COSEWIC
Assessment and Status Report

on the

Seaside Centipede Lichen
Heterodermia sitchensis

in Canada

THREATENED
2021

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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Previous report(s):

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COSEWIC 2000. COSEWIC assessment and status report on the seaside centipede *Heterodermia sitchensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Goward, T. 1996. COSEWIC status report on the seaside centipede *Heterodermia sitchensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. 1-33 pp.

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Seaside Centipede Lichen — Photograph by Shyanne Smith.

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COSEWIC
Assessment Summary

Assessment Summary – April 2021

Common name
Seaside Centipede Lichen

Scientific name
Heterodermia sitchensis

Status
Threatened

Reason for designation
This leafy lichen is known from 20 occurrences on the west coast of Vancouver Island, Canada, and from two in the US. It has highly specific habitat requirements and grows only on partially defoliated small-diameter Sitka Spruce twigs on trees, close to the shoreline, that often receive nitrogen enrichment from sea lion haul-out sites or bird nest sites. The number of mature individuals (thalli) is thought to be less than 1000, and the lichen is highly vulnerable to intense storm activity associated with climate change that destroys the twigs upon which the lichen is found. The change of status from Endangered reflects increased knowledge of the distribution as a result of increased survey effort.

Occurrence
British Columbia

Status history
Designated Endangered in April 1996. Status re-examined and confirmed in May 2000 and in April 2006. Status re-examined and designated Threatened in May 2021.

COSEWIC
Executive Summary

Seaside Centipede Lichen
Heterodermia sitchensis

Wildlife Species Description and Significance

Seaside Centipede Lichen, *Heterodermia sitchensis* Goward & Noble, is a pale greyish, leafy to semi-erect lichen in the *Physciaceae*. It can be recognized by the presence of marginal cilia and tiny urn-like structures near the lobe tips. It was first described from western Vancouver Island.

Seaside Centipede Lichen is among the most northerly members of a predominantly tropical to warm temperate genus. The majority of its global population is found in Canada, where it occupies a very narrow latitudinal range along the west coast of Vancouver Island. The soredia-bearing “urns” located near the lobe tips are believed to be unique among lichens.

Distribution

In Canada, Seaside Centipede Lichen occurs only on Vancouver Island in coastal British Columbia, where it ranges from the Pacific Rim National Park, north 210 km to Kyuquot Sound. Outside of Canada, it is known from two outlying subpopulations in coastal Oregon. In Canada, despite more than 200 person-days of targeted searching by individuals familiar with the species since 2001, there are only 20 known Seaside Centipede Lichen occurrences recorded, forming four subpopulations.

Habitat

Throughout its range, Seaside Centipede Lichen occurs exclusively at the seaside on sheltered but well-ventilated nutrient-enriched and defoliated twigs in the lower canopy of slow-growing old Sitka Spruce trees. In Canada, it is known exclusively from the Very Wet Hypermaritime subzone of the Coastal Western Hemlock Zone. In Oregon, one subpopulation is in old-growth temperate rainforest with Western Hemlock and the other is in a patch of Sitka Spruce and Shore Pine on open dunes.

Biology

In keeping with its strong tendency to colonize small twigs, Seaside Centipede Lichen is a short-lived species with a generation time in the order of 7-10 years. By the end of that period, its substratum is usually overgrown by mosses, hepatics and other lichens, all of

which tend to outcompete it. Seaside Centipede Lichen reproduces exclusively via soredia (powdery asexual propagules made up of algal cells and fungal hyphae). Dispersal is presumed to be poor by wind, rain or birds that feed on invertebrates which live on the twigs where the lichen occurs.

Population Sizes and Trends

The most recent count of Seaside Centipede Lichen in Canada totals 314 thalli. These are divided among twenty spatially separate occurrences, three of which may now be extirpated. The occurrences are grouped into four geographically distinct subpopulations. Sixty-one percent of the total population at last count was found at three occurrences. The number of thalli at a site can vary, depending on the intensity of winter storms, which can both eliminate existing habitat and create new microsites for future colonization. However, no long-term trends in population size have been documented. The results of extensive searches, and the monitoring of Seaside Centipede Lichen populations in Canada, indicate that this rare lichen has very specific habitat requirements, is severely fragmented, and the total population is probably fewer than 1000 mature individuals.

Threats and Limiting Factors

The incidence and severity of threats to Seaside Centipede Lichen are difficult to predict. Habitat disturbance and inundation from tsunamis, climate change and severe weather leading to habitat shifting pose the greatest threats to Seaside Centipede Lichen, along with impacts from human intrusion and disturbance from recreational activities. Habitat destruction through logging or land development is an additional threat to a few occurrences.

There are several limiting factors that cause Seaside Centipede Lichen to be rare throughout its range. As a transient or fugitive species, Seaside Centipede Lichen must colonize as suitable habitat becomes available. This comprises living but partially defoliated twigs of Sitka Spruce. The lichen is then displaced over time by overgrowth of more competitive mosses and lichens. In summary, colonization and survival of Seaside Centipede lichen requires that the lichen must first successfully disperse its propagules to Sitka Spruce twigs growing close to the sea with suitable microclimates that are enriched by high nitrogen levels from birds or marine mammal haulouts.

Protection, Status and Ranks

Seaside Centipede Lichen was assessed as Endangered by COSEWIC in 2006 and is listed as Endangered on Schedule 1 of the federal *Species at Risk Act*. The species is listed by NatureServe as “globally imperiled” (G1) worldwide and “critically imperiled” (S1) within British Columbia. The species is also included on British Columbia’s “Red List” of species at risk of being extirpated, endangered or threatened.

Seaside Centipede Lichen is part of the Multi-species Action Plan for the Pacific Rim National Park Reserve, which lists recovery measures to protect the species and critical habitat for three occurrences within the park. A Recovery Strategy for Seaside Centipede Lichen has also been completed.

Thirteen of the twenty Seaside Centipede Lichen occurrences in Canada have some sort of protection. Eight are within Pacific Rim National Park Reserve and are protected from human disturbance by the *National Parks Act* and by the *Species at Risk Act*. Five are in provincial recreation sites, parks or wildlife management areas.

TECHNICAL SUMMARY

Heterodermia sitchensis

Seaside Centipede Lichen

Hétérodermie maritime

Range of occurrence in Canada (province/territory/ocean): 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)	7-10 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes Inferred decline from the impact of climate change
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	N/A
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Long-term trends in population size have not been documented
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. , there are not enough data to predict a % decline over the next three generations	Inferred future decline based on the impact of climate change
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Observed 32% reduction in number of thalli at eight occurrences visited in 2008 and 2015. However, the long-term trend of past population sizes have not been sufficiently documented.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No b. No c. Unknown
Are there extreme fluctuations in number of mature individuals?	No, but there are fluctuations

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	1650 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	80 km² More occurrences may be discovered, but IAO unlikely to exceed 500 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?	•Possibly The lichen occurs on a number of small islands. Some have fewer than ten thalli and some just a single thallus. •Probably The lichen occurs on islands that are separated by a distance thought to exceed the limited dispersal ability of the lichen which has very specific habitat requirements. (see **Abundance**)
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	Seven The predicted impact of climate change includes more severe storms. Some of the occurrences that are part of the four subpopulations are more exposed and so more affected by high winds and waves from storms. Others are vulnerable to storm surges and rising sea levels. Thus, more than one location is assigned to each subpopulation. (See **Locations** and **Threats)**
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Possibly on the basis of loss of occurrences at the northern or southern end of the distribution.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, inferred and observed from the loss of three occurrences.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Possibly
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Possibly
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred decline of suitable twigs on trees (area and extent of habitat) and decline in nitrogen sources (quality of habitat) related to climate change threats and habitat shifting. (See **Locations** and **Threats)**
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

*See Definitions and Abbreviations on COSEWIC web site and IUCN (Feb 2014) for more information on this term

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
1.) Barkley Sound 1. more exposed: • Dicebox Island • Wouwer Island • Folger Island 2. more sheltered: • Benson Island • Turret Island • Gilbert Island	**74** 0 35 0 37 1 1
2.) Clayoquot Sound 3. more exposed: • Schooner Cove • Lawrence Island • Islet east of Vargas Island • McKinn Islets • Quisitis Point • Florencia Island 4. more sheltered: • Ucluth Peninsula • Raccoon Island • Laddie Islet • Mike's Islet	**169** 2 2 23 3 5 10 0 119 2 3
3.) Nootka Sound 5. more exposed: • Escalante Island	**4** 4
4.) Kyuquot 6. more exposed: • Small island near Kyuquot 7. more sheltered: Spring Island • Unnamed island (south of Spring Island)	**67** 7 21 39
Total The results of extensive searches and the monitoring of Seaside Centipede Lichen populations indicate that it is a rare lichen and the total number of mature individuals is fewer than 1000. Within each subpopulation, there are some occurrences that are more exposed to high winds and waves and others that are more sheltered. The latter are less likely to be affected by high winds and waves but will be threatened by high tides, surges and rising sea levels. Taking these aspects into account, seven locations have been identified (see **Locations**).	**314** **<1000**

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Not available

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

Was a threats calculator completed for this species? Yes, in 2019 (see Appendix 1).

Threats:

i. Human intrusions and disturbance (recreational activities): High-Medium
ii. Climate change and severe weather (habitat shifting and alteration, droughts, temperature extremes, storms and flooding): High-Medium
iii. Geological events (Earthquakes/tsunamis): High-Low
iv. Residential and commercial development (tourism and recreation areas): Medium-Low
v. Biological resource use (logging and wood harvesting): Medium-Low
vi. Pollution: Negligible

What additional limiting factors are relevant?
Ephemeral nature of the habitat and nutrient enrichment at most sites.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. Subpopulations at Cape Lookout State Park and Umpqua Lighthouse State Park in Oregon are small.	Two extant subpopulations in USA
Is immigration known or possible?	Very unlikely
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?	Probably, resulting from changes to habitat due to climate change and increased use by humans.
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?	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: Designated Endangered in April 1996. Status re-examined and confirmed in May 2000 and in April 2006. Status re-examined and designated Threatened in May 2021.

Status and Reasons for Designation:

Status:	**Alpha-numeric codes:**
Threatened	B1ab(iii,v)+2ab(iii,v); D1

Reasons for designation:
This leafy lichen is known from 20 occurrences on the west coast of Vancouver Island, Canada, and from two in the US. It has highly specific habitat requirements and grows only on partially defoliated small-diameter Sitka Spruce twigs on trees, close to the shoreline, that often receive nitrogen enrichment from sea lion haul-out sites or bird nest sites. The number of mature individuals (thalli) is thought to be less than 1000, and the lichen is highly vulnerable to intense storm activity associated with climate change that destroys the twigs upon which the lichen is found. The change of status from Endangered reflects increased knowledge of the distribution as a result of increased survey effort.

Applicability of Criteria
Criterion A (Decline in Total Number of Mature Individuals): Not applicable as long-term trends in population size have not been monitored and documented.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Threatened, B1ab(iii,v)+2ab(iii,v). Both EOO (1650 km²) and IAO (80 km²) are below the threshold (5000 km² and 500 km²; respectively), and there are estimated to be fewer than ten locations based on varying storm intensity faced by subpopulations, and there is an inferred future decline in area, extent and quality of habitat as a result of extreme weather events (iii), and consequently in number of mature individuals (v).
Criterion C (Small and Declining Number of Mature Individuals): Not applicable as trends in the number of mature individuals in the population are unknown.
Criterion D (Very Small or Restricted Population): Meets Threatened, D1, because the estimated number of mature individuals, 314, is below the threshold of 1000.
Criterion E (Quantitative Analysis): Not applicable. Insufficient available data.

PREFACE

Seaside Centipede Lichen, *Heterodermia sitchensis,* appears to be restricted to Canada except for two small subpopulations in Oregon. *Heterodermia sitchensis* was designated as Endangered in Canada, in 1996. This status was re-examined and confirmed in the 2000 and 2006 status reports. A recovery strategy for the species was completed in 2007 and *H. sitchensis* is included in an action plan for Pacific Rim National Park (completed in 2017). In spite of increased awareness of the species since 2006, and extensive surveys and monitoring by Parks Canada as well as searches of intervening areas of coast on Vancouver Island, the only new occurrences recorded have been near known ones.

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 (2021)

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.

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Seaside Centipede Lichen, *Heterodermia sitchensis,* Goward & Noble, is a foliose to semi-erect lichen belonging in the Physciaceae within the order Lecanorales. It was described in 1984 from the west coast of Vancouver Island, British Columbia (Goward 1984). The holotype specimen is deposited at UBC, with isotypes at the Canadian Museum of Nature (CANL), and the University of Helsinki (H), Finland. Although the taxonomic distinctness of this species has not been challenged since its description, *H. sitchensis* is an asexually reproducing lichen, and for this reason could represent the secondary counterpart of a fertile primary species such as *Heterodermia podocarpa* (Bél.) Awas. Lichenologists are not agreed on how best to treat secondary "species", i.e., whether as forms or subspecies of the primary species, or as distinct species in their own right (Molina *et al.* 2013). As *H. sitchensis* is chemically, morphologically, and geographically distinct from *H. podocarpa*, most lichenologists would unhesitatingly accord it species status.

Morphological Description

Heterodermia sitchensis is a semi-erect, cushion-forming, foliose (leaf) lichen about 2 cm across. The lobes are thin, stiff, short to elongate, separate to loosely overlapping, 1-2 mm wide, and have long thin cilia "eyelashes" along the margins. The upper surface is strongly convex, pale greenish white (but readily discolouring to bluish black), and often bears scattered whitish maculae (spots). The lower surface is white, appressed-cottony and unevenly thickened, with strut-like extensions of the lower cortex protruding into the medulla. The most characteristic feature, which distinguishes it from other species, is that mature thalli bear apothecia-like structures in urn-shaped outgrowths near the lobe tips (see photograph on cover of this report). These have prominent flaring rims that in turn bear ring-shaped soredia (powdery asexual reproductive propagules) on their inner surface. A more detailed description is given by Goward (1984).

Chemistry

The chemical substances present in *H. sitchensis* are atranorin, zeorin, and various fatty acids. Atranorin reacts K+ yellow both with the cortex and with the medulla. Goward (1984) reported a PD+ yellowish to pale orange medullary reaction; but this has not been confirmed in recently collected material.

Population Spatial Structure and Variability

Heterodermia sitchensis is restricted to the Pacific Northwest of North America and has an unusually restricted distribution (Figure 1). There are no published studies examining the genetic structure of *H. sitchensis*. The Canadian *H. sitchensis* population is divided into four subpopulations based on estimated likelihood of soredia being transferred between occurrences via birds or wind (subpopulations having one or fewer successful migrant per year). The *H. sitchensis* subpopulations are all 15 kms or further apart.

Figure 1. Global range of Seaside Centipede Lichen, *Heterodermia sitchensis*. The species is predominantly found on the west side of Vancouver Island, on the southwest coast of Canada. Two small subpopulations are found along the coast of Oregon in the United States.

Designatable Units

The Canadian population of *H. sitchensis* is considered to be a single designatable unit. There is no reported evidence for genetically distinct populations or natural disjunctions within the species' Canadian range.

Special Significance

Heterodermia sitchensis is the most northerly member of a group of *Heterodermia* species more characteristic of tropical to warm temperate latitudes, such as *H. japonica*, *H. leucomela*, *H. namaquana*, and *H. obscurata*. Of special interest are the apothecia of *H. sitchensis,* which presumably were once the primary reproductive organ in this species. They no longer produce viable ascospores (Goward 1984). Instead, the apothecial rim has evolved into a highly specialized urn-shaped structure dedicated to the production of soredia, that is, powdery offshoots effective in asexual reproduction.

DISTRIBUTION

Global Range

Heterodermia sitchensis is restricted to Canada and the United States of America (Figure 1). It is known only from the west coast of Vancouver Island in British Columbia, Canada, and from Cape Lookout and Umpqua Lighthouse State Park in Oregon, USA (Stone *et al.* 2009). A report from Alaska (Geiser *et al*. 1994) is based on a misidentification, notwithstanding later reports to the contrary (McCune and Geiser 1997; Geiser *et al*. 1998). *Heterodermia sitchensis* may possibly occur in Washington, USA, but has never been found there (Stone *et al.* 2009).

Canadian Range

In Canada, *Heterodermia sitchensis* occurs only along the west coast of Vancouver Island in coastal British Columbia, where it ranges from Pacific Rim National Park, north 210 km to Kyuquot Sound. At the time of its description in 1984, *H. sitchensis* was known from only two sites. Both of these sites are situated on the outer west coast of Vancouver Island, British Columbia. The first (holotype) site is at Schooner Cove in Pacific Rim National Park Reserve, while the second is 22 km southeast, near Ucluelet on the Ucluth Peninsula. Since then other occurrences have been found and Parks Canada funded a number of surveys for *H. sitchensis* between 2001 and 2011. As a result of these studies, the known range of *H. sitchensis* extended south to Folger Island (48°49'N), and north approximately 200 km to Kyuquot Sound (49°59'N) (Figure 2). Work to date has confirmed early impressions that *H. sitchensis* is a rare species with a sporadic distribution that is dependent on a particularly specific habitat. In Canada, it has been recorded from a total of 20 occurrences (see Table 1), eight of which are in the Pacific Rim National Park Reserve. One occurrence (Folger Island) is located just southeast of the Park's Broken Group

Islands. These occurrences are all within Barkley Sound and form the Barkley Sound subpopulation. The Ucluth Peninsula occurrence is located on private land between the Broken Group and Long Beach units of Pacific Rim National Park Reserve. There are an additional six occurrences found to the north and west of the park in the Tofino area; all of these sites are on provincial land. These occurrences are grouped as the Clayoquot Sound subpopulation. Forty-eight kilometres to the north is the Escalante Island site (provincial land) in Nootka Sound (Nootka Sound subpopulation). Finally, the three Kyuquot sites, forming the Kyuquot subpopulation, are on First Nations Treaty lands and are 78 km north of the Escalante Island site.

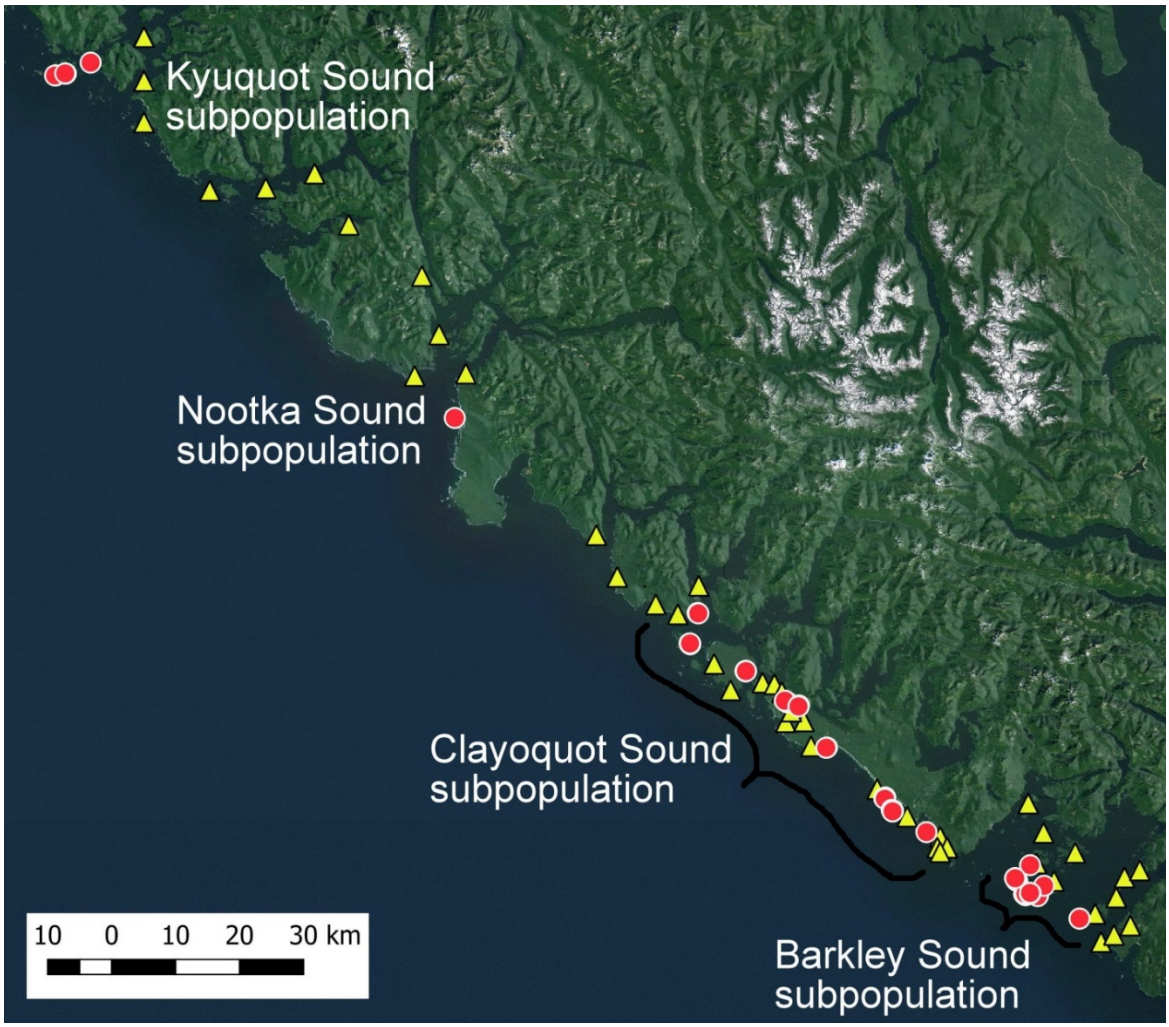

Figure 2. The Canadian occurrences of Seaside Centipede Lichen, *Heterodermia sitchensis* (red circles), and nearby areas searched unsuccessfully (yellow triangles). The range extends from Folger Island in Barkley Sound, north along the western edge of Vancouver Island, to Kyuquot Sound. The occurrences are grouped into four subpopulations: Kyuquot Sound, Nootka Sound, Clayoquot Sound and Barkley Sound.

Table 1. Canadian occurrences and number of Seaside Centipede Lichen, *Heterodermia sitchensis* thalli in relation to survey year. The three medium grey rows indicate occurrences that are likely extirpated.

Site	Land Ownership	2001	2002	2004	2006	2008	2009	2010	2011	2015	2019	Last complete count
Folger Island	Crown Land	-	18	-	-	2	-	-	0	-	-	
Benson Island	Pacific Rim National Park Reserve	-	1	-	-	95	-	-	83	37	-	37
Dicebox Island	Pacific Rim National Park Reserve	1	-	-	-	1	-	-	0	-	-	
Wouwer Island	Pacific Rim National Park Reserve	44	12	-	-	111	-	-	199	35	-	35
Turret Island	Pacific Rim National Park Reserve	-	-	-	-	-	-	-	1	-	-	1
Gilbert Island	Pacific Rim National Park Reserve	-	-	-	-	-	-	-	1	-	-	1
Schooner Cove	Pacific Rim National Park Reserve	1	4	-	-	1	-	-	1	-	2	2
Quisitis Point	Pacific Rim National Park Reserve	6	-	-	5	6	-	-	-	-	5	5
Florencia Island	Pacific Rim National Park Reserve	60	27	-	-	43	-	-	10	-	-	10
Ucluth Peninsula	Private land	2	-	-	-	-	-	-	-	-	-	
Raccoon Island	Tofino Mudflats Wildlife Mgmt Area	-	-	-	4	23	-	-	119	-	8*	119
Mike's Islet	Tofino Mudflats Wildlife Mgmt Area	-	-	-	-	-	-	3	-	-	2*	3
Laddie Islet	Tofino Mudflats Wildlife Mgmt Area	-	-	-	-	-	-	2	-	-	2*	2
Lawrence Island	Crown Land	1	21	-	-	5	-	-	2	-	-	2
Islet E of Vargas Island	Crown land	-	-	-	3	18	-	-	23	-	-	23
McKinn Islets	Flores Island Provincial Park	-	-	-	-	-	3	-	-	-	-	3
Escalante Island	Escalante Island Recreation Site	-	-	-	-	-	4	-	-	-	-	4
Spring Island	First Nations Treaty Land	-	-	14	21	-	-	-	-	-	-	21
Unnamed Isl. S of Spring Isl.	First Nations Treaty Land	-	-	48	39	-	-	-	-	-	-	39
Small island near Kyuquot	First Nations Treaty Land	-	-	-	7	-	-	-	-	-	-	7
# of thalli/survey year		**115**	**83**	**62**	**79**	**305**	**7**	**5**	**439**	**72**	**19***	
Total thalli count as of most recent complete survey		**115**	**92**	**154**	**171**	**372**	**379**	**384**	**524**	**314**	**314**	**314**

*partial survey (not all sites checked); refer to previous survey for # of last known thalli. (-) indicates years when there were no visits to record changes to the occurrence.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) is estimated to be 1650 km^2. The index of area of occupancy (IAO) is calculated to be 80 km^2. The EOO was calculated by drawing a polygon around all occurrences and measuring its area. Sites which may be extirpated were included because they were within the centre of the polygon. The index of area of occupancy (IAO) of 80 km^2 was calculated using a grid of 2 km x 2 km cells and counting the number of cells within which the sites (including potentially extirpated sites) are located. The biological area of occupancy was not calculated, because it was not measured during field visits; however, it would be much smaller than the IAO, because some sites would only be a few square centimetres and none would be larger than one square kilometre.

Search Effort

Macrolichens in the Pacific Northwest, including British Columbia, have been the subject of considerable study, with more than 20,000 collections within the potential range of *H. sitchensis* in Canada (COSEWIC 2006; UBC Herbarium 2019). There have also been a number of rare lichen surveys along the coasts of Washington, Oregon, and California (i.e., McCune *et al.* 1997; Glavich *et al.* 2005; Miller *et al.* 2011). In addition, an intensive search effort has specifically been made for *H. sitchensis* in coastal British Columbia (Figure 5). From 2001 to 2004, Parks Canada supported a considerable search effort for *H. sitchensis*. This lichen occurs on small partially defoliated twigs that are low in the canopy and close to the sea shore (Figure 3). It is a very characteristic lichen (see photo on the front cover of this report), but careful searches with a hand lens confirm its presence. Brian Reader, of Parks Canada, led a total of 30 person-days of search time dedicated to the species each summer. A total of 60 days was devoted to Pacific Rim National Park and 30 each to Gwaii Haanas (South Moresby Island) and northeastern Vancouver Island. The targeted searches by Parks Canada continued in 2006, 2008, 2009, 2011, and 2015. In these years, searches during a total of 74 person-days focused on areas within or near the known Canadian range. In addition, volunteer efforts in 2010 by Barry Campbell located the species on two islets in the Tofino mudflats. Opportunistic searches of two islands north of Vancouver Island (Hope Island by Shyanne Smith and Brian Reader in 2013 and Calvert Island in 2018 by Troy McMullin) did not locate the species. In 2018, Shyanne Smith and Brian Reader spent eight person-days searching suitable habitat at eight sites in five different areas north of the species' known range on northwestern Vancouver Island. In 2019, Shyanne Smith, Brian Reader and Ian Cruickshank spent five person-days revisiting five of the known occurrences in the Tofino area. Prior to these search efforts were several earlier general macrolichen field studies concentrated in coastal B.C., especially those of Dr. Irwin Brodo in the Queen Charlotte Islands in 2000 (COSEWIC 2006).

Figure 3. Habitat of the Seaside Centipede Lichen, *Heterodermia sitchensis*, on the lower twigs of the Sitka Spruce growing just above high tide level. This photo taken at Wouwer Island in 2008 shows the logs are washed up in winter. There is a trail that goes across the island to this area and there is a risk of visitors breaking off colonized branches. Photo by Shyanne Smith.

Work to date has confirmed the early belief that *H. sitchensis* is a rare species with a sporadic distribution that is dependent on a particularly specific habitat. In Canada, it has been recorded from a total of 20 occurrences (see Table 1).

HABITAT

Habitat Requirements

In Canada, *H. sitchensis* is known exclusively from the Very Wet Hypermaritime subzone of the Coastal Western Hemlock Zone (Meidinger and Pojar 1991). In Oregon, one subpopulation is found on Sitka Spruce at a ridgetop exposed to ocean winds, and the other on Sitka Spruce in a patch of Sitka Spruce and Shore Pine (*Pinus contorta* var. *contorta*) on an otherwise open dune.

The basic biophysical attributes of critical habitat for *H. sitchensis* was described in the Multi-species Action Plan for Pacific National Park Reserve (Parks Canada Agency 2017). Compared with most other tree-dwelling lichens, *H. sitchensis* has remarkably stringent habitat requirements. Its occurrence appears to be determined by the following habitat characteristics:

Seaside habitats

Virtually all western *Heterodermia* species (including *H. japonica*, *H. leucomela*, *H. namaquana*, and *H. obscurata*) are found along coastlines. Given the intense level of sampling for epiphytic macrolichens in coastal British Columbia, the strictly seaside occurrence of these lichens is certainly real, not a mere artifact of undercollecting (see COSEWIC 2006; UBC Herbarium 2019). All finds of *H. sitchensis* to date in Canada have been restricted to the outer coast, within the spray zone of the Pacific Ocean. In addition to spindrift, these areas also experience frequent fog.

Within these habitats, *H. sitchensis* is found within protected pockets that maintain some air flow (ventilation). Places offering such protection from the full exposure to maritime conditions include: the leeward sides of bays and small islands, inlets, and the sheltered portions of capes, headlands, spits and peninsulas.

Sitka Spruce

Heterodermia sitchensis is an epiphytic (tree-dwelling) lichen known only from Sitka Spruce. Because epiphytic macrolichens are seldom confined to a single tree species, a careful search of other potential host trees was made, including Red Alder (*Alnus rubra*), Amabilis Fir (*Abies amabilis*), Western Red-Cedar (*Thuja plicata*), Western Hemlock (*Tsuga heterophylla*), and Western Yew (*Taxus brevifolia*). These efforts yielded no additional host trees for this lichen (COSEWIC 2006).

The occurrence of Sitka Spruce is controlled in part by a requirement for periodic disturbance. In the Broken Group Islands of Pacific Rim National Park, for instance, it occurs abundantly on exposed, outer islands. In more sheltered, inner islands, by contrast, it is virtually absent, except where subject to high winds and winter storms. This observation doubtless has profound implications for the occurrence of *H. sitchensis*.

Twigs

Heterodermia sitchensis is mostly restricted to twigs less than 8 mm in diameter, although a few twigs 12 mm in diameter were found to support this species. As a rule, only the defoliated portions of living twigs are colonized, the adjacent foliated portions being perhaps too young or too ecologically unstable to support it. Twigs larger than about 10 to 12 mm in diameter are usually colonized by mosses and hepatics which tend to outcompete *H. sitchensis.*

In common with other lichens of small twigs, *H. sitchensis* appears to be a short- lived species, completing its life cycle within about 10 years. It dies when it is overgrown on a branch by aggressive bryophytes or lichens. This is probably the key reason why it is a rare species. *Heterodermia sitchensis* has a requirement for frequent recolonization but appears to be inefficient at dispersal (see **Dispersal and Migration).**

Branch elongation

Heterodermia sitchensis is mostly restricted to old trees with slow-growing branches (less than about 10 cm per year). It is occasionally found on younger but slow growing trees on rocky outcrops. This is based on observations from years of searching and revisiting sites.

Heterodermia sitchensis is probably most "abundant" following periods of stress to its host trees. Moderate insect defoliation, for example, appears to favour colonization even on more rapidly growing branches. Population dynamics in this species are thus probably cyclic, with episodes of relative abundance at landscape scale alternating with periods of decline. Observations in 2002 suggest that *H. sitchensis* was then entering a period of "abundance" following a defoliation event in about 2000. Similarly, severe storms in the winter of 2006/2007 may have contributed to the abundance of thalli noted in following years. Most favourable for colonization are twigs that survive defoliation, and hence continue to put on new growth in subsequent years. By contrast, branch death eventually leads to loss of bark and, with it, any *H. sitchensis*.

Canopy position

Heterodermia sitchensis appears to be restricted to the lower forest canopy, typically growing within about 4 m of the forest floor. Middle and upper canopies of Sitka Spruce have been opportunistically surveyed when feasible (recently downed trees or branches accessible from cliffs etc.) and no *H. sitchensis* has been found above the lower canopy. Goward (1994) interpreted this as reflecting sensitivity to desiccation, though subsequent observations of healthy thalli growing 13 m above the high tide line suggest this may not always be the case (Goward and Wright 2003). An alternative explanation, not necessarily precluding the first, is that *H. sitchensis* is absent from the middle and upper canopy owing to an unavailability of nitrogen and other nutrients needed to establish the lichen. Nitrogen is likely to be present in the needed high concentration only in the lower canopy, possibly as a result of leaching from higher in the tree or the accumulation of eutrophicated dust. The apparent lack of small-diameter, old and slow-growing twigs with partial defoliation in the mid- to upper canopy also likely restricts *H. sitchensis* to the lower canopy where these very specific conditions exist.

Branch chemistry

There is indirect evidence that *H. sitchensis* has a strong physiological requirement for bark with an elevated pH (Goward *et al.* 2006). At first inspection, this would seem to be out of keeping with its occurrence on Sitka Spruce which, in common with other conifers, tends to have acidic bark (Barkman 1958). However, it is well known that conifer bark subject to

nutrient enrichment of one kind or another can result in a high pH (Goward and Arsenault 2000), and relevant examples are briefly discussed below:

Bird perches

Droppings excreted by perching birds, especially Bald Eagles (*Haliaeetus leucocephalus*), create vertical columns of enrichment that extend downward to the forest floor. These nutrient columns appear to favour the establishment of *H. sitchensis* even on Sitka Spruce with normally a rather acidic bark. Once the supporting bird perch is abandoned, for example as a result of breakage or crowding by younger branches, the nutrient column gradually dissolves. Such a phenomenon may explain the loss of *H. sitchensis* from sites where the lichen is not abundant (Goward and Wright 2003).

Sea lion wintering grounds

One of the most productive sites for *H. sitchensis* is the north shore of Wouwer Island, well known as a winter haulout for California and Steller Sea Lions (*Zalophus californianus* and *Eumetopias jubatus*) which gather here in the hundreds. The sea lions occupy rock shelves, beaches, and even penetrate a short distance into the forest. To judge from the results of elemental analyses of Sitka Spruce twigs collected from this locality (Goward *et al.* 2006), the resulting aerosols impregnate nearby trees, considerably elevating bark pH. Not surprisingly, such localities provide prime habitat for *H. sitchensis.*

Base-rich bedrock

Wouwer Island has 35 thalli and Florencia Island ten *H. sitchensis* thalli. The latter is notable for its largely calciferous bedrock which is rare on the outer coast of British Columbia. This rock has been hypothesized to benefit base-loving arboreal lichens through the uptake of nutrients via tree roots (Goward and Arsenault 2000). The translocated nutrients are later released in the forest canopy. Evidence for nutrient enrichment in at least some stands of Sitka Spruce can be deduced from the presence, as on Florencia Island, of unusually rich assemblages of cyanolichens. This group of lichens prefers base rich rocks and the photosynthesizing partner, a cyanobacterium, requires a good supply of potassium and other elements for nitrogen fixation.

Seabird colonies

On Florencia Island, a supplementary source of enrichment could be derived from its intensive use by nesting seabirds. Glaucous-winged Gulls (*Larus glaucescens)*, Pelagic Cormorants (*Phalacrocorax pelagicus)*, Black Oystercatchers (*Haematopus bachmani)*, and Pigeon Guillemots (*Cepphus columba*) all frequent this island throughout the year, but are especially abundant during the breeding season. In addition to creating localized nutrient columns of the kind already described, the tendency of Glaucous-winged Gulls to defecate while ridge-soaring above the forest edge could provide an additional source of enrichment. This observation was made during visits to Florencia Island, where droppings are prolific.

Old village sites

Another source of enrichment is the shell middens that mark the presence of old Aboriginal villages. The former habit of accumulating seashells by Indigenous peoples in their village sites provides a localized and highly concentrated source of nutrients, particularly calcium, for any nearby *H. sitchensis*. Studies of shell middens on the British Columbia coastline and elsewhere in North America have found higher nutrient levels there and an abundance of lichens. However, to be suitable for colonization by *H. sitchensis,* the other characteristics, mentioned above, need to be present. Old village sites have been a focus for searching for *H. sitchensis* as they have an increased soil pH, and higher forest productivity (e.g. Cook-Patton *et al*. 2014; Trant *et al.* 2016). Such nutrients can elevate bark pH and favour the establishment of nitrophilous lichens like *H. sitchensis*. Disturbances associated with these village sites, more than a century ago, also promote a shoreline fringe of Sitka Spruce and thus potential habitat for *H. sitchensis.*

Small islands

Small islands provide a measure of defence against predation, thereby encouraging regular and prolonged use by nesting seabirds, wintering sea lions, and other animals. The occurrence of a rich fauna promotes high levels of nutrient enrichment, which in turn could favour colonization by *H. sitchensis*. This could explain the relative frequency of *H. sitchensis* on small islands. Capes, headlands, spits and peninsulas are also apparently favourable to this species as they are convenient resting places for migrating birds.

Habitat Trends

In Canada, *H. sitchensis* is restricted to seaside old growth forests along the west coast of Vancouver Island. Here it has probably been protected from resource extraction by the ruggedness of the topography, as well as by this region's relative inaccessibility. However, provincial regulations on forestry practice do not explicitly prohibit logging operations along the outer coast, so it is highly likely that *H. sitchensis* has suffered at least some habitat loss, especially given the exceptional commercial value of its host tree, Sitka Spruce. On the Ucluth Peninsula, logging for land development has already eliminated one or possibly two occurrences (Figure 4). Increasing recreational use of the small islands and shorelines where *H. sitchensis* is found is also likely to continue to degrade the species' habitat.

Figure 4. Logging at the Ucluth site observed in May 2019. Photo by Shyanne Smith.

BIOLOGY

Little is known about the biology of *H. sitchensis* but what is known is described below.

Life Cycle and Reproduction

Mature lobes of *H. sitchensis* invariably bear urn-like apothecia (sexual fruiting structures) in urn-shaped outgrowths near the lobe tips. Notwithstanding their frequency, the apothecia are not involved with reproduction in *H. sitchensis* as the ascospores are apparently vestigial, failing to reach maturity. Instead, reproduction in this species is vegetative through the release of powdery soredia, borne on the inner walls of the urns. Specific seasonality of reproduction and reproductive age are unknown. Because soredia contain both the fungal and algal partners of the lichen, they are effectively “instant lichens,” establishing a thallus directly within a period of five years. This is a good strategy for lichens colonizing defoliated twigs as there is no need for the fungus to acquire its photosynthetic partner to reestablish the symbiosis.

Physiology and Adaptability

With the exception of its presumed requirement for nitrogen enrichment (Goward *et al.* 2006), little is known about the physiological needs of *H. sitchensis*. However, its restricted occurrence in hyperoceanic localities suggests a requirement for cool temperatures and high atmospheric humidity, a pattern supported by the absence in this species of a protective lower cortex. These and other observations led Goward (1994) to propose that *H. sitchensis* may have evolved as a species in equatorial cloud forests.

Compared to other epiphytic lichens, *H. sitchensis* exhibits little adaptability in its choice of habitat. Indeed, careful searching has only turned up thalli of this lichen on living nitrogen-enriched twigs of old Sitka Spruce trees growing by the sea. Such potential host branches for *H. sitchensis* are likely to be available to the lichen only for a short time and depend on the available nutrient supply, suitable substrate (slow-growing Sitka Spruce twigs), diaspore availability, and absence of competing epiphytes. Clearly, *H. sitchensis* is much stricter in its ecological requirements than any of the lichen species with which it occurs, including the related *H. leucomela*.

Dispersal and Migration

Although soredia are produced in great abundance in *H. sitchensis*, they are mostly confined to the inner surface of “urns” that invariably form near the lobe tips. It seems unlikely, with this arrangement, that the propagules would have an efficient means of dispersal, although, in some instances, the urns could function as splash cups as found in *Cladonia chlorophaea* (however, the urns usually face downward). Another possibility, though speculative, is that forest birds that feed on invertebrates found on twigs may disperse the soredia. Possible birds include Chestnut-backed Chickadees (*Poecile rufescens*) and Golden-crowned Kinglets (*Regulus satrapa*). These may peck at the urns while looking for mites and collembola, etc., when foraging among lichens and mosses. Indeed, such birds often clean their bills by swiping them on twigs and may thereby pick up more soredia. After flying to new trees, they may disperse soredia onto new twigs.

Interspecific Interactions

As mentioned above, *H. sitchensis* is a fugitive species. It colonizes living twigs early in their development when the twig is usually devoid of competing epiphytes and has lost some of its needles as a result of some stress, often inundation by seawater. This allows *H. sitchensis* to establish without direct interaction with other species. Within about a decade, however, if winter storms have not further denuded the twig, other epiphytes – mosses, liverworts, and other lichens begin to colonize the host twig, and *H. sitchensis* is overgrown and gradually goes into decline.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Searches since 2001 have targeted the specific habitat suitable for *H. sitchensis,* with suitable coastline habitat identified (from mapping and local knowledge) and explored along most of British Columbia's coast between Sooke and Gwaii Haanas (Figure 5). Since 2006, targeted surveys of known occurrences of the species have been conducted by Parks Canada, resulting in an increase in known sites as well as total thalli. Sampling effort by Parks Canada, assessed by field days, consists of a total of 30 person-days each year from 2001 to 2004 (total of 120 person-days). Between 2006 and 2015, a total of 74 person-days led by Parks Canada were spent searching for new sites and/or revisiting known sites[1] (plus additional unrecorded volunteer opportunistic search efforts). In 2018 and 2019, as part of the writing of this report, there were eight person-days (2018) spent searching potentially suitable habitat at the northwest end of Vancouver Island and five person-days (2019) spent revisiting some of the known sites. Opportunistic searches were also conducted on Hope Island by Shyanne Smith and Brian Reader in 2013 and on Calvert Island by Troy McMullin in 2018 (both islands are near the northern end of Vancouver Island). The increased understanding of the very specific habitat requirements of *H. sitchensis* since the early 2000s has made identifying suitable habitat much easier. Several attempts to find new occurrences since then have shown that *H. sitchensis* is indeed unlikely to be found outside of its currently known range in Canada.

[1]Table 1 indicates which sites were visited each survey year.

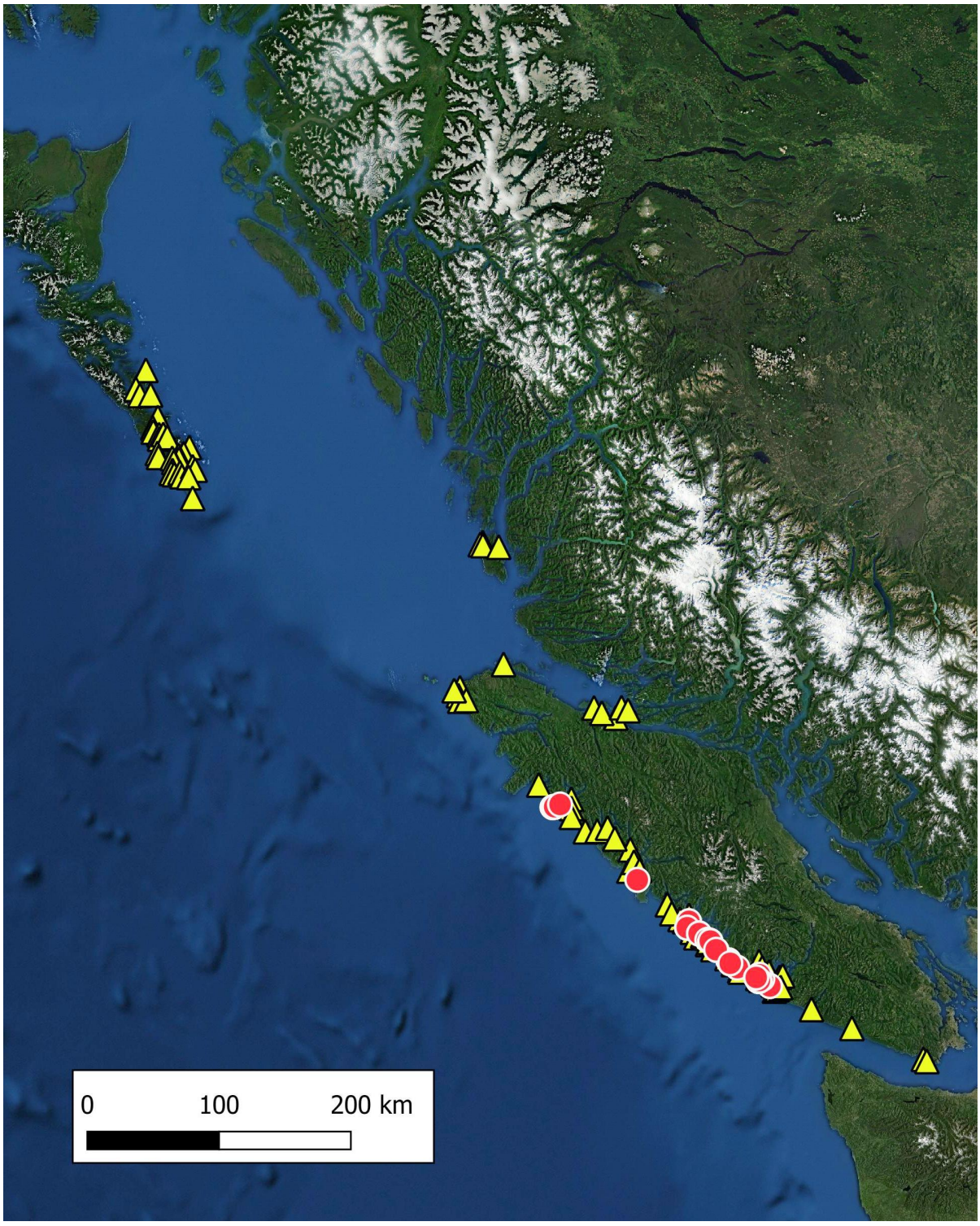

Figure 5. Unsuccessful targeted searches for Seaside Centipede Lichen, *Heterodermia sitchensis* in Canada. Occurrences are shown as red circles and areas searched are shown as yellow triangles (see **Search Effort** for details).

Abundance

The latest tally of *H. sitchensis* abundance is 314 thalli in 20 occurrences. Sixty-one percent (191) of these thalli, however, occur at just three (Benson, Wouwer, and Raccoon Islands) of these 20 occurrences (Table 1). The numbers of thalli for two occurrences in Pacific Rim National Park Reserve were reported to have dropped in 2015, compared to the 2011 survey, but are likely to increase again in the future (e.g., see discussion of trends on Wouwer Island (**Fluctuations and Trends** below**).** Monitoring has revealed year to year variability in the total known population size of *H. sitchensis* from about 100 to 400 thalli. This appears to be typical for this fugitive species (see below and Table 1). Although 20 occurrences are currently recorded, 90% of the known population occurs at just seven occurrences. Of the remaining occurrences, three are extirpated and the others have very small numbers of thalli (fewer than 10 thalli). Further searches may turn up a few new occurrences but the results of the extensive search effort to date lead to the conclusion that the total population of mature individuals in Canada is fewer than 1000. The results of the extensive searches, and the monitoring of *H. sitchensis* populations, indicate that it is a rare lichen, with very specific habitat requirements. The population is fragmented but does not meet criteria for severe fragmentation as it is not clear that (>50%) of its total area of occupancy is in habitat patches that are smaller than are required to support a viable population. It is uncertain how many thalli are required to support a viable population, However, many of the occupied habitat patches are separated from one another by large distances that appear to exceed the limited dispersal capability of *H. sitchensis.* Some occurrences are on isolated islands and 11 of the 20 occurrences have fewer than ten thalli (Table 1). More research is required on this aspect (see **Fluctuations and Trends** for more details)

Fluctuations and Trends

Of the twenty known occurrences of *H. sitchensis,* three are considered extirpated. Repeat visits to known sites have provided insights into *H. sitchensis* population trends (Table 1), indicating fluctuations are common.

At the time of its description in 1984, *H. sitchensis* was known from only two sites. The first (holotype) site is at Schooner Cove in Pacific Rim National Park Reserve. At this time a single Sitka Spruce branch bore at least a dozen thalli. When this same branch was re-examined in 2002, only a single rather moribund thallus of *H. sitchensis* and three apparently dead thalli were observed. Also lacking on this branch in 2002 was *Physcia tenella*, which had been reported two decades earlier (Goward 1984). Both *H. sitchensis* and *P. tenella* are nitrophiles which suggested that the decline was related to a gradual reduction in nutrients (in 1984 the branch was within the nutrient column of a bird perch which was no longer in use 20 years later). Further visits in 2008 and 2011 found only one thallus at this site but a recent visit in 2019 discovered two thalli. One was a large healthy-looking thallus with 15 apothecia on this same branch and birds appear to once again be perching above. The second thallus was small and observed on a twig of a nearby tree.

A second site, 22 km southeast of the holotype, is near Ucluelet on the Ucluth Peninsula. It was affected by logging for a housing development and, in the early 1990s, *H. sitchensis* disappeared from this site (COSEWIC 2006). The reason for the decline of another Ucluth Penninsula site visited in 2001 is currently unknown. In 2019, recent logging was observed in the vicinity of this second Ucluth Penninsula site at the end of Minuto Road. The actual site could not be revisited without permission as access to the site was through private land (Figure 4). Two other likely extirpated occurrences are the Dicebox Island occurrence at which only one thallus has ever been recorded and no thalli found when last visited in 2011, and the Folger Island occurrence. The latter only had two thalli in 2008 and none in 2011. These two occurrences may have been initiated by temporarily suitable habitat conditions such as nitrogen enrichment from droppings by birds which later abandoned the site.

One occurrence where *H. sitchensis* thalli were most numerous was along a stretch of shoreline on Wouwer Island in the Broken Group Islands. Here, in 2001, a dozen thalli were noted on the lower branches of a stunted Sitka Spruce exposed to northwest winds. When the same tree was visited in 2002, only eight thalli were found, one of which was apparently healthy, the others dead. A careful survey of higher up in the canopy revealed twelve more thalli, of which only four were alive. The high incidence of dead thalli points to a die-back event, probably during the winter of 2001/2002. In fact, such a die-back had been predicted by Barry Campbell on the basis of exceptionally strong northwest winds in April of 2002 (COSEWIC 2006). The branches of the host tree appear to have been repeatedly drenched with salt water, as indicated by the greenish algal layer covering the basal portions of the lichens. Epiphytic mosses, too, had been partly smothered by algae. Discoloured lichen thalli were noted in many other sites in 2002, especially those exposed to northwest winds. Six years later, in 2008, the number of thalli at Wouwer had increased to 111, and in 2011, to 199. However, in 2015, only 35 thalli were relocated. The die-back of needles on branches during the winter of 2001/2002 may, in the subsequent few years, have resulted in an increase in available habitat for colonization by *H. sitchensis*, enhanced by the abundant nitrogen source (nearby sea lion haulout). It is uncertain whether the decline reported in 2015 was a result of a change to sea lion haul-out patterns (Yakimishyn pers. comm. 2018), the successional state of the twigs, or some other factor.

Periodic winter storms may cause the loss of thalli at a site if severe, but if less intense may lead to needle death and removal on the young branches and so create new habitat for colonization. It probably takes five years between the landing of a soredium on a twig for it to develop into a thallus visible to the naked eye. Once a thallus has developed, observations have shown that under favourable conditions, thalli can live for as much as a decade and become a persistent source of propagules for nearby uncolonized habitat. For example, a 2019 visit to Quisitis Point found a large thallus at the same site, and of the same size (20+ apothecia), as the one recorded in 2008. Although it is not absolutely certain that this is the same thallus, it does appear that this thallus has persisted for more than 10 years. Thus, under certain conditions, it appears that some occurrences can remain over the longer term. For example, five thalli have consistently been observed at Quisitis Point since 2001. Thalli growing in less suitable habitat develop and become visible but then are lost and not found again on revisits to a site. In conclusion, while fluctuations

occur in relation to available habitat for colonization, and are related to sufficient nutrient enrichment, it seems that the species, while rare, is currently not in decline. In the past, it seems likely that logging and land development had an impact on the population of *H. sitchensis,*

The total number of thalli has not declined since the time thalli have been monitored by Parks Canada but this is over a relatively short time (Table 1). However, three occurrences have been lost and the habitat quality seems to have been in decline at some other occurrences. The effects of the predicted climate change include direct impact on the lichen and its host trees as well as habitat shifting by birds and marine mammals which may change this picture and result in a decline in the population (see **Threats and Limiting Factors** below)**.**

Rescue Effect

At the present time, the majority (20) of known *H. sitchensis* occurrences are within Canada. The two United States occurrences are found at Cape Lookout in Tillamook County and at Umpqua Lighthouse State Park in Douglas County, Oregon (NatureServe 2018), approximately 500 km south of the Canadian occurrences. Because of this, diaspores originating from points south of the border are extremely unlikely to rescue losses in Canada.

THREATS AND LIMITING FACTORS

Threats

Direct threats facing *H. sitchensis* 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.* 2012). Threats are defined as activities or processes that directly negatively affect the Canadian population, and can be ongoing and/or likely to occur in the future. A threats assessment was completed in 2019. The overall threat impact was calculated to be “very high” to “high”. Details on the calculated impact, scope, severity, and timing of threats are presented in Appendix 1. Climate change is the major threat that is predicted to affect *H. sitchensis.* Seven locations have been identified. There are also more local threats that include recreational activities, developments, tourism, and wood harvesting. These local threats are likely to affect only one or a few occurrences (see below and Table 1).

<u>Climate change and severe weather (see Appendix 1, section 11): High - Medium</u>

Habitat shifting and alteration (subsection 11.1): High - Medium

Habitat shifting is a threat to H. sitchensis because the species is often dependent on sea lions or birds for its nitrogen source. Climate change may lead to changes in fish distribution and populations and consequently bird or mammal populations. Not all

occurrences are dependent on specific bird/mammal sources of nitrogen (i.e. some are enriched from mud flats or shell middens). However, bird and mammal habitat shifting could affect at least 16 of the 20 occurrences (most are influenced by a different set of bird/mammal populations). In recent years, sea lions have shifted their haulout sites from near Wouwer Island to other areas, including Batley Island, rocks south of Wouwer, and even further away to Folger Island, Sea Bird Rocks and Perez Rocks (Szaniszlo pers. comm. 2018). This shifting may well have caused the decrease in the number of thalli at Wouwer Island from 199 in 2011 to 35 in 2015. If the sea lions do not return to Wouwer Island, the lichen will likely disappear from this site.

Sea level rise, as well as changes in fish populations and distribution resulting from climate change, may be contributing to habitat shifting by sea lions and birds. In turn this may be leading to a decline of nitrogen enrichment sources needed for *H. sitchensis*.

Sea level rise may also directly affect the lichen colonies because of the species' preference for a habitat low in the tree column. This impact may be small as sea level rise is unlikely to exceed 10 cm in the area where *H. sitchensis* is found within the next three decades. This is because sea level rise along the west coast of Vancouver Island is mitigated by isostatic rebound (BC MoE 2016; Lemmen *et al.* 2016).

Droughts (subsection 11.2): High - Medium

Increased droughts as a result of climate change could impact spruce trees growing in already-difficult conditions along the shoreline, as well as directly reduce fogs upon which *H. sitchensis* thrives. Climate projections indicate that summers will become slightly drier, as well as warmer, in the Pacific Maritime ecozone (Price *et al.* 2011), with a 10% decrease in summer precipitation and greater than 2.3°C summer temperature increase projected for BC's west coast by the 2080s (Vadeboncoeur 2016).

Temperature extremes (subsection 11.3): Negligible

The impact of temperature extremes is currently considered negligible. Change in temperature extremes may not be high enough to be a threat to this lichen or its host tree, at least for the next two decades (summer drought is assessed in 11.2). Note that increased sea temperatures could lead to changes in the distribution of fish, mammal and bird populations (see 11.1 for this).

Storms and flooding (subsection 11.4): High – Low

Severe storms are a threat because large waves or swells can make contact with the twigs on lower branches of host trees, and then dislodge the lichen or inundate them with seawater or large amounts of salt-rich spray. *Heterodermia sitchensis* appears to require periodic storms that cause needle dieback and thus habitat for establishment, However, severe storms can also damage or destroy spruce trees by breaking off suitable branches and twigs or knocking down entire trees.

In other parts of the north coast, severe storms have been observed to destroy entire epiphytic lichen communities over large areas (Nat. Rec. Team for *H. sitchensis* 2007). Searches targeting *H. sitchensis* to the north of its known range have found that the lower spruce branches in suitable habitats appear to be too storm-damaged to host the lichen. In addition, *Heterodermia* is a genus whose distribution is more common in tropical and warm temperate latitudes and its northward spread is likely limited by the colder winter temperatures.

Most *H. sitchensis* thalli are found within 2 m of the ground, many within 50 cm, and often close to high tide level. Severe winter weather events are expected to become more frequent as a result of human-induced climate change (Donovan and Penny 2013; Vadeboncoeur 2016; Bush and Lemmon 2019), and increased winter wave heights are already being recorded along the Pacific coast (Ruggiero *et al.* 2010; Seymour 2011).

Changes in the environment that alter ventilation conditions where *H. sitchensis* occurs may adversely affect the lichen and dispersal of its soredia. The lichen often occupies the leeward side of exposed islands, or protected pockets along more exposed coastlines. Changes in forest or forest understory on the windward side (such as trees uprooted by storms or vegetation being killed by salt water) may lead to damage of the lichen occurrences on the leeward side as their microclimate is affected and the lichens more exposed to salt spray.

Geological events (see Appendix 1, section 10): High - Low

Earthquakes/tsunamis (subsection 10.2): High - Low

There is a 55-60% estimated probability of a tsunami exceeding 1.5 metres hitting the north or southwest coast of Vancouver Island over a 50-year period (Leonard *et al.* 2013). If a tsunami were to impact one of the *H. sitchensis* occurrences where the lichen is most abundant (Raccoon Island, island south of Spring Island, Benson Island or Wouwer Island), it could cause loss of a high percentage of the Canadian population.

Human intrusions and disturbance (see Appendix 1, section 6): High - Medium

Recreational activities (subsection 6.1): High-Medium

Recreational activities are considered to be a high to medium threat to *H. sitchensis*. This is a threat to at least 8 of the 20 occurrences (40%), as they are located in areas that see frequent recreational use (13 of 20 occurrences are in public parks and recreation areas but not all of the sites where *H. sitchensis* occur are easily or frequently accessed). Although the species is technically mostly protected within parks and recreation areas, the twigs that *H. sitchensis* require are extremely slow-growing and to most people would often look dead and therefore of no consequence. Collection of dry twigs and branches from the shoreline for campfires is common practice, even within protected areas. Spruce trees near popular campsites are typically denuded of twigs suitable for *H. sitchensis*. This is important as the lichen has not been found in the tree column above human reach. On more than one

instance, *H. sitchensis* thalli have been found on twigs collected for campfire use. The twigs are of a type that would be collected by beachside campers for starting fires because they are often dry, of a suitable size, and are found near the high tide line where fires and campsites are made.

Heterodermia sitchensis occurs in some of the most popular kayaking areas on the west coast. Aside from collecting twigs, hikers and kayakers have also been observed swinging from spruce branches, tying tarps to them for shelter, or attaching or hanging other things from spruce branches along shorelines.

The Broken Group Islands in Pacific Rim National Park Reserve are a popular kayaking destination and see heavy use in the summer months. Camping and campfires are not permitted on Benson and Wouwer Islands but are permitted on Gilbert and Turret Islands, where *H. sitchensis* was found near campsites in 2011. Breaking branches from trees is not permitted in the National Park Reserve, although enforcement is difficult in this backcountry setting.

Occurrences that are not within parks and protected areas can also be affected by recreational activities. Spring Island is a popular kayaking destination, and now also hosts a seasonal semi-permanent camp run by a commercial tour operator. *Heterodermia sitchensis* does not receive protection under the SARA on Spring Island or the other islands near Kyuqout.

Work and other activities (subsection 6.3): Negligible

Parks Canada has been monitoring the abundance of this lichen but is not likely to collect it for research.

Residential and commercial development (see Appendix 1, section 1): Medium - Low

Tourism and recreation areas (subsection 1.3): Medium - Low

Development for commercial recreational land use (campgrounds) has recently occurred near two occurrences (Spring Island and Ucluth), and further development is possible near several other occurrences such as on the Tofino-Ucluelet peninsula (see below).

Biological resource use (see Appendix 1, section 5): Medium - Low

Logging and wood harvesting (subsection 5.3): Medium – Low

Logging is not prohibited along marine shorelines of British Columbia's south coast. Old Sitka Spruce trees are valuable. Log dumps may be formed along the shorelines in logging areas, to transfer logs to the ocean for transport. Fortunately, most islands where the lichen is found are probably too small to make logging viable. The Quisitis Point occurrence is located within Pacific Rim National Park Reserve on Vancouver Island, but is

near the park boundary, so that occurrences in the park could be affected if trees were felled on adjacent land. Tree felling is also a threat outside of the Pacific Rim National Park Reserve (e.g. Kyuquot area and Folger Island). At least one *H. sitchensis* site (and probably two sites) on the Ucluth Peninsula was lost as trees were felled for development (COSEWIC 2006).

Clearing for resorts and related accommodation, as well as for housing, is in progress, or planned, on the Ucluelet/Tofino peninsula. This may affect areas of potential suitable habitat for *H. sitchensis.* There are known occurrences in the area (Table 1). Future surveys are needed to search for the lichen and quantify the magnitude of this threat (Cruickshank, pers. comm. 2021).

Limiting Factors

Heterodermia sitchensis has a number of limiting factors that make its distribution on the landscape particularly rare and fragmented and increase its vulnerability to threats.

Biology and specific habitat requirements

Heterodermia sitchensis has exceptionally specific habitat requirements, causing it to be rare throughout its range and to be particularly sensitive to threats. In order to become established, it must first successfully disperse its propagules, probably relying on external vectors such as birds (see above).

Disturbance

Heterodermia sitchensis is a successional species and, without disturbance, is eventually overgrown by other lichens and bryophytes. Defoliation from insect outbreaks has been noted to provide new habitat for colonization. An increase in thalli at some sites has been noted in years following storm events. It is difficult to predict the effects of climate change, but the absence of *H. sitchensis* north of Kyuquot (despite several searches in promising places such as inlets near Cape Scott, Hope and Calvert Islands, and Gwaii Haanas that have suitable geophysical characteristics as well as sources of enrichment) suggests that this species cannot tolerate the more severe storms that occur to the north of its known range.

Ephemeral sites

The frequently exclusive association of *H. sitchensis* with nutrient columns below the roosts of perching birds is especially disquieting: it suggests that the occurrence of this species is not stable at most sites. For example, at the holotype locality, the 12 thalli observed in 1983 have dwindled to only one thallus (although an additional thallus was found at a nearby site in 2019). The perch trees themselves may be long-lived, but the roosts are likely to be relatively ephemeral. Several of the sites have no nearby sea lion colonies and are not located on middens. These sites are most likely ephemeral, resulting from bird roosts, or even from “fecal bombing” by sea birds. These ephemeral sites with

only a few thalli can appear and disappear over time. To thrive, they require a source population, and a consistent nutrient enrichment to supply the propagules for dispersal agents like birds.

Number of Locations

The number of locations for *H. sitchensis,* with respect to a major overall threat, is seven.

The occurrences of *H. sitchensis* are grouped into four geographic areas that would most likely be affected separately by stochastic events such as severe storms or tsunamis. The groups are designated as four subpopulations, as follows: 1.) Barkley Sound subpopulation; 2) Clayoquot Sound subpopulation; 3.) Nootka Sound subpopulation; 4.) Kyuquot Sound subpopulation. These four subpopulations are separated by distance greater than the likely dispersal capability of the lichen. Severe storms or a tsunami are unlikely to have an impact on more than one of the subpopulations at a time.

Furthermore, in each subpopulation, there are some occurrences that are more exposed to the impact of high winds and waves and other occurrences that are more sheltered. The latter are less likely to be affected by high winds and waves but will still be threatened by high tides, surges and rising sea levels. Taking these aspects into account, more than one location has been identified for most subpopulations. The seven locations are as follows:

Barkley Sound

1. more exposed: Dicebox Island, Wouwer Island, Folger Island
2. more sheltered: Benson Island, Turret Island, Gilbert Island

Clayoquot Sound

3. more exposed: Schooner Cove, Lawrence Island, Islet east of Vargas Island, McKinn Islets, Quisitis Point, Florencia Island
4. more sheltered: Ucluth Peninsula, Raccoon Island, Laddie Islet, Mike’s Islet

Nootka Sound

5. more exposed: Escalante Island

Kyuquot

6. more exposed: Small island near Kyuquot
7. more sheltered: Spring Island, Unnamed island (south of Spring Island)

Severe storms directly remove thalli from the lower tree branches where they are found or can expose them to salt-containing spray. The larger waves can break off branches and twigs or knock down entire trees. At the more sheltered locations, the high

tides, surges and rising sea levels are the threat to the lichen because it grows on twigs close to ground level that are near to the shore (Figure 3).

H. sitchensis faces another threat associated with climate change, notably, habitat shifting. Changes in sea temperatures may lead to alternations in the distribution and population of fishes and consequently of the bird and or mammal populations that are needed to supply the required nitrogen for this lichen (see **Threats** and **Threats Calculator**).

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Heterodermia sitchensis has been assessed as Endangered as of its last COSEWIC status report in 2006 and is listed as Endangered in Schedule 1 of the federal *Species at Risk Act*.

The species is included within the Multi-species Action Plan for Pacific Rim National Park Reserve, which identifies critical habitat for three *H. sitchensis* occurrences within the park and lists recovery measures to protect the species and critical habitat within the park (Parks Canada Agency 2017). One recovery measure applies specifically to *H. sitchensis*: raising visitor awareness by providing visitors with information regarding species protection. Information on site importance to a variety of species and park regulations is made available to visitors to encourage compliance and minimize human disturbance. In addition, general measures for species at risk in the park include: developing and implementing a media strategy, with at least one media story highlighting species at risk in the park each year, and incorporating species at risk monitoring and recovery into visitor opportunities.

Parks Canada is the lead agency in the *H. sitchensis* surveys conducted since 2001 and Parks Canada published the Recovery Strategy for *H. sitchensis* in 2007 (National Recovery Team for *H. sitchensis* 2007). The occurrences of *H. sitchensis* in Pacific Rim National Park Reserve, where the greatest number of mature individuals of this lichen occur (i.e., on Wouwer, Benson, and Florencia Islands), are protected from human-initiated disturbance under the *National Parks Act* (COSEWIC 2006) and the *Species at Risk Act.*

Camping in the popular Broken Group Islands in the Pacific Rim National Park Reserve is only allowed on seven islands. Camping is not permitted on Wouwer, Benson or Florencia Islands, where the majority of *H. sitchensis* thalli are found. In 2011, however, one *H. sitchensis* thallus was found near the campsites on two of the islands where camping is permitted (Gilbert and Turret). Parks Canada asks visitors to leave all vegetation as it is found and states on its website:

> “A rare lichen, the seaside centipede lichen, has been found in the Broken Group Islands. Breaking lower branches from trees could have a devastating impact on the species.” (Parks Canada website 2019).

Non-Legal Status and Ranks

The species is listed by NatureServe as “globally imperiled” (G1) worldwide and “critically imperiled” (S1) within British Columbia (NatureServe 2018). The species is also included in British Columbia’s “Red List” of species at risk of being extirpated, endangered or threatened.

Habitat Protection and Ownership

There are twenty known *H. sitchensis* occurrences in Canada, thirteen of which have some sort of legal protection, as they occur in protected areas (see Table 1). Eight occurrences are within Pacific Rim National Park Reserve and are protected from human disturbance by the *National Parks Act* and by the *Species at Risk Act*. Five are in provincial recreation sites, parks or wildlife management areas and receive some protection under British Columbia’s *Park Act or Wildlife Act*. Of the remaining seven occurrences, three are on provincial Crown land, three on First Nations Treaty Lands and one is on private land and has no formal protection.

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A special thanks to the late Barry Campbell for his interest in *H. sitchensis* and his efforts in searching out and recording new occurrences of the lichen. The previous status and update status reports, and significant work on understanding the ecology of *H. sitchensis*, were completed by Trevor Goward and Kenneth Wright.

Parks Canada has funded several *H. sitchensis* surveys since 2006 and Environment and Climate Change Canada funded this report and associated fieldwork in 2018 and 2019.

Authorities Contacted

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Shyanne Smith has a Master of Science degree in Geography from the University of Guelph, where she focused on paleoecology and biogeography. She has specialized in the rare plants of British Columbia over the last 15 years, but has a particular interest in the Seaside Centipede Lichen. She participated in field surveys for the rare lichen in 2006, 2008, 2009, 2011 and 2018. She has written or co-written nine COSEWIC status reports and six recovery strategies for species or ecosystems at risk.

COLLECTIONS EXAMINED

Collections were not examined during the writing of this report. All known Canadian collections of *Heterodermia sitchensis* were examined for the 2006 status report, and no collections of this species have been made since this time (see Appendix 2).

Appendix 1. IUCN Threats calculator for the Seaside Centipede Lichen (*Heterodermia sitchensis*).

Species or Ecosystem Scientific Name	Seaside Centipede Lichen (*Heterodermia sitchensis*)
Date:	2019-07-18
Assessor(s):	Dave Fraser (Moderator), David Richardson (Co-chair), Shyanne Smith (SR writer), Nicole Fenton (SSC members), Karen Golinski (SSC members), Greg Wilson (BC), Brian Reader (PCA), Brenda Costanzo (BC), Karen Stefanyk (BC)
References:	Draft 2020 status report, 2006 status report, 2016 Recovery Strategy, 2016 Status Appraisal Summary and Threats Assessment

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	3	0
C	Medium	2	2
D	Low	0	3
Calculated Overall Threat Impact:		Very High	High

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	CD	Medium - Low	Restricted - Small (1-30%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas	CD	Medium - Low	Restricted - Small (1-30%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Development for commercial recreational land use (campgrounds) has recently occurred near two occurrences (Spring Island and Ucluth), and further recreational development is possible near several other occurrences (especially given transfer of land out of BC protected areas, and importance of some islands, such as Benson, for FNs use).
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture						There have been some aquaculture applications in the region, so this is a possibility for the future.
3	Energy production & mining						
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying						not applicable
3.3	Renewable energy						not applicable
4	Transportation & service corridors						
4.1	Roads & railroads						not applicable
4.2	Utility & service lines						not applicable
4.3	Shipping lanes						not applicable
4.4	Flight paths						not applicable
5	Biological resource use	CD	Medium - Low	Restricted - Small (1-30%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
5.1	Hunting & collecting terrestrial animals						This could become a threat in the future if there is an increase in FNs hunting on the islands (increased use - increased risk of damage to twigs on shoreline).
5.2	Gathering terrestrial plants						This could become a threat in the future if there is an increase in FNs gathering on the islands (increased use - increased risk of damage to twigs on shoreline). Collecting trees or logs for ceremonial poles, even if not spruce, could impact the species.
5.3	Logging & wood harvesting	CD	Medium - Low	Restricted - Small (1-30%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Most occurrences are on islands too small to be considered for logging (although logging of the shoreline is not prohibited along the south coast and logs are transported via water). The Quisitis Point occurrence is located within Pacific Rim National Park Reserve on Vancouver Island, but on the boundary with FN land, and could be impacted if the FN land were logged.
5.4	Fishing & harvesting aquatic resources						not applicable
6	Human intrusions & disturbance	BC	High - Medium	Large (31-70%)	Serious - Moderate (11-70%)	High - Moderate	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities	BC	High - Medium	Large (31-70%)	Serious - Moderate (11-70%)	High (Continuing)	A threat for 8 of 20 occurrences (40%). If calculated as a percent of total population (counting thalli instead of occurrences), would be a different (lower) value. Collection of dry twigs and branches from the shoreline for campfires is common, even within protected areas. Although technically mostly protected within parks and recreation areas, the twigs that SCL requires are extremely slow-growing and to most people would often look dead and therefore of no consequence. Occurring at the high-tide line, often between chest and head height, they are found in areas used by hikers and kayakers etc. This species occurs in some of the most popular kayaking areas on the west coast. Hikers/kayakers have been observed swinging from spruce branches, tying tarps for shelter, or attaching/hanging other things from spruce branches along shorelines.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Large (31-70%)	Negligible (<1%)	High - Moderate	Parks Canada has been monitoring the abundance of this lichen but are not likely to collect it for research.
7	Natural system modifications						
7.1	Fire & fire suppression						Fire could become a threat, if conditions change (with climate change).
7.2	Dams & water management/use						not applicable
7.3	Other ecosystem modifications						Pruning or tree planting not likely (other than has already happened as listed above under 1.3.). Not applicable.
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species/diseases						not applicable
8.2	Problematic native species/diseases						This lichen can be outcompeted by native mosses, especially if conditions change to make it more favorable for them but this is a natural process and not due to human impact. Not applicable.
8.3	Introduced genetic material						not applicable
8.4	Problematic species/diseases of unknown origin						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.5	Viral/prion-induced diseases						not applicable
8.6	Diseases of unknown cause						not applicable
9	Pollution		Negligible	Negligible (<1%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
9.1	Domestic & urban waste water						not applicable
9.2	Industrial & military effluents		Negligible	Negligible (<1%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	There is some tanker traffic up and down the coast where this lichen occurs. Oil spills are potentially threatening, or spray containing oil during a storm.
9.3	Agricultural & forestry effluents						not applicable
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events	BD	High - Low	Large - Restricted (11-70%)	Serious - Slight (1-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis	BD	High - Low	Large - Restricted (11-70%)	Serious - Slight (1-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Tsunamis could have a dramatic and serious impact on the population of this lichen in Canada where a large proportion of the population occurs on just three islands. The likelihood of a tsunami in the region is difficult to predict.
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration	BC	High - Medium	Large - Restricted (11-70%)	Serious (31-70%)	High (Continuing)	Changes in nitrogen deposition patterns following alterations in bird populations or mammal haul-out patterns are a threat. Climate change may lead to changes in fish distribution and populations and consequently bird or mammal populations (may already be seeing this habitat shifting occurring). Not all occurrences are dependent on specific bird/mammal sources of nitrogen (i.e. some are enriched from mud flats or shell middens). Bird/mammal habitat shifting could affect 16 of the 20 occurrences (each influenced by different set of bird/mammal populations - a couple may be linked ie. Florencia Bay and Quisitis and Spring Isl and islet near it).
11.2	Droughts	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	Increased droughts as a result of climate change could impact spruce trees growing in already-difficult conditions along the shoreline, as well as directly reduce fogs upon which the lichen thrives. According to a recent climate projection, droughts in the area are likely to increase in the next two decades (2016 appraisal).
11.3	Temperature extremes		Not Calculated (outside assessment timeframe)	Restricted - Small (1-30%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs/3 gen)	Change in temperature extremes may not be high enough to be a threat to this lichen or its host tree, at least for the next two decades (summer drought is assessed in 11.2). Note that increased sea temperatures could lead to changes in the distribution of fish, mammal and bird populations (see 11.1 for this).
11.4	Storms & flooding	BD	High - Low	Large - Small (1-70%)	Serious - Moderate (11-70%)	High (Continuing)	An increase in severe storms is predicted which can have an impact by directly removing thalli from the lower tree branches where they are found or exposing them to salt-containing spray. Severe storms can also damage or destroy spruce trees - breaking off suitable branches and twigs or knocking down entire trees.
11.5	Other impacts						not applicable

Appendix 2. Collections of Seaside Centipede Lichen, *Heterodermia sitchensis*.

Specimen Location	Abundance (no. of thalli/ locality)	Locality Habitat Substrate	Collector Collecting # Date	
UBC	12 (min.)	Canada, British Columbia, Vancouver Island, Schooner Cove	T. Goward 83-326	
		Seaside fringe forest at edge of broad sheltered beach on exposed outer coast	March 30, 1983	
		On twigs of *Picea sitchensis*		
UBC	4 (min.)	Canada, British Columbia, Vancouver Island, Ucluth Peninsula	T. Goward 83-341	
		Seaside fringe forest in sheltered, well-lit bay on exposed outer coast	April 3, 1983	
		On twigs of *Picea sitchensis*		
UBC	42	Canada, British Columbia, Vancouver Island, Broken Group, Wouwer Island	T. Goward 01-344 &	
		Seaside fringe forest in sheltered, well-lit bay on exposed outer coast	01-346 July 20, 2001	
		On twigs of *Picea sitchensis*		
UBC	56	Canada, British Columbia, Vancouver Island, Florencia Island	T. