leupin *et al.* (1994) found that the Western Toad (*Bufo boreas*) usually far outnumbered *S. intermontana* at sites where the two co-occurred and suspected that interspecific competition for food may occur among tadpoles. Spadefoots may be excluded from permanent ponds that have high painted turtle populations (M. Sarell, D. St. John, pers. comm.).

### **Adaptability**

Spadefoots are able to use a variety of open and semi-open habitats and breed opportunistically in a wide range of aquatic habitats, including very small pools and artificial ponds (Leupin *et al.* 1994, Sarell 2004). Seasonal migrations to and from breeding sites and reliance on naturally scarce water bodies for breeding in arid habitats increase the vulnerability of *S. intermontana* in fragmented, human-modified landscapes. These characteristics affect their ability to persist in human modified landscapes provided that key features of both the aquatic and terrestrial habitat are retained. In the United States, the species persists in some areas within the Columbia Basin that have been converted into irrigated agricultural land (Hallock 2005). However, David Cunnington (pers. comm.) has observed that ponds created by irrigation run-off may serve as ecological traps for spadefoots. A large number of animals were observed breeding in a run-off pond in a hayfield but once the hay was harvested the pond rapidly dried, destroying the entire cohort of tadpoles.

## **POPULATION SIZES AND TRENDS**

### **Search effort**

The search effort has been uneven across the species' Canadian range with much focus on the South Okanagan. Many distribution records resulted from FrogWatch submissions, volunteer efforts, or studies on other organisms, or were serendipitous observations. The total search effort is very difficult to quantify, as negative data (i.e., number of localities where the species was not found) is available for only a portion of the records.

In the South Okanagan, St John (1993) surveyed 86 sites and located the species at 56 sites. Also in the South Okanagan, Ashpole and the Canadian Wildlife Service surveyed 108 ponds and conducted additional surveys of river channels from Osoyoos to Oliver in 2003-2006; 43 ponds contained spadefoots but breeding was observed only in about half of the ponds (Ashpole *et al.* 2006a, C. Bishop, pers. comm.). In the Central Okanagan, Tarangle and Yelland (2005) surveyed 24 wetlands in the Kelowna area in

the spring of 2005 and found the species at three sites. In the North Okanagan, Sarell (2006) summarized surveys for the species conducted in 39 ponds on Vernon Military Camp lands from 1999 – 2005; breeding was noted in 10 of these ponds. Leupin *et al.* (1994) surveyed 38 sites in the Thompson area and found the species at 24 sites. In 2005, about 50 water bodies were surveyed within Lac Bios Provincial Park, near Kamloops; three were found to contain breeding *S. intermontana* (Simpson 2005).

After identifying some 800 possible breeding ponds in a 1,300 km<sup>2</sup> region of the South Cariboo region, Verkerk *et al.* (2006) surveyed 17 locations, each consisting of one or two water bodies, during four days in June – August, 2006, near Alberta and Meadow Lakes, west of 70 Mile House. They located calling males or tadpoles of *S. intermontana* at 11 of those 17 localities. It is probable that spadefoots may occupy many more sites, as yet unsurveyed, in the South Cariboo.

Since 1998, many new localities have been found in the Kettle/Granby drainages and in the Nicola River Valley, but there is no information on search effort associated with these records. Several recent surveys have focused on Aboriginal lands in the South Okanagan (Sarell and Alcock 2004, Rebellato 2005) and North Okanagan (2003 – 2006; R. Weir, pers. comm.); search effort and details of the surveys are unavailable at this time.

## **Abundance**

There are no accurate population estimates of the species for any areas. The available information, taken together, indicates that the maximum Canadian population is probably at least 10,000 individuals but much uncertainty is associated with this number and it could be much larger. However, it is almost certain that populations fluctuate greatly in size; the Canadian population at its lowest ebb may well fall below the 10,000 individual threshold. Orchard (1985) stated that the British Columbia population of *Spea intermontana* is certainly greater than 5,000 individuals. This is confirmed by censuses in the South Okanagan (St. John 1993), Kamloops and Douglas Lake areas (Leupin *et al.* 1994), and Nicola Valley (surveys by W.C. Weber). These surveys recorded a total of about 4,200 calling males. Important regions not covered in these surveys were the North Okanagan and Kettle/Granby drainages, where surveys conducted within the past 10 years show that the species is widespread where habitat still exists.

