COSEWIC
Assessment and Status Report

on the

California Sword Fern
Polystichum californicum

in Canada

ENDANGERED
2023

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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California Sword Fern — California Sword Fern. Photograph by Ryan Batten.

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COSEWIC
Assessment Summary

Assessment Summary – May 2023

Common name
California Sword Fern

Scientific name
Polystichum californicum

Status
Endangered

Reason for designation
The Canadian population of this evergreen fern consists of only 48 mature individuals. In Canada, it occurs exclusively on limestone cliffs on Vancouver Island and adjacent Texada Island, in British Columbia. The limestone and associated mineral deposits have commercial value, making the known sites of this fern desirable for quarry operations. Recreational activities, most notably rock climbing, are another potential threat. With the very small number of individuals and the restricted distribution, this plant is at considerable risk of extirpation from Canada.

Occurrence
British Columbia

Status history
Designated Endangered in May 2023.

COSEWIC
Executive Summary

California Sword Fern
Polystichum californicum

Wildlife Species Description and Significance

California Sword Fern is a leathery, evergreen, tufted fern with leaves up to 80 cm in length. The primary leaf divisions have saw-like, spiny teeth, and there are fine threadlike microscales on the undersurface of the leaves.

In Canada, California Sword Fern is at the northern periphery of its range. Canadian plants are found exclusively on limestone cliffs, whereas in the southern part of its range plants are found in a range of moisture and light conditions.

Aboriginal (Indigenous) Knowledge

All species are significant and are interconnected and interrelated. There is no species-specific ATK in the report.

Distribution

California Sword Fern is at the northern limit of its range in southern British Columbia and it is disjunct from the closest confirmed occurrence in Washington by approximately 300 km. In the United States, California Sword Fern occurs southward into Washington, Oregon, and California in the Coast Ranges and Cascade-Sierra physiographic region. It is known from three sites in British Columbia, Canada: two on Texada Island and a third near Horne Lake on Vancouver Island.

Habitat

In Canada, California Sword Fern is found exclusively on limestone cliffs. There are few associated plants here because of its xeric microclimate preference.

Biology

California Sword Fern is a tetraploid (2n=164) that is presumed to take 2 to 5 years to reach maturity and the plants appear to be long-lived. Juvenile California Sword Ferns were observed at Horne Lake but not at either site on Texada Island.

Population Sizes and Trends

The total Canadian population was determined to consist of 48 mature individuals and one immature juvenile in 2021. There do not appear to be fluctuations in the number of mature individuals. Natural rescue of the Canadian population from the United States is theoretically possible but deemed unlikely.

Threats and Limiting Factors

Limestone and associated mineral deposits have high commercial value, making the known sites for California Sword Fern desirable for quarry operations. It is possible that California Sword Fern sites on Texada Island will be impacted by quarrying, but unlikely because of plans for the establishment of a park reserve. The owners of the Horne Lake site are believed to be unlikely to favour quarry development. It is possible but unlikely that logging and wood harvesting activities will impact California Sword Fern. Recreational activities, most notably rock climbing, are a potential threat at Horne Lake but the impact to California Sword Fern plants is expected to be minimal. It is unknown if root rot or other diseases will impact California Sword Fern.

Given the small number of known subpopulations, California Sword Fern numbers may be constrained by a low rate of establishment in the small area of available habitat.

Protection, Status, and Ranks

California Sword Fern is currently not protected under the *Species at Risk Act* and there is no other legal protection for the species in Canada. Provincially, California Sword Fern is red-listed and ranked Critically Imperilled (S1) by the BC Conservation Data Centre. Nationally, it is ranked Critically Imperilled (N1) and, globally, it is ranked Apparently Secure (G4). It is not listed under the Convention on International Trade in Endangered Species (CITES) or the *Endangered Species Act* (United States), and has not been assessed by the International Union for Conservation of Nature (IUCN).

TECHNICAL SUMMARY

Polystichum californicum

California Sword Fern

Polystic de Californie

Range of occurrence in Canada: British Columbia

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	10+ yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations, whichever is longer up to a maximum of 100 years]	Not applicable
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations, whichever is longer up to a maximum of 100 years].	Inferred and suspected stable population
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations, whichever is longer up to a maximum of 100 years].	Suspected total number of mature individuals stable
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any period [10 years, or 3 generations, whichever is longer up to a maximum of 100 years], including both the past and the future.	Inferred and suspected total number mature individuals stable
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Not applicable
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	72 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	12 km²
Is the 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, subpopulations appear to be stable. b. Yes
Number of “locations” (use plausible range to reflect uncertainty if appropriate)	3

Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of “locations” *?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No
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)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Horne Lake (Mt. Mark)	23
Texada Island, Maple Bay	1
Texada Island, Surprise Mountain	24
Total	48

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations whichever is longer up to a maximum of 100 years, or 10% within 100 years]?	Analysis not done

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, see appendix 1. The threat impact is High.

i. 3.2 Mining and Quarrying (High impact)
ii. 5.3 Logging and Wood Harvesting (Possible impact in the long term)
iii. 6.1 Recreational Activities (Possible impact in the long term)
iv. 8.1 Invasive Non-native/Alien Species/Diseases (Possible impact in the long term)
v. 11.2 Droughts (Negligible impact)

What additional limiting factors are relevant?
Unknown degree of dispersal over long distances and uncertain rate of establishment in appropriate habitats. Limited limestone cliff habitat available for northern population. Unknown impacts associated with limited genetic diversity and inbreeding depression.

