

COSEWIC
Assessment and Status Report

on the

Bear's-foot Sanicle
Sanicula arctopoides

in Canada



THREATENED
2015

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 2015

Common name

Bear's-foot Sanicle

Scientific name

Sanicula arctopoides

Status

Threatened

Reason for designation

This perennial wildflower occurs in Canada only along a 30 km stretch of coastline in extreme southeast Vancouver Island. While this wildflower can live more than 10 years, it flowers and fruits once and then dies. It occupies small areas of remaining meadow habitat, which is being modified by invasion of exotic plants. Several new sites, discovered since the species was last assessed, have reduced the risk to this plant. Most of the Canadian population occurs at one site, which is also threatened by grazing by an expanding non-migratory, newly resident Canada Goose population. Severe trampling by humans also affects a few sites. Many of the known subpopulations have relatively few individuals and may not persist.

Occurrence

British Columbia

Status history

Designated Endangered in May 2001. Status re-examined and designated Threatened in November 2015.



COSEWIC
Executive Summary

Bear's-foot Sanicle
Sanicula arctopoides

Wildlife Species Description and Significance

Bear's-foot Sanicle is a tap-rooted, low-growing, herbaceous perennial wildflower. Its basal leaves, which are deeply lobed and sharply toothed, form a compact rosette. The inflorescences are compact with many bright yellow small flowers that produce fruit with hooked bristles. Bear's-foot Sanicle is one of over 50 nationally rare species that are restricted (in Canada) to Garry Oak and associated ecosystems in southern Vancouver Island and the adjacent Gulf Islands.

Distribution

In Canada, Bear's-foot Sanicle occurs only in a 30 km length of shoreline in the vicinity of Victoria, British Columbia. Bear's-foot Sanicle is known from nine extant subpopulations in Canada. In the United States it ranges from the San Juan Islands of Washington State, south along the coast of Washington and Oregon, to California. Subpopulations in Washington State are very small and are imperilled. The nearest US subpopulations (San Juan Islands) are approximately 25 km from the nearest Canadian subpopulation and separated by several kilometres of open ocean, making dispersal between these sites unlikely.

Habitat

In Canada, Bear's-foot Sanicle is restricted to drought-prone maritime meadows at low elevations along shorelines. The plants experience wide seasonal fluctuations in water availability, with abundant rains typically beginning in mid-autumn, and continuing through autumn and winter, ceasing with the onset of the summer drought, when Bear's-foot Sanicle becomes dormant. The dry summer conditions discourage the growth of native trees and shrubs although the exotic invasive Scotch Broom is often present. Bear's-foot Sanicle usually occurs in vegetation dominated by low (< 20 cm tall) forbs and grasses. A few native species may be relatively common in the vegetation but exotic, invasive forbs and grasses tend to dominate.

Biology

Bear's-foot Sanicle is a perennial species with a monocarpic life cycle, meaning that after it flowers and fruits the whole plant dies. Germination occurs as early as December and may continue into March. Plants tend to reach maximum annual size by April or May and the small non-reproductive plants either die or become dormant in late May or early June as the summer drought deepens. Larger, older plants flower in March or April and produce ripe fruits by mid- to late June. The small dry fruits are covered with hooked bristles, which aid in dispersal, by catching on the fur and feathers of passing animals as well as on clothing. Dormant plants resprout in October or November and grow slowly through the winter months. Most seeds germinate in the first fall after dispersal, or else perish in the soil. Most seedlings live only a few months and the survivors grow slowly. Generation time is estimated at 14 years.

Population Sizes and Trends

The total Canadian population is currently estimated at approximately 2,900 mature individuals. There are nine extant subpopulations in Canada. Five of the nine subpopulations had fewer than 50 mature individuals. Approximately 85% of the Canadian population occurs in one subpopulation, on Trial Islands. The only other Canadian subpopulation that consistently produces > 100 mature individuals is at Harling Point, a headland on Vancouver Island close to Trial Islands. Habitat information suggests there has probably been a decline in the number and size of the total Canadian population over the past 3 generations (42 years). Bear's-foot Sanicle is critically imperilled in Washington—there is little likelihood of dispersal from US populations to establish new populations in Canada.

Threats and Limiting Factors

The major limiting factor across the Canadian range of Bear's-foot Sanicle is its restriction to a rare habitat type within a tiny area in Canada. The primary threat to the species is a continuing decline in habitat quality because of the increasing abundance of invasive species. Other major threats include herbivory by the increasing size of the non-migratory and newly resident population of Canada Geese at several Canadian locations of Bear's-foot Sanicle, construction and operation activities, trampling in sites that experience high levels of human visitation and a projected decline in the suitability of occupied habitat as a result of climate change.

Protection, Status, and Ranks

Bear's-foot Sanicle is listed as Endangered on Schedule 1 of the federal *Species at Risk Act* (SARA) and afforded measures of protection under that legislation. It is not protected under BC provincial species at risk legislation. Bear's-foot Sanicle is ranked globally secure but critically imperilled in Canada. Bear's-foot Sanicle is also critically imperilled in Washington State and has not been ranked in Oregon or California, where it also occurs.

TECHNICAL SUMMARY

Sanicula arctopoides

Bear's-foot Sanicle

Sanicle patte-d'ours

Range of occurrence in Canada (province/territory/ocean): British Columbia

Demographic Information

Generation time	14 years
Is there a continuing decline in number of mature individuals? <i>There is an inferred continuing decline over the past three generations (42 years) based on the decline in habitat quality of extant populations due to the arrival and expansion of a number of invasive alien species. Since the previous status report was completed there have been observed declines in several subpopulations but fluctuations in the large subpopulation on Trial Islands has masked any overall trends in the size of the Canadian population.</i>	yes
Estimated percent of continuing decline in total number of mature individuals within 2 generations	unknown
<i>Observed percent reduction</i> in total number of mature individuals over the last 3 generations.	unknown
Projected or suspected percent reduction or increase in total number of mature individuals over the next 3 generations.	unknown
<i>Observed percent reduction</i> in total number of mature individuals over any 3 generations period, over a time period including both the past and the future.	unknown
Are the causes of the decline a) clearly reversible and b) understood and c) ceased? <i>Causes of observed and inferred past decline are understood but have not ceased. Continuing inferred declines associated with invasive plants, herbivory by Canada Geese and trampling are reversible.</i>	a) Yes b) Yes c) No
Are there extreme fluctuations in number of mature individuals?	no

Extent and Occupancy Information

Estimated extent of occurrence (EO)	119 km ²
Index of area of occupancy (IAO)	36 km ²
Is the total population "severely fragmented"? i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a) No b) Possibly
Number of locations	9

Is there an <i>observed</i> decline in extent of occurrence? <i>Within the past three generations there has been an observed loss of the subpopulation at Cattle Point, which lies at the edge of the species range in Canada. Four subpopulations have been discovered since 1999 but they were found in areas that had received little or no botanical study and have likely been present for three or more generations. There has been a 5% reduction in the extent of occurrence since the previous status report was prepared.</i>	yes
Is there an <i>observed</i> decline in index of area of occupancy? <i>The loss of the subpopulation at Cattle Point over the past three generations constitutes a 10% decline in the index of the area of occupancy. Newly discovered subpopulations are unlikely to represent an actual increase in the index of area of occupancy.</i>	yes
Is there an <i>observed</i> decline in number of subpopulations? <i>Observed loss of subpopulation at Cattle Point over past three generations. Newly discovered subpopulations are likely to have been present for over three generations.</i>	yes
Is there an <i>observed</i> decline in number of locations? <i>The location represented by the subpopulation at Cattle Point was lost over the past three generations.</i>	yes
Is there a <i>projected</i> continuing decline in quality of habitat? <i>Projected decline in habitat quality as exotic invasive alien plants increase.</i>	yes
Are there extreme fluctuations in number of subpopulations?	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 subpopulation)

Subpopulation	N Mature Individuals
Trial Islands (2011)	2,479
Alpha Islet (2012)	31
Discovery Island (2012)	2
Saxe Point (2011)	93
Mary Tod Island (2012)	47
Harling Point (2011)	153
Bentinck Island (2012)	4
Bedford Islands (2008)	69
Becher Bay (2010-2012)	20
Total	2,898

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not available
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Threats (actual or imminent, to subpopulations or habitats)

Invasive Plants Non-migratory, newly resident Canada Geese Trampling Climate Change
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Rescue Effect (immigration from outside Canada)

Status of outside population(s)? <i>Bear's-foot Sanicle is critically imperilled in the nearest adjacent jurisdiction (Washington State)</i>	
Is immigration known or possible?	Possible, but highly unlikely
Would immigrants be adapted to survive in Canada? <i>Probable, but not proven</i>	Probably
Is there sufficient habitat for immigrants in Canada? <i>Some habitat is present but insufficient to allow immigrants a significant chance of encountering it.</i>	Yes
Are conditions deteriorating in Canada? <i>There is a continuing decline in the quality of habitat available in Canada.</i>	yes
Are conditions for the source population deteriorating? <i>The potential source population faces the same continuing decline in habitat quality as occurs in Canada.</i>	yes
Is the Canadian population considered to be a sink?	no
Is rescue from outside populations likely?	no

Data Sensitive Species

Is this a data sensitive species	no
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Status History

COSEWIC: Designated Endangered in May 2001. Status re-examined and designated Threatened in November 2015.
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Status and Reasons for Designation

Status: Threatened	Alpha-numeric code: B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)
Reasons for designation: This perennial wildflower occurs in Canada only along a 30 km stretch of coastline in extreme southeast Vancouver Island. While this wildflower can live more than 10 years, it flowers and fruits once and then dies. It occupies small areas of remaining meadow habitat, which is being modified by invasion of exotic plants. Several new sites, discovered since the species was last assessed, have reduced the risk to this plant. Most of the Canadian population occurs at one site, which is also threatened by grazing by an expanding non-migratory, newly resident Canada Goose population. Severe trampling by humans also affects a few sites. Many of the known subpopulations have relatively few individuals and may not persist.	