The database of distribution records, including submissions to the BC FrogWatch program, contains auditory observations of breeding choruses from 2000 to spring 2006. The number of calling males was estimated as low (individuals can be counted, calls not overlapping), moderate (some individuals can be counted, other calls overlapping), or high (full chorus, calls continuous and overlapping, individual calls not distinguishable). Of these observations, 187 were rated as low, 114 as moderate, and 20 as high. Although many environmental factors, such as date, weather, habitat, and condition and size of water body, can influence the size of a breeding chorus, these data suggest that most choruses are small, possibly reflecting the small size of many breeding ponds.

The Osoyoos Lake area seems to be a very important locality for the species in Canada, with 2,000 calling males detected by St. John (1993) around the oxbows at the north end of the lake and in the Osoyoos sewage lagoons. About 40% of the males detected on major surveys by St. John (1993), Leupin *et al.* (1994), and W.C. Weber were found in an area roughly 100 km<sup>2</sup> in size, less than 0.5% of the Canadian range.

## Fluctuations and trends

Lack of baseline data and poor understanding of current population sizes are common problems in assessing population trends for amphibians, and *S. intermontana* is no exception. Orchard (1985) presumed that the British Columbia population was decreasing, based on the loss of prime breeding, foraging and hibernating habitats, particularly in the Okanagan Valley. There are no historical data to validate this presumed decline although local breeding populations in some areas undoubtedly have been lost, and continue to be lost, due to draining and infilling of water bodies used as breeding sites. Although no changes in overall distribution can be discerned from the available data (see “Canadian distribution”), even large changes in abundance at particular localities cannot be determined from distribution data alone.

*Spea intermontana* continues to persist in the Osoyoos sewage lagoons where about 1,000 males were heard calling in early 1990s, but numbers may be much reduced. A full breeding chorus (calls continuous and overlapping, individual calls not distinguishable) was recorded there in May 2002 (distribution records collected for this report). In contrast, few spadefoots were found calling in the ponds in 2003 and 2004, and no tadpoles were seen, but the ponds were surveyed only infrequently (C. Bishop and S. Ashpole, pers. comm.).

Breeding populations of *S. intermontana* can vary substantially from year to year depending on water table levels, temperature and rainfall, although data concerning annual numbers and the precise magnitude of fluctuations are lacking. In the Kamloops area, Thompson River Valley, little breeding was observed in 2003 and 2004, whereas breeding was confirmed at numerous locations in 2005 (Karl Larsen, pers. comm.). Similarly, in the Vernon area, North Okanagan, breeding attempts and success were highly variable from 1999 to 2005, depending on the availability of surface water (Sarell 2006). Differences in recruitment rates can be expected to translate into variance in the size of the breeding population in subsequent years. This aspect of fluctuating population size is consistent with other pond-breeding anurans (Green, 2003) especially those living in areas with sporadic and unpredictable rainfall. Greenberg and Tanner (2005) found considerable temporal and spatial variability across the landscape in breeding ecology of the Eastern Spadefoot (*Scaphiopus holbrookii*). Most recruitment of young occurred in only four of nine years, and only four of the ponds produced metamorphs, although breeding took place in all but one of the ponds. Only ponds with large numbers (>175) of breeding adults produced substantial recruitment. Numbers of breeding adults showed dramatic fluctuations from year to year. Like *S. intermontana*, adult *Scaphiopus holbrookii* breed in ephemeral ponds and occupy surrounding upland habitat in arid environments.

## **Rescue effect**

In Washington State, there are a handful of records of the species from Okanagan, Ferry, and Stevens counties that abut the Canadian border, but no records exist from the immediate vicinity of the border (Washington Herp Atlas 2005). The majority of records from the state are from extensive shrub and grasslands farther south. The northern populations in Washington State are potentially contiguous with the Okanagan-Similkameen and Kettle-Granby populations in British Columbia, and some movement northward is possible. However, modification and fragmentation of the habitat in the valley bottom areas probably restricts dispersal to trivial levels.

## **LIMITING FACTORS AND THREATS**

Persistence of spadefoots in particular areas depends on the availability of both suitable breeding sites and surrounding upland habitat, coupled with suitability of weather conditions and chance events (Greenberg and Tanner 2005). The main threat to *S. intermontana* within its Canadian range is from loss and degradation of habitat due to human activities. Dry grasslands of the Okanagan, especially those in the southern part of the valley, are under tremendous development pressures, both from intensive agriculture such as vineyards and urbanization, and habitat continues to be lost (Hlady 1990; see Habitat Trends). In California, causes of population declines of *S. hammondi* were consistent with local habitat destruction, rather than with other hypotheses tested (pesticide drift, UVB-radiation, climate change), and the number of occupied breeding sites was reduced in areas surrounded by urban or agricultural developments within a 5-km radius (Davidson *et al.* 2002). Similarly, in the eastern Mojave Desert, the lowland amphibian fauna has changed drastically over the past century in conjunction with severe habitat loss and modification; *Spea intermontana* is known only from historical records and appears to have disappeared from this area (Bradford *et al.* 2005).

## **Loss and degradation of breeding ponds**

Perhaps the most critical environmental variable to an amphibian living in an arid environment is the availability of a water source for breeding. Loss of water bodies occurs from infilling and drainage associated with urban developments or conversion of land into agricultural uses. Overdrawing of water for irrigation or other human uses can result in complete drying of small ponds used by spadefoots or reduce the amount of time that the ponds contain water. Reports exist of mass mortality of *S. intermontana* tadpoles in drying ponds (Leupin *et al.* 1994).

Livestock use, pesticides, herbicides, and fertilizers can all degrade water quality in ponds where spadefoots breed. In dry grasslands, cattle almost always congregate around any water source, including the small ponds used by spadefoots for breeding. Cattle could have a negative effect on breeding pools for several reasons. Feces from cattle congregating in small pools could seriously affect water quality (Orchard 1985). Also, deep cattle hoof-prints left in the bottom of muddy temporary pools create a

multitude of tiny pools as the pond dries up instead of a single, larger pool. Very small pools could seriously restrict the foraging ability of larvae and result in entrapment. Leupin *et al.* (1994) found that nearly all breeding ponds examined in the Thomson-Nicola regions showed signs of livestock use. Additionally, Leupin *et al.* (1994) speculated that trampling of newly metamorphosed toadlets by cattle might be an important potential source of mortality.

Preliminary results of ecotoxicological studies on pesticide exposure and spadefoot egg development in the Okanagan Valley during 2003 – 2006 indicate that where pesticide concentrations are highest in pond water, hatching success is lowest (Ashpole *et al.* 2006b.). In the South Okanagan, a large population of *S. intermontana* has been reported from a waste-water effluent pond (St. John 1993), but reproductive success and survivorship patterns at this site are unknown.

Nussbaum *et al.* (1983) suggested that irrigation projects may have benefited the species over much of its range by providing dependable breeding ponds in otherwise dry areas. However, in the South Okanagan, water is often removed from the ponds before spadefoot tadpoles have completed their development, and these ponds act as ecological sinks (C. Bishop, pers. comm.). Agricultural projects also have serious effects on the amount and quality of foraging habitat available to spadefoots by converting shrub steppe habitat to monocultures of agricultural crops.

### **Introduced species**

Where *S. intermontana* breeds in permanent water bodies, it is vulnerable to predation by sport fish, which are a serious threat to many amphibians throughout British Columbia (reviewed in Wind 2005). Non-predatory, introduced fish can also pose a threat to amphibians through habitat modification, competition for food, and as vectors for disease. The introduced Bullfrog (*Rana catesbeiana*) has been reported from a few localities in the South Okanagan (Ashpole *et al.* 2005b, 2006c) and could be a threat to native amphibians if allowed to spread. Although these ponds are not known breeding sites of spadefoots, the species has been caught in fence-traps surrounding ponds occupied by bullfrogs (C. Bishop, pers. comm.). In 2006, bullfrogs were found in the Okanagan Lake for the first time, raising concerns that the species might be more widely spread than previously thought and that eradication might be very difficult (Ashpole *et al.* 2006c).

### **Foraging habitat and hibernation sites**

The quality of habitat in remaining grasslands within the species' range in British Columbia is difficult to address. Little is known about the foraging needs of *Spea intermontana*, and the effects of grazing or other disturbance on terrestrial habitat are unstudied. Almost nothing is known about the hibernating and short-term retreat sites used by *Spea intermontana*. Concern has been raised over the impact of soil compaction by cattle trampling, which would reduce the water content of the soil as well

as make it difficult for burrowing. Effects of ground compaction associated with orchard and vineyard development are also unknown.

Spadefoots are able to burrow into a variety of substrates (Oaten 2003), but coarse gravel and sod substrates hinder burrowing at least in *Scaphiopus holbrookii* (Jansen *et al.* 2001); burrowing is essential for survival of spadefoots in the terrestrial habitat.

### **Fragmentation of habitat and road mortality**

Fragmentation of foraging habitat has almost certainly disrupted traditional dispersal routes used by spadefoots between breeding, foraging, and hibernating sites. Increased road density and the amount of traffic on these roads could significantly increase spadefoot mortality in British Columbia (M. Sarell, pers. comm.). The spadefoots are particularly vulnerable to road mortality during mass migrations to and from breeding sites, and many reports of road mortality exist from several sites (Leupin *et al.* 1994; Sarell 2004; records compiled for this report). During surveys by Ashpole and the Canadian Wildlife Service in the South Okanagan, spadefoots were regularly observed crossing or attempting to cross HWY 97, while moving from higher elevations to breeding ponds in the valley in the spring (C. Bishop, pers. comm.). They were frequently observed feeding and thermoregulating on roads. Both habitat fragmentation and road mortality are difficult to quantify, and their significance to local populations remains unstudied.

### **Disease and parasites**

Disease outbreaks have not been documented for *S. intermontana*, but epidemic disease must now be regarded as a serious potential threat to all amphibian populations. Chytridiomycosis is an emerging infectious disease of amphibians that has been linked to precipitous declines and extirpations of many species worldwide (Daszak *et al.* 1999, Speare 2005), Lethal iridoviruses have also been associated with amphibian epizootics (Daszak *et al.* 1999). In the South Okanagan, the Tiger Salamander (*Ambystoma tigrinum*) has suffered mass mortality at least at one site within the past decade, possibly as a result of disease (Sarell 2004). *S. intermontana* and *A. tigrinum* sometimes use common breeding sites. Fungal infections may have a significant effect on the survival of eggs (Nussbaum *et al.* 1983). Bragg and Bragg (1957) reported a die-off of *Spea bombifrons* tadpoles in a temporary pond due to the water mould *Saprolegnia* but they felt it was a rare event. *Saprolegnia* can be carried from hatchery fish to amphibians (Kiesecker *et al.* 2001), a potential concern where spadefoots breed in permanent water bodies or their immediate vicinity.

### **Climatic factors**

As a dry-land amphibian at the northern edge of its range, *S. intermontana* requires a delicate balance of climatic variables. A series of hot, dry summers could cause a population decline through the reduction of low elevation breeding sites but conversely could open up new habitats at higher elevations. A series of cool, wet summers might

have a negative effect through the reforestation of grassland habitat, reducing the extent and quality of foraging habitat and likely increasing competition with other anurans. Compounding effects of human water use, water tables in the Okanagan basin are predicted to drop as a result of climate change, and small ponds used by amphibians may experience premature or complete drying (Cohen *et al.* 2004, Graham 2004).

## **SPECIAL SIGNIFICANCE OF THE SPECIES**

*Spea intermontana* is one of a suite of grassland and open woodland species restricted to the southern interior of British Columbia. Taxa such as the Pygmy Short-horned Lizard (*Phrynosoma douglassii* – now extirpated), Night Snake (*Hypsiglena torquata*), Gray Flycatcher (*Empidonax wrightii*), Sage Thrasher (*Oreoscoptes montanus*), Pallid Bat (*Antrozous pallidus*), Showy phlox (*Phlox speciosa*), and Lyall's mariposa lily (*Calochortus lyallii*) all inhabit these ecosystems, and occur nowhere else in Canada.

Consultations in Nine Aboriginal communities in south-central British Columbia suggest that although not used for food or medicinal purposes, Spadefoots are considered beneficial as they provide food for other animals, such as turtles (Markey and Ross 2005). They are recognized as an integral part of the ecosystem, and awareness exists about their distribution and habits.

## **EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS**

The British Columbia *Wildlife Act* prohibits the collection, possession, and trade of all native vertebrates, including amphibians. This law has limited effectiveness in protecting *S. intermontana*, because it is difficult to enforce and does not cover damage to habitats. The species is on the provincial Blue List of species at risk; Blue-listed species are indigenous species or subspecies of special concern (formerly vulnerable) in British Columbia (MOE 2006). The species has been designated as “Identified Wildlife” under the BC *Forest and Range Practices Act*, and management guidelines have been prepared (Sarell 2004); the guidelines include criteria for Wildlife Habitat Areas intended to protect important habitats. These guidelines are intended to help implement biodiversity objectives under the BC *Forest and Range Practices Act* and are mandatory on publicly owned forestry and range lands. As of May 2006, no Wildlife Habitat Areas have been designated for this species. Rules and regulations covering temporary ponds often used by spadefoots are minimal resulting in less protection than for permanent ponds.

*Spea intermontana* was assessed nationally as “Threatened” in 2001 by COSEWIC and is listed in Schedule 1 of the *Species at Risk Act*. The species was found to meet the COSEWIC criteria for Endangered under B1ab(iii)c(iv)+2ab(iii)c(iv) and C2a. It was, however, designated Threatened as it was concluded at the time that its abundance may have been underestimated and noted that it will use artificial habitats

for breeding. In light of current knowledge, these provisions can be considered invalid. The species breeds seasonally and population sizes undoubtedly fluctuate. Although it may use artificial habitats for breeding, there is evidence that such habitats may be ecological traps from which there may little or no recruitment.

NatureServe (2005) ranks *S. intermontana* globally as G5 (“demonstrably widespread, abundant, and secure”), nationally in the United States as N5 (as above), and nationally in Canada as N3 (“vulnerable to extirpation or extinction”). The sub-national ranks are as follows: S2 (“imperiled”): Arizona; S3 (“vulnerable to extirpation or extinction”): Colorado, Wyoming, British Columbia; S4 (“apparently secure”): Idaho, Nevada; and S5 (“demonstrably widespread, abundant, and secure”): California, Oregon, Utah, Washington.