* See Definitions and Abbreviations on COSEWIC website for more information on this term.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	The closest population outside Canada is 300 km away in Washington and is ranked Critically Imperilled (S1).
Is immigration known or possible?	Unlikely (see above)
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	No
Are conditions for the source (i.e., outside) population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	Unlikely

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC Status History: Designated Endangered in May 2023.

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes:** D1
Reasons for designation: The Canadian population of this evergreen fern consists of only 48 mature individuals. In Canada, it occurs exclusively on limestone cliffs on Vancouver Island and adjacent Texada Island, in British Columbia. The limestone and associated mineral deposits have commercial value, making the known sites of this fern desirable for quarry operations. Recreational activities, most notably rock climbing, are another potential threat. With the very small number of individuals and the restricted distribution, this plant is at considerable risk of extirpation from Canada.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. May meet Threatened, A3c, with suspected future decline in mature individuals of 22-70% based on the High threat impact. However, the timing of the threat is uncertain and may not occur in the next 30 years (3 generations).
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO of 72 km^2 and IAO of 12 km^2 are below the threshold for Endangered. Population is not severely fragmented and does not undergo extreme fluctuations. Population occurs at 3 locations, but there is no observed, projected, or inferred continuing decline in EOO, IAO, habitat, locations, subpopulations, or mature individuals.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect).

Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Number of mature individuals (48) is below threshold for Endangered, but there is no continuing decline, observed, projected, or inferred, in the number of mature individuals.
Criterion D (Very Small or Restricted Population): Meets Endangered, D1**.** Number of mature individuals is 48, below the threshold of 250. Meets Threatened, D2, with a restricted IAO of 12 km^2 and occurring at 3 locations as it is prone to substantial decline from effects of human activities or stochastic activities within 1-2 generations.
Criterion E (Quantitative Analysis): Not applicable. Analysis not conducted.

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
(2023)

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 and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
Service canadien de la faune
Canada

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

COSEWIC Status Report

on the

California Sword Fern

Polystichum californicum

in Canada

2022

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Polystichum californicum* (D.C. Eaton) Diels

Synonyms:

Aspidium californicum D.C. Eaton;

Polystichum aculeatum (Linnaeus) Roth var. *californicum* (D.C. Eaton) Jepson

Common Name: California Sword Fern (also California Shield Fern)

Common French Name: Polystic de Californie

Family: Dryopteridaceae (Wood Fern Family)

Morphological Description

California Sword Fern is a leathery, evergreen, tufted fern with erect to arching leaves that reach 20-80 cm in length (Wagner 1993) (Figures 1 and 2). The petiole (leaf stem) is 1/5 to 1/3 the length of the blade. The blade is lanceolate (lance-shaped) to linear/lanceolate and the blade is slightly narrowed at the base.

The evolutionary origins of California Sword Fern appear to be from ancestral hybridization between Dudley's Sword Fern (*Polystichum dudleyi*) and either Western Sword Fern (*Polystichum munitum*) or Narrow-leaved Sword Fern (*Polystichum imbricans* (Wagner 1993; Smith 2012; Schmeckpeper 2016).

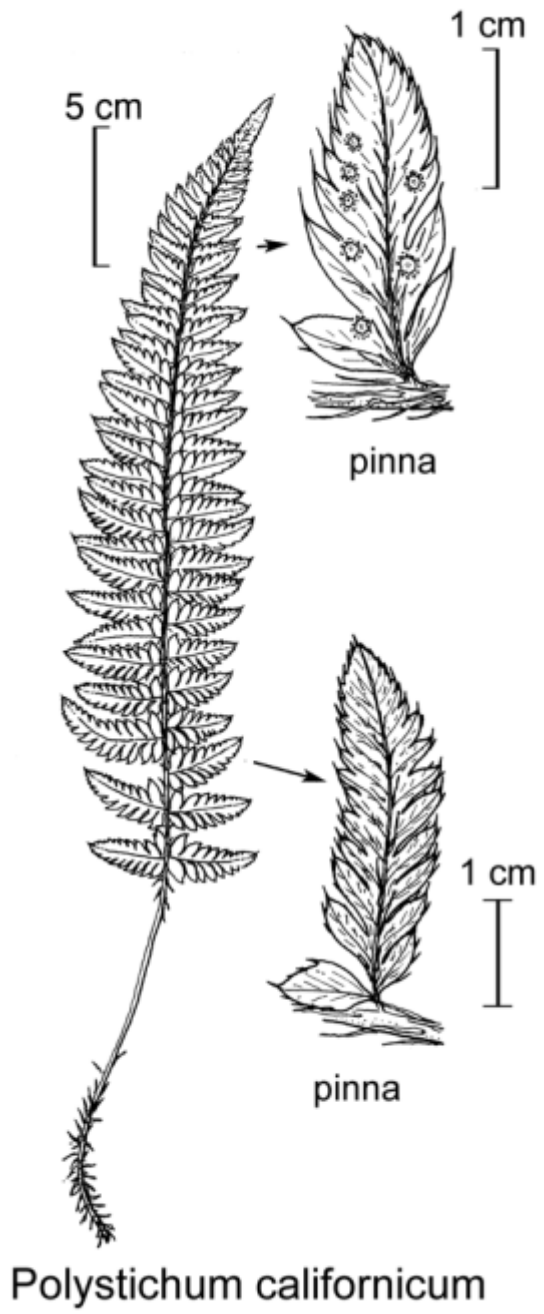

Figure 1. California Sword Fern (Reprinted with permission from Baldwin *et al.* 2012).

Figure 2. Close up of California Sword Fern leaf showing saw-like spiny teeth along the edge of the pinnae. Photo R. Batten (October 10, 2019, Horne Lake).

Stipe and rachis scales are light brown and abruptly decrease in size further up the blade from the roots; they fall off earlier further up the blade (Figure 3). The microscales (small trichomes on the abaxial leaf surface) are filiform (threadlike) and are dense on the undersurface and sparse on the top of the leaves (Wagner 1993). The diagnostic threadlike abaxial scales are postulated to have been inherited from Dudley's Sword Fern (Wagner 1993). Mature spores are brown and are covered by indusia (thin membranes that cover the sporangia), and ciliate with fine hairs at the margins (Figure 4) (Wagner 1993).

Figure 3. Basal scales of California Sword Fern. Photo R. Batten (October 10, 2019, Horne Lake).

Figure 4. Mature sori of California Sword Fern. Note hair-like scales on pinnae. Photo R. Batten (October 10, 2019, Horne Lake).

Infertile backcrosses with parent species are common where the ranges and habitats overlap (Wagner 1993; Smith 2012). At the Horne Lake subpopulation, there are plants that show intermediate characters between California Sword Fern and Western Sword Fern (Figure 5). Western Sword Fern hybrids have less incised pinnae, lack infralaminar scales, and have aborted sporangia (Wagner 1993; Ceska *et al*. 2009a). A hybrid between Narrow-leaved Sword Fern and California Sword fern has only been found once, in Oregon (Callan 1972 in Wagner 1993).

Figure 5. Western Sword Fern (far left), California Sword Fern (far right), and suspected hybrid (middle). Photo R. Batten (October 10, 2019, Horne Lake).

California Sword Fern can be distinguished from Western Sword Fern by its coarse (saw-like) spiny teeth as opposed to the finely toothed pinnae of Western Sword Fern (Figure 5). The provincially red-listed Mountain Holly Fern (*Polystichum scopulinum*) grows in rock outcrops similar to California Sword Fern, but is known in Canada only from the Tulameen River Valley, west of Princeton and Record Ridge, southwest of Rossland in interior British Columbia. Mountain Holly Fern has short scales below rather than the hair-like scales on the underside of the pinnae found in California Sword Fern. Anderson's Holly Fern (*Polystichum andersonii*) is larger than California Sword Fern and grows on the forest floor rather than on rock faces. It has scaly bulblets on the upper 1/3 of the blades between the stems and pinnae bases, whereas California Sword Fern has none.

Population Spatial Structure and Variability

There are 15 species of *Polystichum* in the United States and Canada and between 180 and 500 species worldwide (Wagner 1993; Driscol and Barrington 2007; Jorgensen and Barrington 2017). California Sword Fern is one of six allopolyploid (with ancestral chromosomes from two or more taxa) *Polystichum* species in North America (Soltis *et al.* 1991).

For California Sword Fern, the COSEWIC term “subpopulation” (COSEWIC 2019) corresponds well to the habitat-based plant element occurrence delimitation standards (NatureServe 2021) where a subpopulation is defined using a default separation distance of 1 km, except in the case of riparian corridors, dynamic landscape mosaics and continuous apparently suitable habitat (NatureServe 2020).

Designatable Units

There are no recognized subspecies/varieties or discrete/evolutionarily significant populations that could be recognized as designatable units for the Canadian population. The occurrence of California Sword Fern in Canada is considered one designatable unit.

Special Significance

In Canada, California Sword Fern is at the northern periphery of its range. The Canadian occurrences are disjunct by approximately 300 km from the closest confirmed occurrence in Washington. The habitat of northern populations in Canada and Washington is distinctly different from that of the southern populations. Canadian plants have been found exclusively on limestone cliffs, while in the southern part of its range it is a more versatile species found in a range of moisture and light conditions (CPNWH 2021; Washington Natural Heritage Program 2021).

ABORIGINAL (INDIGENOUS) KNOWLEDGE

Aboriginal Traditional Knowledge (ATK) is relationship-based. It involves information on ecological relationships between humans and their environment, including characteristics of species, habitats, and locations. Laws and protocols for human relationships with the environment are passed on through teachings, stories, and Indigenous languages, and can be based on long-term observations. Place names provide information about harvesting areas, ecological processes, spiritual significance or the products of harvest. ATK can identify life history characteristics of a species or distinct differences between similar species.

Cultural Significance to Indigenous Peoples

This species is culturally significant to Indigenous Peoples who hold detailed knowledge on the evolving, dynamic nature of the species. California Sword Fern is important to Indigenous Peoples who recognize the interrelationships of all species within the ecosystem.

DISTRIBUTION

Global Range

In the United States, California Sword Fern is found in Washington, Oregon, and California in the Coast Ranges and Cascade-Sierra physiographic region (Figure 6). It is most abundant north of San Francisco in the Coast Range (Wagner 1993). The range extends north into British Columbia, Canada.

Figure 6. Global distribution of California Sword Fern. Red polygons in the United States show counties where one or more occurrences have been recorded. and the squares in Canada show generalized locations (more details in Figure 7). Sites in the United States were compiled from the Consortium of Pacific Northwest Herbaria (2022) and GBIF (2022). Map prepared by Alain Filion (COSEWIC Secretariat).

Canadian Range

California Sword Fern is known from three sites in British Columbia, Canada (Figure 7). Two of the sites are approximately 3 km apart on Texada Island and the third is approximately 50 km away on Mt. Mark next to Horne Lake on Vancouver Island.

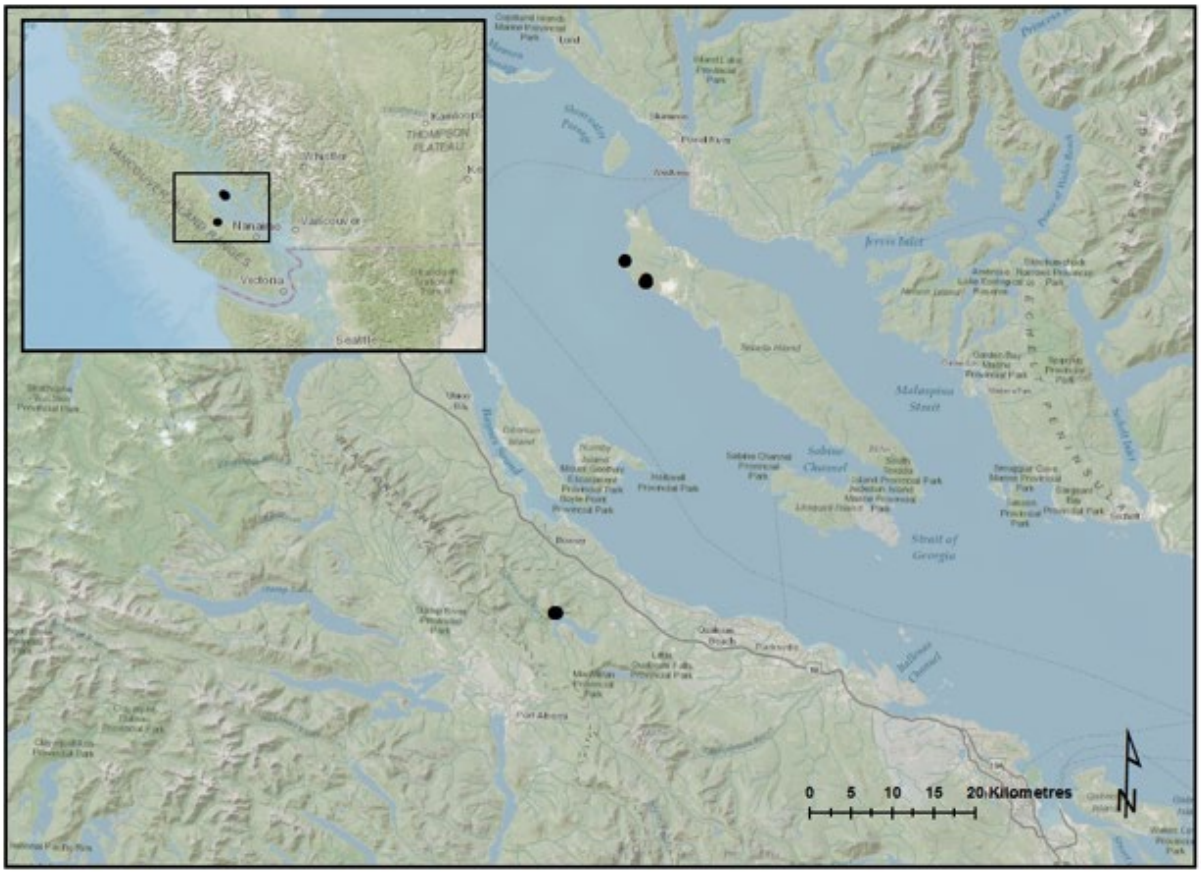

Figure 7. Canadian distribution of California Sword Fern. Map prepared by Alain Filion (COSEWIC Secretariat).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO), based on a minimum convex polygon around extant observations, is 72 km^2. There are large expanses of water between subpopulations because they occur on different islands. The index of area of occupancy (IAO), based on a 2x2-km grid over the extant observations, is 12 km^2.

Search Effort

California Sword Fern can be observed year-round, although it may be mistaken for other fern species if not examined closely. It occurs in a small area of eastern Vancouver Island and on one of the Gulf Islands, which are easily accessible and have been botanized

for many years. Although the limestone cliff habitat is naturally rare on the landscape, it is difficult to survey because of the steepness. It is possible that there are more undocumented plants in areas that are difficult to access. The restricted extent of its suitable, 'botanically attractive' habitat, however, suggests that additional discoveries of this conspicuous plant are unlikely.

California Sword Fern was first collected in Canada in 1897 on "rock" on Texada Island by W. B. Anderson. This specimen (V000178) consists of a single small frond that was originally identified as *Polystichum scopulinum*. In 1976, D.H. Wagner re-identified the specimen as the only record of California Sword Fern in British Columbia (Wagner 1979). Although the species was included in the *Ferns and Fern Allies of Canada* (Cody and Britton 1989), it was excluded from the *Illustrated Flora of British Columbia* because there were no recent specimens (Douglas *et al*. 2000).

In August 2007, Terry Ludwar found a single California Sword Fern plant growing on a vertical rock wall on Texada Island (Maple Bay subpopulation). Three fronds were collected by A. Ceska (V225590 at UBC Herbarium) and confirmed by D.H. Wagner.

A second subpopulation was found on Texada Island in 2008 by James Mack and John Wood at the southwestern base of Surprise Mountain (Ceska *et al*. 2009b). A third site was found by Randal Mindell in 2019 at Horne Lake (iNaturalist 2019). The Horne Lake site was revisited in 2019 by Ryan Batten, who made collections of both California Sword Fern (V250844) and a hybrid with Western Sword Fern (V250846). There are many recent photos of California Shield Fern (the iNaturalist name for *P. californicum*) on iNaturalist (2023) but these are all from the Horne Lake site.

All three known subpopulations were re-surveyed in 2021. The total targeted search effort in 2021 included suitable habitat within a 145 km stretch (recorded on the routes of the GPS) and 43 search hours of targeted search at known sites and at potential sites (e.g., Saanich Inlet) with suitable habitat similar to current Canadian records (Maslovat 2021). Potential habitat mapping has not been done.

