

Recovery Strategy for the Sharp-tailed Snake (*Contia tenuis*) in British Columbia



Prepared by the Sharp-tailed Snake Recovery Team



Ministry of
Environment

August 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 its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada – British Columbia Agreement on Species at Risk*.

What is recovery?

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

What is a 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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Contia tenuis, juvenile, Saltspring Island, BC. Photo by Kristiina Ovaska

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Disclaimer

This recovery strategy has been prepared by the Sharp-tailed Snake 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 Sharp-tailed Snake 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 Sharp-tailed Snake.

RECOVERY TEAM COMPOSITION

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See Acknowledgements.

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providing updates on distribution, habitats, and stewardship efforts. The Habitat Conservation Trust Funds' Species at Risk Restricted Account funded the preparation of the strategy. Thanks to Jenny Feick and Robert Weaver for valuable review comments and to David Fraser, David Cunnington, and Arthur Robinson for their contributions to the recovery team. The recovery team extends a special thank you to all the landowners who have taken an interest in protecting this species and its habitat.

EXECUTIVE SUMMARY

The Sharp-tailed Snake, *Contia tenuis*, is a small, non-venomous, secretive snake endemic to western North America. Its range extends from British Columbia (B.C.) south to western California. The species has an extremely limited Canadian distribution within a relatively densely populated part of southwestern B.C. As of March 2008, distribution records exist from 10 sites located in the Gulf Islands (North and South Pender, Saltspring, Galiano) and southern Vancouver Island. All recent records are from the Capital Regional District (Victoria, BC), where pressures on remaining natural areas are intense due to a rapidly growing human population.

Suitable habitats for the species are naturally fragmented, but threats to the persistence of populations are largely human-induced. The main threats are from habitat loss, fragmentation, and degradation, primarily due to urbanization and the development of associated infrastructures. The loss or degradation of potential oviposition and hibernation habitats is of particular concern; rocky slopes with a southern exposure in small forest openings are thought to be important habitat features for these functions. Road mortality is a threat, but its significance to populations is unknown.

The long-term goal for recovery is to ensure the persistence of the Sharp-tailed Snake across its natural range in Canada. The short-term goal is to ensure the persistence of Sharp-tailed Snake populations at each known site and to prevent the loss of important habitats. The objectives for the next 5 years are to (1) protect all known Sharp-tailed Snake habitats and populations; (2) prevent fragmentation of habitat within occupied sites; (3) investigate the existence of additional populations throughout the species' Canadian range, including suitable habitats outside the known range within the Georgia Depression Ecoprovince; (4) protect habitats important to the species' survival and recovery as they are identified; (5) continue to reduce gaps in our knowledge of habitat requirements; (6) continue to reduce gaps in our knowledge of the species' population ecology; and (7) increase awareness of the Sharp-tailed Snake and its habitats. This recovery strategy addresses the above objectives and responds to identified threats, while building on existing and ongoing recovery work and on collaborative efforts that have already been established with various agencies, organizations, and landowners.

The approaches to meet the recovery objectives have been grouped into the following broad strategies: habitat protection, habitat stewardship, habitat inventory, population inventory, research, and outreach. The primary focus is habitat protection to ensure that further loss and fragmentation of habitats are prevented. The approach involves collaborating with land managers and local planners to incorporate habitat protection needs of this species into the planning process and examining opportunities for land acquisitions and covenants. Because several sites are on private lands within residential areas, initiating and continuing stewardship activities with landowners is also a priority.

Several new localities for the Sharp-tailed Snake have been discovered over the past few years through increased search effort and public awareness programs; additional populations may well exist. Habitat assessment throughout the species' range, along with surveys for snakes, will help delineate the species' Canadian distribution more accurately and is the first step towards the

protection of habitats at new sites. Inventory efforts should also focus on known sites to provide information on the extent of local distribution and on areas with historical records. Threats dealing with habitat degradation and inadvertent mortality of snakes are largely addressed through outreach, such as strategic distribution and display of stewardship and interpretive materials, delivery of workshops, and other initiatives that increase public awareness of the snakes and their habitats.

Research is needed to clarify threats from road mortality and to fill in data gaps on habitat use, genetic structure of populations, demographic patterns, and life history. The most urgent need is to collect information necessary to identify critical habitats, including seasonal pattern of habitat use, movements, and important micro- and macro-habitat features. An action plan that identifies activities needed to implement the recovery strategies is in preparation, to be completed before or by 2015.

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BACKGROUND

Species Assessment Information from COSEWIC

Date of Assessment: April 1999
Common Name (population): Sharp-tailed Snake
Scientific Name: *Contia tenuis*
COSEWIC Status: Endangered
Reason for Designation: This species occurs in low numbers and has a highly fragmented distribution. Area of occupancy is less than 10 km². The species has low fecundity and low potential of increase with no chance of a rescue effect.
Canadian Occurrence: British Columbia
Status history Designated Endangered in April 1999. Status re-examined and confirmed in October 1999. Last assessment based on an existing status report.

Description of the Species

The Sharp-tailed Snake, *Contia tenuis*, is a small, harmless snake endemic to western North America. Adults are slender (about the thickness of a pencil) and about 20–30 cm in total length. The back and sides are brown or reddish brown and the underside has characteristic black and white barring; juveniles are typically more brightly coloured than adults. The short tail ends in a small thorn-like scale, which gives the species its common name.

Populations and Distribution

The range of the Sharp-tailed Snake extends from southwestern British Columbia (B.C.) south through Washington and Oregon to central California. Populations occur at scattered locations in the northern portion of the species' range in B.C. and Washington (Leonard and Ovaska 1998), whereas the distribution is more continuous and populations appear to be larger in Oregon and California (Cook 1960; Hoyer *et al.* 2006). Recent morphological and genetic evidence suggest that two distinct forms of the Sharp-tailed Snake exist (Crother *et al.* 2001). A long-tailed form is found in coastal areas of California and parts of southern Oregon and may represent a separate species (Hoyer 2001; Feldman and Spicer 2002). Snakes from the remainder of the species' distribution—in the interior of California, most of Oregon, Washington, and B.C.—constitute another form. Specimens from B.C. are genetically similar to those from Washington and Oregon at the species level, based on analysis of a small number of samples from the province (M. Blouin, pers. comm., 2001; C. Feldman, pers. comm., 2008). Finer scale differences, such as among populations on different Gulf Islands, remain to be investigated.

In Canada, the Sharp-tailed Snake has an extremely limited distribution and is known from only a few localities in southwestern B.C. The extent of occurrence¹ is about 1200 km², calculated using the minimum polygon method from records since the 1940s. The area of occupancy¹ is less than 10 km². Although these populations represent a small proportion of the world distribution and abundance of the species (about 5% in terms of extent of occurrence based on a total range

¹ As defined by COSEWIC (<http://www.cosewic.gc.ca/eng/sct0/Assessment_process_tbl3_e.cfm>).

of 25,000 km²; NatureServe 2007), they may be important reservoirs of genetic variability and may contain unique ecological adaptations.

In B.C., the Sharp-tailed Snake has been recorded from North Pender, South Pender, Saltspring, and Galiano islands in the southern Gulf Islands, and from the southern tip of Vancouver Island (Spalding 1993, 1995; COSEWIC 1999; Engelstoft 2004, 2005, 2006, 2007). Where these occurrences² are separated by dispersal barriers such as major water bodies, or by distances of more than 5 km, they are considered to represent different sites (NatureServe 2007). Whether sites on the same island represent separate populations is unknown. Since the preparation of the COSEWIC status report, four new sites have been found: three on southern Vancouver Island and one on Saltspring Island (Engelstoft 2004, 2005, 2006, 2007, and pers. comm., 2008). The area of occupancy at the previously known sites on Saltspring, Vancouver, and South Pender islands has increased slightly due to new records from different points within these sites (C. Engelstoft, pers. comm., 2008). The species is known from only one site record on Galiano Island, in 1981 (Spalding 1993, 1995). In total, since the 1940s, the species has been recorded from 10 sites in southwestern B.C. (Figure 1). An additional, isolated record exists from near Chase in the B.C. Interior (Tanner 1967), but its validity is questionable (Leonard and Ovaska 1998).

Population sizes and trends are poorly known. At four sites where the species has been studied through capture-recapture studies over several years (one site each on Saltspring and North Pender; two sites on Vancouver Island), the number of individual snakes detected ranged from 13 to more than 50. This variation reflected both sampling effort and the size of the areas surveyed. Analysis of mark-recapture data at the most intensively studied site on North Pender resulted in a mean population estimate of 49 snakes (95% confidence interval: 43–65 snakes) and mean density of 0.067 snakes per square metre (Govindarajulu *et al.*, in prep.). Over a 6-year period, from 1997 to 2002, this population was stable or slightly declining (growth rate = 0.89; 95% confidence interval: 0.79–1.1).

Globally, the Sharp-tailed Snake is ranked as G5 (secure) (NatureServe 2007). Subnational rankings are S5 (California), S4 (Oregon), S2 (Washington), and S1 (British Columbia).

² An area in which a species is, or was, present.

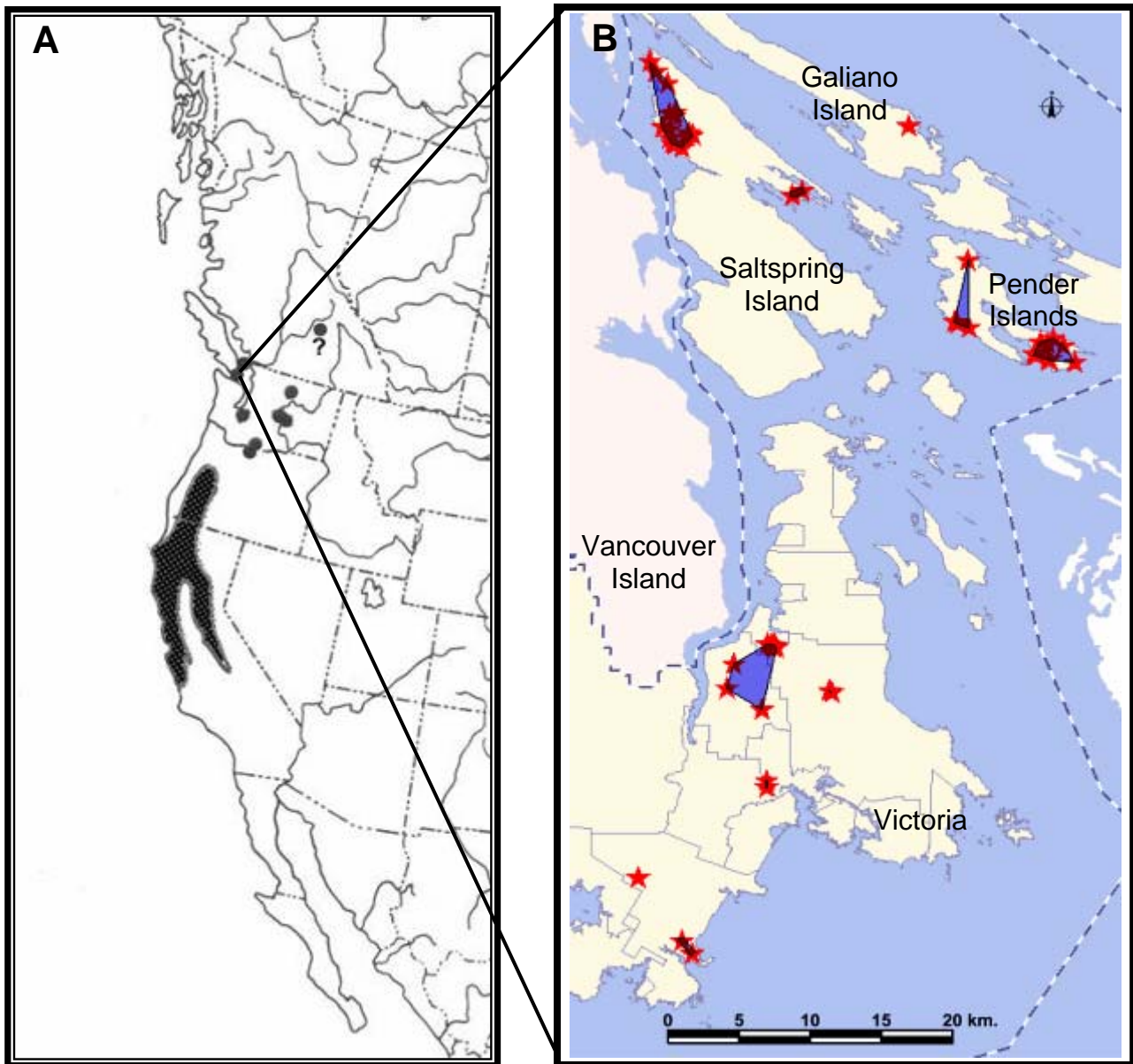


Figure 1. Distribution of the Sharp-tailed Snake in western North America (A) and in southwestern British Columbia (B). “?” in Panel A indicates a questionable record from near Chase, BC. Panel B shows southern tip of Vancouver Island and southern Gulf Islands. Dashed line indicates the boundary of the Capital Regional District. Occurrences less than 5 km apart are shown as a polygon, representing a single site. Sources: Panel A, COSEWIC (1999); Panel B, courtesy of Christian Engelstoft, March 2008.

Needs of the Sharp-tailed Snake

Habitat and biological needs

All confirmed distribution records for the species are from the Coastal Douglas-fir (CDF) biogeoclimatic zone, which encompasses a narrow strip of land on the southeast coast of Vancouver Island and adjacent Gulf Islands, and also includes a fringe of the mainland coast (Meidinger and Pojar 1991). This zone covers about 200,000 ha, most of which is below 150 m in elevation (MacKinnon and Eng 1995).

The Sharp-tailed Snake has been found in relatively open-canopy forest dominated by Douglas-fir (*Pseudotsuga menziesii*) and arbutus (*Arbutus menziesii*) (COSEWIC 1999). Some of the sites on Vancouver Island and Saltspring Island contain Garry oak (*Quercus garryana*) or are within a matrix of Garry oak and associated ecosystems (Engelstoft 2004 and pers. comm., 2008). Garry oak ecosystems are Red-listed (critically imperiled) in the province. Many Sharp-tailed Snake sites on Vancouver Island are on rocky hillsides in open woodland habitats dominated by Douglas-fir and arbutus. Several Douglas-fir–arbutus ecosystems in the CDF biogeoclimatic zone are at risk (B.C. MOE 2008).

Suitable habitats for the Sharp-tailed Snake must provide thermoregulation, oviposition, hibernation, and aestivation sites, as well as foraging opportunities in a spatial pattern that is within the movement capabilities of individual snakes. COSEWIC (1999) identified the availability of suitable oviposition sites as an important, potentially limiting factor for the Sharp-tailed Snake in B.C. and suggested that rocky, south-facing slopes in small forest openings provide such habitat. Brodie *et al.* (1969) suggested that a paucity of suitable exposed southern slopes, especially those with talus, was responsible for the concentration of reptiles, including the Sharp-tailed Snake, at a communal egg-laying site in Oregon. No eggs of this species have ever been found in B.C., but the presence of hatchling-sized young at a rocky slope supports the suggestion that such habitats are important for reproduction (Engelstoft and Ovaska 1999). In addition to oviposition sites, rocky slopes may provide suitable thermoregulation and hibernation sites for the snakes (Engelstoft and Ovaska 1999). Habitat features at sites where the Sharp-tailed Snake was found tended to have southern exposure, shallow soil and leaf litter, and a high cover of rock when compared with random points 50 m away (Wilkinson and Gregory 2005).

The availability of refuges appears to be important for all activities, as the snakes are seldom found in the open, away from cover-objects. The Sharp-tailed Snake has been found under and within decaying logs (COSEWIC 1999), but the importance of coarse woody debris as a habitat component for the species is unclear. Similarly, foraging habitats of the snakes are poorly understood. The snakes feed on small invertebrates, primarily slugs; presumably, during their active season, they require proximity to moist areas where slugs are abundant.

Limited information collected to date on movements indicates that individual snakes confine their activities to relatively small areas during the active season from spring to autumn. Within a rural residential area on North Pender Island, individuals used an area usually less than 55 m along the greatest dimension at a site (Engelstoft and Ovaska 1999). In relatively undisturbed habitat, individual snakes moved straight-line distances of up to 31 m (Ovaska and Engelstoft

2005). There was no evidence at either site of extensive seasonal migrations between habitats, such as that undertaken by some other species of snakes. The Sharp-tailed Snake is thought to spend much of its time underground (Cook 1960; COSEWIC 1999), but virtually nothing is known of its underground habitat use or requirements. Whether the species is associated with particular terrain features (such as fissures in bedrock) or geomorphologies is unknown.

The Sharp-tailed Snake can coexist with humans, provided that sufficient cover and other habitat features are retained. In California and Oregon, many observations are from backyards and other disturbed areas within or near urban areas (Cook 1960; Hoyer *et al.* 2006). In B.C., the snakes have been found in compost heaps, borders of gardens, and woodpiles within low-density residential areas, and they readily use artificial cover-objects constructed of wood, metal, or asphalt roofing (Engelstoft and Ovaska 1999; C. Engelstoft, pers. comm., 2008).

Ecological role

The Sharp-tailed Snake is a unique component of the forest ecosystems that it occupies, including rare Garry oak–arbutus habitats. The snakes are important in the food web both as predators of slugs and other invertebrates and as prey for various vertebrates. They are thought to be beneficial to humans as they feed mainly on slugs, including introduced garden pests (Zweifel 1954; Cook 1960).

Limiting factors

The small Canadian range and localized distribution pattern of the Sharp-tailed Snake are probably due to past climatic conditions and historical factors rather than to human activities (COSEWIC 1999). In B.C., climate probably limits northward range expansion of the Sharp-tailed Snake. Present-day populations may represent remnants of a wider past distribution during periods when conditions were more suitable for egg-laying reptiles, such as during the warmer Hypsithermal Interval about 8500–5000 years ago (COSEWIC 1999).

The Sharp-tailed Snake is one of two egg-laying (oviparous) squamates³ that occur in coastal B.C.; the other is the non-native European Wall Lizard, *Podarcis muralis*. In reptiles, incubation temperatures influence both developmental rates and phenotypic traits of offspring, which in turn can affect survival (Burger 1998). The availability of nest sites with appropriate thermal conditions thus plays an important role in determining the distribution of oviparous species (Shine 2004), and probably limits the distribution of the Sharp-tailed Snake to certain habitats in the southern part of the province.

Threats

Current threats to the persistence populations of the Sharp-tailed Snake are largely human-induced (COSEWIC 1999). The Coastal Douglas-fir biogeoclimatic zone where the species occurs is one of the most modified ecosystems in the province (MacKinnon and Eng 1995), and land conversions and development of remnant forest habitats continue at a rapid rate. These

³ Snakes and lizards.

threats may be compounded with natural sources of mortality due to predation or adverse climatic conditions, especially in small habitat patches. Small isolated populations are inherently vulnerable to disturbances and chance events.

The main human-caused threats to the species include (1) habitat loss; (2) habitat fragmentation at broad and fine scales; (3) habitat degradation; and (4) road mortality. Additional threats that may affect local populations include (5) predation by domestic and feral animals; (6) use of molluscides and other pesticides; and (7) direct persecution of snakes (Table 1). Most of the above threats are associated with increasing residential development and construction and improvement of roads and other associated infrastructure.

Threat classification

Table 1. Threat classification table for the Sharp-tailed Snake.

1 Urban development		Threat attributes		
Threat category	Habitat loss	Extent		
			Local	Range-wide
General threat	Residential development, land clearing, road construction, quarrying	Occurrence	Historical & ongoing	Historical & ongoing
		Frequency	High	High
Specific threat	Disturbance of habitats needed for essential life history functions	Causal certainty	High	High
		Severity	High	High
Stress	Reduced survival and reproductive success; accidental mortality	Level of concern	High	
2 Urban development		Threat attributes		
Threat category	Habitat fragmentation at broad and fine scales	Extent		
			Local	Range-wide
General threat	Residential development, land clearing, road construction	Occurrence	Historical & ongoing	Historical & ongoing
		Frequency	High	High
Specific threat	Barriers to movements	Causal certainty	Moderate	Unknown
		Severity	Moderate	Unknown
Stress	Isolation and fragmentation of populations	Level of concern	Moderate	
3 Gardening and landscaping activities		Threat attributes		
Threat category	Habitat degradation	Extent		
			Local	Range-wide
General	Lawn mowing;	Occurrence	Ongoing	

threat	mechanical weed trimming; removal of rocks and other shelter; burning; facilitating spread of invasive plants	Frequency	Recurrent	
Specific threat	Loss of shelter; degradation of oviposition sites; accidental mortality	Causal certainty	Moderate	
		Severity	Low moderate, depending on intensity of activities	
Stress	Reduced survival or productivity; accidental mortality	Level of concern	Moderate	
4	Road construction and improvements	Threat attributes		
Threat category	Road mortality	Extent		
			Local	Range-wide
General threat	Accidental mortality while crossing roads or using roadside habitats	Occurrence	Historical and ongoing	
		Frequency	Recurrent (documented at 2 sites)	
Specific threat	Decreased survival probability	Causal certainty	High	
		Severity	Unknown	
Stress	Excessive loss of juveniles or breeding adults, resulting in a population decline	Level of concern	Moderate	
5	Predation	Threat attributes		
Threat category	Predation by domestic or feral animals	Extent		
			Local	Range-wide
General threat	Cats, birds	Occurrence	Continuous	
		Frequency	Unknown (documented at 1 site)	
Specific threat	Mortality from predation	Causal certainty	High	
		Severity	Unknown	
Stress	Excessive loss of juveniles or breeding adults, resulting in a population decline	Level of concern	Low-Moderate	
6	Pesticides & herbicides	Threat attributes		
Threat category	Use of pesticides, especially molluscides, and herbicides	Extent		
			Local	Range-wide
General	Contamination of	Occurrence	Unknown	

threat	foraging areas and loss of prey; contamination of snakes	Frequency	Recurrent	
Specific threat	Loss of foraging opportunities; poisoning	Causal certainty	Low – moderate, depending on chemicals used	
		Severity	Moderate	
Stress	Mortality or reduced survival or productivity	Level of concern	Low – moderate	
7	Persecution	Threat attributes		
Threat category	Persecution	Extent		
			Local	Range-wide
General threat	Wanton killing of snakes by humans	Occurrence	Unknown	
		Frequency	Recurrent	
Specific threat	Death	Causal certainty	High	
		Severity	Unknown	
Stress	Reduced survival probability; population decline	Level of concern	Low	

Description of threats

1. Habitat loss

Primary threats to the habitat of the Sharp-tailed Snake consist of expanding urbanization, including housing developments and associated road building and infrastructure development. These developments are concurrent with an expanding human population throughout the species' range on the Gulf Islands and southern Vancouver Island. Further habitat loss is a major threat to the Sharp-tailed Snake because of low numbers of populations and individuals and small Canadian range of the species. The loss of any population would reduce probability of persistence and opportunities to conserve the species.

The eastern coastal lowlands of Vancouver Island and the adjacent Gulf Islands are one of the most extensively modified and fragmented areas of the province. Most of this area (92.1%) consists of urban or rural landscapes or forests less than 100 years old (Ward *et al.* 1998). Woodland ecosystems are widely scattered and comprise only 0.6% of the area (Ward *et al.* 1998). Remnant woodland ecosystems consist of open forests dominated by Garry oak, Douglas-fir–Garry oak, or Douglas-fir–arbutus and often occur on south-facing rocky knolls and exposed bedrock; the Sharp-tailed Snake often use such areas.

All recent Sharp-tailed Snake records are from within the Capital Region, which covers the extreme southern portion of Vancouver Island and includes the Gulf Islands from Galiano Island southwards. According to the Sensitive Ecosystems Inventory, only about 6200 ha of older forest (i.e., > 100 years) remains within this area (CRD 2003). Most of the remaining older forest is in the Western Communities (i.e., the western districts and municipalities of the Capital Regional District; about 4500 ha) and the Gulf Islands (about 1200 ha). Garry oak ecosystems are

extremely rare, with a small fraction remaining from their original coverage (about 512 ha remaining in 1997 compared to estimated 10,443 ha in the 1800s) (GOERT 2007).

The pressure on the remaining natural areas within the Capital Region is intense due to increased human population growth. From 1991 to 2001, the population within the Capital Region increased by 8.2% (CRD 2008a). The fastest growing areas were the Western Communities (16.6%) and Gulf Islands (18.2%); in both areas, most of the population expansion took place during the first half of the 10-year period. Population growth and associated rate of land conversions will most likely continue in these relatively undeveloped areas over the next decade. Western Communities and Gulf Islands are forecast to experience growth rates of 92.1% and 43.5%, respectively, by 2026 relative to population sizes in 1996 (CRD 2008a).

2. Habitat fragmentation at broad and fine scales

Suitable habitats for the Sharp-tailed Snake are naturally fragmented, and land conversions, road building, and other human activities continue to accentuate this fragmentation both at broad (across the species' Canadian range) and fine (within habitats occupied by local populations) spatial scales. Apparently suitable, potential habitat for the Sharp-tailed Snake exists in the Gulf Islands and southern Vancouver Island, but its extent has not been fully assessed. Very little is known about the dispersal abilities of this species, and thus the ability of the Sharp-tailed Snake to colonize unoccupied habitats is unknown but is suspected to be low. Habitat fragmentation due to both human activities and natural barriers is likely to hinder dispersal movements. At a finer scale (within a site), roads, driveways, lawns, and other developments contribute to habitat fragmentation. In particular, known localities on the Gulf Islands are within residential areas in highly fragmented landscapes. Increased fragmentation exposes snakes to accidental mortality, including road kill (see below), and may constrain movements of the majority of the population and access to essential habitat components.

3. Habitat degradation

Where the species occurs within residential areas, landscaping and gardening practices can result in habitat degradation. The degradation of potential oviposition and hibernation habitats is of particular concern (COSEWIC 1999). Activities that include removal of rocks and other cover decrease habitat quality for the snakes, as well as possibly resulting in accidental crushing of snakes. Inadvertent mortality of snakes has occurred during lawn-mowing and mechanical weed-trimming. Introduced invasive plants (such as Himalayan blackberry, *Rubus discolor*, and Scotch broom, *Cytisus scoparius*) are prevalent at many of the localities occupied by the Sharp-tailed Snake. Although habitat structure is likely to be more important for snakes than specific composition of plant species, dense monocultures of invasive, introduced plants may reduce gastropod prey, shade basking sites, and decrease habitat complexity. Encroachment of coniferous forest on more open woodlands and Garry oak meadows is also likely to degrade Sharp-tailed Snake habitats. In the past, periodic burning maintained these ecosystems, and fire suppression over the past 150 years has changed the natural disturbance regimes. In addition to wildfires, aboriginal peoples used controlled burning to maintain meadow and woodland habitats on southern Vancouver Island for harvesting of plants and wildlife (Cook 2004).

4. Road mortality

Snakes are vulnerable to road mortality when moving within or between their seasonal habitats in fragmented landscapes. Reports exist of six specimens of the Sharp-tailed Snake found dead on roads (five on North Pender and one on South Pender islands), including three specimens on North Pender Island in the autumn of 2003 (Spalding 1995; Engelstoft and Ovaska 1999; C. Engelstoft, pers. comm., 2008). The significance of road mortality to populations of the Sharp-tailed Snake is unknown but can be expected to increase concomitant with a growing human population and vehicle traffic. One Sharp-tailed Snake site is in the immediate vicinity of a ferry terminal on Saltspring Island, which has experienced about 45% annual increase in vehicle traffic within the past decade (from 147,830 vehicle trips in 1992–1993 to 214,787 trips in 2001–2002; B. Bourquin, pers. comm., 2002). Another site on Vancouver Island is bisected by a popular recreational trail, and mortality from collisions with bicycles is a possibility although undocumented.

5. Predation

All known Sharp-tailed Snake sites in the Gulf Islands are close to human habitation with associated domestic and feral animals (for example, introduced pheasants). One snake was found dead on a driveway, probably killed by a cat (Spalding 1995). Several snakes found at this site had scarring consistent with attempted predation by birds (either native or introduced) (Engelstoft and Ovaska 1999). The magnitude of threat posed by native and introduced predators to this species is unknown.

6. Use of molluscides/pesticides

Pesticide use could adversely affect snakes. If molluscides, such as metaldehyde slug bait, are used, the prey base of the Sharp-tailed Snake, including native species of slugs, might be affected. It is also possible that feeding on animals that have consumed molluscides harms snakes. High densities of introduced European land snails (particularly *Helix aspersa*) have been recorded from one site where the Sharp-tailed Snake occurs on Saltspring Island (D. Fraser, pers. comm., 2002). This snail is on the list of pests regulated in Canada (Canadian Food Inspection Agency 2005), and its spread is of concern to Agriculture Canada due to the snails' invasive habits and threat to agricultural products. In this case, the Canadian Food Inspection Agency has agreed to use manual control rather than chemical molluscides to control the introduced snail *Helix aspersa* (D. Fraser, pers. comm., 2002). However, broadcast of pesticides to control this or other invasive species of gastropods at other sites could adversely affect the Sharp-tailed Snake and its natural prey base.

7. Direct persecution of snakes

Although no venomous species are present in coastal B.C., snakes often have an unfavourable public image that may lead to persecution. The Gulf Islands and parts of Vancouver Island are experiencing a relatively high rate of population growth and expanding tourism. Both of these factors increase the probability of people encountering snakes.

Actions Already Completed or Underway

Recovery work already completed or underway includes the following:

Habitat protection

- Stewardship agreements (legally non-binding) signed by private landowners at most Sharp-tailed Snake sites and several other sites with suitable habitat for the species on Saltspring, North and South Pender, and Vancouver islands (by Habitat Acquisition Trust and Salt Spring Island Conservancy; 2005–2008).
- A conservation covenant was established in 2004 on a residential property on North Pender Island to protect a small but important rocky knoll used by the Sharp-tailed Snake.
- Information on habitat protection measures for the species has been provided to Islands Trust planners and North Pender Island Local Trust Committee Members. Development permit areas in the revised North Pender Island Official Community Plan and include Sharp-tailed Snake habitat (by Habitat Acquisition Trust and Salt Spring Island Conservancy).
- Guidelines for protecting the habitat of this species were incorporated into the document *Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia* (Ovaska *et al.* 2003).

Inventories and research

- Multi-year habitat assessment and survey project through the Government of Canada Interdepartmental Recovery Fund (IRF) on properties of numerous federal departments/agencies, Department of National Defence (DND), Parks Canada, and National Research Council (NRC):
 - Gulf Islands National Park Reserve, 2002 (Engelstoft *et al.* 2002), followed by inventories in 2003–2007, ongoing (Engelstoft 2004, 2005, 2007, ongoing)
 - DND properties on southern Vancouver Island, 2003–2007, ongoing (Engelstoft 2004, 2005, 2007, ongoing)
 - NRC property on southern Vancouver Island (2007, ongoing)
 - Coast Guard lands on Discovery Island (2004–2005)
 - Transport Canada lands on Saltspring Island (2007)
- Population monitoring and capture-recapture study at a DND property (2004–2007, ongoing; Engelstoft 2004, 2005, 2007; Ovaska and Engelstoft 2005).
- Habitat assessment and surveys within Capital Regional District (CRD) Parks and Trails System:
 - Galloping Goose Regional Trail right-of-way in Metchosin, near earlier records (Engelstoft 2002)

- All major Capital Regional District parks (2006–2008, ongoing) (Engelstoft 2006 and pers. comm., 2008)
- Surveys of private lands on Saltspring, Pender, Mayne, Galiano, and Vancouver islands (ongoing); Habitat Acquisition Trust and island conservation groups on Gulf Islands.
- Thermal ecology studies, 2003 (Isaac and Gregory 2003).
- Habitat characterization studies, 2004 (Wilkinson and Gregory 2005).
- Research into distribution, ecology, and movements, 1996–2000 (Engelstoft and Ovaska 1997, 1998, 1999; Ovaska and Engelstoft 2000).

Habitat restoration

- Habitat restoration at eight private properties on Saltspring Island, 2002–2008 (Meier 2001; C. Engelstoft, pers. comm., 2008).

Extension materials produced

- Sharp-tailed Snake identification guide. 2006. B.C. Ministry of Environment.
- Training video produced by DND.
- Sharp-tailed Snake. 2004. Wildlife in British Columbia at Risk Series. Habitat Conservation Trust Fund (HCTF) and B.C. Ministry of Water, Land and Air Protection (B.C. MWLAP).
- Attracting snakes into your backyard — tips for reptile-friendly landscaping and gardening. 2003. Brochure funded by Habitat Stewardship Program, HCTF, and B.C. MWLAP.
- Sharp-tailed Snake, *Contia tenuis*. 2002. British Columbia's Wildlife at Risk Series. Fact sheet produced by B.C. MWLAP.
- Stewardship workshop package (including PowerPoint presentation), 2002–2003; funded by HSP.

Collaboration

The Sharp-tailed Snake Recovery Team has formed working partnerships with several groups and agencies whose participation is crucial to successful recovery of this species.