Applicability of Criteria

<p>Criterion A (Decline in Total Number of Mature Individuals): Does not meet criteria. Although there has been a decline in total number of mature individuals from last assessment and significant declines in several subpopulations, fluctuation in individuals at largest subpopulation complicates the interpretation of trends.</p> <p>Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Threatened B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v). Although the EOO (119 km²) and the IAO (36 km²) meet the threshold for Endangered, the number of locations (9) meets the threshold for Threatened. The population is not severely fragmented. There is a continuing decline in the EOO, IAO, area and quality of habitat, and number of subpopulations, as well as an inferred future decline in number of mature individuals due to the level of threats.</p> <p>Criterion C (Small and Declining Number of Mature Individuals): Does not meet criteria. Recent population estimate of 2,898 mature individuals meets Threatened threshold, and there is evidence of a continuing decline in habitat and quality, and, likely number of mature individuals. Largest population is > 1000 mature individuals and contains about 85% of all mature individuals, therefore, not meeting thresholds. Although the population has fluctuated, it does not have extreme fluctuations.</p> <p>Criterion D (Very Small or Restricted Total Population): Not applicable.</p> <p>Criterion E (Quantitative Analysis): Not applicable. Not done.</p>
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PREFACE

Four subpopulations of Bear's-foot Sanicle have been discovered since 1999, when fieldwork was conducted for the original status report. All four subpopulations have fewer than 70 mature individuals and the smallest of them, on Discovery Island, only had two mature individuals at last count. The presence of previously unreported populations of several other rare plant species in the vicinity of each of the four recently discovered subpopulations of Bear's-foot Sanicle suggests that these are not recently established, but rather are long-established but previously unreported subpopulations.

Sizable fluctuations in the size of the large subpopulation on Trial Islands have masked any trend in the size of the Canadian population of Bear's-foot Sanicle but most of the other subpopulations are stable or in decline. The subpopulations at Saxe Point and Bentinck Island appear to have declined by more than 90 percent over the past 16 years.

Recovery goals and objectives for Bear's-foot Sanicle were established in a federal multi-species recovery strategy for species at risk occurring in maritime meadows associated with Garry Oak ecosystems (Parks Canada 2006) but the majority of the 10-year objectives established in 2006 have not been initiated and there has been no rigorous monitoring program to track trends in the Canadian population or to assess the efficacy of the few recovery objectives that have been implemented.



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 (2015)

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.



The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

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Bear's-foot Sanicle

Sanicula arctopoides

in Canada

2015

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Sanicula arctopoides* Hook. & Arn.

Synonyms: *Sanicula X howellii* (J.M. Coult. & Rose) Shan & Constance, *Sanicula crassicaulis* var. *howellii* (J.M. Coult. & Rose) Mathias

Common English Names: Bear's-foot Sanicle, Snake-root Sanicle, Footsteps of Spring, Yellow Mats

Common French Name: Sanicle patte-d'ours

Family Name: Apiaceae (Carrot Family)

Bear's-foot Sanicle is a distinctive species with no described subspecies or varieties. Bear's-foot Sanicle (with or without the hyphen) is the most commonly used English name both in Canada and in the United States. Footsteps of Spring is the only other English name in common use in Canada.

Morphological Description

Bear's-foot Sanicle is a tap-rooted, low-growing, herbaceous perennial. Its basal leaves, which are deeply lobed and sharply toothed, form a compact rosette. The inflorescences are compact, bright yellow umbels. At first, the umbels are closely packed to form a bright yellow "button" nestled in the rosette of basal leaves (Figures 1, 2). As the flowers mature (particularly following pollination) the internodes of the flowering stem elongate, lifting the inflorescence well above the basal rosette. When this has happened, 1-3 cauline leaves become evident; similar to those of the basal rosette although typically somewhat smaller and narrower. It is also evident, at least when the flower stalks have elongated, that each umbel is subtended by a ring of 5-15 mm long bracts (involucels). Each fertilized flower produces a globular dry fruit (schizocarp), which splits into segments that have hooked bristles (Figure 2) on their outer surface, and enclose a seed (Hitchcock *et al* 1961; Fairbarns pers. obs.).

Bear's-foot Sanicle is one of five sanicle species found in B.C. and one of three found in coastal meadows in southwestern B.C. The other two species that occur in coastal meadows are Purple Sanicle (*Sanicula bipinnatifida*) and Pacific Sanicle (*Sanicula crassicaulis*), both of which have a more erect form and inconspicuous involucels. The flowers of Pacific Sanicle are usually yellow, as in Bear's-foot Sanicle, while Purple Sanicle (which is Threatened in Canada) bears purple flowers as its name suggests. Three-parted Pacific Sanicle, which also may occur in coastal meadows and is generally treated as a variety of Pacific Sanicle (*Sanicula crassicaulis* var. *tripartita*), has purplish-brown flowers and is intermediate in form between Pacific Sanicle and Purple Sanicle.



Figure 1. Bear's-foot Sanicle in flower. Photo by Matt Fairbarns, with permission.

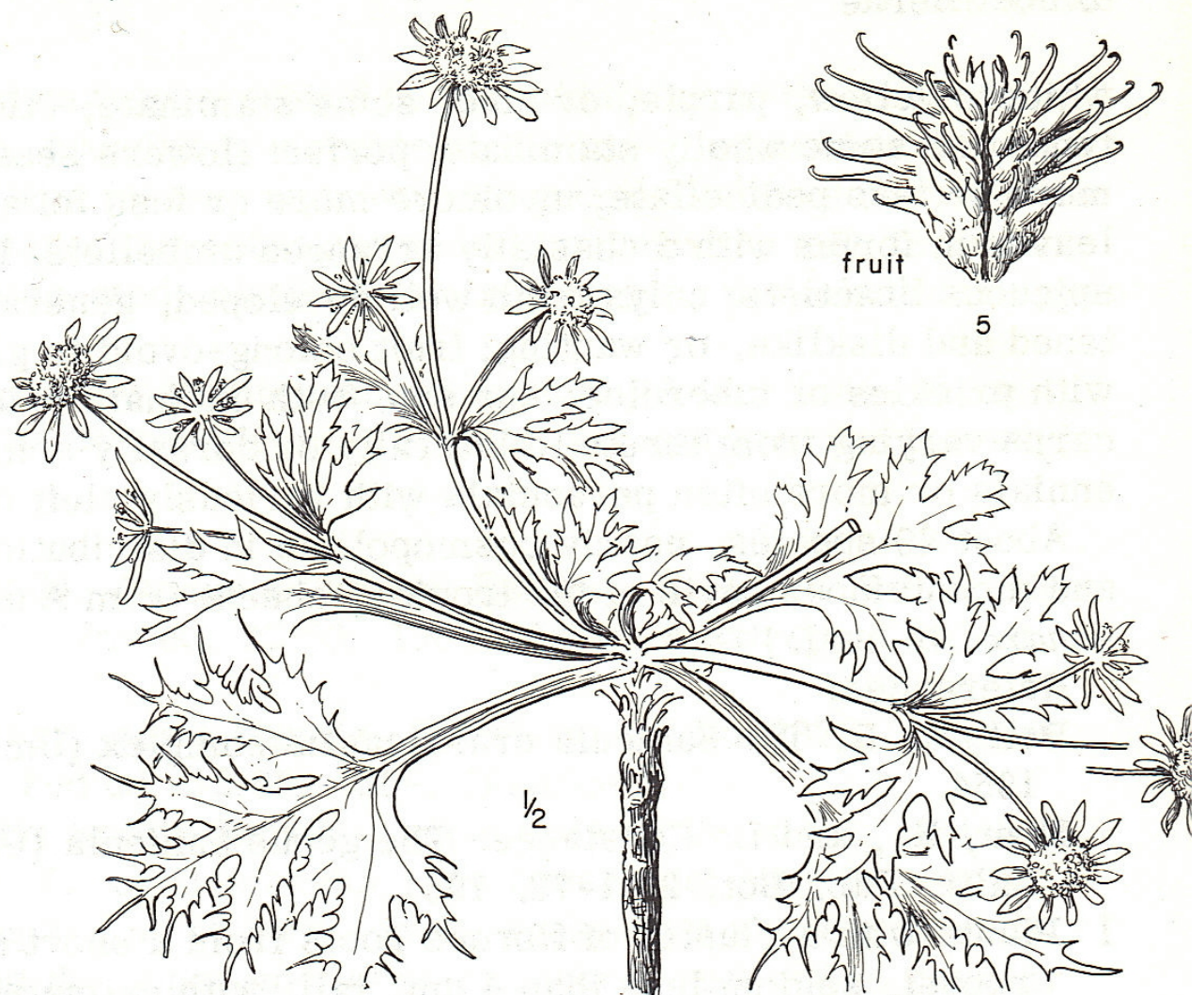


Figure 2. Line drawing of Bear's-foot Sanicle. J.R. Janish from Hitchcock *et al.* 1961 with permission.

Population Spatial Structure and Variability

There are no known studies of genetic variation among Canadian subpopulations or between Canadian subpopulations and those in the United States.

Designatable Units

There are no studies of genetic distinctiveness among Canadian subpopulations; there are no natural disjunctions between substantial portions of the species' geographic range in Canada; and Canadian subpopulations all lie within the Pacific National Ecological Area. For these reasons the Canadian subpopulations comprise a single designatable unit.

Special Significance

Bear's-foot Sanicle is one of over 50 nationally rare species that are restricted (in Canada) to Garry Oak (*Quercus garryana*) and associated ecosystems in southern Vancouver Island and the adjacent Gulf Islands (GOERT 2012).

DISTRIBUTION

Global Range

Bear's-foot Sanicle occurs from the vicinity of Victoria, British Columbia and the San Juan Islands of Washington State, south along the coast of Washington, Oregon and California as far as Point Sal, in northwestern Santa Barbara County (Figure 3) (Consortium of Pacific Northwest Herbaria 2007-2011; CalFlora 2012). There is no evidence of recent global range contraction or expansion.

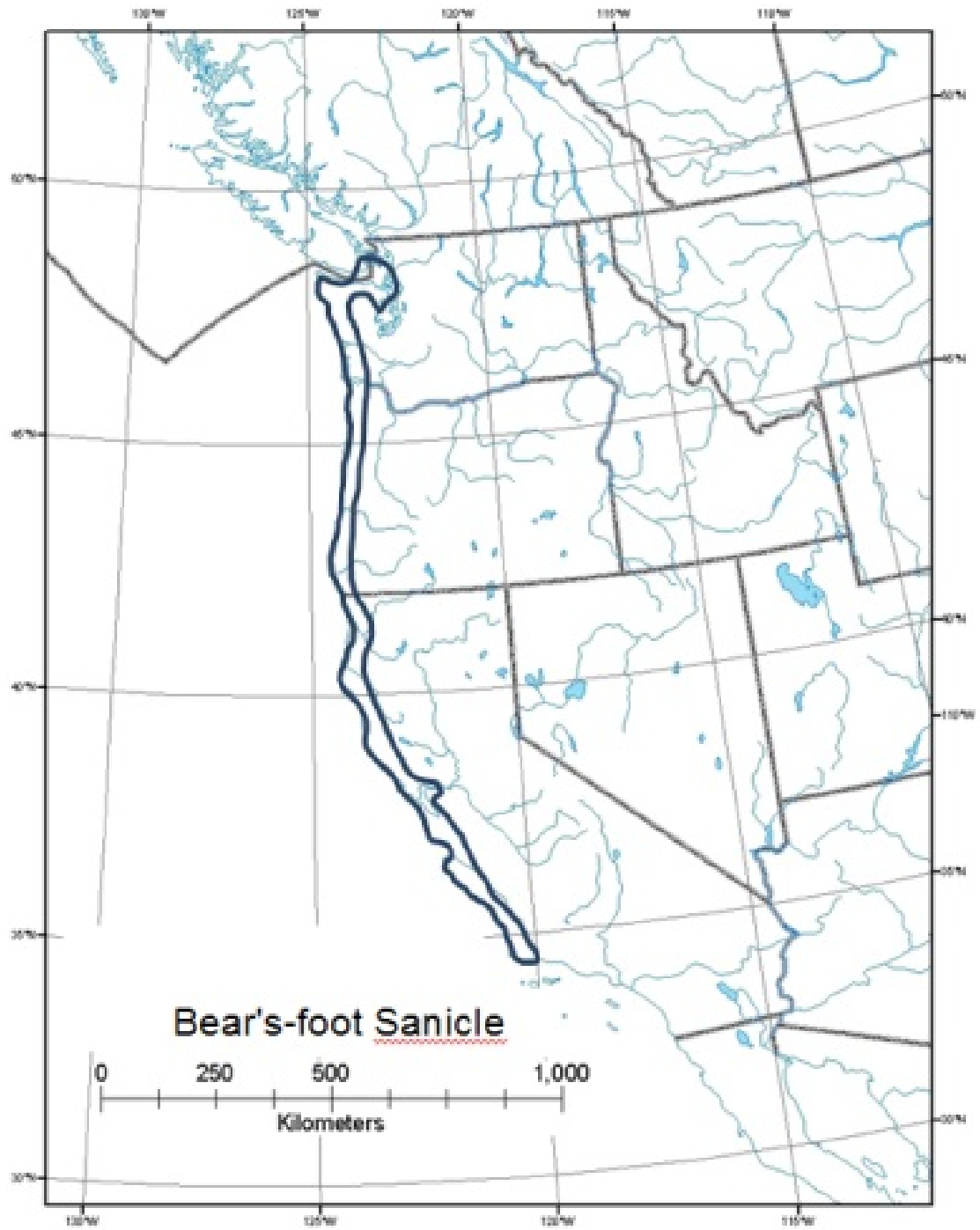


Figure 3. Global range of Bear's-foot Sanicle.

Canadian Range

In Canada, Bear's-foot Sanicle is known from a 30 km long area along the shores of Vancouver Island centred on Victoria (Figure 4). Less than 1% of the species' range lies within Canada.

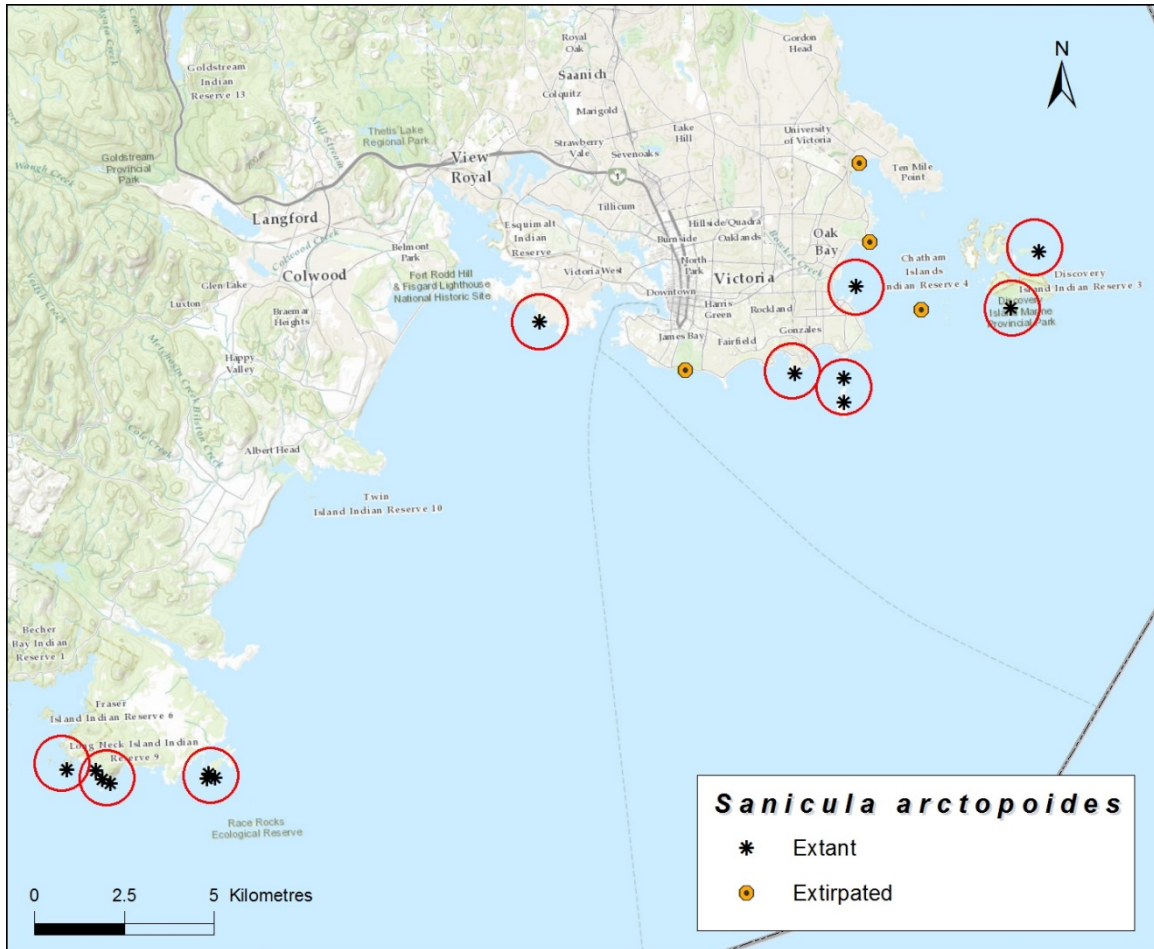


Figure 4. Canadian distribution of Bear's-foot Sanicle. Each circle represents one location. Map prepared by Jenny Wu, COSEWIC Secretariat.

Subpopulations are defined by a separation distance of >1 km of unsuitable habitat or, where part of the same riparian system and not sharing the same water-current flow, a distance of >2 km of unsuitable habitat (NatureServe 2012b). Using this definition, thirteen subpopulations of Bear's-foot Sanicle have been reported from Canada (Table 1). Four of these subpopulations have been lost leaving nine extant subpopulations. The subpopulation reported from Cattle Point appears to have been last observed sometime between 1971 and 1991 (Brayshaw pers. comm. n.d.). This suggests it may have disappeared within the past three generations (42 years). Small areas of suitable habitat remain at the site but Cattle Point receives very heavy trampling and some portions of Cattle Point have been overgrown by carpets of English Ivy (*Hedera helix*).

Table 1. Bear's-foot Sanicle subpopulation and location data.

