COSEWIC
Assessment and Status Report

on the

Sharp-tailed Snake
Contia tenuis

in Canada

ENDANGERED
2009

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC
Assessment Summary

Assessment Summary – November 2009

Common name
Sharp-tailed Snake

Scientific name
Contia tenuis

Status
Endangered

Reason for designation
This tiny snake is confined to a handful of isolated, small populations in southeastern Vancouver Island and the southern Gulf Islands of British Columbia. Most of these populations are threatened by development and may not be viable. Increased search effort since the last assessment has found three previously undiscovered populations. Despite this, it is likely that overall numbers are decreasing and threats continue unabated. Major threats include ongoing development, increasing human populations, off trail recreation, fragmentation by roads and stochastic effects on small populations.

Occurrence
British Columbia

Status history
Designated Endangered in April 1999. Status re-examined and confirmed in October 1999 and November 2009.

COSEWIC
Executive Summary

Sharp-tailed Snake
Contia tenuis

Species information

The Sharp-tailed Snake, *Contia tenuis* (Reptilia: Squamata: Dipsadidae), is a small, slender snake with adults reaching about 205–455 mm in total length. The body scales are smooth and unkeeled, and there is a thorn-like scale at the tip of the tail, from which the species derives its common name. The back and sides are red- or yellow-brown, occasionally greyish, and the underside is banded with black and white bars. Distinct longitudinal stripes are lacking.

Currently, only one species of *Contia* is recognized, but morphological and genetic evidence indicate that there are two forms, probably representing sister species: a long-tailed form in coastal California and parts of southern Oregon, and a shorter-tailed form in the interior of California, parts of Oregon and Washington, and southwestern British Columbia.

Distribution

The geographic range of the species extends from southwestern British Columbia south to the Sierra Nevada and to the central coast of California in western North America. In Canada, the Sharp-tailed Snake is known from southern Vancouver Island and four of the Gulf Islands in the Strait of Georgia (North Pender, South Pender, Saltspring, and Galiano), British Columbia. Currently, there are records of the species from eight areas, each of which probably represents a separate population. Four populations are on extreme southern Vancouver Island: one in the District of Metchosin and three on the Saanich Peninsula. There is one population on each of Saltspring, North Pender, South Pender, and Galiano Islands. The larger populations contain several clusters of records.

Habitat

The snakes inhabit relatively open-canopy woodlands dominated by Douglas-fir, Arbutus, and/or Garry Oak within the Coastal Douglas-fir Biogeoclimatic Zone. Habitats of the species are naturally fragmented, exacerbated by human habitation, roads, and other developments. The snakes are often found in or near small openings on rocky outcrops and hillsides. Occupied sites usually have a southern exposure, shallow soil and leaf litter, and a high cover of rock. Rocky slopes with a southern exposure probably provide warm microhabitats required for egg-laying and thermoregulation. Requirements for hibernation sites in winter and retreat sites in summer are poorly known, but the snakes probably occupy areas year-round, as there is no evidence of longer migratory movements.

Biology

The Sharp-tailed Snake is secretive and semi-fossorial, making it difficult to find and study. As a result, little is known of its life history and habits. In spring or early summer, females lay a clutch of about 3 to 5 eggs, which hatch by autumn. Capture–recapture studies on North Pender Island indicate that annual survival rates are relatively high (66 – 75%) and show a positive correlation with body size. Individual snakes can live to 9 years or more. Surface activity of the Sharp-tailed Snake is highly seasonal and largely restricted to relatively cool periods in spring and autumn. The snakes have also been found active on warm summer nights. They tend to form aggregations, particularly in the spring.

Population sizes and trends

Very little information exists on population sizes or trends of the Sharp-tailed Snake anywhere within its range, and baseline historical data are lacking. From 1997 to 2004, a population monitored on North Pender Island was stable or slightly declining. This population within the about 1 ha study area was estimated to be 43 – 65 individuals, resulting in a population density of 0.067 individuals per square metre.

Of eight populations known from British Columbia, three have been discovered since 2003 as a result of increased search effort. The species continues to persist at four of the five remaining areas with previous (1948 – 1980) records: on Saltspring, North Pender, and South Pender Islands, and in the Metchosin District, Vancouver Island; there are new (1996 – 2008) records from all these areas. On North Pender Island, the species has not been found again at one of the two original (1949 – 1951) sites despite several searches and landowner participation. There have been no further observations from Galiano Island since the original sighting in 1981, but the search effort has been less intensive than on the other islands.

Limiting factors and threats

The rarity of the species in Canada is likely due to both climatic and historical factors. The species exists at the northern limits of its range in southern British Columbia, and present-day populations are probably relicts from a more extensive past distribution. Main immediate threats consist of habitat loss, degradation, and fragmentation throughout the species' Canadian range. Expanding rural or urban development and associated roads and other infrastructure threaten populations at most known sites.

Special significance of the species

The Sharp-tailed Snake is part of a unique group of snakes and until recently was the sole representative of the genus *Contia*. As one of only five species of native snakes and lizards in coastal British Columbia, it contributes significantly to the biodiversity of the region. It is one of few vertebrates at risk in Garry Oak ecosystems, where it co-occurs with many rare plants and invertebrates.

Existing protection

Under Canada's *Species at Risk Act*, the Sharp-tailed Snake is listed as Endangered on Schedule 1, the official list of wildlife species at risk. At present, the provisions of the Act apply to federal lands where the species occurs: two Department of National Defence properties and a National Research Council property on Vancouver Island; and a National Park on South Pender Island. The species also occurs in several Capital Regional District parks and in a municipal park on Vancouver Island. However, the majority of occupied sites and potentially suitable habitat are on unprotected private lands. The *Wildlife Act* of British Columbia prohibits the collection, handling, and trade of all native wildlife species without a permit.

COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS (2009)

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

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

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

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

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune
Canada

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COSEWIC Status Report

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Sharp-tailed Snake

Contia tenuis

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SPECIES INFORMATION

Name and classification

The Sharp-tailed Snake, *Contia tenuis* (Baird and Girard, 1952), is a member of the family Dipsadidae (Reptilia: Squamata) (Collins and Taggard 2009). Until recently, the species was considered part of the large cosmopolitan family Colubridae, which recently has been split. The relationship of the genus to all other genera — from which it differs in the structure of the hemipenes and in various skeletal features such as the jaw and teeth — is obscure (Stickel 1951, Storm and Leonard 1995). Only one species is currently recognized in the genus *Contia* (Crother 2008). However, morphological and genetic data suggest that within the nominal species there are two distinct clades, which probably represent separate species (Hoyer 2001, Feldman and Spicer 2002; see Genetic description for distribution).

Morphological description

Contia tenuis is a small, slender snake with adults about 205 - 455 mm in total length (Matsuda *et al*. 2006). Individuals from British Columbia are usually shorter than 320 mm (Engelstoft and Ovaska 1999, Ovaska and Engelstoft 2008, and unpublished data). Newly hatched juveniles are about 80 – 100 mm long (Brodie *et al*. 1969). The body scales are smooth and unkeeled, and there is a thorn-like scale at the tip of the tail, from which the species derives its common name (Figure 1). The anal plate is divided. The dorsum is red- or yellow-brown, occasionally greyish, and the ventral surface is banded with black and white as result of a conspicuous dark bar on the anterior end of each ventral scute. Juveniles are often more brightly coloured than adults (Figure 1). Distinct stripes along the length of the body are lacking, and there is never a mid-dorsal central stripe. Detailed descriptions and illustrations can be found in Storm and Leonard (1995), Leonard and Ovaska (1998), St. John (2002), and Matsuda *et al*. (2006).

Figure 1. Adult (top) and juvenile (bottom) *Contia tenuis* from Saltspring Island, British Columbia. Photos by Kristiina Ovaska.

Genetic description

Feldman and Spicer (2002) examined genetic variation in populations of *C. tenuis* from California and southern Oregon using mitochondrial DNA markers. They found two distinct clades, likely representing different species. The genetic data corroborated variation found in morphology. A long-tailed form occurs in northern coastal California and parts of southern Oregon, while a shorter-tailed form occurs in the interior of California, most of Oregon, Washington, and British Columbia (see Fig 2). The authors deferred formal taxonomic revision until further studies clarify the geographic distribution of each clade. DNA samples from the northern part of the species range included one sample from British Columbia, from North Pender Island (C. Feldman, pers. comm.). This sample was very similar to specimens from Washington, northern Oregon, and interior and southern California, corresponding to the range of the larger clade, which would remain *C. tenuis* once the nominal species is redescribed. Finer scale genetic differentiation remains to be investigated, including relationships of populations from the different islands in British Columbia.

Designatable units

Although there has been some study of mitochondrial genetic variation across the US range of the Sharp-tailed Snake (Feldman and Spicer (2002), there has been no genetic study comparing within or among population variation in Canada. All Canadian populations occupy the same faunal province and the Coastal Douglas-fir Biogeoclimatic Zone. There are no known differences among populations in morphology or behaviour. Thus, the species is considered to be a single designatable unit.