Team participants and partners include the following:

Government agencies and organizations (federal, provincial)

- B.C. Ministry of Environment
- Canadian Forest Service
- Canadian Wildlife Service
- Department of National Defence
- Parks Canada

Local governments

- Capital Regional District Parks

Non-government organizations

- Garry Oak Ecosystems Recovery Team
- Habitat Acquisition Trust
- Islands Trust
- Galiano Conservancy Association
- Mayne Island Conservancy Society
- Pender Islands Conservancy Association
- Salt Spring Island Conservancy
- University of Victoria

In addition, contacts with private landowners have been established as a part of research and stewardship programs at several sites.

Knowledge Gaps

Knowledge gaps directly related to recovery planning have been identified in the following areas: (1) habitat availability and assessment; (2) distribution and area of occupancy; (3) habitat requirements and critical habitat description; (4) life history and movements; and (5) population genetics. The most pressing issues that need to be addressed are habitat assessment across the species' range, possible existence of undocumented populations, and details of habitat requirements.

- 1. Habitat availability and assessment.* Potentially suitable habitat exists in many areas of the Gulf Islands and southern and eastern Vancouver Island but, apart from small areas, its suitability for the Sharp-tailed Snake has not been systematically assessed. Information on habitat suitability across the species' potential Canadian range within the Georgia Basin Ecoprovince is needed to locate possible undocumented populations and to address habitat protection needs and habitat connectivity issues at a broad scale. Information is also needed on the occurrence of the species within protected areas, which could function as core areas for recovery efforts.
- 2. Distribution and area of occupancy.* Many potential habitats within the species' range have been surveyed inadequately or not at all. Increased search effort in recent years has resulted in the documentation of several new occurrences, but additional undocumented populations may well exist. It is important that these populations are located, so that threats to them can be assessed and protection measures applied as needed. In addition, more accurate information on the distribution of the species is required to better assess the status of populations and habitat protection needs across the species' range. At a smaller scale, information on the area of occupancy at known sites is needed for assessing threats to local populations, evaluating detailed habitat restoration and protection requirements, and obtaining estimates of population size.

3. *Habitat requirements and critical habitat description.* Specific features of habitats required by the snakes for their seasonal and/or daily activities are poorly known. Information on habitats or habitat features needed for oviposition, foraging, thermoregulation, and hibernation is needed to accurately identify critical habitats for this species. In addition, the effectiveness of specific habitat restoration measures is unknown, including landscaping practices implemented as a part of stewardship programs.
4. *Life history and movements.* Many aspects of the life history and behaviour of the Sharp-tailed Snake remain unknown, including patterns of survival and recruitment and reproductive parameters such as clutch size and frequency and timing of oviposition. This information is needed to assess population viability and reproductive potential. Information is also needed on dispersal, seasonal, and short-term movements of individual snakes, which would elucidate their colonizing ability, responses to habitat fragmentation, and threat from road mortality.
5. *Population genetics.* Known populations of the Sharp-tailed Snake in British Columbia are small and isolated from each other, and hence they may be subject to loss of diversity through genetic bottlenecks and inbreeding. Genetic material from snakes from the Gulf Islands was donated for phylogenetic studies of *Contia* across its range, but DNA was obtained only from a limited number of B.C. samples (M. Blouin, pers. comm., 2001; 1 sample, from North Pender Island: C. Feldman, pers. comm., 2008). The results suggest that snakes from B.C. are part of a widespread mtDNA lineage within *Contia tenuis*, similar to samples from Washington and parts of Oregon and California (C. Feldman, pers. comm., 2008). However, finer-scale differences such as the degree of genetic differentiation among populations from different islands are unknown.

RECOVERY

Recovery Feasibility

Recovery of the Sharp-tailed Snake is feasible because multiple populations with reproductive individuals exist, and the available habitat is thought to be sufficient to support populations, provided that threats are reduced (see below for analysis).

1. *Are individuals capable of reproduction available to support recovery? – Yes*
Several populations of the Sharp-tailed Snake are known, and additional populations may be found with more survey effort. Populations may be larger than suggested by the relatively few observations, as these snakes are secretive and appear to spend much of their time underground. Individuals may live a decade or more and populations can thus withstand several years of adverse conditions and low recruitment.
2. *Is sufficient habitat currently available to support recovery? – Yes*
Apparently suitable habitat for this species exists in many areas of the Gulf islands and southern and eastern Vancouver Island. Some of these habitats are within protected areas (regional, provincial, and national parks). Surveys of apparently suitable habitat have

already resulted in discovery of new sites and an increase in area of occupancy at known sites.

3. *Can significant threats to the species or its habitat be avoided or mitigated through recovery actions? – Yes*

The primary threat to this species is habitat loss. However, these snakes require relatively little space and can coexist with humans, provided that certain precautions are taken and key habitat features are protected. Stewardship measures already undertaken (such as workshops in selected communities near known Sharp-tailed Snake sites and close collaboration with landowners and land managers) have proved successful to date in protecting and restoring habitat.

4. *Do the necessary recovery techniques exist and are they known to be effective? – Yes*

Standard techniques are required to recover the species, and efforts to date, such as stewardship activities, are already successful.

Recovery Goal

The long-term goal (over the next 20 years) of this recovery strategy is to ensure the persistence of the Sharp-tailed Snake across its natural range in Canada. The short-term goal (over the next 5 years) is to ensure the persistence of Sharp-tailed Snake populations at each known site and to prevent the loss of habitat important to the species' survival and recovery.

Rationale for the Recovery Goal

The Sharp-tailed Snake has a naturally small distribution in Canada, and the numbers of populations is low and occur within fragmented habitats. Therefore, the key to recovery of this species is removing threats to its habitat (through habitat securement) and ensuring that possible undocumented populations are located through expanded survey efforts. Down-listing may be possible, if threats to the habitat can be removed and/or a significant number of undocumented populations are discovered. Additional information (to be obtained through objectives five and six below) is required before we can define quantitative recovery targets.

Recovery Objectives

1. Protect all known Sharp-tailed Snake habitat and populations.
2. Prevent fragmentation of habitat within occupied sites.
3. Investigate the existence of additional populations throughout the species' Canadian range, including suitable habitats outside the known range within the Georgia Depression Ecoprovince.
4. Protect habitats important to the species' survival and recovery as they are identified.
5. Reduce gaps in our knowledge of the species' habitat requirements.
6. Reduce gaps in our knowledge of the species' population ecology.
7. Increase awareness of the Sharp-tailed Snake and its habitats.

Approaches Recommended to Meet Recovery Objectives

The approaches outlined in Table 2 have been grouped into the following broad strategies: habitat protection, habitat stewardship, habitat inventory, population inventory, research, and outreach. These strategies, in turn, address the objectives listed above and respond to the threats identified for populations of the Sharp-tailed Snake in Canada. The following threats are addressed:

1. *Habitat loss.* This threat is addressed through habitat protection, stewardship strategies, and inventories. The strategy to prevent further habitat loss includes proactively approaching land managers and planners, and encouraging the incorporation of habitat needs of this species into management and land use plans (i.e., Official Community Plans). Stewardship initiatives address habitat protection on private lands. Assessing habitat throughout the species' range, followed by surveying for snakes, is a first step towards protecting habitats of possible undocumented populations. Surveys should focus both on habitats that are already protected, as they may form core areas for recovery efforts, and on areas that require additional management or protection measures.
2. *Habitat fragmentation at broad and fine scales.* These threats are addressed through habitat protection, stewardship strategies, and habitat inventories. At the landscape scale, the approach is to proactively incorporate habitat needs of the species into land use and management plans. Habitat assessment throughout the species' range will provide information on fragmentation and isolation of suitable habitats and on opportunities to maintain connectivity, for example, through strategic land use planning or acquisition. At finer scales, at known Sharp-tailed Snake sites, stewardship initiatives are to focus on landowners and managers to maintain habitat connectivity.
3. *Habitat degradation.* This threat is addressed through habitat protection and stewardship activities. Habitat protection measures are aimed at protecting important habitat components, such as presumed egg-laying habitats, from disturbance. Stewardship activities focus on collaboration with land managers and owners to encourage practices that maintain habitat features required by the snakes and to curtail harmful activities, such as intensive landscaping.
4. *Road mortality.* This threat is addressed through stewardship, threat clarification, and research strategies. As a proactive measure, close contact with landowners and managers is encouraged through stewardship initiatives to ensure that no new roads are built near known Sharp-tailed Snake habitats. At present, the significance of road mortality to Sharp-tailed Snake populations is unknown, and monitoring mortality on public roads near known sites with a potential problem is a first step to address this issue.