Subpopulation/ Location	Sites	Most Recent Observer/Date	Mature Individuals	Ownership
1. Trial Islands	1a. Main	Fairbarns/ McCoy 2011	2,476	Mixed Crown
	1b. Lesser	Fairbarns 2011	3	BC Parks Ecoreserve
2. Alpha Islet	single location	Fairbarns 2012	31	BC Parks Ecoreserve
3. Discovery Island	single location	Fairbarns 2012	2	BC Marine Park
4. Saxe Point	single location	Fairbarns 2011	93	Municipal Park
5. Mary Tod Island	single location	Fairbarns 2012	47	Municipal Park
6. Harling Point	single location	Fairbarns 2011	153	Private
7. Bentinck Island*	7a. West	Miskelly 2012	0 ^a	DND
	7b. Southwest	Miskelly 2012	4	DND
	7c. Beach	Miskelly 2012	0 ^a	DND
8. Bedford Islands	single location	Fairbarns 2008	69	Indian Reserve
9. Becher Bay*	9a. Seedbank	Miskelly 2012	0 ^a	DND
	9b. Minuartia	Miskelly 2012	19	DND
	9c. Swordfish	Miskelly 2010	1	DND
10. Cattle Point	n/a	Brayshaw, n.d.	extirpated	Municipal Park
11. Cadboro Bay	n/a	Taylor 1913	extirpated	unknown
12. Beacon Hill	n/a	Eastham 1938	extirpated	Municipal Park
13. Chain Island	n/a	Anderson 1897	extirpated	BC Parks Ecoreserve

* The three sites are separated by very different ecosystem types, which could limit dispersal and threatening events

^a Immature individuals were present

The precise location of the Cadboro Bay population, reported in 1913, is unknown. Most of Cadboro Bay has been converted to residential properties and the remaining area, a municipal park, receives very heavy recreational use.

There are numerous collections from the Beacon Hill subpopulation (including Clover Point) between 1897 and 1938, but the shoreline area in and near Beacon Hill Park has been heavily impacted by trampling, dog-walking, invasive species and residential development, which presumably led to the extirpation of the subpopulation.

The subpopulation on Chain Island has not been reported since 1897 and the island is now dominated by invasive herbaceous plants with very little left of the native flora. The cormorant (both Pelagic and Double-crested) colonies on Great Chain Island and adjacent islets increased dramatically in size in the last half of the 20th century (Campbell 1983)—this probably exacerbated/accelerated the invasive plant problem, and radically changed the soil chemistry of the islands.

The earliest Canadian records of Bear's-foot Sanicle come from collections made in 1897 (UBC herbarium specimen accession # 28817).

The nearest US subpopulation (San Juan Islands) is approximately 25 km from the Canadian extent of occurrence.

Extent of Occurrence and Area of Occupancy

The *apparent* extent of occurrence and area of occupancy has increased considerably since 1999, when fieldwork was conducted for the original status report. This is almost certainly an artifact of an increased search effort as the four subpopulations discovered since 1999 were probably present before then, as evidenced by the presence of numerous subpopulations of other rare species in their vicinity, which had also not been discovered prior to 1999.

The smallest convex-sided polygon containing all Canadian subpopulations measures 119 km². The loss of the subpopulation at Cattle Point over the past three generations has resulted in a 5% decline in the extent of occurrence.

Some of the subpopulations are relatively close together; consequently, only nine cells in a 2 km x 2 km grid are occupied. As a result, the index of area of occupancy is 36 km². The actual area of habitat occupied by the species is less than 1 ha. The loss of the subpopulation at Cattle Point has resulted in a 10% decline in the index of area of occupancy over the past three generations.

Search Effort

Because of its striking appearance, its preference for open habitats where it stands out, and its perennial habit, Bear's-foot Sanicle is more likely than most other rare plants to be reported through incidental observations. Numerous suitable sites have been surveyed since the early 1980s in a series of field trips that documented the distribution of rare plants in open meadows in southeast Vancouver Island and the Gulf Islands. The principal investigators included Adolf and Oldriska Ceska, Matt Fairbarns, Hans Roemer, Jenifer Penny, Chris Brayshaw, Harvey Janszen, Frank Lomer and George Douglas, all of whom are familiar with the species.

Fairbarns conducted a detailed search for Bear's-foot Sanicle in forty-one meadow complexes on southeast Vancouver Island and offshore islets and islands between 2002 and 2012. The surveys included detailed examination of over 95% of the maritime meadow complexes (approximately 200 in total) within the known extent of occurrence in Canada. Sites were examined by walking throughout maritime meadow complexes. Any promising habitat (with vegetation and site conditions similar to those occurring in one or more known Canadian sites) found in this fashion was examined in detail by using the "meander search" survey method which is typically followed for reconnaissance surveys in complex terrain. This involved walking through each target site and searching for Bear's-foot Sanicle in all microhabitats that resemble areas where it had been previously found. The major drawback of the meander search approach is a tendency for surveyors to oversample areas that are easier to walk in. This was addressed by overlaying a gridded transect survey in areas where habitat conditions were most suited to Bear's-foot Sanicle.

HABITAT

Habitat Requirements

In the US, Bear's-foot Sanicle is largely restricted to coastal bluffs, headlands and dunes at elevations of less than 250 m (Hitchcock *et al* 1961; Constance and Wetherwax 2013). In Washington State, it has been collected from open grassy areas, either on shallow soils over bedrock or on stable sand dunes (Consortium of Pacific Northwest Herbaria 2007-2011).

In Canada, Bear's-foot Sanicle is restricted to maritime meadows in the Coastal Douglas-fir Biogeoclimatic Zone. It has been found at elevations ranging from 3-8 m and slope angles of 2-50%. Slope aspect varies but most sites face southwest and none with slopes of > 5% are oriented northeast. The soils are usually 10-20 cm deep over bedrock but are sometimes shallower, while on sites that are particularly exposed to wind, the soil is occasionally over 25 cm deep. Exposed bedrock is often present and may cover as much as 25% of sites where Bear's-foot Sanicle is present. The cover of exposed cobbles and stones rarely exceeds 2%. The cover of bare mineral soil varies from 0-15% but is generally under 2%. Soils of the maritime meadows experience wide seasonal moisture fluctuations. They gradually moisten with the onset of autumn/winter rains and remain moist

for long periods in the winter, although the soil is rarely saturated. The soil gradually dries out in the late spring and early summer as a result of higher temperatures and scant summer precipitation. The soil is dry by late summer, when most of the vegetation has died back. The prolonged summer drought discourages the growth of native trees and shrubs although the exotic invasive Scotch Broom (*Cytisus scoparius*) is often present. Bear's-foot Sanicle usually occurs in vegetation dominated by low (< 20 cm tall) forbs and grasses. A few native species may be relatively common in the vegetation but exotic, invasive forbs and grasses tend to dominate (Fairbarns pers. obs.).

Habitat Trends

In Canada, Bear's-foot Sanicle is restricted to Garry Oak and associated ecosystems. Within the suite of Garry Oak and associated ecosystems, Bear's-foot Sanicle is restricted to vestigial patches of natural and semi-natural habitat along the shoreline of Victoria and outlying communities. Its discontinuous distribution in a habitat type that was relatively extensive prior to residential development suggests that the species was once relatively widespread within its limited extent of occurrence.

The extent and condition of Garry Oak ecosystems in Canada have declined by more than 95% since the mid-19th century. Many factors contributed to the decline of Garry Oak ecosystems including clearing for agriculture and residential property development, and fire suppression (which led to forest infilling and ingrowth) (Lea 2006). Fairbarns (pers. obs.) examined the habitats where Bear's-foot Sanicle occurs or was formerly present and used this information to analyze the degree to which such habitats have been lost, based on an examination of aerial photography and site visits throughout its range in Canada. He found that forest ingrowth and infilling have had little effect on the extent of suitable habitat for Bear's-foot Sanicle but over 95% of formerly suitable habitat had been lost to residential and commercial property development by the mid-20th century. Pressures to develop areas with Bear's-foot Sanicle continued at least until 1990, when an application was made to rezone the rocky southern portion of Harling Point (where Bear's-foot Sanicle persists) to allow for residential property development. The District of Oak Bay turned down the request and zoned the entire property as a cemetery use zone making residential development impractical (Lai 2010). The other remaining subpopulations of Bear's-foot Sanicle occur on public lands, primarily within parks and protected areas. While habitat loss has, therefore, been the greatest threat to Bear's-foot Sanicle in the past, little further direct loss due to development is anticipated.

In contrast, a continuing increase in the abundance and diversity of exotic plants (see **THREATS AND LIMITING FACTORS**) is driving a continuing, observed decline in habitat quality at all sites.

BIOLOGY

Much of the available information on the field biology of Bear's-foot Sanicle comes from a series of small studies of the species in its range in Canada (Fairbarns 2005a,b, 2009). These sources of information have been supplemented by unpublished observations (Fairbarns pers. obs.) as well as those of other naturalists and botanists.

Life Cycle and Reproduction

Bear's-foot Sanicle is a perennial species and it is dormant during the dry summer months and the early autumn. Existing plants tend to break dormancy in October or early November, soon after the soil has been moistened by the first autumn rains, but grow very slowly over the winter months. In contrast, most germination occurs between January and early March. Germination rarely extends beyond April (Fairbarns 2005a).

Rates of germination/early establishment are higher on exposed mineral soil than on even the thin layer of plant litter characteristic of maritime meadows (Fairbarns 2005b, 2009).

The most vigorous seedlings tend to produce a stout taproot by early March. Above-ground vegetative growth of both seedlings and overwintering plants is concentrated in March and April. Plants tend to reach their maximum size by April and leaves tend to fade, discolour or wither by May. Seedlings and plants with fewer than five leaves tend to die back first while large, non-reproductive rosettes remain green longest into late spring or early summer. By June or early July all shoots have died back (Fairbarns 2005a, 2009).

Bear's-foot Sanicle does not form clones. Bear's-foot Sanicle has a monocarpic life cycle; it flowers and fruits once and then dies. Bear's-foot Sanicle is andromonoecious, producing both bisexual and staminate flowers on the same plant. Larger flowering plants, which tend to flower earliest, tend to produce a high proportion of staminate flowers on the last umbels that they produce. Smaller flowering plants, which mature somewhat later in the season, may benefit from the abundance of pollen produced by the final umbels produced by their larger neighbours, which may explain the adaptive significance of the lower proportion of staminate flowers in their late-developing umbels (Lowenberg 1997).

Floral buds first become evident as early as February but flowers do not fully open until March or April. The flower stalks are quite short when flowering begins, consequently they form compact cushions nestled within the cup of basal leaves. Pollinators, particularly bumblebees, are abundant during the flowering season and most inflorescences produce at least some filled seed. Flowering occasionally extends into May but most reproductive plants bear green fruit by mid-May. A few late-developing umbels may produce flowers but fail to produce viable seeds before the plant dies as the result of moisture stress brought on by summer drought (Fairbarns 2005a).

Three experiments, one in a garden setting and two in maritime meadows, indicated that the seed bank created by Bear's-foot Sanicle is largely transient and that most seeds either germinate in the first year or perish in the soil (Fairbarns 2005b, 2009). Amongst plants that have germinated, almost all mortality occurs in the twelve months following germination. In an *in situ* experiment examining seedling fate (apart from those seedlings that die within the first few weeks and were therefore never detected) approximately 16.9% of seedlings died within their first four years of growth (Fairbarns 2009). Fairbarns (2005a) estimated the average age of reproductive individuals (generation time) to be about 13-14 years using a simple analysis of demographic data collected over a three year period at each of three sites. This estimate should be treated with caution because data collected over a short period, from a small number of sites, cause difficulties in parameter estimation, which in turn leads to uncertain estimates of generation time.

Physiology and Adaptability

The physiology of Bear's-foot Sanicle has not been studied. The apparent short life of seed banks in the soil suggests that the species is not adapted to extended (multi-year) periods of conditions unsuited to germination. As an herbaceous perennial species, Bear's-foot Sanicle survives summer drought and winter cold by dying back to the ground.

There is no record of the species being grown to maturity in horticultural environments nor is there any record of attempts to plant out propagated Bear's-foot Sanicle into natural environments.

Dispersal and Migration

As flowers mature, and particularly after pollination, the elongating flowering stalks lift the reproductive structures well above the basal leaves. Ripe fruit have usually developed by mid- to late June and dehiscence tends to begin shortly afterwards (Fairbarns 2005a).

The small (2-5 mm long) dry fruits are covered with hooked bristles which may serve to aid in dispersal, by catching on the fur and feathers of passing animals, as well as on clothing. At most sites, fruit dispersal may continue until August or September and a few undispersed fruit are sometimes present in early October. If the dead stalks are broken before all of their fruits have been dispersed, they may be blown short distances in a "tumbleweed" fashion. Fruits are sometimes dispersed earlier at sites where there is considerable foot traffic, because walkers tend to pick up seeds as they pass by or actually crush the dead shoots. Most dispersal on Canada Coast Guard property on Trial Islands ends abruptly when the plots are first mown, although fruits on some prostrate plants occasionally survived mowing (Fairbarns 2005a).

Surprisingly, subpopulations rarely expand into unoccupied, apparently suitable habitat, even near large subpopulations (Fairbarns pers. obs.). It is possible that the unoccupied habitat is not suitable for Bear's-foot Sanicle but this is implausible given the similarities in soil structure, lithology and vegetation composition of the unoccupied sites in question. It is also possible that fruits are rarely deposited in sufficient numbers in nearby suitable unoccupied habitat to enable the establishment of new subpopulations.

Interspecific Interactions

Lowenberg (1994) examined the effect of floral herbivory on Bear's-foot Sanicle. Plants were able to fully compensate from the loss of up to 1/3 of their flowers, as long as it occurred as a single event early in the flowering season. Plants were not able to fully compensate for the effects of repeat clipping, clipping late in the flowering season, or clipping of the majority of the flowering material. The only evidence of herbivory observed in Canadian subpopulations was the result of grazing by Canada Geese (*Branta canadensis*) (see **THREATS AND LIMITING FACTORS**).

SUBPOPULATION SIZES AND TRENDS

Sampling Effort and Methods

For the purposes of this report, the term "mature individual" refers to a plant that has shown at least some development of reproductive tissues such as flower buds. All but one of the known sites were visited between 2010 and 2012 (Table 1). The exception (the Bedford Islands site, where access is difficult) was last visited in 2008. The mature individuals were counted at each site. Visits were conducted in late March, April and early May when flowering was at its peak. There was no ambiguity regarding what constitutes an individual because of the distinct rosettes formed by the species and the lack of rhizomes or any form of asexual reproduction. The sites where Bear's-foot Sanicle was known to occur were small and thorough searches could be conducted with ease. The large, bright yellow inflorescences ensured that flowering individuals were not likely to be overlooked. Immature individuals were not examined because of the difficulty of properly counting small, non-flowering individuals and because juvenile plants may enter dormancy or die quickly in response to brief, sharp periods of drought.

Abundance

The current Canadian population is estimated at 2,898 mature individuals (Table 1). Approximately 85% of the Canadian population occurs on Trial Islands. The only other Canadian subpopulation that consistently produces > 100 mature individuals is at Harling Point, a headland on Vancouver Island close to Trial Islands.

Fluctuations and Trends

The extent and condition of apparently suitable habitat within the Canadian range of Bear's-foot Sanicle declined by more than 95% in the 100 years following initial European colonization in the mid-nineteenth century and the mid-20th century, at which time most of the waterfront, apart from municipal parks, had been converted to residential and commercial properties (see **Habitat Trends**) and a commensurate decline in the Canadian population of Bear's-foot Sanicle is plausible. There is no evidence that any subpopulations have been lost due to habitat conversion since the 1950s.

Fluctuations and trends (Table 2) over the past 3 generations (estimated at 42 years) are difficult to quantify due to the limited data collected and inadequate documentation of methods used in some of the older surveys.

Table 2. Historical subpopulation data.

Subpopulation /Site	Year	Observer	Population Estimate	Notes
Trial Islands – main island	1951	unknown	No count	
	1961	Calder	No count	
	1964	Hatt	No count	
	1966	Turner	No count	
	1974	Brayshaw	No count	
	1992	Douglas	No count	
	1999	Donovan	6,713	May have included non-flowering individuals
	2002	Fairbarns	2,000-3,000	Flowering individuals
	2006	Fairbarns	5,781	Flowering individuals
	2011	Fairbarns & McCoy	2,476	Flowering individuals
Alpha Islet	1992	Roemer	No count	
	1999	Donovan and Douglas	52	Flowering individuals
	2012	Fairbarns	31	Flowering individuals
Discovery Island	2002	Miller	9	Flowering individuals
	2009	Fairbarns	12	Flowering individuals
	2012	Fairbarns	2	Flowering individuals
Saxe Point	1955	Unknown	No count	
	1961	Calder	No count	
	1963	Meyer	No count	
	1991	Cadrin	No count	
	1999	Donovan	1,145	May have included non-flowering individuals
	2006	Cadrin	745	Flowering individuals
	2009	Penny	1,133	Flowering individuals
	2011	Fairbarns	93	Flowering individuals

Subpopulation /Site	Year	Observer	Population Estimate	Notes
Mary Tod Island	2001	Douglas and Donovan	97	Flowering individuals; reported from 2 locations
	2012	Fairbarns	47	Flowering individuals; no discontinuities so merged into a single location
Harling Point	1954	Unknown	No count	
	1961	Calder	No count	
	1975	Fyles	No count	
	1978	Douglas	No count	
	1991	Douglas and Donovan	81	Flowering individuals
	2000	Fairbarns	107	Flowering individuals
	2002	Fairbarns	50-70	Flowering individuals
	2006	Fairbarns	178	Flowering individuals
Bentinck Island	2011	Fairbarns	153	Flowering individuals
	1983	Ceska	No count	
	1999	Donovan	71	Includes non-flowering individuals; did not report any flowering individuals
	2002	Fairbarns	3	Flowering individuals
Bedford Islands	2012	Miskelly	4	Flowering individuals
	2009	Fairbarns	69	Flowering Individuals
Becher Bay - Swordfish	2003	Fairbarns	6	Flowering individuals
	2005	Fairbarns	11	Flowering individuals
	2006	Fairbarns	2	Flowering individuals
	2010	Miskelly	1	Flowering individuals
Becher Bay - Minuartia	2003	Fairbarns	14	Flowering individuals
	2004	Fairbarns	31	Flowering individuals
	2007	Fairbarns	26	Flowering individuals
	2012	Miskelly	19	Flowering individuals
Becher Bay - Seedbank	2002	Fairbarns	0	Flowering individuals
	2003	Fairbarns	2	Flowering individuals
	2007	Fairbarns	4	Flowering Individuals
	2012	Miskelly	0	Flowering Individuals

Source: BC Conservation Data Centre 2012, Fairbarns pers. obs.

A significant decline in the size of the Trial Islands subpopulation during the latter third of the 20th century is inferred from air photographs which show, during this period, a major increase in the cover of patches of Scotch Broom, English Ivy and other invasive woody species beyond densities generally tolerated by Bear's-foot Sanicle. Woody invasive species are not abundant within the subpopulations of Bear's-foot Sanicle at Saxe Point, Harling Point, or Alpha Islet so there is no basis for inferring that invasive woody species affected subpopulation sizes at those sites during the late 20th century. Woody invasive species were relatively uncommon within the Bear's-foot Sanicle subpopulation at Bentinck Island until the early 21st century.

Recent increases in the cover of invasive species on Mary Tod Island, Bentinck Island, and at Becher Bay similarly suggest a decline in habitat quality and likely in the abundance of Bear's-foot Sanicle at these three sites. Increased trampling damage between 2000 and 2015 within the habitat occupied by Bear's-foot Sanicle at Harling Point (Fairbarns pers. obs.) suggests a decline in that subpopulation as well. Most of the plausible decline in the Canadian population of Bear's-foot Sanicle at extant sites probably occurred between 1970 and 2012.