## TECHNICAL SUMMARY

### *Spea intermontana*

Great Basin Spadefoot

Crapaud du Grand Bassin

Range of Occurrence in Canada: British Columbia

<b>Extent and Area Information</b>	
<ul style="list-style-type: none"> <li>• <i>Extent of occurrence (EO)(km<sup>2</sup>)</i> The range consists of several separate regions in the Okanagan valley Similkameen valley, Kettle-Granby River valley, Thompson-Nicola valley and South Cariboo, respectively. Populations in the Nicola Valley and in the South Cariboo might be further separated from the rest of the northern population. <b>Calculated from distribution records from 1985 to 2006.</b></li> </ul>	30,770 km <sup>2</sup>
<ul style="list-style-type: none"> <li>• <i>Specify trend in EO</i></li> </ul>	Stable
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in EO?</i></li> </ul>	No
<ul style="list-style-type: none"> <li>• <i>Area of occupancy (AO) (km<sup>2</sup>)</i> Method A) Calculated as the area of all observations from 1985 to 2006 buffered by a 1 km radius circle centred on each observation; overlapping circles were merged together to avoid counting the same area more than once. Method B) Calculated as the area of the 2 km × 2 km grid squares intersecting all observations from 1985 to 2006.</li> </ul>	619 km <sup>2</sup> (method A) 864 km <sup>2</sup> (method B)
<ul style="list-style-type: none"> <li>• <i>Specify trend in AO</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in AO?</i></li> </ul>	Probably not
<ul style="list-style-type: none"> <li>• <i>Number of known or inferred current locations</i> Calculated from distribution records from 1985 to 2006; localities closer than 500 m were considered the same site, and each distribution record was treated equally.</li> </ul>	About 235 sites, possibly more in the Cariboo region
<ul style="list-style-type: none"> <li>• <i>Specify trend in #: The increase in number of known sites within past 10 years due to increased search effort does not reflect an expansion of AO; it is unknown whether all sites recorded since 1985 are still occupied</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in number of locations? The number of occupied breeding sites fluctuates greatly from year to year, depending on environmental conditions, mainly availability of water</i></li> </ul>	Yes
<ul style="list-style-type: none"> <li>• <i>Specify trend in area, extent or quality of habitat</i></li> </ul>	All are declining
<b>Population Information</b>	
<ul style="list-style-type: none"> <li>• <i>Generation time (average age of parents in the population):</i> No data available – approximated from sexual maturity, which occurs at 2-3 years, and longevity (10 or more years)</li> </ul>	Ca. 3-5 years
<ul style="list-style-type: none"> <li>• <i>Number of mature individuals:</i> based on observations of a few, very large choruses although numbers fluctuate from year to year and most choruses are small.</li> </ul>	Maximum 10,000 but due to fluctuations may periodically be much less.
<ul style="list-style-type: none"> <li>• <i>Total population trend:</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>% decline over the last/next 10 years or 3 generations.</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in number of mature individuals?</i> Based on breeding records and comparison with related species.</li> </ul>	Yes
<ul style="list-style-type: none"> <li>• <i>Is the total population severely fragmented?</i></li> </ul>	Yes
<ul style="list-style-type: none"> <li>• <i>Specify trend in number of populations</i></li> </ul>	unknown
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in number of populations?</i></li> </ul>	Not at large scales

<ul style="list-style-type: none"> <li>List populations with number of mature individuals in each: Thompson-Nicola valleys/South Cariboo: thousands of adults; Okanagan, Similkameen, Kettle-Granby River valleys: possibly &gt;5,000 adults; no accurate estimates available</li> </ul>	
<b>Threats (actual or imminent threats to populations or habitats)</b>	
<ul style="list-style-type: none"> <li>Loss of aquatic breeding sites as a result of human activities (housing developments; agriculture)</li> <li>Degradation of the quality of breeding habitat (altered hydrology, pesticides and other pollutants, intensive use by livestock)</li> <li>Fragmentation of habitat and road mortality.</li> <li>Disease, including chytridiomycosis</li> <li>Introduced species, including bullfrogs and predatory fish</li> <li>Loss and degradation of terrestrial foraging habitat and hibernation sites (housing, viticulture, soil compaction by cattle trampling)</li> </ul>	
<b>Rescue Effect (immigration from an outside source)</b>	
<ul style="list-style-type: none"> <li><i>Status of outside population(s)?</i> <b>USA: Not at risk: N5</b> ("demonstrably widespread, abundant, and secure") Arizona - S2 ("imperiled"). Colorado and Wyoming - S3 ("vulnerable to extirpation or extinction"). Idaho and Nevada - S4 ("apparently secure"). California, Oregon, Utah and Washington - S5 ("demonstrably widespread, abundant, and secure").</li> </ul>	
<ul style="list-style-type: none"> <li><i>Is immigration known or possible?</i></li> </ul>	Possible
<ul style="list-style-type: none"> <li><i>Would immigrants be adapted to survive in Canada?</i></li> </ul>	Probably
<ul style="list-style-type: none"> <li><i>Is there sufficient habitat for immigrants in Canada?</i></li> </ul>	Possibly
<ul style="list-style-type: none"> <li><i>Is rescue from outside populations likely?</i></li> </ul>	No
<b>Quantitative Analysis</b> NA	Not enough information
<b>Current Status</b>	
<b>COSEWIC: Threatened (2001, 2007)</b> BC: Blue list, S3 NatureServe: N3	

### Status and Reasons for Designation

<b>Status:</b> Threatened	<b>Alpha-numeric code:</b> B2ab(ii,iii)c(iv)
<p><b>Reasons for Designation:</b></p> <p>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.</p>	
<p><b>Applicability of Criteria</b></p>	
<p><b>Criterion A:</b> (Declining Total Population): Insufficient data to quantify decline.</p> <p><b>Criterion B:</b> (Small Distribution, and Decline or Fluctuation): Qualifies for Threatened as the Area of Occupancy is &lt;1,000 km<sup>2</sup> and declines are evident in Area of Occupancy and in the area, extent and quality of habitat. The species is critically dependent upon a limited number of small breeding sites that are increasingly isolated from each other due to habitat fragmentation. Furthermore, there is a high probability of large fluctuations in the number of adult individuals.</p> <p><b>Criterion C:</b> (Small Total Population Size and Decline): May meet the criteria for Threatened C2a as the total adult population size may fluctuate below 10,000 individuals and overall decline in abundance may be inferred from the loss and degradation of habitats. Accurate estimations of decline in abundance are likely precluded due to fluctuating population sizes.</p> <p><b>Criterion D:</b> (Very Small Population or Restricted Distribution): Not applicable.</p> <p><b>Criterion E:</b> (Quantitative Analysis): Not applicable.</p>	

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## BIOGRAPHICAL SUMMARY OF REPORT WRITERS

The original (1998) version of this report was prepared by Richard J. Cannings, who has a B.Sc. in Zoology from the University of British Columbia and an M.Sc. in Biology from the Memorial University of Newfoundland. He was Assistant Curator of the Cowan Vertebrate Museum at the University of British Columbia for 15 years, and is now a consulting biologist living in the Okanagan Valley. Although his primary focus is on bird biology, he has a broad interest in natural history and has recently co-authored “British Columbia: A Natural History” with his brother Sydney. He grew up in the Okanagan Valley, and has been interested in *Spea intermontana* ever since he found

spadefoot toad eggs and tadpoles in the birdbath in his backyard almost thirty years ago.

This report was updated in 2006 by Kristiina Ovaska, M.Sc., Ph.D. She has studied behaviour and ecology of amphibians in western North America, Central America, and the West Indies for over 20 years. Her studies have addressed social behaviour and population dynamics of plethodontid salamanders, courtship behaviour of neotropical frogs, interactions with forestry practices, effects of UV-B radiation on hatching success of aquatic-breeding amphibians, and effects of endocrine-disrupting compounds on amphibian metamorphosis and tadpole behaviour. She has also carried out numerous surveys for amphibians, including species at risk. She is the author of over 40 publications in the scientific literature, many of them on amphibians.

### COLLECTIONS EXAMINED

Distribution records for *Spea intermontana* were compiled from the following sources:

- Database compiled by Laura Friis (BC Ministry of Environment, Victoria, BC), which contains records from Canadian Museum of Nature, Royal British Columbia Museum, Cowan Vertebrate Museum, University of British Columbia, and sight and auditory records submitted to the BC Frog Watch Program or contributed by various researchers, consultants, and private individuals
- Museum and sight records from appendices in the original (1998) COSEWIC status report for *Spea intermontana*
- Database used for the distribution map for *S. intermontana* in “Amphibians and Reptiles of British Columbia” (Matsuda *et al.* 2006), contributed by David Green
- BC Conservation Data Centre records (mapped records and loose files; received in May 2006)
- Additional sight records in the MOE database, Penticton, contributed by Orville Dyer
- Sight records by various researchers and individuals (see Acknowledgements)

The following collections were contacted in May 2006 for specimen records since 1996:

- Royal BC Museum (Kelly Sendall; 1 new record: RBCM #1956.00)
- Canadian Museum of Nature (Michèle Steigerwald; no new records)