Other threats. Other threats dealing with habitat degradation and inadvertent mortality of snakes are addressed through outreach. Outreach activities include strategic distribution and display of stewardship and interpretive materials; delivery of workshops; and other initiatives that increase public awareness, appreciation, and understanding of the snakes and their habitats.

Recovery planning table

Table 2. Recovery planning table for the Sharp-tailed Snake.

Priority	Obj. no.	Threat or limiting factor addressed	Broad strategy to address threats	Recommended approaches to meet recovery objectives
1	1, 2, 4	Habitat loss & fragmentation	Habitat protection	<ul style="list-style-type: none"> - Collaborate with regulators to include habitat protection measures into land use plans (e.g., development permit areas in Official Community Plans) - Encourage parks planners and managers with municipal, regional, provincial, and federal governments to survey for and manage this species on their lands - Encourage First Nations groups to survey for and manage this species on their lands - Encourage private landowners (including developers) to formally protect key habitats (e.g., through covenants) - Collaborate with developers near known sites to ensure protection of important habitats and maintenance of habitat connectivity
1	1, 2, 7	Habitat loss & fragmentation; habitat degradation	Habitat stewardship	<ul style="list-style-type: none"> - Establish or continue contacts with land managers and landowners at all known sites - Engage in habitat restoration/ enhancement projects with landowners and volunteers to promote active involvement and habitat stewardship
2	5, 7	Habitat loss; habitat degradation	Habitat stewardship	<ul style="list-style-type: none"> - Assess effectiveness of restoration projects through monitoring and research, involving landowners and volunteers
1	3, 4	Habitat loss & fragmentation	Habitat inventory	<ul style="list-style-type: none"> - Assess habitat suitability throughout the species' Canadian range
1	3, 4	NA	Population inventory and monitoring	<ul style="list-style-type: none"> - Conduct surveys of high-suitability habitats, as identified through habitat assessment - Conduct surveys at historical sites to determine occupancy
2	5, 6	NA	Population inventory and monitoring; research	<ul style="list-style-type: none"> - Monitor population trends at selected sites - Obtain information on seasonal habitat use and movements - Obtain information on life history
2	1, 2	NA	Population inventory and monitoring	<ul style="list-style-type: none"> - Determine the extent of the distribution at known sites
2	1, 2	Road mortality	Threat clarification/ research	<ul style="list-style-type: none"> - Assess threats from habitat fragmentation and road mortality at each known site - Collect information on road mortalities through surveys and community outreach
3	7, 3	Habitat loss/ fragmentation; habitat degradation; inadvertent mortality or persecution	Outreach	<ul style="list-style-type: none"> - Make stewardship and interpretive materials available to targeted audiences at strategic locations - Prepare new materials as needed (e.g., an identification brochure) - Conduct workshops at selected locations

Priority	Obj. no.	Threat or limiting factor addressed	Broad strategy to address threats	Recommended approaches to meet recovery objectives
1	5	NA	Research	- Conduct research on habitat use, including daily and seasonal pattern of movements - Identify important habitat features and components for oviposition, hibernation, and foraging
3	6	NA	Research	- Conduct research into the species' life history, demography, and ecology - Conduct research into the population genetics to elucidate the degree of isolation and uniqueness of different B.C. populations - Develop partnerships with universities & other agencies to promote research on all aspects of the species' biology throughout its range

Description of the recovery planning table

- A. Habitat protection.* The primary focus of this recovery strategy is to ensure that further loss and fragmentation of habitats of the Sharp-tailed Snake are prevented. Protection measures are to focus on habitats at known sites and surrounding areas. Possible new localities are to be incorporated into the process as they are discovered. This approach to habitat protection involves collaboration with managers and planners to incorporate habitat protection needs of this species into the planning process at different levels. The feasibility of land acquisitions and the establishment of covenants are to be investigated.
- B. Habitat stewardship.* Because several known sites are on private lands, working closely with landowners is a priority. Initiating and maintaining personal contacts with landowners of all properties where the Sharp-tailed Snake occurs will provide a proactive approach to protect key habitat features and to anticipate changes in either ownership or land use. Landowners are to be encouraged to protect Sharp-tailed Snake habitat and collaborate with researchers in monitoring populations. Habitat restoration/enhancement projects are to be conducted as needs for these activities are identified and as opportunities arise. Restoration projects on private lands foster stewardship by bringing together volunteers, landowners, and researchers. Monitoring the use of the restored habitat by snakes is essential to assess the effectiveness of the measures and whether similar measures are expected to be useful at other sites.
- C. Habitat inventory.* A first step towards locating possible undocumented populations is to assess habitat suitability across the species' Canadian range. Such an assessment has already been prepared for portions of the species' range; habitats within remaining areas with suitable habitat on Vancouver Island and Gulf Islands are to be similarly assessed. Whether suitable habitat exists on the mainland B.C. within the Georgia Depression Ecoprovince also needs to be examined. A broad-scale assessment is to be followed by detailed, finer-scale assessments of selected priority areas. Habitat features to be incorporated in the assessment include forest and vegetation cover, rocks and coarse woody debris, aspect, slope, and other terrain features.
- D. Population inventory.* Inventory efforts are to target three types of areas: (1) high-quality habitats identified through habitat assessment to locate possible new populations; (2) known

sites to provide information on the extent of local distribution; and (3) areas with historical records of the species that either have not been surveyed or have received little survey effort in recent years. High-quality habitats both in protected areas and outside these areas are to be surveyed.

E. Threat clarification. Road mortality poses a potential but unknown threat to Sharp-tailed Snake populations. The strategy consists of examining the degree of habitat fragmentation by roads at all known sites and assessing potential threats. Where needed, field surveys are to be conducted to examine movements of snakes across roads and/or incidence of road-kill. Landowners and residents near known Sharp-tailed Snake sites are to be encouraged to collect and report road-killed snakes.

F. Outreach. This strategy consists of (1) distribution of information and interpretive materials to targeted audiences at strategic locations, such as near known distribution records; (2) preparation of new interpretive materials, such as an identification brochure; and (3) delivery of workshops in communities near known or potential Sharp-tailed Snake habitat. In addition to raising awareness of the species and its habitats, workshops help to establish contacts with landowners and locate new sites from reports by the public.

G. Research. Research is needed into several aspects of the species' biology. The most urgent need is to collect information on habitat use patterns, including seasonal pattern of habitat use, movements, thermal ecology, and important micro- and macro-habitat features. This information is needed to identify critical habitats. Other data gaps exist with respect to isolation and genetic structure of different populations in B.C., demographic patterns, and life history parameters; research into all these aspects is to be encouraged. Information on the genetic structure of populations will help direct recovery efforts and to assess significance of habitat fragmentation; information on demographic and life history parameters provide information on recovery potential and are essential for assessing and monitoring population viability.

Performance Measures

Objective 1: Protect all known Sharp-tailed Snake habitat and populations

- On private lands, percentage of known sites where landowners or residents are actively involved in stewardship through restoration, population monitoring, habitat protection, or other activities
- On private lands, percentage of sites where landowners have signed stewardship agreements or established conservation covenants
- On public lands (federal lands, provincial, municipal), percentage of sites where management measures for the species have been implemented
- Percentage of sites considered secure on private and public lands
- Evidence of long-term persistence of snake populations at sites where management actions (stewardship and protection) have been implemented

Objective 2: Prevent fragmentation of habitat within occupied sites

- Number of land use or development plans with provisions for habitat of the Sharp-tailed Snake and the percentage of suitable habitat that they cover
- Number of sites where habitat fragmentation is reduced or prevented through management actions
- Evidence of long-term persistence of snake populations at landscape level in areas where management actions (stewardship and protection) have been implemented

Objective 3: Investigate the existence of additional populations throughout the species' Canadian range, including suitable habitats outside the known range within the Georgia Depression Ecoprovince

- Percentage of the Georgia Basin Ecoprovince and subzones assessed for habitat suitability at broad and fine scales
- Percentage of high-suitability habitats surveyed for the species
- Number of new localities found for the species (through survey efforts or reports from the public)

Objective 4: Protect habitats important to the species' survival and recovery as they are identified

- Percentage of newly identified habitats where management, stewardship, or other protection measures are applied

Objective 5: Continue to reduce gaps in our knowledge of the species' habitat requirements

- Movement patterns and seasonal habitat use clarified
- Important habitat components, such as oviposition, hibernation, and foraging sites, described
- More accurate description of critical habitat produced, as a result of addressing knowledge gaps

Objective 6: Continue to reduce gaps in our knowledge of the species' population ecology

- Information obtained on population trends and demography
- Life history features and requirements clarified
- More accurate information produced on management requirements, as a result of addressing knowledge gaps

Objective 7: Increase awareness of the Sharp-tailed Snake and its habitats

- Number of landowners or community members involved in various stewardship activities
- Number of new sites discovered as a result of public input

Critical Habitat

Identification of the species' critical habitat

Critical habitat for the Sharp-tailed Snake in B.C. cannot be identified at this time, but it may be identified at a later date, in an addition to the recovery strategy posted by Environment Canada

or in a future action plan. Habitat needs of the Sharp-tailed Snake are poorly known, and more definitive information on the species' distribution must be obtained before any specific sites can be formally proposed as critical habitat. It is expected that critical habitat for the Sharp-tailed Snake will be identified following: (1) completion of outstanding work required to quantify specific habitat and area requirements for these species, as described in Table 3, and (2) consultation and development of stewardship options with affected landowners and managers.

In B.C., areas where the Sharp-tailed Snake has been found consist of small forest openings with abundant cover, such as talus, coarse woody debris, and/or fissures in rock (COSEWIC 1999; Engelstoft 2004, 2005, 2006, 2007). Known sites have either a southern or western aspect, shallow soil and litter cover, and relatively high rock cover (Wilkinson and Gregory 2005). Proximity to the forest and moist foraging areas is also thought to be important, but this aspect of the species' habitat requirements is poorly understood. Seasonal habitat use, including locations of hibernation and oviposition sites in relation to summer foraging areas, is poorly known. This information is logistically difficult to obtain for this rare and secretive species.

At all known sites, the area occupied by the species appears to be relatively small. However, the area of occupancy is difficult to estimate accurately because of the species' secretive habits, apparent low densities, and paucity of information on movement patterns. These characteristics also make it problematic to confirm the extent of distribution of Sharp-tailed Snakes at known sites.

A schedule of studies outlining the work necessary to identify critical habitat is shown below.

Recommended schedule of studies to identify critical habitat

Table 3. Schedule of studies required for the identification of critical habitat.

Description of activity	Outcome/rationale	Timeline
Complete broad-scale habitat suitability assessment throughout the species' Canadian range	- Produces habitat suitability maps to direct inventory effort - Fills in knowledge gaps of the species distribution - Identifies opportunities for enhancing habitat connectivity	2008–2010
Survey all broad areas that have not been previously covered	- Fills in knowledge gaps of the species' distribution	2008–2012
Collect detailed information on seasonal habitat use and movements in disturbed and more natural habitats	- Clarifies spatial requirements	2008–2012
Identify characteristics of important habitat features and components, such as oviposition and hibernation sites, and foraging areas	- Identifies key components of critical habitat	2008–2012
Prepare a habitat model based on survey results and research	- Allows delineation of remainder of critical habitat in unsurveyed areas	2010–2011

Existing and Recommended Approaches to Habitat Protection

Most of the land base within the range of the Sharp-tailed Snake is privately owned. In total, only about 5% of forested areas within the Coastal Douglas-fir biogeoclimatic zone are within

protected areas (B.C. MOE 2002). Within the Capital Regional District, about 34% of remaining older forest occurs within parks (CRD 2003). In the Gulf Islands, sensitive ecosystems occur in fragmented patches, which are largely outside of protected areas (CRD 2003). These areas include older forests, coastal bluffs, and woodlands, some of which provide potential habitat for the Sharp-tailed Snake.

The Gulf Islands National Park Reserve protects about 33 km² (including a 25-m intertidal zone) in the southern Gulf Islands (Parks Canada 2007). The park includes land on North and South Pender, Saturna, and Mayne islands, as well as on a number of smaller islands. Several of the park properties contain potential habitat for the Sharp-tailed Snake (Engelstoft *et al.* 2002), but as of March 2008, the species has only been located at one site within the park — Greenburne Lake on South Pender (Engelstoft 2007). The CRD Parks and Trails system includes 28 parks and 2 trails that protect 11,500 ha of land (CRD 2008b). The parks range from under 2 to 4100 ha, and most of them are small. Several B.C. provincial parks with suitable habitat for the species are on southern Vancouver Island (e.g., Sooke Potholes, Gowlland Tod, John Dean, and McDonald provincial parks) and adjacent small islands.

The ownership of the five occurrences of the Sharp-tailed Snake on Vancouver Island is as follows:

- Site 1 (Metchosin): federal land (DND), right-of-way regional trail (Galloping Goose Regional Trail, CRD Parks), and adjacent private, rural residential land;
- Site 2 (Sooke Hills): private, rural residential land;
- Site 3 (Langford): regional park (Mill Hill, CRD Parks);
- Site 4 (Saanich): federal land (DND), regional park (Mount Work, CRD Park), municipal park (Highlands District), and private, rural residential land; immediately adjacent to Gowlland Tod Provincial Park; and
- Site 5 (Saanich): federal (National Research Council property), surrounded by private, rural residential lands.

On the Gulf Islands, all occurrences are mostly from private, urban, or rural residential lands. The exceptions are portions of two sites: (1) Greenburne Lake within the Gulf Islands National Park Reserve on South Pender Island, and (2) B.C. provincial land at the Vesuvius ferry terminal on Saltspring Island.

The public lands where the species have been found are used for multiple purposes, including military training (DND lands) and recreational activities (CRD parks and trails; Gulf Islands National Park Reserve). DND and Parks Canada are actively surveying and managing habitat for this species through collaboration with researchers. CRD Parks have similarly taken an active role on their lands. It is important to continue surveys on these lands and to initiate surveys on other public lands, such as B.C. provincial parks, several of which contain suitable habitat and are in areas adjacent to known occurrences. Many provincial, regional, and local parks within the Capital Regional District are small and receive intense recreational use, which may threaten the species if not managed. Information on distribution of the species within both protected and unprotected areas is essential to effectively manage and mitigate threats from human uses. On private lands, the recommended approach to conservation is by promoting stewardship activities and involving landowners and community members in habitat protection and restoration. Such

efforts are underway in some communities on the Gulf Islands and have already proven successful.

Effects on Other Species

In addition to the Sharp-tailed Snake, the habitat protection, stewardship, and outreach strategies outlined in Table 2 are expected to benefit other components of the ecosystem. The benefits will extend to Garry oak–arbutus ecosystems, which are at risk in B.C.

Surveys for the snakes could disturb the habitat if carried out carelessly. However, adverse effects can be eliminated or minimized by taking proper precautions, which include replacing all natural cover searched, avoiding disturbance to unstable talus slopes, and consulting a botanist before placing artificial cover-objects in sensitive habitats, such as within Garry oak ecosystems.

Socioeconomic Considerations

Socioeconomic impacts of the recovery strategies described in this document could affect new residential developments and associated infrastructure, including road building. Possible effects include changes to location or configuration of new developments or roads, and changes to management practices. These impacts are expected to be minor. On private lands, the focus is on voluntary stewardship activities, most of which can be implemented with little or no monetary cost. Rather than burdening developers or residents, these actions may actually enhance the value of the properties by creating an environmentally friendly image. The geographic scale of the impacts is restricted to known sites and their immediate vicinity and to new sites that are potentially found through increased survey efforts.

The Sharp-tailed Snake has high potential as a subject for environmental awareness and educational programs. These snakes are harmless and are considered beneficial as their diet consists largely of slugs, including introduced garden pests. The Sharp-tailed Snake could serve as a focal species for conservation of natural areas within the Coastal Douglas-fir biogeoclimatic zone, including rare Douglas-fir–arbutus and Garry oak plant communities.

Statement on Action Plans

An action plan is in preparation and is to be completed before or by 2015.