Brayshaw's (pers. comm. n.d.) report of Bear's-foot Sanicle from Cattle Point was based on a map showing locations of rare plants observed at the site since 1970 so the loss of that subpopulation has likely occurred within the past 3 generations.

The subpopulations on the Chain Islets, at Cadboro Bay, and in Beacon Hill Park have not been seen since 1938 or earlier, and are therefore considered extirpated.

The subpopulations on Mary Tod Island, Discovery Island, the Bedford Islands, and Becher Bay were discovered subsequent to field studies that supported preparation of the initial status report in 2000. These localities had received little previous attention from botanists and it is likely that their subpopulations of Bear's-foot Sanicle have long been present and had simply escaped notice until recently. Douglas and Donovan observed approximately 100 mature individuals on Mary Tod Island when they discovered the subpopulation in 2001 and Fairbarns found 47 mature individuals in 2012.

The Bear's-foot Sanicle population in Canada is not severely fragmented because most of the individuals are found in a single population that occupies more than half the area of occupancy.

Rescue Effect

Bear's-foot Sanicle is critically imperilled (S1) in Washington (WA NHP 2015), where the largest subpopulation has declined precipitously, from at least 2,000 plants in 1982 to 60-75 (mostly vegetative) plants in 2002. More recent reports indicate the decline has continued. There are recent (2005-2009) collections from six small subpopulations (<50 mature individuals) on islands in San Juan County; they are poorly documented but all of them are probably small (Arnett pers. comm. 2012; Giblin pers. comm. 2012).

The U.S. subpopulations are all at least 25 km from the Canadian populations and separated by open ocean. No other subpopulations have been reported from Washington State in recent years although there are old records from low elevations in the southwest Olympic Peninsula (Buckingham *et al* 1995). There is, therefore, little prospect of rescue if the Canadian population became extirpated.

THREATS AND LIMITING FACTORS

The major limiting factor across the Canadian range of Bear's-foot Sanicle is its restriction to a rare habitat type within a small area in Canada. Direct threats facing Bear's-foot Sanicle assessed in this report were organized and evaluated based on the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Master *et al*/2009). Threats are defined as the proximate activities or processes that directly and negatively affect the Bear's-foot Sanicle population. Results on the impact, scope, severity, and timing of threats are presented in tabular form in Appendix 1. The overall calculated and assigned threat impact is High-Medium.

Invasive Plant Species (8.1 Invasive Non-Native/Alien Species)

A continuing increase in the abundance and diversity of exotic plants and consequent decline in habitat quality constitutes the most serious threat to all extant subpopulations of Bear's-foot Sanicle over the next three generations. Currently, most subpopulations occur in vegetation that has a substantial component of non-native species of shrubs, grasses and forbs, and these non-native species continue to increase at the expense of native plants (Fairbarns pers. obs.).

The most common exotic shrubs in Canadian habitats still supporting Bear's-foot Sanicle are Scotch Broom and European Gorse (*Ulex europaeus*) (Fairbarns pers. obs.). Bear's-foot Sanicle appears to tolerate the slightly lower light conditions found within open stands of Scotch Broom, but is absent from patches of European Gorse and denser, mature stands of Scotch Broom. Grove *et al* (2012) found evidence that Scotch Broom may produce allelopathic compounds, which can have long-lasting effects on ecosystems by altering soil microbial communities, although their use of activated carbon to test for signs of allelopathy may lead to false conclusions (Lau *et al* 2008). Spurge-laurel (*Daphne laureola*), another exotic invasive shrub, is present in most subpopulations of Bear's-foot Sanicle but has not yet become dominant in these locations (Fairbarns pers. obs.). Elsewhere in the region, however, Spurge-laurel has formed dense stands that exclude almost all other species. It appears that Spurge-laurel, which has only recently become widespread in the region, presents an increasing threat to subpopulations of Bear's-foot Sanicle. English Ivy is another exotic species that presents a major and growing threat to Bear's-foot Sanicle. In open meadows, English Ivy often forms a solid mat of vines that shade out all herbaceous plants. Exotic shrubs and English Ivy constitute severe threats to Bear's-foot Sanicle on the Trial Islands and Mary Tod Island, which support over 85% of the Canadian population of Bear's-foot Sanicle. A series of projects, beginning in 2002 and supported with assistance from the Habitat Stewardship Program since 2006, has reduced the abundance of exotic woody shrubs and English Ivy on Trial Islands (present funding scheduled to end in 2016). As a result of these efforts, over 95% of the biomass of Scotch Broom had been removed from Trial Islands by 2012 along with about 10% of the English Ivy. It is not possible to quantify the benefits of Scotch Broom or English Ivy removal on Bear's-foot Sanicle because any improvements are masked by fluctuations in subpopulation numbers and the lag period that results from the slow spread and maturation of Bear's-foot Sanicle. Nevertheless, there is little doubt that Scotch Broom would have

continued to increase in cover and density where it formerly occurred as well as spreading into areas it had not yet reached (Fairbarns pers. obs.).

Scotch Broom has a long-lived seed bank; its seed may persist for up to 30 years in natural environments (Smith and Harlen 1991; Bossard 2000) although reports of seedbank longevity of up to 80 years should be dismissed as they are based on a study of seeds stored in glass bottles in museums (Turner 1933). Due to its long-lived seedbank, Scotch Broom is expected to rapidly re-invade cleared areas without significant continued efforts.

Exotic grasses and forbs tend to be an abundant component of the herb layer in all subpopulations of Bear's-foot Sanicle. Rosette-forming perennials such as Hairy Cat's-ear (*Hypochaeris radicata*) and sod-forming grasses such as Kentucky Bluegrass (*Poa pratensis*) pre-empt space, reducing the availability of safe germination sites. Taller invasive herbaceous plants create too much shade for Bear's-foot Sanicle to flourish. Tall exotic perennial grasses such as Orchard Grass (*Dactylis glomerata*) and Common Velvet Grass (*Holcus lanatus*) are continuing to increase in some meadows where Bear's-foot Sanicle occurs, preempting space, reducing light levels and smothering sanicle plants under annual accumulations of thatch (Fairbarns pers. obs.).

Herbivory (8.2 Problematic Native Species)

A non-migratory and newly resident population of Canada Geese has recently become a threat to Bears-foot Sanicle and poses a threat only second to that from invasive plants. Until the late 1950s, Canada Geese were migrants and sometimes summer visitors in the region. Christmas bird counts did not report Canada Geese until 1958. Since then, transplanted goslings and breeding stock were introduced to coastal British Columbia. These introduced birds, which did not imprint on migratory stock, became year-round residents (EBB Environmental Consulting Ltd. 2012).

Overwintering Canada Goose numbers in Victoria have increased rapidly since the late 1980s (Figure 5) and a continued exponential increase in goose numbers is predicted unless a new management regime is adopted (EBB Environmental Consulting Ltd. 2012).

Modelling suggests that Canada Goose numbers in the Capital Regional District will only decline if an egg addling program is implemented along with an annual cull of at least 100 birds, and that the population is likely to resume exponential growth if the addling + cull program is discontinued (EBB Environmental Consulting Ltd. 2012). Egg addling permits have been approved for Trial Islands each year since 2013. Since then very few goslings have been reported from Trial Islands; however, the islands continue to be used by adult geese throughout the year and the area damaged by geese continues to expand (Fairbarns pers. obs.). Annual culls of adult birds have not been possible (Fairbarns pers. obs.).

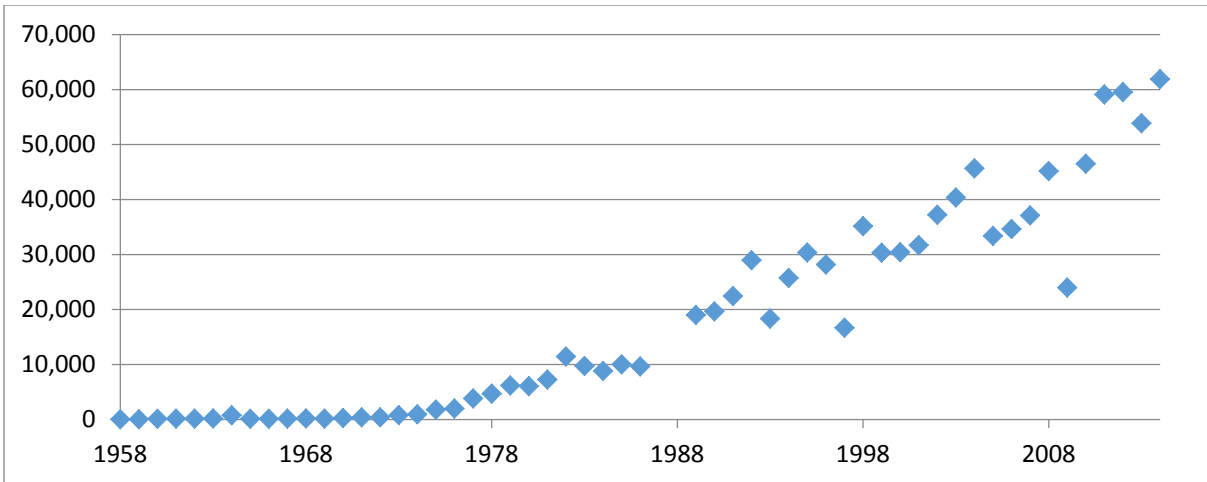


Figure 5. Wintering Goose Population in Victoria, British Columbia: 1958-2014. Graph prepared by Matt Fairbarns using data from National Audubon Society 2010.

