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

Prepared by the British Columbia Southern Interior Reptile and Amphibian Recovery Team

BRITISH COLUMBIA
The Best Place on Earth
Ministry of Environment

January 2008

About the British Columbia Recovery Strategy Series

This series presents the recovery strategies that are prepared as advice to the Province of British Columbia on the general strategic approach required to recover species at risk. The Province prepares recovery strategies to meet our 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 recovery strategy?

A recovery strategy represents the best available scientific knowledge on what is required to achieve recovery of a species or ecosystem. A recovery strategy outlines what is and what is not known about a species or ecosystem; it also identifies threats to the species or ecosystem, and what should be done to mitigate those threats. Recovery strategies set recovery goals and objectives, and recommend approaches to recover the species or ecosystem.

Recovery strategies are usually prepared by a recovery team with members from agencies responsible for the management of the species or ecosystem, experts from other agencies, universities, conservation groups, aboriginal groups, and stakeholder groups as appropriate.

What's next?

In most cases, one or more action plan(s) will be developed to define and guide implementation of the recovery strategy. Action plans include more detailed information about what needs to be done to meet the objectives of the recovery strategy. However, the recovery strategy provides valuable information on threats to the species and their recovery needs that may be used by individuals, communities, land users, and conservationists interested in species at risk recovery.

For more information

To learn more about species at risk recovery in British Columbia, please visit the Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

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Disclaimer

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

This document identifies the recovery strategies that are deemed necessary, based on the best available scientific and traditional information, to recover Great Basin Spadefoot populations 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 objectives and findings.

The responsible jurisdictions and all members of the recovery team 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 recovery team.

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 strategy. The Ministry of Environment encourages all British Columbians to participate in the recovery of the Great Basin Spadefoot.

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RESPONSIBLE JURISDICTIONS

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EXECUTIVE SUMMARY

The Great Basin Spadefoot (*Spea intermontana*) is small (4–6 cm), grey, brown, or greenish with dark spots (bumps), often with orange centres, a vertical pupil, and a sharp-edged dark ridge (“spade”) on the inner side of each hind foot, used for burrowing. The Great Basin Spadefoot lives in the Okanagan, Similkameen, Kettle-Granby, Fraser, Thompson and Nicola Valleys and the South Cariboo Region of British Columbia in low elevation shrub-steppe and open forest habitats. Spadefoots breed and lay eggs in wetlands during the spring. Tadpoles develop rapidly, metamorphose into juveniles, and migrate from the wetlands to nearby terrestrial habitats (within about 500 m of breeding sites). Juveniles and adults spend the remainder of the year on land, sometimes on the surface during rainy nights but generally buried underground in sandy or loamy soils, where they forage on invertebrates and estivate (become dormant) through the winter.

In 2001, the Great Basin Spadefoot was designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Threatened. The major threats to the species are habitat loss and degradation due to housing development, crop production, and related activities including road building. Direct mortality from exotic species, such as non-native fish and bullfrogs, and reduced reproductive success due to pollution from pesticides are also serious and widespread threats. Road mortality and intensive livestock trampling in wetlands cause local impacts. Disease and climate change are emerging issues that require more research.

The recovery goal is to ensure that there is sufficient, secure[1] habitat distributed throughout the historic range to maintain a self-sustaining population, or populations, in each major watershed.

Sufficient information to quantify long-term population and habitat targets for the recovery goal is unavailable due to knowledge gaps. Short-term (2008–2012) targets, necessary to maintain the species over the short term while knowledge gaps are addressed, are presented in the objectives.

The recovery objectives (2008–2012) are to:

1. Secure a minimum of 280 ha of known, wetland, and breeding habitat, and a minimum of 1200 ha of terrestrial habitat surrounding and connecting priority breeding sites distributed throughout all major watersheds within the historic range by 2012.
2. Address knowledge gaps that clarify the distribution, habitat requirements, population processes, terrestrial movements, threats, population viability, critical habitat, and long-term habitat securement targets, required to support recovery implementation, by 2012.
3. Build sufficient understanding, knowledge, and support for habitat protection by stakeholders and the public to enable implementation of recovery by 2012.

One or more action plans will be completed by 2011.

[1] Secure habitat is Great Basin Spadefoot habitat that is managed to maintain the species for a minimum of 100 years and includes suitably connected breeding, foraging, overwintering, and dispersal habitat. 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 its habitat. Habitat protection will be accomplished through voluntary stewardship agreements, conservation covenants, eco-gifts, sale of private lands by willing landowners, land use designations and management, and/or protected areas.

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BACKGROUND

Species Assessment Information from COSEWIC

Date of Assessment: April 2007 (No Change)
Common Name (population): Great Basin Spadefoot
Scientific Name: *Spea intermontana*
COSEWIC 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 the Southern Interior of 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 diseases. The protected areas it inhabits are losing surrounding natural buffer habitats due to encroaching agricultural and housing developments. Consequently, 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, such habitats may be ecological traps from which there may be little or no recruitment.
Canadian Occurrence: British Columbia
COSEWIC 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.

Description of the Species

The Great Basin Spadefoot, *Spea intermontana* (see cover photo), is small (adult size 4–6 cm in snout-vent length) with a squat body, short limbs, and a short, upturned snout (Jones et al. [eds.] 2005). Although commonly referred to as "toads," Spadefoots are distinct in appearance and not closely related to true toads (genus Bufo). 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 dark ridge ("spade") on the inner side of each hind foot, used for burrowing. Spadefoots are nocturnal and secretive, spending much of the year burrowed in sandy soil. During the breeding season in the spring and early summer, their presence is revealed by the loud, grating, snore-like advertisement calls that males produce, especially on wet nights. Eggs are laid in small, loose clusters attached to vegetation or on the bottom substrate. Tadpoles are dark with metallic-coloured speckling. Tadpoles develop rapidly and are able to transform and leave the breeding site within 1–2 months from egg-laying (Jones et al. [eds.] 2005).

Populations and Distribution

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 (Jones et al.

[eds.] 2005) (Figure 1). In Canada, the species is restricted to low to mid-elevations in dry valleys of the Southern Interior and plateau areas of the Central Interior of British Columbia (COSEWIC 1998, 2007) (Figure 2). Canada has less than 5% of the species' global distribution.

In British Columbia, the Great Basin Spadefoot occurs in the Okanagan, Similkameen, Kettle-Granby, Fraser, Thompson and Nicola River valleys and the South Cariboo Region (Figure 2). The species' Canadian range appears to be discontinuous and divided into northern and southern portions. The Thompson Valley is the centre of the northern portion which extends from Barriere, along the North Thompson River, through the Kamloops area, west to Cache Creek and north to Meadow Lake, west of 70 Mile House in the South Cariboo Region. The Great Basin Spadefoot has also been found in the Nicola Valley. It is unknown whether this population is disjunct from the Thompson or reflects low search effort in the intervening areas. The southern portion includes the Okanagan-Similkameen and Kettle-Granby River valleys and extends north to Vernon, west to Princeton, and east to Grand Forks.

There are no population trend data, but the species is thought to be in decline in British Columbia based on widespread loss and fragmentation of arid grassland habitats (COSEWIC 2007). The number of adults speculated to be about 10,000, but there is a wide margin of error associated with this value (COSEWIC 2007).

NatureServe (2005) ranks the Great Basin Spadefoot globally as G5 ("demonstrably widespread, abundant, and secure"), nationally in the United States as N5 and in Canada as N3 ("vulnerable to extirpation or extinction"). The sub-national ranks for the species are S2 ("imperilled"; Arizona), S3 (Colorado, Wyoming, British Columbia), S4 ("apparently secure"; Idaho, Nevada), and S5 (California, Oregon, Utah, Washington). In British Columbia, the species is on the Blue list of species at risk (BCMOE 2005a).