REFERENCES

- B.C. Ministry of Environment (B.C. MOE). 2002. Environmental trends in British Columbia: protected areas. <<http://www.env.gov.bc.ca/soerpt/>> [Accessed March 2008]
- _____. 2008. BC Species and Ecosystem Explorer. <<http://srmwww.gov.bc.ca/atrisk/toolintro.html>> [Accessed March 2008]
- Brodie, E.D., Jr., R.A. Nussbaum, and R.M. Storm. 1969. An egg-laying aggregation of five species of Oregon reptiles. *Herpetologica* 25:223–227.
- Burger, J. 1998. Effects of incubation temperature of hatchling pine snakes: implications for survival. *Behav. Ecol. Sociobiol.* 43:11–18.
- Canadian Food Inspection Agency. 2005. <<http://www.inspection.gc.ca/english/sci/surv/pesrave.shtml>> [Accessed May 2005]
- Capital Regional District (CRD). 2003. Report on the environment: monitoring trends in the Capital Regional District. <<http://www.crd.bc.ca/rteold/report/summary1.htm>> [Accessed March 2008]
- _____. 2008a. Demographics. <<http://www.crd.bc.ca/>> [Accessed March 2008]
- _____. 2008b. Parks home page <<http://www.crd.bc.ca/parks/>> [Accessed March 2008]
- Cook, M. 2004. Fighting fire with fire. Controlled burns bring back native plants. *UBC Reports* 50(6). <<http://www.publicaffairs.ubc.ca/ubcreports/2004/04jun03/fire.html>> [Accessed March 2008]
- Cook, S.F. 1960. On the occurrence and life history of *Contia tenuis*. *Herpetologica* 16:163–173.
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 1999. COSEWIC status report on Sharp-tailed Snake, *Contia tenuis* (Baird & Girard, 1852). Original prepared by K. Ovaska and C. Engelstoft. COSEWIC, Hull, QC.
- Crother, B.I., J. Boundy, J.A. Campbell, K. de Queiroz, D.R. Frost, R. Highton, J.B. Iverson, P.A. Meylan, T.W. Reeder, M.E. Seidel, J.W. Sites, Jr., T.W. Traggart, S.G. Tilley, and D.B. Wake. 2001. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. *Society for the Study of Amphibians and Reptiles Herpetological Circular* 29. iii + 82 pp.
- Engelstoft, C. 2002. Sharp-tailed snake inventory and habitat assessment along the Galloping Goose Regional Trail, km 18–38, in the District of Metchosin. Unpublished report prepared by Alula Biological Consulting for CRD Parks, Victoria, BC.
- _____. 2004. Sharp-tailed snake habitat assessment and survey on Coast Guard, DND and Parks Canada properties in the Capital Region, BC, 2003–04. Unpublished report prepared by Alula Biological Consulting for Parks Canada.
- _____. 2005. Sharp-tailed Snake habitat assessment and survey on Coast Guard, Department of National Defence, and Parks Canada, Capital Region, British Columbia, and in Mount Work Regional Park and Gowlland Tod Provincial Park. Unpublished report prepared by Alula Biological Consulting for D. Smith, Dep. Natl. Defence, Victoria, BC.

- _____. 2006. Sharp-tailed Snake habitat assessment and detection in selected CRD Parks, 2006. Unpublished report prepared by Alula Biological Consulting for CRD Parks, Victoria, BC.
- _____. 2007. Sharp-tailed Snake inventory and populations monitoring on DND, NRC, and Parks Canada properties on Southern Vancouver Island and Southern Gulf Islands. Unpublished report prepared by Alula Biological Consulting for Pac. For. Cent., Victoria, BC.
- Engelstoft, C. and K. Ovaska. 1997. Sharp-tailed Snake inventory within the Coastal Douglas-fir biogeoclimatic zone, June-November 1996. Unpublished report prepared by Alula Biological Consulting for the B.C. Min. Environ., Lands and Parks, Vancouver Island Region, Nanaimo, BC.
- _____. 1998. Sharp-tailed Snake study on the Gulf Islands and southeastern Vancouver Island, March-November 1997. Unpublished report prepared by Alula Biological Consulting for the B.C. Min. Environ., Lands and Parks, Vancouver Island Region, Nanaimo, BC.
- _____. 1999. Sharp-tailed Snake study on the Gulf Islands and southeastern Vancouver Island, March-November 1998. Unpublished report prepared by Alula Biological Consulting for the B.C. Min. Environ., Lands and Parks, Vancouver Island Region, Nanaimo, BC.
- Engelstoft, C., L. Sopuck, and K. Ovaska. 2002. Assessment of Sharp-tailed Snake habitats in the proposed Gulf Islands National Park – Phase 1. Unpublished report prepared by Biolinx Environmental Research Ltd. for Parks Can., Victoria, BC.
- Feldman, C.R. and G.S. Spicer. 2002. Mitochondrial variation in Sharp-tailed Snakes (*Contia tenuis*): evidence of a cryptic species. *J. Herpetol.* 36:648–655.
- Garry Oak Ecosystems Recovery Team (GOERT). 2007. <<http://www.goert.ca/>> [Accessed March 2008]
- Govindarajulu, P.P., L.A. Isaac, C. Engelstoft, and K. Ovaska. In prep. Estimating life-history parameters of an elusive endangered snake: Sharp-tailed Snake, *Contia tenuis*.
- Hoyer, R.F. 2001. Discovery of a probable new species in the genus *Contia*. *Northwest. Nat.* 82:116–122.
- Hoyer, R.F., R.P. O'Donnell, and R.T. Mason. 2006. Current distribution and status of sharp-tailed snakes (*Contia tenuis*) in Oregon. *Northwest. Nat.* 87:195–202.
- Isaac, L.A. and P.T. Gregory. 2003. Determining the extent of Sharptail Snake, *Contia tenuis*, distribution in southwestern British Columbia using landowner participation and thermal ecology studies. Unpublished report for the Endangered Species Recovery Fund, World Wildlife Fund, Canada.
- Leonard, W.P. and K. Ovaska. 1998. *Contia, C. tenuis*. Catalogue of American amphibians and reptiles. Society for the Study of Amphibians and Reptiles. 30 November 1998. 677.1–677.7.
- MacKinnon, A. and M. Eng. 1995. Old forests. Inventory for coastal British Columbia. *Cordillera* (summer):20–33.
- Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. B.C. Min. For., Victoria, BC. Spec. Rep. Ser. 6.

- Meier, L. 2001. Restoration of Sharp-tailed Snake (*Contia tenuis*) habitat on North Pender Island, British Columbia. Environmental Restoration diploma project, Dep. Environ. Studies, Univ. Victoria, Victoria, BC.
- NatureServe. 2007. NatureServe Explorer: an online encyclopedia of life [web application]. Version 6.1. Arlington, VA. <<http://www.natureserve.org/explorer>> [Accessed March 2008]
- Ovaska, K. and C. Engelstoft. 2000. Population study of the Sharp-tailed Snake on North Pender Island (March 1999–April 2000). Unpublished report prepared for the Friends of Ecological Reserves, Victoria, BC.
- _____. 2005. Identification of critical habitat components for Sharp-tailed Snake. Unpublished report prepared for Endangered Species Recovery Fund. Project # 2005-ESR1116.
- Ovaska, K., L. Sopuck, C. Engelstoft, L. Matthias, E. Wind, and J. MacGarvie. 2003. Best management practices for amphibians and reptiles in urban and rural environments in British Columbia. Report prepared for B.C. Ministry of Water, Land and Air Protection, Nanaimo, BC, by Biolinx Environmental Research Ltd. and E. Wind Consulting. <<http://www.env.gov.bc.ca/wld/BMP/herptile/bmpherptile.html>> [Accessed March 2008]
- Parks Canada. 2007. Gulf Islands National Park Reserve of Canada. <http://www.pc.gc.ca/pn-nc/bc/gulf/index_e.asp> [Accessed March 2008]
- Shine, R. 2004. Incubation regimes of cold-climate reptiles: the thermal consequences of nest-site choice, viviparity and maternal basking. *Bio. J. Linn. Soc.* 83:145–155.
- Spalding, D.J. 1993. Status of the Sharp-tailed Snake in British Columbia. B.C. Wildl. Branch, Victoria, BC. Wildl. Work. Rep. No. WR-57.
- _____. 1995. The Sharp-tail snake. A British Columbia rarity. *Cordillera* 2:20–25.
- Tanner, W. 1967. *Contia tenuis* Baird and Girard in continental British Columbia. *Herpetologica* 23:323.
- Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth, and C. Cadrin. 1998. Sensitive ecosystems inventory: east Vancouver Island and Gulf Islands, 1993–1997. Vol. 1: Methodology, ecological descriptions and results. Can. Wildl. Serv., Pacific and Yukon Region, B.C. Tech. Rep. Ser. No. 320.
- Wilkinson, S.F. and P.T. Gregory. 2005. Characterization of habitats used by the endangered Sharp-tailed Snake (*Contia tenuis*) in southwestern British Columbia. Unpublished report for the Endangered Species Recovery Fund, World Wildlife Fund, Canada.
- Zweifel, R.C. 1954. Adaptation to feeding in the snake *Contia tenuis*. *Copeia* 1954:299–300.

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