Canada Geese were not resident on Trial Islands until about 2002 (Fairbarns pers. obs.). Since then, the number of nests on the main Trial Island has increased exponentially, and in April 2012 Dickman (pers. comm.) observed 104 adults, forming 48 pairs and creating 25 detectable nests. She noted that these numbers confirmed a continuing trend of increasing numbers from 2010-2012. As the population numbers increase, new areas of Trial Islands are converted from natural vegetation to a mowed appearance. Grazing-sensitive native species are replaced by more resilient species, primarily invasive grasses. As well, many sanicle plants are heavily grazed and the grazing is often sufficiently intense and late in season to depress or eliminate seed production (Fairbarns pers. obs.). Similarly, Isaac-Renton *et al* (2010) found that in the southern Gulf Islands of British Columbia there were significant positive relationships between the percent cover of goose feces and exotic annual grasses. They speculated that immediate reductions in Canada Goose populations in the area may prevent the expansion of zones dominated by annual grasses but were uncertain of the potential for damaged areas to recover to native vegetation if geese were removed.

Canada Goose eradication on Trial Islands is complicated by the inclusion of the area within the Victoria Harbour Migratory Bird Sanctuary (Environment Canada n.d.). Canada Geese have also been making increasing use of meadow areas at several of the other locations of Bear's-foot Sanicle in Canada (Fairbarns pers. obs.).

Construction and Facility Maintenance (1.2 Commercial and industrial areas)

The Trial Islands subpopulation of Bear's-foot Sanicle has been directly and indirectly impacted by a variety of construction, maintenance and operational activities associated with the infrastructure on the communications lease and the lighthouse.

In the communications lease, the impacts to Bear's-foot Sanicle have occurred primarily along and adjacent to informal footpaths linking buildings. In the late 1990s herbicide was applied in order to control vegetation impeding the movement of materials along at least one footpath, where it passed through a patch of Bear's-foot Sanicle. In the late 2000s an ATV, used to move materials from the beach to various outbuildings, passed over an area of Bear's-foot Sanicle, crushing a number of juvenile and mature plants. Also in the late 2000s a trench was dug through a patch of Bear's-foot Sanicle to allow electrical wires to be buried below ground (Fairbarns pers. obs.).

In 2012-13 the existing radio communication towers were removed and replaced. The leaseholder established an agreement with the BC Ministry of Forests, Lands and Natural Resource Operations that included provisions to protect species and ecosystems at risk during the construction and maintenance activities. The initial construction phase (completed between Sept 16-27, 2012) had little impact on rare species or ecosystems because the equipment was moved by foot, and because the late onset of summer/autumn rains maintained plants in a dormant state until after the construction activities had been completed (Fairbarns pers. obs.).

The 2013 construction activities led to greater damage because much heavier equipment was needed to prepare difficult sites and move heavy materials. The subsequent cohort of plants consisted primarily of small to mid-sized individuals as the larger individuals had lost vigour and/or died. Two years later, the number of flowering plants had reached or surpassed pre-construction levels (Fairbarns pers. obs.; Miskelly pers. comm. 2015).

Trampling (6.1 Recreational activities)

Bear's-foot Sanicle appears to thrive in areas with light trampling. The species grows well in lightly trampled areas of Saxe Point, Trial Islands and Harling Point (Donovan and Douglas 2000; Fairbarns pers. obs.), likely because foot traffic discourages the growth of tall (for the most part exotic, invasive) plants that would otherwise shade out Bear's-foot Sanicle. Bear's-foot Sanicle is, however, rare or absent from heavily trampled areas at Saxe Point and Harling Point where mineral soil has been exposed and eroded by foot traffic over the past few decades. Foot traffic is unlikely to decline, and trampling damage will likely cause additional erosion at these sites.

Oil Spill Response (6.3 Work & other activities)

Although an oil spill has a low probability of occurrence, tankers do move through the Strait of Juan de Fuca. A response to an oil spill could potentially impact sites located on small islands as there is limited land to set up a response station.

Climate Change (11.1 Habitat shifting & alteration & 11.4 Storms & flooding)

Climate change models differ in their predictions of changes in temperature and precipitation (Murdock and Spittlehouse 2011) so the potential mechanisms by which climate change will affect Bear's-foot Sanicle are unclear. Nevertheless, presuming that existing sites will experience significant changes in soil moisture and temperature regimes, it seems likely that their capacity to support Bear's-foot Sanicle will decline even though there may be a compensatory increase in the abundance of climatically suitable unoccupied sites. The apparent inability of Bear's-foot Sanicle to spread into apparently suitable unoccupied habitat (see **Life Cycle and Reproduction**) suggests that any significant degree of climate change may reduce the Canadian subpopulation of Bear's-foot Sanicle unless attempts at assisted dispersal are successful.

Climate change is also changing sea levels. The rise in sea level in conjunction with storms increases the threat to some subpopulations.

Military Use (6.2 Military Exercises)

Although some military use is possible at Bentinck Island, the site is known by the military.

Natural System Modifications

A change in fire regimes (7.1 Fire & fire suppression) from historical First Nations burning is difficult to quantify but has occurred. Mowing (7.3 Other ecosystem modifications) is conducted in some areas but has negligible impact overall, at this time.

Number of Locations

There have been 13 documented locations of Bear's-foot Sanicle in Canada and the species has disappeared from four of these locations. All extant Canadian subpopulations are threatened by one or more factors. Although invasive species comprise the primary threat to each of the Canadian subpopulations, secondary threats vary by subpopulation and management action to control threats is most likely to be directed toward individual subpopulations. As such, each of the nine subpopulations is considered a separate location (Table 1). Each subpopulation occupies a small area (12 ha or less) where a single threatening event or process could rapidly affect all individuals. Three of the nine locations/subpopulations had fewer than 20 mature individuals, and five had fewer than 50 mature individuals, in 2011/2012. The three smallest subpopulations/locations face a serious, although unquantifiable, risk of demographic collapse.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

The Province of British Columbia has no stand-alone species-at-risk legislation to protect subpopulations of species at risk on non-federal lands.

Bear's-foot Sanicle was assessed by COSEWIC as Endangered in 2000, and was reassessed as Threatened in 2015. This species (is protected on federal lands under Schedule 1 of the federal *Species at Risk Act* (SARA) and afforded measures of nominal protection under that legislation. This constitutes about 30 percent of the Canadian population.

Bear's-foot Sanicle has been included within a recovery strategy for rare species of maritime meadows associated Garry Oak ecosystems (Parks Canada 2006). The strategy establishes two goals for the recovery of Bear's-foot Sanicle, one calling for the maintenance of all existing subpopulations at no less than their current levels of abundance and the other calling for the establishment of a minimum of two more subpopulations. Over the subsequent nine years there has been no monitoring program to effectively determine whether the Canadian population is increasing, decreasing or merely fluctuating without evident trend so the goal of maintaining existing subpopulations at no less than their current levels of abundance cannot be evaluated. There have been no attempts to establish new subpopulations in order to meet the second goal. The recovery strategy establishes a number of recovery objectives for the 2006-2015 period designed to meet these goals. The objectives relating to protection of Bear's-foot Sanicle, and the degree of success in achieving these objectives, are as follows:

1. Establish protection for existing known populations: No protection agreements have been established for subpopulations on private or public lands except where those protections existed before implementation of the recovery strategy.
2. Engage the cooperation of all involved landowners and land managers in habitat protection: Several landowners and land managers have permitted, encouraged or even led efforts to protect habitat occupied by Bear's-foot Sanicle.
3. Determine the causes of extirpation, and/or population decrease or loss: there have been no formal studies of these issues so our understanding remains based on anecdotal observations and conjecture.
4. Identify and prioritize sites for inventories and conduct surveys to determine whether there are any undocumented populations (i.e. to determine necessity of re-introductions): no progress.
5. Identify critical habitat required to establish new populations, as outlined in species-specific goals: a project to identify such habitat was initiated in 2014.
6. Develop techniques and priorities to establish new populations and one experimental population per species (if appropriate based on above research): no progress.

Non-Legal Status and Ranks

In 1990 Bear's-foot Sanicle was ranked by NatureServe (2012a) as G5 (globally secure). NatureServe has not conducted subsequent reviews on its global status. In Canada it is ranked as N1 (critically imperilled) according to NatureServe (2012a) and has a General Status rank (Canadian Endangered Species Conservation Council 2011) of 1: at risk.

In British Columbia, Bear's-foot Sanicle is ranked S1 (critically imperilled). It is a priority 1 species under the B.C. Conservation Framework (Goal 3: maintain the diversity of native species and ecosystems) and is included on the British Columbia Red List, which consists of species that have been assessed as endangered, threatened or extirpated based on available information. Inclusion on the Red List does not confer any legal protection (B.C. Conservation Data Centre 2012).

Bear's-foot Sanicle is ranked S1 in Washington State but has not been ranked in Oregon or California, where it also occurs (NatureServe 2012a).

Habitat Protection and Ownership

Federal Lands

The small subpopulation on Bentinck Island and the three Becher Bay subpopulation components occur entirely within federal lands managed by the Department of National Defence. A significant portion of the large Trial Islands subpopulation occurs on a light station managed by the Canadian Coast Guard.

The small Bedford Islands subpopulation occurs on an Indian Reserve.

None of the subpopulations on federal lands are regularly managed to control threats such as invasive species; however, these lands still fall under the federal *Species at Risk Act*.

B.C. Protected Areas

The small subpopulation on Discovery Island, the moderate-sized subpopulation on Alpha Islet and a significant portion of the large subpopulation on the Trial Islands lie within B.C. Provincial Parks or Ecological Reserves and are therefore formally protected under general provisions of the *B.C. Parks Act*. This formal protection does not provide effective protection from major threats including habitat changes resulting from invasive woody species or herbivory by Canada Geese. The extirpated subpopulation at Chain Islets occurs within an Ecological Reserve established, primarily because of their seabirds, in 1979; this subpopulation may have been lost before 1979.