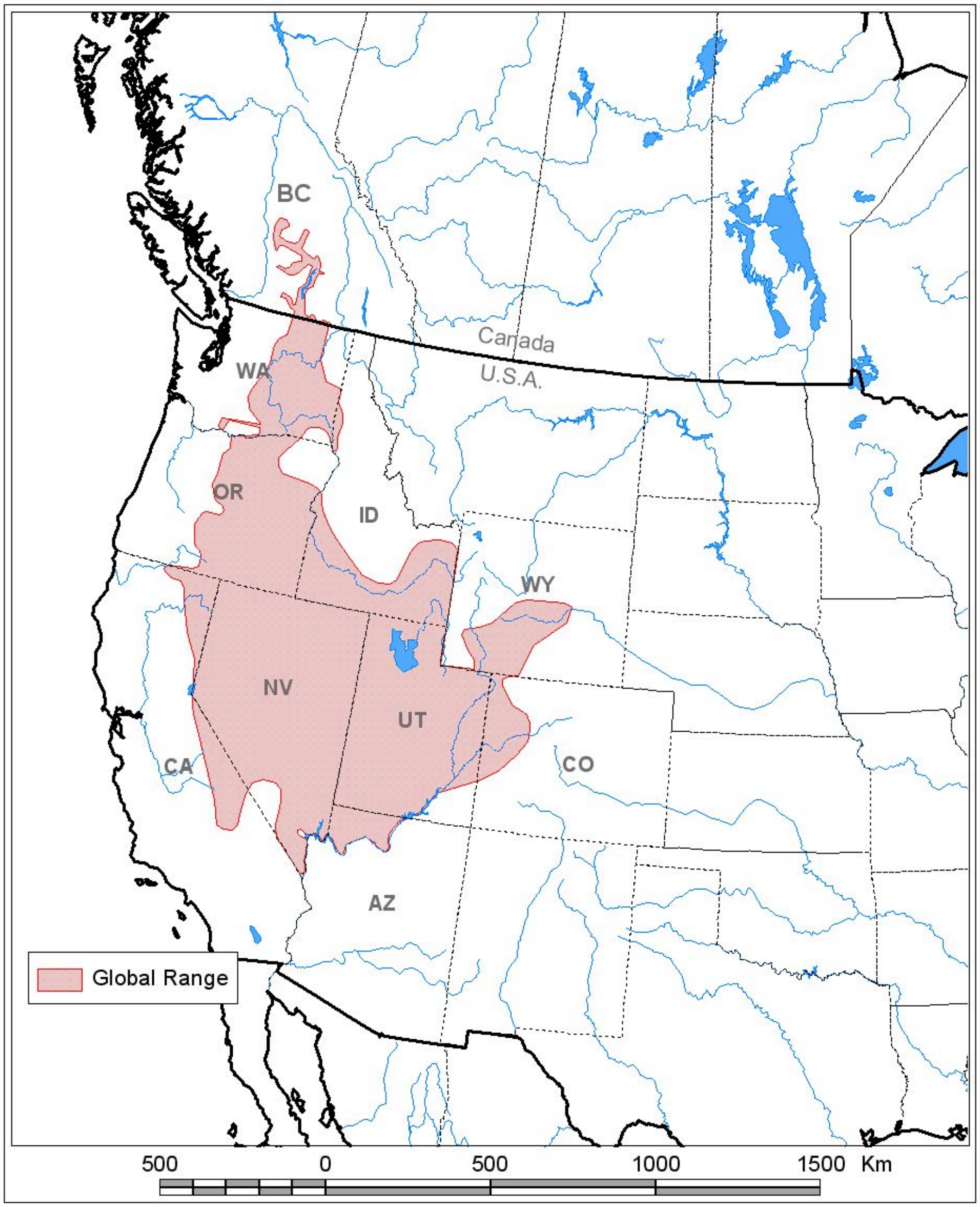

Figure 1. Global distribution of the Great Basin Spadefoot.

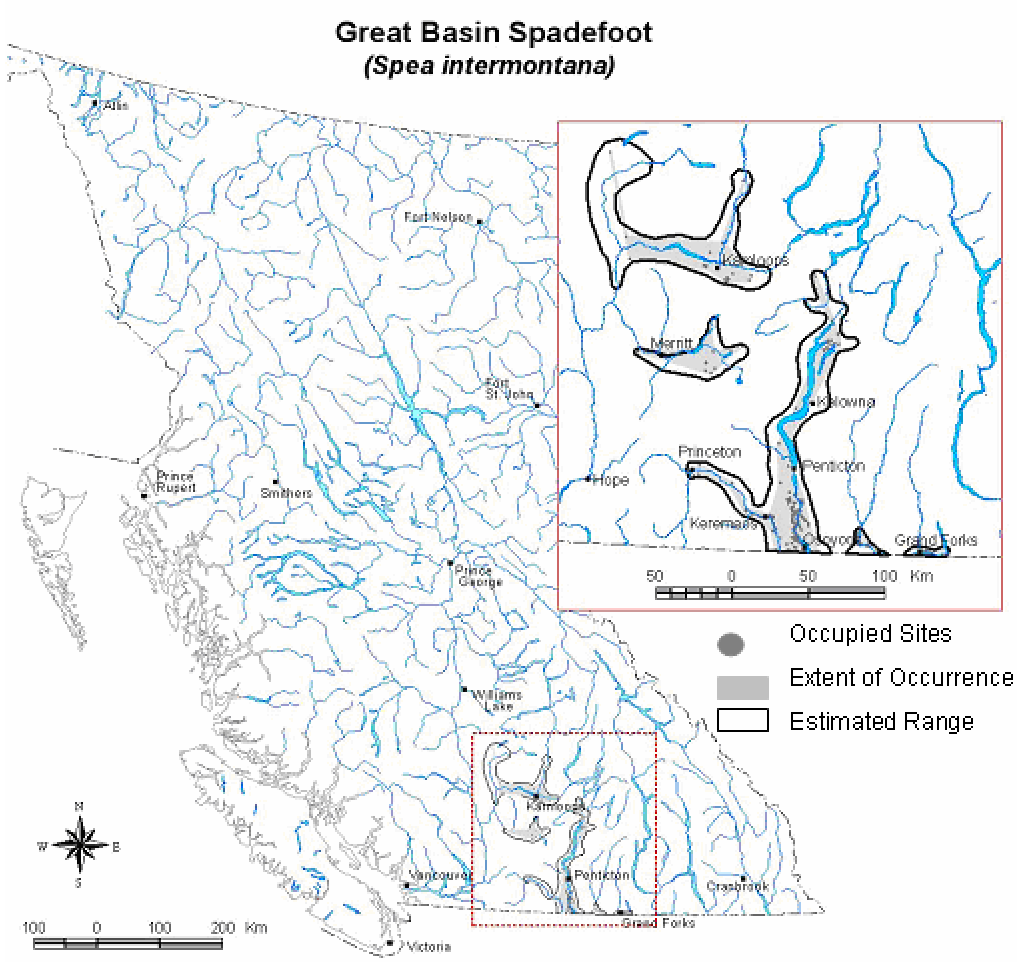

Figure 2. Distribution of the Great Basin Spadefoot in British Columbia.

Needs of the Great Basin Spadefoot

Habitat and biological needs

The Great Basin Spadefoot occurs in grass/shrub-steppe and open pine forest (COSEWIC 1998, 2007; Jones et al. [eds.] 2005). In British Columbia, records exist from valley bottoms up to about 1800 m (Leupin et al. 1994). In the Southern Interior Region, low elevation sites appear to provide the most suitable habitat; most known breeding sites in the South Okanagan are below 600 m (St. John 1993). In the central interior region the most suitable breeding habitat appears to be plateau areas above 1000m (Packham, pers.comm, 2007).

Aquatic breeding habitat: The availability of a water source for breeding is critically important for this desert-adapted species (COSEWIC 1998, 2007). Spadefoots breed in a wide variety of temporary and permanent water bodies, including human-made sites such as irrigated depressions, ponds, pools, or ditches, but seem to prefer small vernal pools that fill in and dry up each year (COSEWIC 1998, 2007; Jones et al. [eds.] 2005). Seasonally wetted margins of wetlands and larger bodies also provide high-quality breeding habitat. Ephemeral breeding sites typically have relatively few predators and can produce large numbers of recruits to the population during years when conditions are optimal. In contrast, permanent water bodies are expected to carry the population through drought years when temporary breeding sites either are unavailable or produce few or no recruits. Important features of breeding sites include retention of water until tadpoles have metamorphosed (from April to at least until end of May in British Columbia), warm shallow areas for egg-laying and larval development, and absence of introduced fish (COSEWIC 1998, 2007; Sarell 2004). Very alkaline water bodies with pH of 10 or more appear to be unsuitable (COSEWIC 1998, 2007).

Terrestrial foraging, overwintering, and estivation habitats: Spadefoots require suitable semi-arid terrestrial habitat for foraging, overwintering, and estivation. They are adapted to survive long periods of unsuitable conditions (cold in winter; dry in summer) buried underground (COSEWIC 1998, 2007; Jones et al. 2005). Important features of the terrestrial habitat include abundant invertebrate prey; loose, deep, and friable (crumbly) soils that allow for burrowing; and rodent burrows for shelter (COSEWIC 1998, 2007; Sarell 2004). They are unlikely to be able to burrow in substrates such as sod and gravel, as shown for the Eastern Spadefoot, S. holbrookeii (Jansen et al. 2001). Little specific information on terrestrial habitat use is available for the Great Basin Spadefoot. The Western Spadefoot (S. hammondii) uses shallow burrows for diurnal (daytime) retreats and as bases for foraging activities during the active season, and deeper burrows (up to 90 cm below the surface) for hibernation and estivation (Ruibal et al. 1969). Concentrations of hibernation burrows have been recorded in patches of suitable soils (Ruibal et al. 1969). Newly metamorphosed Western Spadefoots shelter under surface cover-objects or in shallow burrows along margins of the breeding sites (Weintraub 1980). Shallow burrows of adults of this species have also been located close to breeding sites in the spring (Svihla 1953). Spadefoots require terrestrial habitat year-round.

Migration and dispersal habitat: Aquatic breeding sites and terrestrial habitats containing foraging areas, overwintering, and estivation sites need to be suitably connected to permit seasonal migrations. Unfortunately, almost no information is available on movement capabilities of the Great Basin Spadefoot or the proximity of hibernation and estivation sites to breeding sites. In Florida, adults of the Eastern Spadefoot (Scaphiopus holbrookii) moved relatively short distances (130 m on average; up to 416 m) from breeding sites and showed high fidelity to particular breeding sites from year to year (Greenberg and Tanner 2005). Based on anecdotal information on a number of species, Hammerson (2005) reported that Spadefoots move several hundred metres or more from breeding sites and suggested that, without specific information, the minimum extent of terrestrial habitat around breeding sites can be set at 500 m.

For aquatic-breeding amphibians, connectivity through suitable terrestrial habitat is required among breeding sites to permit dispersal, colonization of new sites, and persistence of populations across the landscape (Semlitsch 2000, 2002). Habitat connectivity is especially important for species such as the Spadefoot that rely on ephemeral breeding sites that might not be available each year due to environmental variation. Major highways, high-density urban developments, and large, wide rivers are expected to form barriers to movements of Spadefoots (Hammerson 2005).

Ecological role

The Great Basin Spadefoot is potential prey for a number of animals, including other species at risk such as the Burrowing Owl and Tiger Salamander; in turn, it preys on a wide variety of invertebrates (COSEWIC 1998, 2007). Its ecological role is poorly understood.

Limiting factors

The Great Basin Spadefoot requires suitably connected aquatic breeding habitats and terrestrial foraging, hibernation, and estivation habitats to complete its life cycle (COSEWIC 1998, 2007). The loss of any one of the different habitats is deleterious to the local population. Spadefoots undertake mass migrations to and from breeding sites, exposing themselves to becoming road kill, predation, and other sources of accidental mortality (COSEWIC 1998, 2007). Spadefoots often breed in ephemeral water bodies and can develop very rapidly (Jones et al. [eds.] 2005). While this strategy allows them to exploit a variety of breeding habitats, it also attracts them to unsuitable sites, such as water-filled depressions of cattle hoof prints, swimming pools, or other “sink” habitats where the completion of the life cycle to metamorphosis is unlikely (COSEWIC 1998, 2007; Sarell 2004).

Threats

The following threats are listed by priority to demonstrate the greatest impact on the species.

Description of the threats

Habitat loss or degradation: Conversions of terrestrial and wetland habitat to housing development and crop production, and associated activities such as road construction and lawn establishment, are the greatest threats to Spadefoots. These threats have occurred historically and continue to occur throughout the species’ range in British Columbia (Orchard 1989; Redpath 1990; COSEWIC 1998, 2007; Holmes 2003). Temporary wetlands, in particular, have been lost at an alarming rate throughout populated areas of western North America through infilling and changes in drainage patterns, to the detriment of amphibians that use these habitats for breeding (Adams 1999, 2000). The water table has dropped significantly within parts of the species’ range in British Columbia over the past 20 years (COSEWIC 1998, 2007 and references therein), likely as a result of increased demands for water for irrigation and domestic consumption (COSEWIC 1998, 2007). A decrease in the water table is likely to either eliminate temporary shallow water bodies or shorten their hydro-period, and accentuate effects of periodic droughts characteristic to the region. Crop irrigation may also create habitat but these sites may decrease as agriculturists convert from overhead sprinklers to drip irrigation.

Habitat loss creates habitat fragmentation, which is widespread and continuing. Fragmentation is a serious problem for migratory aquatic-breeding amphibians (Hitchings and Beebee 1997; Knutson et al. 1999; Guerry and Hunter 2002) such as the Great Basin Spadefoot in B.C. (COSEWIC 1998, 2007; Sarell 2004). Habitat connectivity is required to maintain dispersal between breeding and terrestrial habitats and among clusters of breeding/terrestrial habitat. Dispersal is essential for maintaining population dynamics across the landscape, and interruption of dispersal movement is likely to increase the probability of local extirpations (Semlitsch 2000, 2002).

Habitat degradation occurs locally, particularly at shallow wetlands, where livestock congregate to drink water. Trampling can alter the configuration of the water body and speed up the drying of ephemeral pools, resulting in mortality of eggs and tadpoles (COSEWIC 1998, 2007; Sarell 2004). Known incidents relate mainly to cattle hoof prints creating many, small puddles (one for each print) within a wetland, which traps tadpoles in rapidly evaporating environments rather than allowing them to move to and survive in deeper spots within contiguous water.

Exotic species: Introduced fish are a serious, widespread, and ongoing threat to aquatic-breeding amphibian populations in British Columbia (see reviews and references in Wind 2005) primarily through direct predation on breeding adults, eggs, and tadpoles (COSEWIC 1998; Sarell 2004). In some areas of North America, wetland conversion to permanent water bodies by damming has increased these impacts to amphibians by providing more habitat for sport fish (Adams 1999, 2000). This appears to be the case locally in BC as well. Illegal introductions of bass, carp and perch, particularly in shallow wetlands that do not support sport fish due to winter kills, impact Spadefoots in the south Okanagan (S. Ashpole, pers. comm., 2006). These introductions are widespread and increasing throughout the Spadefoot range (A. Wilson, pers. comm., 2006). Introduced bullfrogs also occur at a few south Okanagan sites and likely impact Spadefoots locally (S. Ashpole, pers. comm., 2006). A bullfrog eradication program is in progress.

Pollution: Impaired reproduction and abnormal development of amphibians can occur as a result of increased exposure to toxic and teratogenic substances released from escalating human developments in valley bottoms and accumulating in aquatic habitats (see reviews and references in Harfenist et al. 1989; Bishop 1992; Crump 2001). 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 the egg hatching success is lowest (Ashpole 2004 and unpubl. data). Both historically and currently used pesticides are present at research sites and research is continuing to clarify the effects of individual chemicals. The impacts are believed to be widespread and continuing because similar chemicals have been and continue to be used throughout much of the low elevation range of the species, particularly in the Okanagan Valley and Kamloops areas. Widespread insecticide applications (i.e., Vectobac, Malathion) as part of mosquito control programs to control spread of the West Nile virus is a developing issue that may impact Spadefoots, if implemented in the future, and requires additional research (O. Dyer, pers. comm., 2006).

Climate change: Ephemeral wetland ecosystems are very closely tied to water temperature and precipitation patterns and consequently are vulnerable to climate change (Graham 2004). Relatively small changes in timing and amount of precipitation can alter the balance of the system and affect whether individual species are able to persist. Over the long term, water tables in the Okanagan basin are expected to drop as a result of climate change, and small ponds used by amphibians may experience premature or complete drying (Cohen et al. [eds.] 2004). These effects are potentially widespread and serious. Climate change is likely to exacerbate habitat loss and degradation due to human land use.

Accidental mortality: Road construction within the Spadefoot's range increases vulnerability to direct mortality from vehicles during mass migrations to and from breeding areas (COSEWIC 1998, 2007). Road mortality of Spadefoots has been recorded from several sites (Sarell 2004), and mass migrations of newly metamorphosed Spadefoots across roads have been reported (COSEWIC 1998). Thermoregulation and foraging on roads have also been observed (S. Ashpole, pers. comm., 2006). Increased road density and traffic volumes within the species' range in British Columbia have the potential to seriously decrease adult and juvenile survivorship in some areas and reduce local populations. The threat is both historic and ongoing over a widespread area. The degree of threat is variable throughout the range but is likely severe at some local sites. The application of magnesium chloride to desiccate gravel road surfaces for dust abatement during road maintenance can lead to mortality of migrating Spadefoots and other amphibians. This is an emerging threat that is becoming more widespread and requires research (R. Packham, pers. comm., 2007).

Epidemic disease: No disease outbreaks are known to affect the Canadian population of Great Basin Spadefoot. However, epidemic disease must now be considered a serious potential threat to all amphibian populations. Chytridiomycosis, caused by the fungus Batrachochytrium dendrobatidis, is an emerging infectious disease of amphibians that has been linked to precipitous declines and even extirpations of populations of many species worldwide (Daszak et al. 1999; Speare 2005). The fungus has been isolated from other amphibians (Leopard Frog, Rana pipiens) in British Columbia. Other emerging diseases of amphibians associated with epizootics include lethal iridoviruses (Daszak et al. 1999).

Disturbance: Intensive use of off-highway vehicle (OHV) recreation in breeding wetlands may cause direct mortality at local sites and may degrade habitat by compressing the loose sandy soils that Spadefoots need for burrowing, collapse burrows, or alter shallow breeding sites to create sink habitats similar to cattle trampling. This potential impact is likely very localized but may be a severe threat at those sites.

Actions Already Completed or Underway

- Inventory throughout the range (Orchard 1989; St. John 1993; Leupin et al. 1994; Sarell et al. 1998; P. McAllister, unpubl. data, K. Larsen, unpubl. data; Sarell and Alcock 2004; Rebellato 2005; Tarangle and Yellend 2005, Nicolson and Packham, unpubl. Data).
- Occupied habitat is protected from destruction in several protected areas. Some examples include: South Okanagan Grasslands Protected Area, White Lake Grasslands Protected Area, The Nature Trust acquisition of Kilpoola property, and Lac du Bois Grasslands Protected Area.
- Habitat suitability models for five areas in the Okanagan-Similkameen (Warman et al. 1998; Sarell et al. 2002; Sarell and Haney 2003; Haney and Sarell 2005; Haney and Sarell, in prep.).
- South Okanagan–Similkameen Conservation Program (SOSCP) established in 2000; Landscape Recovery Strategy in preparation.
- Okanagan Cooperative Conservation Program (in development).
- Public involvement through the Puddle Project (2002 to present).
- Toxicology of selected breeding sites in the South Okanagan assessed (Ashpole 2004).

- Ponds for Peepers project, developing experimental, artificial amphibian breeding sites in the South Okanagan (2006, 2007).
- Species account in Identified Wildlife Management Strategy, Version 2006 (Sarell 2004).
- Wetlands Primer for Local Governments; Wetland Stewardship Partnership (Ducks Unlimited, UVIC).
- Bullfrog eradication project at four wetlands in the South Okanagan Valley (2005–2007).
- Alberta Lake Badger and Spadefoot Enhancement Project (2007-2008)

Knowledge Gaps

Additional information is needed on the distribution, population biology, habitat requirements, and threats to accurately identify recovery objectives and activities for the Great Basin Spadefoot. The main information gaps, based on reviews in COSEWIC (1998, 2007) and Sarell (2004), are outlined below:

Distribution:
- The geographic distribution is unclear.
- Long term habitat use data is lacking for most sites.

Population biology:
- Population size and density, particularly in relation to habitat quality (i.e., natural and modified habitats), is not available.
- Survivorship patterns for eggs, tadpole, and adults in space and time, especially in relation to habitat and landscape connectivity is required.
- Gene flow among subpopulations and structure of metapopulations is unknown.

Habitat requirements:
- Breeding and terrestrial habitat quality, especially in relation to natural and modified habitats and population survival, is poorly understood.
- Dispersal movements, patterns, and distance in the terrestrial habitat are poorly quantified.
- The amount and spatial arrangement of habitat needed to ensure long-term population viability is unknown.

Threat clarification:
- The degree of impact of current and expected future urban and agricultural development (including road infrastructure, irrigation, and livestock use) on habitat use, dispersal, and population survivorship is not known.
- The distribution and degree of impact on all life stages of the population from exotic fish and bullfrogs is poorly quantified.
- The distribution and degree of impact on all life stages of the population from pesticides, agricultural run-off, and waste water ponds is not well understood.
- The impacts of road mortality on a varied sample of local sites in relation to road density and vehicle use volumes have not been measured.
- Baseline data on disease, especially chytrid fungus, is not available.

- Patterns of climate variation and expected outcomes of climate change, related to impacts on breeding sites, requires research.
- The magnitude of Spadefoot mortality associated with the application of magnesium chloride on gravel road surfaces requires research.

RECOVERY

Recovery Feasibility

Recovery of the Great Basin Spadefoot is technically and biologically feasible. Populations are still present in several areas of the species' range. Individual females produce large numbers of eggs (300–800) each year (Leonard et al. 1993), contributing to the ability of populations to recover quickly under suitable conditions. Substantial amounts of breeding and terrestrial habitats still exist in reasonable configurations. Significant threats can be reduced or mitigated through shared stewardship. Recovery techniques such as habitat protection through stewardship, predatory fish control, and translocation of individuals to new breeding ponds are known to be reasonably effective.

Table 1. Technical and biological feasibility

	Recovery criteria	Great Basin Spadefoot
1.	Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?	Yes
2.	Is sufficient habitat available to support the species or could it be made available through habitat management or restoration?	Yes
3.	Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?	Yes
4.	Do the necessary recovery techniques exist and are they known to be effective?	Yes

Recovery Goal

To ensure that there is sufficient, secure[2] habitat distributed throughout the historic range to maintain a self-sustaining population, or populations, in each major watershed. .

Rationale for the Recovery Goal

Sufficient information to quantify long-term population and habitat targets for the recovery goal is currently unavailable. This is due to poor knowledge of population distribution and size, threats, and specific habitat needs required to maintain population viability. Short-term (2008–2012) targets are presented in the objectives. The targets are believed by the recovery team to be

[2] Secure habitat is Great Basin Spadefoot habitat that is managed to maintain the species for a minimum of 100 years and includes suitably connected breeding, foraging, overwintering, and dispersal habitat (see "Needs of the Great Basin Spadefoot"). Habitat securement can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas

necessary to maintain the species over the short term and achievable within 5 years while knowledge gaps are addressed. The minimum breeding habitat securement target (280 ha) includes an average of 1 ha of wetland for each of approximately 280 breeding sites identified up to 2007. To achieve this target, artificial wetlands may be created to replace damaged or destroyed natural wetlands, if necessary, but natural wetlands are preferred. The terrestrial habitat securement target (1200 ha) includes 10 ha of terrestrial and connectivity habitat around priority breeding locations. The 10 ha target for each priority breeding location is recommended by the BC Identified Wildlife Management Strategy Version 4 (BCMWLAP 2004a, Great Basin Spadefoot chapter). The 1200 ha target is believed to be necessary to conserve the species in the short term and achievable, using current land securement techniques and processes, by 2012, based on recovery team consensus. Priority breeding locations generally will include occupied habitats associated with good quality terrestrial habitat, high connectivity among breeding wetlands, low threats, and a high probability of long-term securement success. The target includes 700 ha of Crown land (~90% of known, Crown land sites) and 300 ha of private land (~20% of known, private land sites; this is the expected voluntary stewardship success rate in 5 years based on the experience of three local stewardship programs). A portion of the habitat target has partial protection through Crown and private protected areas but is not quantified at this time. A voluntary, cooperative stewardship approach will be used to achieve the targets (see “Recommended Approach for Recovery Implementation”).

Recovery Objectives (2008 to 2012)

1. Secure a minimum of 280 ha of known, wetland, and breeding habitat, and a minimum of 1200 ha of terrestrial habitat surrounding and connecting priority breeding sites distributed throughout all major watersheds within the historic range by 2012.
2. Address knowledge gaps that clarify the distribution, habitat requirements, population processes, terrestrial movements, threats, population viability, critical habitat, and long-term habitat securement targets, required to support recovery implementation, by 2012.
3. Build sufficient understanding, knowledge, and support for habitat protection by stakeholders and the public to enable implementation of recovery by 2012.

Approaches Recommended to Meet Recovery Objectives

Threats to the Great Basin Spadefoot will be addressed primarily through habitat securement, habitat management, research, and outreach.

Research is required to clarify the distribution, severity, and management options related to threats from exotic species, pesticides, intensive livestock use, and road mortality. These threats will be addressed in an ongoing manner as priority sites with potentially successful mitigation options are identified.

Recovery planning table

Table 2. Recovery planning table

Objective	Broad strategy	Threat or concern addressed	Priority	General steps
1	Habitat securement and management	Habitat loss and degradation, disturbance.	Urgent	Monitor selected sites to assess long term habitat use, population persistence and to identify high priority sites for securement.
			Urgent	Identify land ownership for known breeding sites and priority terrestrial habitat.
			Urgent	Develop best management practices to mitigate impacts from livestock grazing practices, road kills, pollution from agricultural chemicals and West Nile Virus control programs, exotic species and recreation (i.e., all-terrain vehicles).
			Urgent	Implement private landowner contact program to develop stewardship agreements and implement best management practices on private land.
			Urgent	Work with municipal and regional governments to incorporate habitat stewardship into planning processes such as Community Plans and bylaws.
			Urgent	Work with First Nations to identify and implement opportunities for cooperative habitat conservation projects both on and off reserves.
			Urgent	Implement stewardship through existing land use designations and best management practices on Crown land.
			Urgent	Improve inventory standards and continue species and habitat inventory to clarify geographic distribution and identify sites for securement.
		Exotic species	Urgent	Develop and implement a strategy to reduce or eliminate illegal introductions of non-native fish species.
			Urgent	Continue to work toward eliminating introduced bullfrogs.
		Pollution	Urgent	Develop and implement a strategy to reduce impacts from pollution and West Nile Virus control strategies.
			Urgent	Develop best management practices for the application of magnesium chloride on gravel road surfaces in proximity to Spadefoot breeding habitat.
		Road Mortality	Urgent	Develop and implement a strategy to reduce impacts from road mortality at priority sites.
		Infectious Disease	Urgent, if disease is detected	Control infectious disease, if identified.
		Disturbance	Necessary	Develop and implement a strategy to reduce impacts from habitat disturbance by OHV's at priority sites.
2	Research	Knowledge gaps	Urgent	Use radio-telemetry and mark-recapture to clarify movement and dispersal patterns, habitat use and quality in natural and modified habitats, population demography, and metapopulation dynamics to help identify critical habitat.
			Urgent	Develop and implement a program to create and monitor artificial breeding sites.
			Urgent	Conduct genetic studies to investigate population structure and quantify gene flow among sub-populations and structure of metapopulations.

Objective	Broad strategy	Threat or concern addressed	Priority	General steps
			Urgent	Use population viability analysis to clarify population and habitat targets and spatial arrangement of secured habitat required for recovery.
			Urgent	Work with First Nations to identify traditional ecological knowledge.
			Urgent	Clarify threats from road mortality at priority sites.
			Urgent	Continue research to quantify threats from pollution, particularly agricultural chemicals and effects of West Nile Virus control strategies.
			Urgent	Develop research partnerships to assist with disease identification and containment options.
			Urgent	Develop base line data and monitor for infectious disease, particularly chytrid fungus, at priority sites.
			Urgent	Clarify threats from climate variation and change on the breeding ponds.
			Necessary	Clarify potential impacts from livestock activities at priority sites.
			Necessary	Clarify threats from urban and agriculture development at priority sites.
3	Outreach	N/A	Necessary	Develop and implement an outreach strategy to increase awareness of threats, stewardship options, and best management practices; and encourage involvement in and support for recovery actions.

Performance Measures

- Measure progress toward the breeding habitat securement target of 280 ha by quantifying the number of hectares secured in each type of securement category (i.e., number and area of wildlife habitat areas, stewardship agreements) by 2012.
- Measure progress toward the terrestrial/connectivity habitat securement target of 1200 ha by quantifying the number of hectares secured in each type of securement category by 2012.
- Determine if a written research strategy was developed by 2008 to clarify knowledge gaps and critical habitat and quantify progress regarding its implementation by 2012.
- Determine whether a written outreach strategy was developed by 2008 to increase awareness and participation in recovery actions, and quantify whether it was implemented, whether awareness increased, and whether habitat stewardship increased as a result of the plan implementation by 2012.

Critical Habitat

Identification of the species' critical habitat

No critical habitat, as defined under the federal *Species at Risk Act* [S.2], is proposed for identification at this time. Critical habitat for the Great Basin Spadefoot will be identified following completion of the schedule of studies.

Relatively little is known about the population size and distribution, terrestrial habitat needs or requirements to maintain viable populations for the Great Basin Spadefoot. More definitive work must be completed before any specific sites can be formally proposed as critical habitat. It is expected that critical habitat will be proposed following completion of outstanding work required to identify specific habitat and area requirements for this species. Consultation and development of stewardship options with affected landowners and organizations will also be necessary. A "schedule of studies" to identify critical habitat is outlined below.

In general, critical habitat may include wetlands for breeding and associated grassland, shrub-steppe, and open forest to maintain terrestrial foraging habitat and connectivity among subpopulations to support viable populations across the landscape.

Recommended schedule of studies to identify critical habitat

A "schedule of studies" to identify critical habitat is outlined in the following table.

Table 3. Schedule of studies

Description of activity	Outcome/rationale	Timeline
Conduct research to quantify habitat requirements and use	Quantification of dispersal distance and habitats, home range, foraging, breeding, and habitat connectivity requirements	2008 to 2012
Inventory and monitor species distribution, abundance, occupied habitat, and potential recovery habitat	Clarification of population size, distribution, persistence, movement barriers, land ownership, and site-specific threats	2008 to 2012
Develop a population viability model	Identification of options for establishing a network of managed habitat to support a viable population over a long term (>100 years)	Draft 2010 to 2011; final by 2012
Use social research methods to consult potentially affected landowners and develop effective stewardship options.	Identification of effective protection and best options for securing critical habitat	2011 to 2012

Existing and Recommended Approaches to Habitat Protection

Some breeding and upland habitat for this species has been protected from destruction in the following areas: South Okanagan Grasslands Protected Area, White Lake Grasslands Protected Area, The Nature Trust acquisition of Kilpoola property, and Lac du Bois Grasslands Protected Area. Opportunities exist to mitigate impacts from forest and range practices on Crown lands through the Identified Wildlife Management Strategy. The Okanagan Puddles Project and South

Okanagan-Similkameen Conservation Program have developed and implemented outreach and stewardship activities to increase awareness and implement best management practices on private land.

Habitat protection may be accomplished through voluntary stewardship agreements; conservation covenants; eco-gifts; sale of private lands by willing landowners; land use designations and management; and protection in federal, provincial, and local government protected areas.

Effects on Other Species

Many other species at risk occupy habitats that are used by the Great Basin Spadefoot in the arid interior of British Columbia. In particular, Spadefoot habitats overlap with the Tiger Salamander (*Ambystoma tigrinum*; endangered) and the Western Toad (*Bufo boreas*; special concern) at some sites. Similar recovery strategies will benefit these three species. Other species at risk may benefit from Spadefoot recovery through grassland or shrub-steppe habitat protection. Those species include the Burrowing Owl (*Athene cunicularia*; endangered), Badger (*Taxidea taxus*; endangered), Sage Thrasher (*Oreoscoptes montanus*; endangered), Behr's Hairstreak butterfly (*Satyrium behrii*; threatened), and Pallid Bat (*Antrozous pallidus*; threatened). Tiger Salamanders are natural predators of Spadefoot larvae but habitat overlaps are incomplete and predation impacts are expected to be low. Recovery conflicts between species are unlikely to occur, as the Spadefoot is not known to prey upon or directly compete with any other species at risk.

Socioeconomic Considerations

The species possesses unique adaptations to life in arid environments and has potential value for wildlife viewing, education, and research. Traditional ecological knowledge keepers in First Nations (Secwepemc) communities suggest that Spadefoots are highly regarded due to their environmental, resource management, and educational values (Markey and Ross 2005). In the past, their appearance was used as a cue of a change in weather and for timing some activities. The Secwepemc do not use the Spadefoots directly, but consider them beneficial as they provide food for other animals and are an intricate part of the ecosystem.

Recommended Approach for Recovery Implementation

The strategy will be accomplished using a landscape conservation approach mainly through existing Crown land designations and partnerships with non-government groups such as the South Okanagan-Similkameen Conservation Program, Okanagan Cooperative Conservation Program (OCCP), Grasslands Conservation Council of BC, The Nature Trust of BC, The Land Conservancy, and The Nature Conservancy of Canada. A multi-species approach will also be used to protect wetland habitat for Tiger Salamanders, Great Basin Spadefoots, and Western Painted Turtles and upland habitats for Western Rattlesnakes and Badgers. An ecosystem approach, to ensure linkage between wetland and upland habitat, is also recommended and should be implemented through the BC Grasslands Action Plan (in prep.).

There is a strong need to encourage and support the voluntary cooperation of landowners and managers in stewardship activities on various land tenures to make recovery activities successful. This stewardship approach includes different kinds of activities, such as following guidelines or best management practices, land use designations on Crown lands, conservation agreements, covenants, eco-gifts, and sale of private lands by willing landowners. To be useful, protected habitat needs to be large enough and in adequate condition for this species to carry out its seasonal activities and life cycle.

Statement on Action Plans

One or more action plans will be completed by 2012.

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