HABITAT

Habitat Requirements

In the southern part of its range, California Sword Fern grows in a wide variety of habitats including riparian woodlands, redwood (S*equoia sempervirens*) forests, rocky open slopes, streambanks, cliffs, rock crevices and moist forests at elevations ranging from 100 to 850 m (Wagner 1993), under a range of light conditions (Smith 2012; CPNWH 2021). In Washington, the habitat is similar to that at British Columbia sites; plants grow in cliff crevices and rock outcrops at elevations from 240 to 340 m (Washington Natural Heritage Program 2021).

In British Columbia, California Sword Fern has only been found associated with limestone cliffs and is presumed to be an obligate calciphile. The Horne Lake (Mt. Mark) subpopulation is found in rock crevices and along the bottom edge of limestone cliffs (Maslovat pers. obs. 2021). The limestone is overlain by Karmutsen basaltic rock and underlain by volcanic McLaughlin Ridge breccias (Fischl 1992).

There are two large masses of limestone outcrop on Texada Island (Fischl 1992). The Maple Bay subpopulation on Texada Island is found about 2 metres above the base of a coastal cliff, and is exposed to salt spray (Ceska *et al*. 2009a; Maslovat pers. obs. 2021). The Maple Bay site is predominantly composed of Karmutsen volcanics, with infrequent lenses of limestone of variable thickness. The Surprise Mountain plants are found in rock crevices in a cliff face with limestone seepage (Figure 8). Both subpopulations on Texada Island occur on massive and pillowed basaltic volcanic substrate (Fischl 1992).

There are few associated plants as the xeric microclimates where California Sword Fern occurs prevent the establishment of species that are adapted to more mesic conditions. The two larger sites (Surprise Mountain and Horne Lake) are shaded by adjacent Douglas-fir (*Pseudotsuga menziesii*) forest with Bigleaf Maple (*Acer macrophyllum*) present, but the Maple Bay site is in full sun.

Figure 8. California Sword Fern at the base of a limestone cliff at Surprise Mountain, Texada. Photo C. Maslovat (June 21, 2021).

Habitat Trends

Suitable habitat is naturally fragmented because there is a limited supply of naturally occurring limestone outcrops in British Columbia. Limestone deposits are a commercially valuable, locally limited resource and have been targeted for extraction near the Horne Lake and Texada Island subpopulations. There has been no appreciable change in habitat availability since the species was reconfirmed in Canada in 2007.

BIOLOGY

There is limited information on the biology and ecology of California Sword Fern. The information presented below is compiled from research on related species and personal observation by the report writers.

Life Cycle and Reproduction

California Sword Fern is a tetraploid (2n=164) (Soltis *et al*. 1991; Wagner 1993; Smith 2012). Although some ferns in the Dryopteridaceae have high rates of self-fertilization (Tyron 1986; Flinn 2006), other species maintain mixed or outcrossing mating systems (Barker and Willmot 1985; Soltis and Soltis 1992). The genus *Polystichum* appears to be highly outcrossing (Wagner 1993); however, California Sword Fern has higher rates of intragametic selfing than either of its parent species (Soltis and Soltis 1992).

Other medium-sized fern species take 1-5 years to reach maturity (Haeussler *et al*. 1990) and *Dryopteris* species live 50-60 years (Reznicik pers. comm. 2022). Based on the size of the plants and the persistence of the single plant at Maple Bay since 2007, California Sword Fern plants are expected to be long-lived, likely over 20 years, and generation time is conservatively presumed to be greater than 10 years.

Most evergreen fern species retain some mature spores over the winter, which are released the following spring (Farrar 1976). *Polystichum* species can form persistent, widespread soil spore banks, and fern spores from other genera can remain viable for at least a year buried in the soil (Dyer and Lindsay 1992). Sexual reproduction does occur in British Columbia. A juvenile plant presumed to be a California Sword Fern was observed at Horne Lake.

Physiology and Adaptability

There is little information available on the physiology and adaptability of California Sword Fern.

Polystichum species in North America have high genetic similarity, which likely allows for frequent interspecific hybridization and allopolyploidy (Soltis *et al*. 1990). Allopolyploids are produced when unreduced (e.g. 2n) gametes are produced in each of two species, and these gametes then form hybrid zygotes and subsequent adults. Because a full

complement of chromosomes from each species is found in that adult, normal meiosis followed by initial self-fertilization can perpetuate the new allopolyploid lineage. Because allopolyploids have multiple genomes, there are generally fewer deleterious alleles expressed and less inbreeding depression due to their genetic diversity (Soltis and Soltis 1992; Jorgensen and Barrington 2017).

Dispersal and Migration

Most fern spores in temperate forests settle to the ground over relatively short distances (<100 m) (Raynor *et al*. 1976; Peck *et al*. 1990). With favourable conditions (e.g., strong wind, good atmospheric mixing) fern spores, which are tiny and lightweight, may be dispersed long distances, e.g., to oceanic islands isolated from mainland sources by thousands of kilometres (Tyron 1970; Geiger and Ranker 2005; Driscol and Barrington 2007). Colonization of long-distance sites may occur via single-spore establishment, and the resulting populations have been shown to have low genetic diversity and high inbreeding coefficients (De Groot *et al*. 2012). The range of homosporous ferns is determined primarily by the ecology of the habitat because they do not rely on the presence of animal vectors for dispersal or pollination (Tyron 1986; Jorgensen and Barrington 2017).

Both Horne Lake and Texada Island are sites that have been targeted for limestone quarrying, and the mining history on Surprise Mountain dates from the late 1800s (Houle 2015; Papalia 2018). It is possible that spores from this species were dispersed by anthropogenic means; however, the possibility of a human role in the spread of xeric rock-wall taxa is extremely remote (Brunton pers. comm. 2022).

Interspecific Interactions

California Sword Fern does not require pollinators, and no herbivory was observed during field surveys. There are no confirmed fungal associates in British Columbia.

California Sword Fern is known to hybridize (backcross) with Western Sword Fern and Narrow-leaved Sword Fern and to produce sterile hybrids in locations where it occurs with other *Polystichum* species in the same habitat (Wagner 1993). Hybrids usually have robust growth and show intermediate characters of both parents. Hybrids generally exhibit the characteristics most similar to the parent they grow with and are found in habitat typical of the parent species (Wagner 1993). Sterile hybrids can be recognized by their misshapen (aborted) sporangia, which appear as small black dots instead of fuzzy brown bumps (Wagner 1993).

There is some overlap between the distribution of California Sword Fern and Giant Chain Fern (*Woodwardia fimbriata*) in Washington and Oregon (Ceska *et al*. 2009a). Giant Chain Fern, which is blue-listed in British Columbia, is also uncharacteristically abundant on Texada Island and is found in proximity to both known California Sword Fern sites.

POPULATION SIZES AND TRENDS

COSEWIC defines population size as the total number of mature individuals of the taxon (COSEWIC 2019). Subpopulations are defined as “geographically or otherwise distinct groups in the population where there is little demographic or genetic exchange” (COSEWIC 2019). For California Sword Fern, the subpopulation definition used is consistent with habitat-based plant element occurrence delimitation standards and is defined as a group of occurrences that are separated by less than 1 km as outlined above (NatureServe 2020).

Sampling Effort and Methods

Surveys were conducted at previously known sites and in adjacent suitable habitat from June 6 to June 22, 2021. Additional areas on Texada Island that appeared to have suitable habitat were surveyed but no new subpopulations were found. It is possible but unlikely that additional subpopulations will be found in the future, likely in difficult to access terrain or on private property.

Abundance

COSEWIC defines the number of mature individuals as the number of individuals known, estimated or inferred to be capable of reproduction (COSEWIC 2019). In 2021, a total of 48 mature individuals and one immature juvenile were counted in the Canadian population.

Fluctuations and Trends

The Texada Island, Maple Bay subpopulation was documented as a single plant in 2007 and 2008 (British Columbia Conservation Data Centre 2021a) and the same single plant was observed in 2021. At Texada Island, Surprise Mountain, 18 plants were noted in 2009 (British Columbia Conservation Data Centre 2021b) and 24 plants were observed in 2021. This does not reflect an increase in the number of plants; instead, it is due to more systematic surveys over a larger area that found previously unrecorded plants.

Rescue Effect

The closest confirmed occurrence outside of Canada is in Washington approximately 300 km away. Although long-distance dispersal events do occur in other fern species, they are infrequent and require ideal conditions for establishment. It is possible, but very unlikely, that there would be rescue from naturally dispersing US populations should extirpation of the Canadian population occur.

THREATS AND LIMITING FACTORS

Direct threats facing California Sword Fern assessed in this report were organized and evaluated based on the IUCN-CMP (International Union for Conservation of Nature – Conservation Measures Partnership) unified threats classification system (Master *et al.* 2012). Threats are defined as the proximate activities or processes that directly and negatively affect the 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 for California Sword Fern is high.

Threats

3.2 Mining and Quarrying (High impact)

The three existing quarries on Texada Island extract 4.2 million tonnes of limestone each year. Since both limestone and dolomite are defined as minerals under the *Mineral Tenure Act*, they are subject to the staking of mineral claims (Fischl 1992). Texada Island has other commercially valuable mineral commodities that are subject to staking of mineral claims. The California Sword Fern plants at the Surprise Mountain site fall under two mineral claims: tenure ID # 53714 (Blubber Bay 12) held by CRH Canada group (valid until June 15, 2023) and tenure ID # 552803 (Surprise) held by Lafarge Canada Inc. (valid until February 26, 2024) (iMap 2023).

Limestone has high commercial value and is in limited supply; however, quarrying in the future is an unlikely risk for these sites due to limited profitability of mineral quality and quantity. The Texada Island mine owner Lafarge has been participating in local plans to establish a park reserve that extends from Maple Bay to Welcome Bay (which includes the Surprise Mountain site) (Mack pers. comm. 2021). The threat from quarrying is listed as high impact until such time as the park is established, as mining claims were recently renewed. The Horne Lake site is owned by a community resort association and is jointly owned strata common land (Horne Lake Community no date), which is unlikely to favour quarry development because of the recreational focus of the properties.

5.3 Logging and Wood Harvesting (Possible impact in the long term)

Threats associated with logging are unlikely in the short term at all three sites. Logging activities could impact California Sword Fern if logs are dragged down cliff faces or trees are felled into the cliffs, dislodging the plants. Changing light and humidity conditions associated with adjacent wood harvesting may also impact the ferns by increasing drought; however, the species is adapted to xeric conditions and the extended range of the species into California suggests it can tolerate intense drought conditions. Trees above the cliff at Maple Bay are small and the current private landowner is conservation-minded and unlikely to log. Local plans for a park reserve at Surprise Mountain will likely prevent forestry activities. The Horne Lake subpopulation is within the common land owned by a strata corporation in an actively managed forest, but there is little commercially valuable timber on the cliff faces and removal of trees above and below the cliffs is unlikely to negatively impact the cliff habitat.

6.1 Recreational Activities (Possible impact in the long term)

The area surrounding the Horne Lake subpopulation is a popular rock-climbing site with bolted anchors and ladder rungs embedded in the rock to provide access to graded routes. None of the currently established routes are directly adjacent to California Sword Fern plants and future impact from recreation is expected to be negligible and presumably could be controlled by conservation management regulations.

8.1 Invasive Non-native/Alien Species/Diseases (Possible impact in the long term)

Western Sword Fern die-off has been observed in the Puget Sound area of Washington over large areas (up to 1,000 m^2) (Alexander *et al*. 2017; Elliott *et al*. 2017) and in California (Tidwell and Kosta 1984). A similar die-off has been noted on Hornby Island (Alexander *et al.* 2017). It is unknown if root rot (*Phytophthora cinnamomi*) will impact California Sword Fern but it is unlikely given that its habitat is isolated from vector species. It is unknown if other diseases that are known to infect Western Sword Fern, including fungi (leaf blister [*Taphrina* spp.], dry rot [*Fusarium* spp.], rusts [*Milesia* spp.]), bacteria (*Pseudomonas* sp., *Xanthomonas* sp.) and nemotodes (*Aphelenchoides fragariae*) (Sandino 1962), will impact California Sword Fern.

11.2 Droughts (Negligible impact)

The impact of drought caused by increased temperatures and reduced precipitation associated with climate change on overall fitness and reproduction is not known. Climate change is unlikely to have significant impacts given the extremely xeric habitat and the species' wide range which extends far to the south.

Limiting Factors

In Canada, California Sword Fern has only been found on rare limestone substrates. The species may be limited by infrequent long-distance dispersal events or low rates of establishment in appropriate habitats.

Small, isolated subpopulations can suffer from limited genetic diversity and inbreeding depression (Ilves *et al*. 2003; Reed and Frankham 2003; Leimu *et al.* 2006; De Groot *et al*. 2012; Szczecińska *et al*. 2016). The impacts on California Sword Fern associated with small population size are unknown but the negative impacts may be mitigated by the presence of multiple genomes (Soltis and Soltis 1992; Jorgensen and Barrington 2017).

Number of Locations

There are three occurrences as defined by the BC Conservation Data Centre using the default minimum separation distance of 1 km (NatureServe 2020). Based on threat evaluation of the British Columbia population, there are 3 locations (Table 1). Within each location, the number of clumps of plants ranges from 1 to 24.

Table 1. Number of Locations, Primary Threats and Number of Mature Individuals

BC CDC EO#	Location	Ownership	Number of Mature Individuals	Primary Threat
1	Texada Island, Maple Bay	Private	1	Invasive Non-native/ Alien Species/Diseases
2	Texada Island, Surprise Mountain	Provincial crown	24	Mining and Quarrying
No EO #	Horne Lake (Mt. Mark)	Horne Lake Resort Corporation	23 mature + 1 juvenile	Logging and Wood Harvesting/ Recreational Activities

PROTECTION, STATUS AND RANKS

Legal Protection and Status

There is currently no legal protection for California Sword Fern in Canada. This status report provides the foundation for the first COSEWIC assessment.

It is not listed under the Convention on International Trade in Endangered Species (CITES) or the *Endangered Species Act* (United States) and it has not been assessed by the International Union for Conservation of Nature (IUCN) (CITES 2021; IUCN 2021; US Fish and Wildlife Service 2021).

Non-Legal Status and Ranks

Provincially, California Sword Fern is ranked Critically Imperilled (S1) by the BC Conservation Data Centre, and it is nationally ranked Critically Imperilled (N1). It is ranked Critically Imperilled (S1) in Washington, Imperilled (S2) in Oregon, and is Not Ranked (SNR) in California. However, Ferguson (pers. comm. 2021) stated that it is not a species that is tracked nor considered rare in California. A rank of Apparently Secure (S4) was estimated using the NatureServe rank calculator (Biotics V2) (Bennett pers comm. 2021). Globally, it is ranked Apparently Secure (G4) (last reviewed 1989, NatureServe 2021).

Habitat Protection and Ownership

The Horne Lake subpopulation is located on 1,295 hectares of land with the title registered to Horne Lake Resort Corporation. The land was originally a Crown grant to the Esquimalt & Nanaimo (E&N) railway, which was bought in 1952 by Ocean Cement for limestone mining (Chettelburgh 1995). Texada Logging Ltd. owned the land from 1962-1999, when it was transferred to Texada Land Corporation. Currently, the land is a common asset owned by the 400 strata lot owners of Strata Plan VIS 5160, and insurance, forest management and other expenses are funded by the strata corporation. It is managed for timber production, and silvicultural activities include mapping, planting, thinning, pruning,

and fire prevention, with plans for sustainable harvesting in the future. Motorcycles, trail bikes, dune buggies and off-road vehicles are not allowed on the common property (Horne Lake Community no date).

The Maple Bay subpopulation is on privately owned land. The Surprise Mountain subpopulation is on provincial Crown land and was mined for precious metals in the late 1800s (Papalia 2018). An active group of residents is working to establish a park reserve to protect the site (Mack pers. comm. 2021).

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Carrina Maslovat works as a botanist in plant communities at risk, primarily Garry Oak ecosystems. Her work includes inventories of rare plants in regional, municipal, federal and provincial parks, finding new subpopulations of species at risk, and monitoring rare plant populations' abundance and vitality over time. Her reports include management plans for nature reserves, best management practices to minimize impacts to species at risk, four COSEWIC status reports, four status report updates, and several recovery planning documents. She has designed and implemented ecological restoration projects to provide habitat for species at risk.