Some of the invasive plant species present on the Trial Islands Ecological Reserve are being controlled through a program supported by the federal Habitat Stewardship Program, the Garry Oak Ecosystems Recovery Team, B.C. Parks, and staff time donated by Aruncus Consulting.

Other B.C. Crown Land

A major portion of the Trial Islands subpopulation occurs on B.C. Crown Land leased to a communications firm that has established radio transmission towers and associated infrastructure. There is no legal protection for rare species occurring on the site apart from a lease document that encourages management actions aimed at preventing damage to rare species on the lease and the habitat that supports them.

Municipal Parks

The subpopulations at Saxe Point and Mary Tod Island occur within municipal parks. Although neither of the municipalities involved have legislation protecting the subpopulations of Bear's-foot Sanicle, both currently provide some level of support for their management.

The extirpated subpopulations at Cattle Point and Beacon Hill occurred within municipal parks but this did not prevent their extirpation.

Private Land

The subpopulation at Harling Point occurs on private land owned by the Chinese Consolidated Benevolent Association (CCBA). This area, which has been designated as a National Historic Site, is not formally protected from development. Nevertheless, after an unsuccessful attempt to create a residential subdivision on a portion of the site in the 1990's, the CCBA has declined to pursue further development options and has endorsed volunteer efforts to protect the Bear's-foot Sanicle subpopulation from invasive species.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

Marian McCoy assisted with the fieldwork on Trial Island. Jenifer Penny and Marta Donovan (B.C. Conservation Data Centre) provided useful background information. Dr. David Giblin and Joe Arnett provided invaluable background material as well as information on the distribution and status of subpopulations in Washington State.

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Dr. Rhonda L. Millikin. A/Head Population Assessment, Pacific Wildlife Research Centre. Canadian Wildlife Service. Delta, British Columbia.

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David F. Fraser. Endangered Species Specialist, Ecosystem Branch, Conservation Planning Section. Ministry of Environment, Government of British Columbia. Victoria, British Columbia.

Jenifer Penny. Botanist. British Columbia Conservation Data Centre. Victoria, British Columbia.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Matt Fairbarns has a B.Sc. in Botany from the University of Guelph (1980). He has worked on rare species and ecosystem mapping, inventory and conservation in western Canada for approximately 30 years.

COLLECTIONS EXAMINED

Collections at the University of British Columbia, Royal British Columbia Museum, Simon Fraser University, University of Victoria, Pacific Forestry Centre, and University of Washington, were consulted through the online database of the Consortium of Pacific Northwest Herbaria (2007-2011).

Appendix 1. Threats Assessment for Bear's-foot Sanicle.

Species or Ecosystem Scientific Name	Bear's-foot Sanicle (<i>Sanicula arctopoides</i>)																																								
Element ID		Elcode																																							
Date (Ctrl + “;” for today’s date):	05/11/2015																																								
Assessor(s):	Members: Del Meidinger, Bruce Bennett, Karen Timm. External Experts: Matt Fairbarns (author), Dave Fraser (BC, moderator), Brenda Costanzo (BC), Syd Cannings (EC), Marta Donovan (BC), Louise Blight (BC)																																								
References:																																									
Overall Threat Impact Calculation Help:	<table border="1"> <thead> <tr> <th colspan="2" rowspan="2">Threat Impact</th> <th colspan="2">Level 1 Threat Impact Counts</th> </tr> <tr> <th>high range</th> <th>low range</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Very High</td> <td>0</td> <td>0</td> </tr> <tr> <td>B</td> <td>High</td> <td>1</td> <td>0</td> </tr> <tr> <td>C</td> <td>Medium</td> <td>1</td> <td>1</td> </tr> <tr> <td>D</td> <td>Low</td> <td>1</td> <td>2</td> </tr> <tr> <td colspan="2">Calculated Overall Threat Impact:</td> <td>High</td> <td>Medium</td> </tr> <tr> <td colspan="2">Assigned Overall Threat Impact:</td> <td colspan="2"></td> </tr> <tr> <td colspan="2">Impact Adjustment Reasons:</td> <td colspan="2"></td> </tr> <tr> <td colspan="2">Overall Threat Comments</td> <td colspan="2"> <i>Maritime meadows more abundant in past; maintained in open vegetation condition by burning of areas by First Nations. Considerable urban development in historic area of occupation. Generation time 14 years (x3 = 42 years); major limiting factor = restriction to rare habitat type (maritime meadows)</i> </td> </tr> </tbody> </table>			Threat Impact		Level 1 Threat Impact Counts		high range	low range	A	Very High	0	0	B	High	1	0	C	Medium	1	1	D	Low	1	2	Calculated Overall Threat Impact:		High	Medium	Assigned Overall Threat Impact:				Impact Adjustment Reasons:				Overall Threat Comments		<i>Maritime meadows more abundant in past; maintained in open vegetation condition by burning of areas by First Nations. Considerable urban development in historic area of occupation. Generation time 14 years (x3 = 42 years); major limiting factor = restriction to rare habitat type (maritime meadows)</i>	
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Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
1.1	Housing & urban areas		Not Calculated (outside assessment timeframe)			Insignificant/Negligible (Past or no direct effect)	Definite impact in the past; unlikely in future.
1.2	Commercial & industrial areas	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	At communication lease on Trial Islands, formal and informal footpaths have impacts. Construction in 2012 had low impact; much greater impact with 2013 construction; however, subpopulation appears to have recovered. Construction in the past and unknown when it will return; however, possible as activities have been ongoing.
1.3	Tourism & recreation areas						Some areas are in parks; some of high use, but activity considered under 6.1
2	Agriculture & aquaculture						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors						
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						Some seed collecting.
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	CD	Medium - Low	Restricted - Small (1-30%)	Serious (31-70%)	High (Continuing)	
6.1	Recreational activities	CD	Medium - Low	Restricted - Small (1-30%)	Serious (31-70%)	High (Continuing)	Light trampling OK, perhaps beneficial; possibly due to exclusion of exotic plants. Heavy trampling at Saxe Point and Harling Point impacting on subpopulations.
6.2	War, civil unrest & military exercises		Negligible	Negligible (<1%)	Serious (31-70%)	High (Continuing)	Some military use of Bentinck Island.
6.3	Work & other activities	D	Low	Small (1-10%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs)	Oil spill response is possible threat as it would likely entail onshore bases for cleanup activities; the greatest potential impact would occur if a spill impacted Trial Islands. The areas near the shoreline are at greatest risk to response activities. Possible at any time, but low probability.
7	Natural system modifications		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
7.1	Fire & fire suppression		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Suppression of fire from historic burning by First Nations.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.2	Dams & water management/use						
7.3	Other ecosystem modifications		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Mowing is conducted in some areas; impact is dependent upon frequency and timing. Mowing regime at Saxe Pt. has no impact; some annual mowing at Harding Pt. where plants occur and Trial Islands. Mowing at Trial Islands would likely increase if geese were reduced.
8	Invasive & other problematic species & genes	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	roll-up higher because of increased impacts of both.
8.1	Invasive non-native/alien species	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Decline in habitat quality due to increasing abundance and diversity of exotic plants: mostly Scotch Broom & European Gorse; also Spurge-laurel, English Ivy. Severe threat on Trial Islands and Mary Tod Island (85% of Cdn population). Removal program on Trial Islands - may end 2016. If program continues on Trial Islands, scope on Cdn population is reduced. Also exotic grasses & forbs competing for space and light: Hairy Cat's-ear, Kentucky Bluegrass, Orchard Grass, Common Velvet Grass. Potential for rats to eat seeds on some islands.
8.2	Problematic native species	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Exponential increase in numbers of resident Canada Geese since 1980s; some culling & egg addling going on in CRD. Resident on Trial Islands since about 2002; addling initiated 2013 but adult geese are still grazing.
8.3	Introduced genetic material						
9	Pollution						
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events		Not Calculated (outside assessment timeframe)	Large (31-70%)	Serious (31-70%)	Low (Possibly in the long term, >10 yrs)	
10.1	Volcanoes						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10.2	Earthquakes/tsunamis		Not Calculated (outside assessment timeframe)	Large (31-70%)	Serious (31-70%)	Low (Possibly in the long term, >10 yrs)	Possible tsunami impact as a result of a major subduction zone earthquake; while it is plausible that such an event may occur over the next 10 years the chance of this happening is very unlikely, so we have indicated that it is possible in the long term. If a tsunami did happen, Trial Islands would be perpendicular to the incoming tsunami and the impact could be serious. Strictly speaking, it is possible that even over the short term there could be a subduction zone earthquake severe enough to result in a major tsunami event but the probability of such an event happening over the next ten years is so low that the timing component of the tsunami threat assessment was set to "low" to more accurately reflect the risk that tsunamis present to <i>Sanicula arctopoides</i> over the next ten years
10.3	Avalanches/landslides						
11	Climate change & severe weather		Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate - Low	
11.1	Habitat shifting & alteration		Negligible	Negligible (<1%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Potential impact includes changes to soil moisture and temperature regimes. Although <i>S. arctopoides</i> occurs in drier and warmer areas than SE Vancouver Island, local shifting of key habitat may occur and it is unknown if plant will migrate into new habitat as it doesn't appear to spread into what now appears to be OK habitat.
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding		Negligible	Negligible (<1%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs)	Sea level rise increases threat to subpopulations during storms and potential flooding. For the Strait of Georgia, a mean rise, by 2100, of 35 cm, with a min of 18 cm, high of 51 cm. This includes isostatic rebound and rising sea level ... but not the extra impact of higher winter rain and ENSO, etc.

Classification of Threats adopted from IUCN-CMP, Salafsky *et al* (2008).