DISTRIBUTION

Global range

The geographic range of *C. tenuis* extends from southwestern British Columbia to the southern Sierra Nevada and to the central coast of California (Figure 2). Within this distribution, coastal areas in northern California and southern Oregon represent the range of an undescribed form, but the detailed demarcation of the distribution of the two forms is unclear. Throughout its northern portion, the range of *C. tenuis* is highly fragmented (Cook 1960, Stebbins 1966, Storm and Leonard 1995), whereas the species is more widespread farther south, in Oregon and California (Cook 1960, Hoyer *et al*. 2006). Records from Washington and British Columbia are restricted to a few, isolated sites (Spalding 1993, 1995, Leonard and Ovaska 1998). The species was recently reported for the first time from the San Juan Islands (Orcas Island), Washington, adjacent to the southern Gulf Islands in British Columbia (O'Donnell and McCutchen 2008).

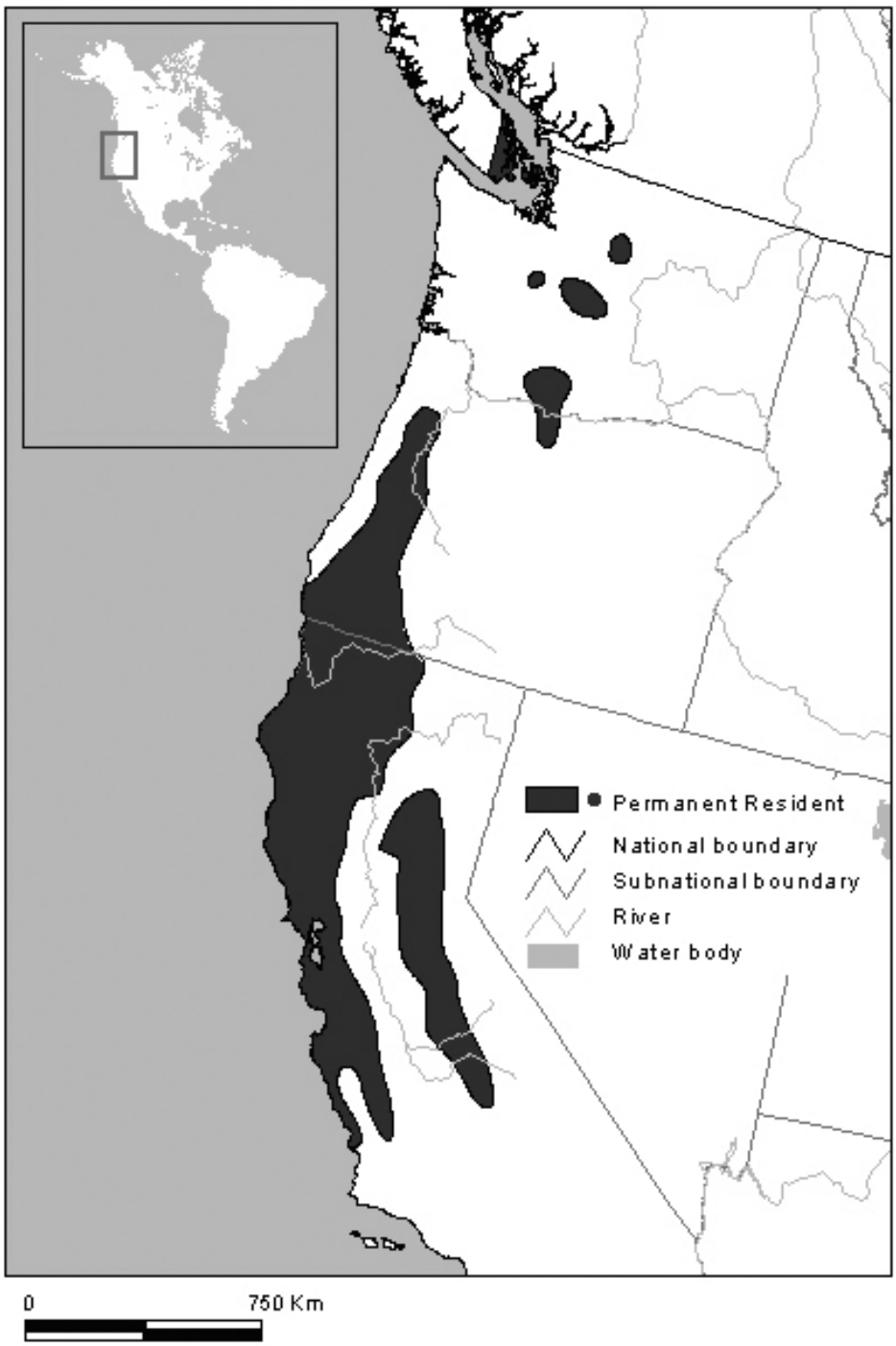

Figure 2. World distribution of *Contia tenuis* in North America. Map from NatureServe (2008: Digital Distribution Maps of the Reptiles of the United States and Canada, version 1.0. NatureServe, Arlington, Virginia, USA); used with permission.

Canadian range

In Canada, *C. tenuis* is known from southern Vancouver Island and from four of the Gulf Islands in the Strait of Georgia, British Columbia: North and South Pender (joined by a bridge), Saltspring, and Galiano Islands (Figure 3). An additional record from the southern interior of British Columbia (McGillvray Lake) is probably in error but requires further investigation.

Figure 3. Canadian distribution of *Contia tenuis* in southwestern British Columbia. Small symbol – single observation or multiple observations within an area of ca. 25 m in radius; medium symbol – multiple observations within an area of ca. 250 m in radius; large symbol – multiple observations within an area of ca. 500 m in radius. Sites that are comprised of observations that are ≥20 years are considered historic (open symbols). Map updated to Oct. 2009.

The first specimen from British Columbia was collected between 1857 and 1861 on Vancouver Island. In the literature, Cowichan District is cited as the collection site (Carl 1950, 1971), but information currently associated with the specimen in the Natural History Museum (London UK) does not specify a location on the island (P. Gregory, pers. comm.). The species was not documented again until 1949, when it was reported from North Pender Island (Carl 1949). Currently (up to 2008 and excluding the 1800s record), there are records of the species from eight areas in southwestern British Columbia, each of which probably represents a separate population with little or no opportunity for gene flow among populations (Figure 3). Four populations are on extreme southern Vancouver Island: one in Metchosin and three on the Saanich Peninsula (in Highlands, Saanich, and Langford districts). There is one population each on Saltspring, North Pender, South Pender, and Galiano Islands. The larger populations contain several clusters of records, which are referred to as subpopulations or localities[1] (Table 1). All three populations from the Saanich Peninsula have been discovered since 2004. Since 2000, several new records from the vicinity of other previous observations have expanded the known area of occupancy in Metchosin, Vancouver Island, and on Saltspring, North Pender, and South Pender Islands. On Galiano Island, the species is known from one 1981 sight record only (Spalding 1993, 1995).

[1]COSEWIC definition: "Location: A geographically distinct area where a group of individuals of a wildlife species is (or has been) found. The total population of a wildlife species may comprise a number of locations. Dispersal between locations is impossible or very rare. A single threatening event can rapidly affect all individuals in a location. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat. (Source: adapted from IUCN 2008)"

Table 1 . Estimated area of occupancy (km^2) and number of sites (cluster of records) for *Contia tenuis* in British Columbia.

Population	Current area of occupancy (km^2)	Current (2008) # of sites	# of sites (pre-1998)	References
Vancouver Island: Metchosin	0.22	3	1	Spalding 1995, Engelstoft and Ovaska 1998, Engelstoft 2005, Habitat Acquisition Trust, unpublished files
Vancouver Island: Highlands	10.35	5	0	Engelstoft 2005, 2006a,b, 2007a,b Habitat Acquisition Trust, unpublished files
Vancouver Island: Saanich	0.08	1	0	Engelstoft 2005; Engelstoft 2007b; Habitat Acquisition Trust, unpublished files
Vancouver Island: Langford	0.08	1	0	Engelstoft 2007b
Saltspring Island	29.73	3	1	Spalding 1993, 1995, Engelstoft and Ovaska 1999, Salt Spring Island Conservancy, unpublished files
North Pender	0.17	1	2	Carl 1949, 1950, Spalding 1995, Engelstoft and Ovaska 1998, 1999; Habitat Acquisition Trust, unpublished files
South Pender	3.06	3	2	Carl 1971, Spalding 1995, Engelstoft and Ovaska 1999, 2008, Habitat Acquisition Trust, unpublished files
Galiano	?		1	Spalding 1993, 1995
Total	43.7	17	7	

Two specimens were reported from McGillivray Lake, near Chase, in the southern interior of the province (Tanner 1967). This locality is about 375 km from the nearest known site in coastal British Columbia and about 400 km from the nearest known locality in the interior of Washington State (Cle Ellum site, Leonard *et al*. 1996). The habitat is extremely dissimilar to that at the coastal sites and other sites in the northwest United States (D.M. Green, pers. comm.). The validity of this record has been questioned, based on erroneous labelling of other specimens from the same collecting trip and locality (Nussbaum *et al*. 1983; E. Brodie, Jr., pers. comm.). J. Heinrich, the collector, however, maintains that the locality information for *C. tenuis* is accurate (pers. comm.), and the record remains enigmatic.

The extent of occurrence of the species in Canada is 591 km^2, using the minimum polygon method and subtracting the area covered by ocean. The current area of occupancy is estimated to be less than 5 km^2, calculated from Figure 3 and assuming that areas with the radius of 25 m, 250 m, and 500 m are occupied at sites represented by small, medium-sized and large circles, respectively. Two historical point records with no observations for over 25 years (on Galiano and North Pender Islands) were excluded. The index of the area of occupancy is 96 km^2, calculated by superimposing a grid with 2 x 2 km cells on the range and counting the number of cells that contain records of the species, as per COSEWIC standards.

The current area of occupancy is estimated to be 43.7 km^2, calculated as the total area of polygons shown in Figure 3, excluding two historical point records with no observations for over 25 years (on Galiano and North Pender Islands). The index of the area of occupancy is 152 km^2, calculated by superimposing a grid with 2 x 2 km cells on the range and counting the number of cells that contain records of the species, as per COSEWIC standards.

HABITAT

Habitat requirements

All confirmed records of *C. tenuis* in British Columbia are from the Coastal Douglas-fir Biogeoclimatic Zone, which includes the southeast coast of Vancouver Island, a fringe of the adjacent mainland coast, and the southern Gulf Islands in the Strait of Georgia, between the two land masses (Meidinger and Pojar 1991). This zone covers about 2000 km^2, most of which is below 150 m in elevation (MacKinnon and Eng 1995). Summers are characteristically warm and dry, and winters are mild and wet. Douglas-fir (*Pseudotsuga menziesii*) is the most common tree, often accompanied by western red cedar (*Thuja plicata*), grand fir (*Abies grandis*), and/or Arbutus (*Arbutus menziesii*). Garry Oak (*Quercus garryana*) woodlands occur at scattered locations.

The snakes inhabit relatively open-canopy woodlands dominated by Douglas-fir, Arbutus and/or Garry Oak and are often found in or near small openings on rocky outcrops and hillsides (Engelstoft and Ovaska 1999, Engelstoft *et al*. 2002, Engelstoft 2006a, Wilkinson *et al.* 2007). Occasionally, they have been found in more heavily wooded areas, but never far from forest openings or forest edge. The degree to which the snakes use denser forest habitats is uncertain due to the difficulty of detecting these secretive snakes in the forest. However, they have never been encountered during surveys for salamanders and terrestrial gastropods, involving extensive searches of the forest floor in denser forest in the Capital Regional District (K. Ovaska, unpublished data).

Several records are from Garry Oak ecosystems (Engelstoft and Ovaska, unpublished data). Open rocky slopes with a southern exposure appear to be important for the snakes and probably provide warm microhabitats for egg-laying and for thermoregulation by young and adults. Concentrations of snakes have been found on such slopes in British Columbia, especially in the spring and autumn (Engelstoft and Ovaska 1999, Ovaska and Engelstoft 2005, 2008). There are no records of nests of *C. tenuis* from British Columbia, but hatchling-sized snakes have been found on a small, stable south-facing talus slope on Saltspring Island (Engelstoft and Ovaska 1997, 1999). Brodie *et al*. (1969) suggested that in Oregon suitable warm slopes with talus are in short supply causing snakes to aggregate at communal egg-laying sites. In Oregon, Brodie *et al*. (1969) found an egg-laying aggregation of five species of reptiles, including *C. tenuis*, within a 14 m^2 patch of talus. The habitat consisted of an unshaded, grass-covered southern slope by an oak knoll. There are no other reports of egg-laying sites of *C. tenuis* in nature.

The snakes are semi-fossorial, but virtually nothing is known of their underground habitat use or requirements. Presumably, they use existing crevices and cracks in the soil or bedrock or burrow into loose substrates. When released, snakes captured during mark-recapture studies most often attempted to burrow into the substrate rather than fleeing laterally along the surface (C. Engelstoft and K. Ovaska, pers. obs.). When on the surface, the snakes are seldom found away from cover, and shelter provided by rocks and/or coarse woody debris forms an important microhabitat requirement. Comparison of habitat at observation locations and at random points 50 m away revealed that microsites where the species was found on Vancouver Island and the southern Gulf Islands tended to have a southern exposure, shallow soil and leaf litter, and a high cover of rock (Wilkinson *et al*. 2007).

There is no information on hibernation sites or habitats of this species. Similar to other snakes in northern climates, *C. tenuis* likely requires hibernation sites that remain frost-free and contain sufficient moisture to prevent dehydration (Gregory 1987). Habitat requirements in the summer, when the snakes are largely inactive, are also unknown. There is no evidence to suggest that individual snakes undertake migration movements between seasonal habitats, and hibernation and aestivation might take place within habitats occupied year-round.

Woodland habitats of the species are naturally fragmented. This fragmentation is compounded with human habitation, roads, and other developments. Road densities, representing an index of habitat fragmentation, are among the highest in British Columbia on southeastern Vancouver Island (2.0 – 3.5 roads/km^2; BC Ministry of Forestry and Range 2006). On southern Vancouver Island, suitable habitat is largely confined to hillsides, surrounded by residential areas (see Threats section for details of habitat fragmentation at specific sites occupied by the species).

Habitat trends

The Coastal Douglas-fir Biogeoclimatic Zone is the most disturbed forested zone in British Columbia with almost half of its former forests converted to agricultural, urban, or other uses over the past century (BC Ministry of Forestry and Range 2006). Of the remaining forests, less than 5% are older than 140 years (BC Ministry of Forestry and Range 2006). Garry Oak ecosystems are scattered within the Coastal Douglas-fir Biogeoclimatic Zone and often occur on rocky hillsides occupied by *C. tenuis*. These ecosystems are in dramatic decline, and remaining fragments have been heavily modified (Erickson 2008). About 10% of the original (pre-European settlement) area of Garry Oak ecosystems presently remains and only about half of them are relatively intact (Lea 2006). The remaining 5% are severely degraded by invasive alien species or other factors.

All recent Sharp-tailed Snake records are from the Capital Region, which covers the extreme southern portion of Vancouver Island and the southern Gulf Islands. The pressure on the remaining natural areas within the Capital Region is intense due to increased human population growth. From 1991 to 2001, the human population within the Capital Region grew by 8.2% (CRD 2008). The fastest growing areas were the Western Communities (16.6%) and Gulf Islands (18.2%). Population growth and associated rates of land conversions will most likely continue throughout the region over the next decades. 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 2008).

Habitat protection/ownership

Only about 5% of the forests in the Coastal Douglas-fir Biogeoclimatic Zone are within protected areas (BC Ministry of Forestry and Range 2006). The vast majority of the lands within the range of *C. tenuis* in British Columbia are privately owned.

Contia tenuis occurs on the following federal lands: Department of National Defence (DND) properties in Metchosin and Saanich Districts, Vancouver Island; National Research Council property in Saanich, Vancouver Island; and Gulf Islands National Park Reserve property on South Pender Island. The DND and National Research Council properties are currently excluded from land conversions, but long-term habitat protection is afforded only by Parks Canada lands. On Vancouver Island, the species occurs in Mount Work, Lone Tree Hill, and Mill Hill Regional Parks and along the right-of-way of the Galloping Goose Trail, all of which are part of the Capital Regional Districts Parks and Trails System, and in Cal Revelle Park, a municipal park. The complex of protected areas in the Highlands District and bordering the Saanich District is particularly important, as it provides a relatively large area of contiguous habitat for *C. tenuis*. This complex includes Heals Rifle Range (DND property), Mount Work and Lone Tree Hill Regional Parks, Cal Revelle Nature Sanctuary, and intervening Gowlland Tod Provincial Park, where the species is yet to be found.

Apart from a Department of National Defence property, occupied and potential habitats of the population of *C. tenuis* in the Metchosin District on Vancouver Island are mostly privately owned. Similarly, the vast majority of known and potential habitats of the snakes on the Gulf Islands are on private lands. Regulation of development through Development Permit Areas in the North Pender Island Official Community Plan provides some protection for habitats on that island. Stewardship and outreach programs have resulted in the formal protection of small areas of occupied habitat through conservation covenants (5.6 ha and 0.36 ha, respectively, on two properties). In addition, local conservation groups have signed voluntary stewardship agreements with many private landowners with known or potential Sharp-tailed Snake habitat. However, these agreements are not legally binding, and protection is not guaranteed over the long term.

BIOLOGY

Life cycle and reproduction

Contia tenuis is oviparous, and eggs are probably laid in spring or early summer and hatch by the following autumn (Cook 1960, Nussbaum *et al*. 1983). Storm and Leonard (1995) reported a clutch size of 3 – 5 eggs, but few data are available in the primary literature. A captive, gravid female collected by R.C. Stebbins in California laid a clutch of 5 eggs in July (Cook 1960). Another gravid female collected from Washington State laid a clutch of 3 eggs in captivity, also in July (Leonard *et al*. 1996). Near Corvallis, Oregon, Brodie *et al*. (1969) discovered a communal egg-laying site used by five species of reptiles, including *C. tenuis*. They found a total of 43 eggs of *C. tenuis* in groups of 2, 3, 4, 8, and 9 eggs. The authors suspected that the larger groups might have resulted from communal oviposition by two or more females. Six hatchlings were found near hatched eggs between 26 September and 19 October at this site. In California, hatchling-sized snakes have been found in autumn and also in spring (Cook 1960). Probably, little or no growth takes place during winter, explaining the small size of snakes caught in spring (Cook 1960).

In British Columbia, timing of reproduction appears to follow a similar pattern as farther south: eggs are laid in spring or early summer and hatch sometime in late summer or autumn. Adult males and females have been found together on several occasions in March – May, suggesting that mating occurs at that time (Spalding 1995, Ovaska and Engelstoft 2008). Gravid females have been found from March to May. The mean number of eggs detected through palpation of 16 gravid females was 3.1 $\pm$ 1.1 eggs (Govindarajulu *et al.*, *in prep*.), but no egg clutches have been found in nature in British Columbia. Whether individual females reproduce annually or less frequently is unknown. Hatchling-sized snakes have been found in late September (Engelstoft and Ovaska 1997 and unpublished data) and in March – April (Govindarajulu *et al*., *in prep*).

In Oregon, six hatchlings found next to hatched eggs weighed 0.4–0.6 g and measured 75–92 mm in snout-vent length (Brodie *et al*. 1969).

In British Columbia, 128 individual *C. tenuis* ranged from 84 – 328 mm in SVL at first capture (mean = 195 mm ± 54.3 mm SD; median = 208 mm; data for four sites from 1997 to 2005 pooled). Adult females were larger and heavier than adult males (Govindarajulu *et al*., *in prep*). These values are within the range of previously reported body sizes for the species from United States (Nussbaum *et al*. 1983, Leonard *et al*. 1996) but smaller than the maximum body size.

In British Columbia, annual growth rates of adults averaged 4.1 mm (± 5.1 mm SD) for males and 4.6 mm (± 6.7 mm SD) for females (Govindarajulu *et al*., *in prep*). Juveniles initially grew rapidly, at an average rate of 19.0 mm per year (± 10.1 mm SD), but growth slowed down with increasing body size until sexual maturity was reached, presumably around 200 mm SVL. Females may mature later and at a larger body size than males, but few data are available. The average body size of gravid females was 260 mm SVL (± 22.5 mm SD), and the smallest was 219 mm.

Time to sexual maturity was estimated to be 5 – 6 years for one population on North Pender Island, as extrapolated from growth rates derived from the program MARK (Govindarajulu *et al.*, *in prep*). However, it may have been overestimated due to very small numbers of juveniles in the sample. Capture – recapture studies at the same site on North Pender Island indicate that annual survival rates are relatively high for all size classes (mean = 0.71; 95%; Confidence Interval, CI = 0.59 to 0.81) and show a positive correlation with body size (Govindarajulu *et al*., *in prep*). Annual survivorship was the highest (75%) for large adults with SVL about 275 mm and the lowest (66%) for small juveniles with SVL about 95 mm. Surprisingly, the average life expectancy of the snakes was only 2.9 years, as calculated from mean annual survival rates. However, the analysis indicated that 25% of the population is expected to survive for 5 years and 10% up to 8 years (Govindarajulu *et al*., *in prep*). Field studies at this site recaptured some snakes over many years, and one individual was estimated to be least 9 years old (Ovaska and Engelstoft 2008). Generation time (GT) is not known but can be estimated as: GT=1 + AM/AMR; where AM = age at maturity and AMR = annual adult mortality rate (COSEWIC definition from IUCN). Thus, GT = 1 + 5/0.25 – 0.34 (based on estimated annual survival rates (see above) for adult (75%) and juveniles (66%)) : GT = 1+ = 16-21 years.

Seasonal and daily activity

Surface activity of *C. tenuis* is highly seasonal and believed to be largely restricted to cool, moist periods in spring and autumn (Cook 1960, Stebbins 2003). Cook (1960, p. 164) stated that "compared to most snakes within the same range, the periods of activity for *Contia* differ considerably, especially in California". Surface activity of the snakes there appears to peak in February–April with a smaller peak in November. Nussbaum *et al*. (1983) noted that in the Willamette Valley the surface activity of *C. tenuis* extends from late February to November, with a peak from late March to early June. On the eastern slope of the Cascade Mountains, Washington, most captures of *C. tenuis* in 1996 took place in April and September, and few snakes were caught during single visits in each of June and July (Leonard *et al*. 1996, W. Leonard, pers. comm.).

In British Columbia, *C. tenuis* has been observed in all months except December. On the Gulf Islands, most observations took place in February – April, with a second, smaller peak in surface activity in late September–October (Ovaska and Engelstoft 2008). On Vancouver Island, the snakes were also most frequently captured in the spring, with the exception of one site, where they were found primarily in the autumn (Engelstoft 2005, 2006a, 2007a, Engelstoft and Ovaska 2008). Occasional observations took place in summer at all sites, particularly after periods of rain (Engelstoft and Ovaska 1999) or at night (Engelstoft 2006b, Engelstoft and Ovaska 2008).

The snakes probably hibernate in winter and may aestivate during dry, warm periods in summer (Cook 1960). In coastal British Columbia, low temperatures from mid-November to early February typically preclude surface activity; high temperatures and low rainfall in July–August appear to result in periods of inactivity or changes in behaviour, but whether the snakes aestivate is unknown.

Several authors have suggested that Sharp-tailed Snakes are primarily nocturnal (Wright and Wright 1957, Froom 1972, Spalding 1993, 1995), but few data are available to support this suggestion. In Washington, two individuals were found live on roads during a warm (air temperature 27.5°C) night in June (Weaver 2004). In British Columbia, Sharp-tailed Snakes have been found under artificial cover-objects at night at ambient temperatures of 12 – 25°C in June – August, whereas searches during the day during the same period produced no captures (Ovaska and Engelstoft 2005, Engelstoft and Ovaska 2008, and unpublished data).Only one individual was found active on the surface, away from cover, and that occurred on a warm, wet night in June. Some daytime activity, however, does occur. Spalding (1993) pointed out that at least two British Columbia specimens were found in the open in gardens during the day.

Movements and dispersal

Movement patterns of *C. tenuis* are poorly known and difficult to study. At study sites in British Columbia, individual snakes tended to move relatively short distances and showed high fidelity to particular sites and cover-objects. Within a rural residential area on North Pender Island, 16 recaptured adult snakes were found within areas of usually less than 55 m along the greatest dimension (average = 25 m; range: 16 – 93 m) over a year (Engelstoft and Ovaska 1999). The longest movement was by an adult male that moved a straight-line distance of 93 m within a 3-week period in March–April (Engelstoft *et al*. 1999). In relatively undisturbed habitat on Vancouver Island, 5 recaptured snakes moved straight-line distances of up to 32 m within one active season (Ovaska and Engelstoft 2005). No evidence of seasonal migrations between habitats has been found, but long movements are very difficult to document. The snakes have occasionally been found on roads, one individual was crushed in the doorway of a building, and another was found in the basement of another building (C. Engelstoft, unpublished data). Whether these individuals were dispersing or moving to or from hibernation or aestivation sites is unclear.

Food habits

The diet of *C. tenuis* is thought to consist largely of small slugs (Cook 1960; Leonard and Ovaska 1998). In Oregon, Darling (1947) found slugs in stomachs of six of 23 snakes, and, in California, Woodin (unpubl. report cited in Cook, 1960, pp. 168–169) found slugs in stomachs of 9 of 67 preserved specimens. No other food items were reported. In captivity, *C. tenuis* from California (Zweifel 1954; Woodin, cited in Cook, 1960, p. 169) and British Columbia (S. Orchard, pers. comm.) also feeds on small slugs. Zweifel (1954) interpreted the elongated teeth of the species as an adaptation for feeding on slippery slugs.

Cook (1960) pointed out that since the European colonization of western North America, both the structure and distribution of the prey base of *C. tenuis* has changed drastically. Nearly ubiquitous introduced slugs of European origin have dramatically changed the patterns of prey availability in complex ways (see Limiting Factors and Threats). In coastal British Columbia, various species of both introduced and native slugs are common in habitats occupied by *C. tenuis*. Prey availability likely restricts foraging to wet, cool periods and hence can potentially affect both the distribution and the seasonal and daily activity patterns of the snakes.

Predators and predator defence

A variety of vertebrate predators may prey on *C. tenuis*, but few cases of predation have been documented. The species has been recovered from the stomachs of the Brook Trout (*Salvelinus fontinalis*) and Western Toad (*Bufo boreas*; cited in Leonard and Ovaska 1998). Likely predators in British Columbia include various birds that scratch the ground such as corvids (Corvidae), American Robins (*Turdus migratorius*), and introduced pheasants (Phasianidae), as well as Raccoons (*Procyon lotor*) and shrews (*Sorex* spp.). Many individual *C. tenuis* caught at the study sites on North Pender and Saltspring Islands had scars on various parts of the body, and two had missing tail tips, suggesting injuries from unsuccessful predation attempts (Engelstoft and Ovaska 1999). A crescent-shaped scar on the neck of two individuals suggested attacks by birds.

The secretive habits of *C. tenuis*, including their tendency to remain hidden under cover objects, probably provide some protection from visual predators. Nussbaum *et al*. (1983, p. 265) reported, "when picked up, Sharp-tailed Snakes thrash from side to side, and, if confined, they press the tail spine against one's skin. This is a startling experience for a collector and presumably would also startle a small predator that had seized the snake." Hatchling-sized snakes frequently coil up into a ball when handled, a behaviour that may render them more difficult to ingest (Ovaska and Engelstoft 1999; Leonard and Stebbins 1999). Leonard and Stebbins (1999) reported a variety of other anti-predator behaviours by *C. tenuis*, including immobility, exposure of the banded underside, and bluffing a strike.

Behaviour

Contia tenuis is secretive and most often is found concealed under cover-objects rather than in the open (Cook 1960, Spalding 1993, Engelstoft and Ovaska 1998, 1999). A small number of snakes followed with a harmonic direction finder system were invariably below ground during relocations, both during the day and night (Engelstoft *et al*. 1999, Ovaska and Engelstoft 2005). Secretive, semi-fossorial behaviour, together with small size, makes the species very difficult to find and study.

The snakes tend to aggregate, particularly in spring (Cook 1960, Spalding 1993, Leonard *et al*. 1996, Ovaska and Engelstoft 2008). Groups of up to 11 snakes have been reported from California (Cook 1960) and up to 6 in British Columbia (Engelstoft and Ovaska 1998). Aggregations of 3–5 *C. tenuis* occurred frequently on the North Pender Island site in March–April (Ovaska and Engelstoft 2008). Whether these aggregations reflect dispersion of suitable habitat patches, such as hibernation, oviposition or thermoregulation sites, or social behaviour is unclear.

Physiology and temperature relations

The snakes appear to have an affinity for cool, moist conditions (Cook 1960; Engelstoft and Ovaska 1998, 1999). Stebbins (1954) found *C. tenuis* active and with food in the stomach at cloacal temperatures as low as 11–16°C (52–61°F). He suggested that in its seasonal activity and microhabitat use, *C. tenuis* resembles plethodontid salamanders, rather than other sympatric species of snakes.

On the Gulf Islands in 1997 when study sites were sampled intensively from March to November (Engelstoft and Ovaska 1999), approximately 85% of captures were on days with maximum temperature below 18°C, and all occurred when it was below 23°C. About 80% of captures occurred on days with minimum temperature below 10°C; there were no captures on days with minimum temperatures below 1°C. For pooled data of 154 observations of *C. tenuis* on Vancouver Island and the Gulf Islands from 1997 to 2008, most observations (47%) occurred when ambient temperature at the time of the survey was 11 – 15°C, followed by observations at 16 – 20°C (33%) and 21-25°C (14.3%). There were few observations at lower (6 – 10°C: 4.5%) or higher ambient temperatures (26 – 30°C: 1.3%; C. Engelstoft and K. Ovaska, unpublished data).

Similarly, Isaac and Gregory (2003) found that most observations of *C. tenuis* on the Gulf Islands occurred during relatively cool conditions (10.3 – 24°C air temperature; 10.5 – 24°C substrate temperature). In the laboratory, three snakes provided with a thermal gradient ranging from 10°C to 45°C for 24 hours selected relatively low temperatures (20 – 22°C). Also in the laboratory, crawling speed of snakes maintained at three different temperatures (16, 22 and 26°C) were similar, suggesting that the snakes were able to perform across a wide range of relatively low body temperatures (Isaac and Gregory 2003).

Adaptability

Contia tenuis can coexist with humans within residential areas, provided that sufficient cover and other required habitat features are present. 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 British Columbia, most records from the Gulf Islands are from low-density residential areas. There the snakes have been occasionally found in compost heaps, orchards, borders of gardens, and woodpiles. They readily use artificial cover-objects of wood, metal, or asphalt roofing for refuges (Engelstoft and Ovaska 2000). However, snakes within populated areas are vulnerable to habitat fragmentation, road mortality, and loss of key habitat features, such as egg-laying and thermoregulation sites and cover from predators.

POPULATION SIZES AND TRENDS

Search effort

From the rediscovery of *C. tenuis* in British Columbia in 1948 on North Pender Island until about 1990, encounters with the species were largely serendipitous. In the early 1990s, compilation and verification of records were carried out as part of the preparation of a provincial status report and were associated with efforts to find the species on the Pender Island (Spalding 1993). A concerted effort to locate the species at known and new sites began in 1996 with support from the BC Ministry of Environment and Forest Renewal BC and has continued to 2008 with support from various governmental and non-governmental agencies and organizations and under guidance from the Sharp-tailed Snake Recovery Team (Table 2).

Table 2. Summary of search effort for *Contia tenuis* on Vancouver Island and the Gulf Islands, 1996 - 2008.

Description of area	Land status	Years	Survey method*	Lead agency
Southern Vancouver Island from Metchosin to Cowichan Bay; southern Gulf Islands (North and South Pender, Saltspring, Galiano, Mayne, Saturna and many smaller islands)	Private, federal, provincial	1996 - 1999	TCS; ACO	BC Ministry of Environment (Vancouver Island Region)
Gulf Islands National Park Reserve: 5 properties in total on North Pender, South Pender, Saturna, and Prevost Islands	Federal; National Park	2002 – 2008 (multiple times each year on larger islands)	TCS; ACOs	Parks Canada; Interdepartmental Recovery Fund (IRF) project (lead: Department of National Defence)
Southern Vancouver Island: 6 Department of National Defence properties in Metchosin and Central Saanich	Federal	2003 – 2008 (ongoing)	ACOs	Department of National Defence; IRF project
Southern Vancouver Island: Observatory Hill	Federal	2007 – 2008, ongoing	TCS; ACOs	National Research Council; IRF project (lead: Department of National Defence)
Capital Regional District (CRD) parks on southern Vancouver Island (7 parks)	Regional parks	2002; 2006 – 2008 (ongoing)	ACOs	CRD Parks
Prevost and Discovery Islands (Coast Guard lands)	Federal	2004 – 2005	ACOs	IRF project (lead: Department of National Defence)
Saltspring Island	Private	2006 – 2008 (ongoing)	ACOs	Salt Spring Island Conservancy (landowner contact programs)
North and South Pender Island, Mayne Island, Saturna Island, Galiano Island; southern Vancouver Island	Private	2003 – 2008 (ongoing)		Pender Islands Conservancy Association; Habitat Acquisition Trust (landowner contact programs)

* TCS – time-constrained survey of natural cover; ACO – artificial cover-object survey with repeated checks each year

From 1996 to 1999, attempts were made to survey all previously reported localities and their vicinity on Vancouver, Pender, Saltspring, and Galiano Islands; likely habitats on Mayne and Saturna Islands and many smaller islands in the Strait of Georgia were also surveyed (Engelstoft and Ovaska 1999). From 2002 to 2008 surveys have been carried out in habitats deemed suitable for the species on 14 federal properties on Vancouver Island and the southern Gulf Islands. Six of the federal properties are on Department of National Defence (DND) lands, one on National Research Council lands, five within the Gulf Islands National Park Reserve on North Pender, South Pender, Prevost, and Saturna Islands, and two on Canadian Coast Guard lands. The search effort has been most intensive on DND properties. For example, 302 artificial cover-objects were examined multiple times for a total of 3250 cover-object flips during one year (April 2008 – March 2009) on DND properties; during the same period, 302 cover-objects (3250 flips) were examined on the other federal properties. Seven Capital Regional District Parks were surveyed from 2006 to 2008 by repeatedly inspecting artificial cover-object arrays. Some survey effort has taken place on Galiano Island, site of one record of the species in 1981, but the island has not been surveyed with the same intensity as other large southern Gulf Islands.

Intensive monitoring of populations through capture-recapture methods has been carried out at three sites on federal lands on Vancouver Island (Metchosin: 2004 – 2005; two sites in Saanich: 2004 – 2008; 2007 - 2008; ongoing monitoring at both sites); two sites on private lands (North Pender Island: 1997 – 2000 and sporadically from 2001 – 2004; Saltspring Island: 1997– 1999); and one site abutting a monitoring site on DND lands within a Capital Regional District Park (2007 – 2008, ongoing). In addition, landowners are engaged in monitoring efforts at several sites on private properties with varying levels of intensity. Efforts have been expended to determine the area of occupancy at most monitored sites.

In 2005, habitats deemed suitable for *C. tenuis* within the Capital Regional District were delineated using orthophotos (see Natural Areas Atlas, www.crd.bc.ca). On Saltspring Island a GIS model was developed using slope, aspect, forest cover, and soil type as the main habitat parameters. The habitat suitability maps have been used to identify priority areas for outreach programs.

An intensive outreach and stewardship program targeting landowners and residents has been conducted in selected neighbourhoods on the southern Gulf Islands and on Vancouver Island from 2003 to 2008. To date, these approaches have resulted in new records of the species from 30 private properties (Habitat Acquisition Trust, Victoria, B.C., and Salt Spring Island Conservancy unpublished files). Currently, landowners are participating in the search for the species on numerous private properties using artificial cover-objects installed in likely habitats. This search effort is difficult to quantify as both checking frequency and record keeping vary greatly among landowners.

Limited survey effort has been expended on southeast coast of Vancouver Island, north of Saanich Peninsula. These surveys included searches of several sites in the Cowichan area in 1997 and 2007 (Engelstoft and Ovaska 1997, Engelstoft 2007a) and repeated inspections of artificial cover-objects at a Department of National Defence property in Nanoose Bay in 2008. Little effort has been spent attempting to verify a dubious record from the southern interior, from near McGillivray Lake (Tanner 1967). This site was searched in 1975, but no snakes were found (D.M. Green, pers. comm.).

Abundance

Very little information exists on population sizes or densities of *C. tenuis* in British Columbia or the United States. The secretive behaviour of the snakes makes them difficult to locate and confounds attempts to estimate abundance. In Washington State, the snakes may be locally abundant in optimal habitat (Storm and Leonard 1995). In a 1 x 35 m strip of high-quality habitat in Washington, Leonard *et al*. (1996) found up to 22 snakes (in April) during repeated surveys in 1996.

In British Columbia, capture-recapture studies at sites monitored with artificial cover-objects provide some information on abundance (snakes were not marked but were individually identified by pattern). On North Pender Island, 39 individuals were caught within an approximately 1 ha study area over 8 years; on Saltspring Island, 24 individuals were caught within an approximately 0.5 ha plot in one year (Ovaska and Engelstoft 2008). One intensively monitored site (over 100 inspections of artificial-object arrays over 5 years) on Vancouver Island has resulted in the capture of 66 individual snakes within an 8-ha area (Engelstoft 2007a, Engelstoft and Ovaska 2008, and unpublished data). At two other monitoring sites on Vancouver Island, the number of individual snakes caught ranged from 14 within 1 ha to 5 within 3 ha of habitat surveyed over 2 – 3 years.

Sufficient data to calculate population parameters existed for snakes at only one site, about 1-ha study area on North Pender Island, using the program MARK (White and Burnham 1999). The mean population size using the artificial cover-objects per year was estimated to be 49 individuals (95% CI: 43 to 65 individuals) (Govindarajulu *et al*., in prep.).

Relative abundance of *C. tenuis* is usually much lower than that of other syntopic snakes. *Thamnophis ordinoides* outnumbered *C. tenuis* by 3.4 and 3.7 times, respectively, at two sites on the Gulf Islands where individual snakes of both species were marked or otherwise identified (Engelstoft and Ovaska 1998). In terms of numbers of captures in data pooled over several years, there was an approximately equal number of captures of *C. tenuis* and *T. ordinoides* at one site on Vancouver Island (Saanich Peninsula), whereas there were 10 times as many captures of *T. ordinoides* as of *C. tenuis* at four other sites (C. Engelstoft, unpublished data). There were very few observations of other species of garter snakes (*T. sirtalis* and *T. elegans*) at sites occupied by *C. tenuis*.

Fluctuations and trends

Very little information exists on population trends of *C. tenuis* anywhere within its range, and baseline data on historical patterns of abundance are lacking. From 1997 – 2004, the mean growth rate (λ) of one population in British Columbia, on North Pender Island, was estimated to be 0.89 (95% CI: 0.79 to 1.1), suggesting that it was stable or slightly declining (Govindarajulu *et al., in prep*.).

Of eight populations in British Columbia, three have been discovered since 2003 as a result of increased search effort. The species continues to persist in at least four of the five remaining locations where it was known previously (1948 – 1980) (Saltspring, North Pender, and South Pender Islands; Metchosin District on Vancouver Island; new records from 1996 to 2008 at all sites). New sites have been found on each of the three Gulf Islands and within 5 km of the original observations on Vancouver Island, expanding the area of occupancy at all these localities (Engelstoft 2005, 2006a,b, 2007a,b, and unpublished data). On North Pender Island, the species has not been found again at one of the two original (1949 – 1951) sites despite several searches and ongoing landowner participation. There are no further observations from Galiano Island since the original sighting in 1981.

Rescue effect

Populations on the Gulf Islands and Vancouver Island are isolated from each other and from populations in the United States by stretches of ocean, precluding dispersal movements and gene flow. The nearest population in the United States is on Orcas Island in the San Juan archipelago, about 30 km from the South Pender and Vancouver Island. The stretch of ocean separating the North Pender and Saltspring Island is about 5 km, North Pender and Vancouver Island about 18 km, and Saltspring and Vancouver Island about 2 km. The subpopulations on Vancouver Island, Saltspring Island, and South Pender Island are also isolated from each other to varying degrees as a result of natural and anthropogenic habitat fragmentation.

LIMITING FACTORS AND THREATS

The rarity of *C. tenuis* in Canada is likely due to both climatic and historical factors. The species exists at the northern extremity of its geographic range in southern British Columbia, and present-day populations are probably relicts from a more extensive past distribution. The factors leading to the fragmentation of the northern portion of the species' range are poorly understood but might be associated with climate cooling that occurred after the Hypsithermal Interval, which ended about 5,500 years ago. A fragmented northern distribution is characteristic of a southward contracting range (Green *et al*. 1996). After the retreat of the Cordilleran ice sheet, which covered the present Canadian range of the species up to at least 13,000 years ago (Pielou 1991), the snakes probably expanded their range northward. Maximal extent of climate warming occurred during the Hypsithermal Interval, about 8,500 – 5,000 years before present and might have

facilitated range expansion. The species' range probably contracted during cooler periods characteristic of the late Holocene, resulting in the fragmentation of the geographic range and isolation of the present-day Canadian populations.

In Canada, oviparous reproduction probably limits the northern distribution of all egg-laying reptiles, which, in contrast to viviparous species, must rely entirely on conditions at the oviposition site to provide a suitable thermal environment for the developing embryos (Gregory and Campbell 1984). The availability of nest sites with appropriate thermal conditions is an important factor determining the distribution of oviparous species (Shine 2004). Habitat fragmentation and availability of suitable oviposition sites are probably important factors limiting the distribution and population growth of *C. tenuis* in British Columbia. Habitat patches occupied by the species are naturally unevenly distributed within the landscape, augmented by additional fragmentation and barriers to movements posed by human developments. On a local scale, warm partially exposed slopes with stable talus or other cover that forms suitable breeding habitat for the species might be in short supply.

Main immediate threats to *C. tenuis* consist of habitat loss, degradation, and fragmentation mainly due to expanding urbanization throughout the species' Canadian range. On Vancouver Island, the population in the Highlands area is probably the most secure, embedded within a rural area with few roads and large lots and encompassing relatively large, protected natural areas. The other two populations on Saanich Peninsula and its vicinity are veritable habitat islands within developed areas. Dense urban developments surround one site on three sides with a major highway on the remaining side (Figure 4), whereas the other site is sandwiched between two main roads. For these reasons, the long-term viability of these populations is questionable. In Metchosin, residential development is expanding near sites where the species has been found. One rocky slope used by the snakes on private land was destroyed for gravel extraction in 2005. On Saltspring and Pender Islands, the populations are embedded within expanding rural and urban landscapes. A large residential development is currently in progress in occupied habitat on Saltspring Island. Even in protected areas, infrastructure development can adversely impact habitat if not mitigated. Where important habitat features, such as rock outcrops or stable talus slopes, are destroyed, the effects for the species are expected to be immediate and severe. However, there is more uncertainty associated with assessing threats from habitat fragmentation and from past developments, as movement patterns, extent of distribution at particular sites, and viability of populations are unknown.

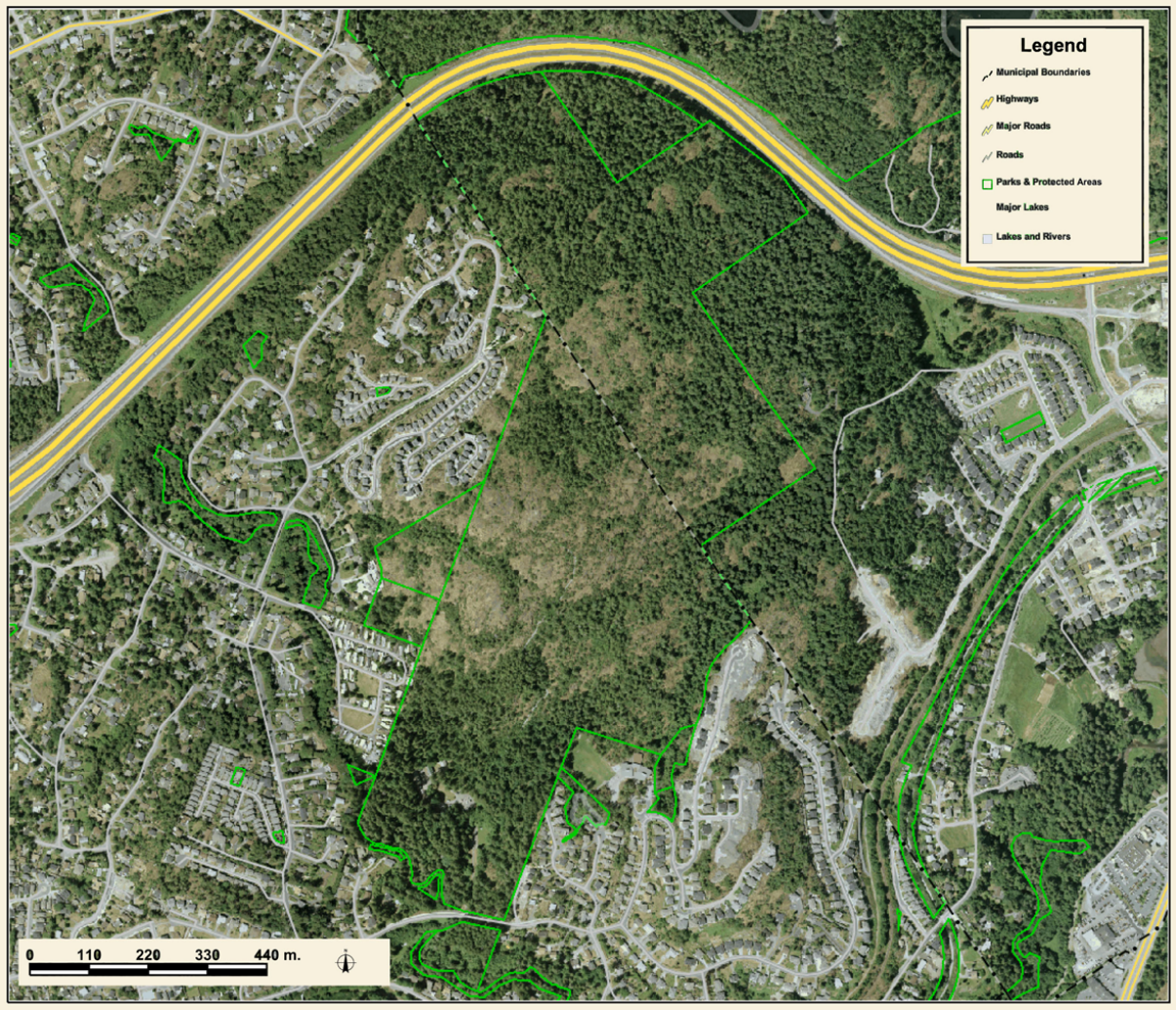

Figure 4. Habitat of *Contia tenuis* on a hillside in Langford, Victoria, BC, surrounded by a highway and residential areas. The species was found on the sparsely wooded hillside near the centre of the image.

Other threats include road mortality, catastrophic fire, predation by introduced predators or pets, pesticides, accidental mortality from landscaping and gardening practices, and possibly competition with the introduced European Wall Lizard, *Podarcis muralis*. Several cases of road mortality from Pender Islands are known (Spalding 1995; C. Engelstoft, unpublished data), and major roads intersect or abut snake habitat at most known sites. On Saltspring Island, the snakes occur in the immediate vicinity of a busy ferry terminal. The significance of road mortality to populations of *C. tenuis* is unknown, but any additional mortality might be detrimental to these small populations (Row *et al*. 2007).

Although low-intensity wildfires probably create habitat and increase habitat diversity for reptiles (Bury 2004), high intensity wildfires can be detrimental to ground dwelling snakes, as demonstrated in other areas (Webb and Shine 2008). Garry Oak habitats on hillsides inhabited by the Sharp-tailed Snake are historically fire-maintained. Fire prevention policies have allowed fuel to accumulate, and high human use of many of these habitats has increased the risk of fires. Small populations of snakes on isolated hillsides are vulnerable to high-intensity fires that may result from such conditions.

Recreational activities and other human use of sensitive Sharp-tailed Snake habitats can destroy important microhabitat features, such as talus and coarse woody debris, and cause damage to the ground vegetation and moss layer. Off-trail human activities, such as unauthorized mountain biking, have been documented from some Sharp-tailed Snake sites, including a regional park and a federal property. In addition, authorized off-trail human use, such as military training activities on DND lands, could result in habitat deterioration if not mitigated.

Possible control programs against introduced mollusc pests of agricultural products could threaten populations of *C. tenuis* (D. Fraser, pers. comm.). Aggressive pesticide use could significantly reduce the available prey base of both native and introduced slugs or directly harm snakes that feed on contaminated prey. Snakes have been occasionally killed during weed trimming and other gardening activities within residential areas (C. Engelstoft, unpublished data). One snake was found dead on a driveway, probably killed by a cat (Spalding 1995), and scars suggesting predator attacks have been noted on several snakes (Engelstoft and Ovaska 1999).

The introduced European Wall Lizard is expanding its range on southern Vancouver Island (Bertram 2004) and has been found at one site occupied by *C. tenuis* (Engelstoft and Ovaska 2008 and unpublished data). This site is in relatively undisturbed habitat and probably the most secure of the sites occupied by *C. tenuis* in British Columbia. Hence, the presence of the lizard may be a concern. The lizards can reach very high densities in suitable habitats and may compete with *C. tenuis* for prey or basking or egg-laying sites, but evidence is lacking.

The most plausible threats and their spatial and temporal extent were assessed for each cluster of Sharp-tailed Snake observations to determine the number of locations, as per COSEWIC definition (Table 3). This analysis suggested that each cluster of observations should be regarded a COSEWIC location, resulting in a total of 18 locations. There is some subjectivity in applying the definition of locality to this species, because the size and timing of development projects, which are the main threat, are largely unknown.

Table 3. Threats for sites with clusters of records of *Contia tenuis* and their assignment to COSEWIC locations. Numbers refer to individual identification numbers for sites or locations.

Population	Cluster of records or site (land status)	Threat (in order of priority)	Location #
Vancouver Island: Metchosin	1 (federal)	Human disturbance Development (currently federal land but could be sold) Road mortality Wildfire	1
Vancouver Island: Metchosin	2 (regional trail surrounded by private lands)	Development Wildfire Off-trail recreation Road mortality	2
Vancouver Island: Metchosin	3 (private land protected by Conservation Covenant)	Severe weather or stochastic events (small, isolated population) Wildfire	3
Vancouver Island: Highlands	1 (private land)	Development Road mortality Wildfire	4
Vancouver Island: Highlands	2 (regional park)	Wildfire Off-trail recreation	5
Vancouver Island: Highlands	3 (municipal park)	Development (possibility of removal from park) Wildfire	6
Vancouver Island: Highlands	4 (part regional park, part federal land)	Off-trail recreation or other human activity Wildfire	7
Vancouver Island: Highlands	5 (regional park)	Wildfire Off-trail recreation	8
Vancouver Island: Highlands	6 (regional park)	Wildfire Off-trail recreation	9
Vancouver Island: Saanich	1 (federal land)	Severe weather or stochastic events (small, isolated population) Road mortality	10
Vancouver Island: Langford	1 (part is regional park; surrounded by private lands)	Development Severe weather or stochastic events (small, isolated population) Road mortality Wildfire	11
Saltspring Island	1 (private land)	Development Road mortality Wildfire	12
Saltspring Island	2 (private land)	Road mortality Development	13
Saltspring Island	3 (private land)	Road mortality Development	14
North Pender	1 (private land)	Road mortality Development	15
South Pender	1 (private land)	Development Road mortality Wildfire	16
South Pender	2 (private land; partially in National Park)	Development Road mortality Wildfire	17
South Pender	3 (private land)	Development	18

SPECIAL SIGNIFICANCE OF THE SPECIES

Contia tenuis is part of a unique group of snakes and until recently was the sole representative of the genus *Contia* (an undescribed sister species exists in coastal California and southern Oregon). It is one of only five species of native lizards and snakes known from Vancouver Island and the Gulf Islands and contributes significantly to the biodiversity of the region. The species reaches the northern limits of its distribution in southern British Columbia, and populations here are subject to environmental conditions that are different from those experienced by more southern populations in the United States. Populations of *Contia tenuis* in Canada are hence of scientific interest for studies on evolution and biogeography.

Populations of *C. tenuis* are also of conservation interest, as populations at the margins of a species' distribution may become increasingly important when confronted with large-scale environmental change (Furlow and ArmijoPrewitt 1995). The general pattern of range collapse of many terrestrial vertebrates has been towards the periphery rather than towards the centre of their ranges (Lomolino and Channell 1995, 1998). The species occurs in rare Garry Oak/Douglas-fir – Arbutus ecosystems within the Coastal Douglas-fir Biogeoclimatic Zone, which itself is threatened and among the most disturbed biogeoclimatic zones in British Columbia. *Contia tenuis* is one of few vertebrates at risk in Garry Oak ecosystems, where it co-occurs with many rare plants and invertebrates.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

NatureServe (2008) provides the following status designations for *C. tenuis* (last reviewed 30 August 2006): Global status: G5 – widespread, abundant and secure; National status: USA – N5 (widespread, abundant and secure); Canada – S1 (critically imperiled); Subnational status: California – S5 (widespread, abundant and secure); Oregon – S4 (apparently secure); Washington – S2 (imperiled); British Columbia – S1 (critically imperiled)

Contia tenuis was assessed by COSEWIC as Endangered in 1999. The species is on British Columbia's Red-list of species at risk. *Contia tenuis* is on Schedule 1, the official list of wildlife species at risk in Canada, under the *Species at Risk Act*. At present, the immediate requirements of the Act apply only to federal lands, which for *C. tenuis* consist of two Department of National Defence and one National Research Council property on southern Vancouver Island and one park in the Gulf Islands National Park Reserve. It is unclear how the Act will be applied to other public and private lands. The *Wildlife Act* of British Columbia prohibits the collection, handling, and trade of all native wildlife species without a permit.

TECHNICAL SUMMARY

Contia tenuis
Sharp-tailed Snake — Couleuvre à queue fine
Range of occurrence in Canada: British Columbia

Demographic Information

Generation time (GT, usually average age of parents in the population; IUCN guidelines (2008): GT = 1 + AM/AMR = 1 + 5/ 0.25- 0.34 = 16- 21 years. where AM= age at maturity; AMR= estimated annual adult mortality	16-21 years or 48-63 years for 3 generations
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? A slight decline was observed in one population within a developed area; population trends are unknown for other populations but are projected for other small populations in disturbed areas.	Yes, projected
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence 995 km² calculated with the minimum polygon method using all distribution records with the exception of an isolated, dubious record from the interior of BC. Of this area about 400 km² is covered with ocean.	995 km² (includes ocean); 591 km^2 (excludes ocean)
Index of area of occupancy (IAO) The index was calculated by superimposing a grid with 2 x 2 km cells on all locations in the Canadian range and counting the number of cells that contained records for the species. A detailed map of observations (confidential information) was used to accurately place the observations within the cells. The species is known from 24 cells and thus is 96 km^2. The actual area of occupancy is less than 5 km². This AO was calculated from data in Figure 3 and applying a circular area with a radius 25 m, 250 m, and 500 m, respectively, for the different-sized symbols in Figure 3. Note that the resulting value overestimates AO around the larger symbols, as not all habitat is suitable. Point records for Galiano and North Pender Islands (Fig. 3) were excluded, because no observations from these sites exist for over 25 years.	96 km²

Is the total population severely fragmented? All eight populations are isolated from each other by 5 km or more, which is much more than projected movement distance by individual snakes. Isolation is also by stretches of ocean surrounding islands (Vancouver Island, Saltspring Island, and North and South Pender Islands) and by residential developments, highways, and other infrastructure on islands. All but one population (Highlands) are not secure and either in small isolated habitat fragments or within very fragmented developed areas. More than 50% of the habitat patches might not support viable populations.	Yes
Number of "locations∗" Analysis of the spatial extent and timing of most plausible threats that could rapidly decimate subpopulations suggests that each cluster of records is a separate location, resulting in a total of 18 locations (see Table 3). However, there is much uncertainty about the size and timing of urban development, which is the greatest threat. Two point locations (a single site from Galiano Island and 1 of 2 sites on North Pender Island) are excluded from the count because of lack of recent observations.	18
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	Unknown
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of populations?	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of locations? Due to increased search effort, the known number of locations has increased from 7 (pre-2000) to 18 (post-2000). However, the real trend in number of locations is unknown and is possibly decreasing as a result of continuing habitat loss. One location on North Pender Island has likely been lost (no records since 1940s) and another location on Galiano Island may also have been lost (no records since 1981)	Yes, projected
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Yes, observed and projected
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations∗?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	**N Mature Individuals**
Very few data on population size are available and they are from only a few sites. At one site on North Pender Island, mark-recapture studies estimated the mean population size per year as 49 individuals, with about 22% of them juveniles at first capture. At another site on Vancouver Island, about 60 individuals have been identified over several years of study, with about 46% of them juveniles at first capture. Assuming that the population at each of 17 known localities contains 30 adults, the total minimum number is 510 snakes. The upper value is a best guess but probably much less than 2500. Vancouver Island: (1) Metchosin; (2) Highlands; (3) Saanich; (4) Langford	Unknown but probably < 2500

∗ See definition of location.

Gulf Islands: (5) Saltspring Island; (6) North Pender Island; (7) South Pender Island (relatively large); (8) Galiano Island (might be lost) The number of individuals in the different populations is unknown. On Vancouver Island, the Highlands population is the largest in area and probably in number of snakes; on the Gulf Islands, the Saltspring and South Pender Island populations are similarly the largest, based on current knowledge (sampling effort has been uneven throughout the islands). See Figure 3 for the location of the populations.	
Total	<2500

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	NA

Threats (actual or imminent, to populations or habitats)

The main threats are habitat loss, degradation, and fragmentation due to expanding urbanization throughout the species' Canadian range, because the species' populations are embedded and isolated within populated areas.

Other threats include roadkill, catastrophic fire, off-trail recreational activities and other human disturbance, and possible contamination from pesticides applied to "control" introduced molluscs.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Closest populations in WA are S2 (Imperilled)	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Possibly
Is there sufficient habitat for immigrants in Canada?	No
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Endangered (November 2009)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B1ab(iii) + 2ab(iii); C2a(i)

Reasons for designation:

This tiny snake is confined to a handful of isolated, small populations in southeastern Vancouver Island and the southern Gulf Islands of British Columbia. Most of these populations are threatened by development and may not be viable. Increased search effort since the last assessment has found three previously undiscovered populations. Despite this, it is likely that overall numbers are decreasing and threats continue unabated. Major threats include ongoing development, increasing human populations, off trail recreation, fragmentation by roads and stochastic effects on small populations.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not Applicable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(iii)+2ab(iii). Both EO and IAO are well below the thresholds for Endangered, the species is severely fragmented, and habitat quality and amount are declining.
Criterion C (Small and Declining Number of Mature Individuals):Meets Endangered C2a(i). A decline projected in the number of mature individuals because of habitat loss and degradation. There are fewer than 2500 adult individuals in Canada and no population contains more than 250 adults
Criterion D (Very Small or Restricted Total Population): Not applicable
Criterion E (Quantitative Analysis): Not applicable

ACKNOWLEDGEMENTS AND AUTHORITIES CONSULTED

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The following individuals provided specific information for this update or for the previous (1999) version of the status report and are cited as personal communications in this report: Edmund Brodie, Jr. (in 1998); Chris R. Feldman (in July 2008); David Fraser (in 1999); David M. Green (in 1999); Patrick Gregory (in 2007); J. Heinrich (in 1998); William Leonard (in 1998); Stan Orchard (in 1998).

The following government contacts were consulted: David Cunnington (Canadian Wildlife Service; email, July 2008), Brian Reader (Parks Canada; email, July 2008), David Fraser (B.C. Ministry of Environment; email, July 2008), Kari Nelson (B.C. Ministry of Environment; chair of Recovery Team for the Sharp-tailed Snake; informed of report preparation by email in July 2008; review by Recovery Team members and chair requested in November 2008), Lea Gelling (B.C. Conservation Data Centre, email, July 2008), Gloria Goulet and Alain Filion (COSEWIC Secretariat, email, July 2008). Funding for this report was provided by Environment Canada.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Kristiina Ovaska, Ph.D., M.Sc., received her doctoral degree (biology) from the University of Victoria in 1987, after which she completed two post-doctoral studies in population biology and behavioural ecology of amphibians with the University of British Columbia and McGill University, respectively. Presently, she is research associate at the Department of Forest Sciences, University of British Columbia, and senior ecologist and partner at Biolinx Environmental Research Ltd., Victoria, BC. Over the past 20 years, Dr. Ovaska has studied behaviour and ecology of amphibians and reptiles in western North America, Central America, and the West Indies. She has carried out numerous surveys and habitat assessments for amphibians, reptiles, and turtles, including species at risk, and designed and implemented environmental monitoring studies. Since 1996, Dr. Ovaska has participated in inventories and population studies for the Sharp-tailed Snake on the Gulf Islands and Vancouver Island. These studies have involved multi-year capture-recapture studies to investigate population structure and trends, habitat use, and movements of the snakes, and stewardship activities through outreach and landowner contact programs. She has been an active member of the Sharp-tailed Snake Recovery Team, since its inception in 2001. Dr. Ovaska is the author of over 40 publications in refereed scientific literature, most of them dealing with amphibians and reptiles.

Christian Engelstoft, M.Sc., RPBio, has over 20 years of experience in wildlife inventories and environmental studies in British Columbia and internationally and is the principal of Alula Biological Consulting (Saanichton, BC). He has conducted surveys for a variety of wildlife in Canada and internationally, including reptiles and amphibians in British Columbia. He has been the principal investigator for studies on the Sharp-tailed Snake (*Contia tenuis*) and other reptiles on the Gulf Islands and Vancouver Island from 1996 to 2008. The focus of these studies included assessing habitat at a landscape scale, inventories on federal and private lands, and developing harmonic direction finder methodology for tracking movements and habitat use of the Sharp-tailed Snake. He has also developed and implemented inventory and monitoring protocols for this species. Currently, he is the scientific advisor to the Sharp-tailed Snake Recovery Team.

COLLECTIONS EXAMINED

The British Museum of Nature, London, England, has the following specimen, examined by Patrick Gregory in August 2001:

Catalogue number	Collection date	Location Name
	1857-1861	Vancouver Island

The Royal British Columbia Museum, Victoria, BC, has the following specimens:

Catalogue number	Collection date	Location Name	Geoposition
0856.00	5-Nov-49	North Pender Island	
0859.00	27-Jan-50	South Pender Island	
0875.00	25-Jun-50	North Pender Island	
1516.00	25-Sep-82	Salt Spring Island (N side of Vesuvius, Mt. Pk. Dr.)	
1806.00	7-Apr-80	Vancouver Island; Pedder Bay	
1807.00	15-Jun-80	Vancouver Island; Pedder Bay	
1900.00	7-May-92	Pender Island	
1221.00	29-Aug-68	South Pender Island	
1930.00	9-Mar-98	Saltspring Island	48°52.72'N, 123°33.73'W
1931.00	20-Jun-97	South Pender Island	48°43.05'N, 123°18.17'W

Museum of Vertebrate Zoology at the University of California, Berkeley, has the following specimens:

Catalogue number	Collection date	Location name	Geoposition
MVZ 257255	March 2005	South Pender Island	48.7435°N, 123.2246°W
MVZ 257256	July 2006	Saltspring Island	48.8934°N, 123.5821°W
MVZ 257257	28 Sept 2004	North Pender Island	48.7644°N, 123.3003°W
MVZ 257258	28 Sept 2004	North Pender Island	48.7644°N, 123.3003°W
MVZ 257259	28 Sept 2004	North Pender Island	48.7644°N, 123.3003°W