Ryan Batten is a botanist and plant ecologist with 15 years of experience specializing in rare plants, wetlands and biodiversity inventory. He has broad floristic knowledge from conducting field work in British Columbia, Alberta, Saskatchewan, Ontario and Nunavut. He

is an active member of the BC Flora Update Committee and has been affiliated with the Royal BC Museum Herbarium for the last decade. In 2019 he prepared the status ranks for all of BC's vascular plants for the federal government's General Status of Wild Species in Canada program. Ryan works frequently with the BC Conservation Data Centre where he spends the majority of his time drafting conservation status reports, range mapping rare species and training within the NatureServe methodology for status assessment. His current research interests include geospatial floristics, human mediated dispersal, and traits of rarity.

COLLECTIONS EXAMINED

- Canadian Museum of Nature (CAN): No specimens
- Consortium of Pacific Northwest Herbaria (accessed online): Canadian specimens RBCM V000178; UBC V225590.
- Department of Agriculture, Ottawa (DAO): No specimens
- Royal British Columbia Museum (V): V000178 (W.B. Anderson 1897).
- University of British Columbia (UBC): V225590 (A. Ceska 2008/Det. D.H. Wagner 2008); V250844 (R. Batten 2019); V250846 (R. Batten 2019).

Appendix 1. Threat calculator assessment for California Sword Fern

Species or Ecosystem Scientific Name	California Sword Fern - *Polystichum californicum*			
Element ID			**Elcode**	
Date (Ctrl + ";" for today's date):	2022-07-05			
Assessor(s):	Del Meidinger (facilitator; co-chair); Bruce Bennett (co-chair); Carrina Maslovat (writer); Purnima Govindarajulu (BC rep); Varina Crisfield, Mannfred Boehm, and Brenda Costanzo (SSC members); Marie-Eve Corbin and Alyssa Pogson (ECCC Secretariat); Linda Takahashi (CWS)			
References:				
	Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	1	1
	C	Medium	0	0
	D	Low	0	0
	Calculated Overall Threat Impact:		High	High
	Assigned Overall Threat Impact:		**B = High**	
	Impact Adjustment Reasons:		If the park is not established on Texada, the threat level is HIGH; if the park is established, the overall threat impact is negligible.	
	Overall Threat Comments		Horne Lake subpopulation about 48% of population; Texada Surprise Mountain 50%, and Texada Maple Bay 2%; Generation length 10+ years in provisional report; plants have been known to live 15-20 years or more. For the purposes of the threats calculator, a generation length of 10+ years was used and a three generation time of >30 years. This was considered to likely be a conservative estimate.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture						
3	Energy production & mining	B	High	Large (31-70%)	Extreme (71-100%)	Moderate - Low	
3.1	Oil & gas drilling						
3.2	Mining & quarrying	B	High	Large (31-70%)	Extreme (71-100%)	Moderate - Low	Although possible that mining could occur based on Texada Island mining claims, there are plans for a park reserve. The Horne Lake site is jointly owned common strata land so quarry development is unlikely. Half the population is under a mining claim and if the park proposal is unsuccessful and mining proceeds, a considerable portion of the population could be lost.
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		Not Calculated (outside assessment timeframe)	Restricted (11-30%)	Slight (1-10%)	Low (Possibly in the long term, >10 yrs/3 gen)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						Not the kind of sites that have easy access for fern collectors. Collecting is not known to occur.
5.3	Logging & wood harvesting		Not Calculated (outside assessment timeframe)	Restricted (11-30%)	Slight (1-10%)	Low (Possibly in the long term, >10 yrs/3 gen)	Logging at elevations above sites could impact plants. Logging very unlikely due to plans for establishment of park at largest Texada Island site (Surprise Mountain); and the ownership of the Horne Lake site by a community association. Logging unlikely to be supported as it could also cause damage to cabins below the cliffs at Horne Lake site.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Not Calculated (outside assessment timeframe)	Restricted - Small (1-30%)	Slight (1-10%)	Low (Possibly in the long term, >10 yrs/3 gen)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities		Not Calculated (outside assessment timeframe)	Restricted - Small (1-30%)	Slight (1-10%)	Low (Possibly in the long term, >10 yrs/3 gen)	Climbing activities could have some impact on plants, although present climbing routes do not cross local sites where plants occur. If a new route went over plants, unlikely to have much of an impact as the plants are firmly embedded into the rock. There are a lot of routes on the rock faces, so possible that route expansion could take place, but based on the sites where the ferns are, it seems that they would not put holds right over the plants.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications						
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes		Not Calculated (outside assessment timeframe)	Unknown	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	
8.1	Invasive non-native/alien species/diseases		Not Calculated (outside assessment timeframe)	Unknown	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	Western Sword Fern die-off, due to root rot, known in Washington State, and similar die-off known at Hornby Island, offshore of Vancouver Island. Not known on Vancouver or Texada islands. Unknown if root rot would impact California Sword Fern.
8.2	Problematic native species/diseases						
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution						
9.1	Domestic & urban wastewater						
9.2	Industrial & military effluents						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
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)	Pervasive (71-100%)	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis		Not Calculated (outside assessment timeframe)	Pervasive (71-100%)	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	No impact from earthquakes in past 10 years, so unknown if future earthquakes would impact plants.
10.3	Avalanches/landslides						
11	Climate change & severe weather		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
11.1	Habitat shifting & alteration						
11.2	Droughts		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Plants are adapted to xeric sites and the species also ranges far to the south of the Canadian range, so unlikely that increased drought will impact plants.
11.3	Temperature extremes						
11.4	Storms & flooding						Increased severity of storm events possible, but unknown if storms will impact plants. Maple Bay site could possibly be impacted by severe storm salt spray, but unknown if this would kill plant. Sites very unlikely to be subject to increased erosion from storm runoff.
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky et al. (2008).							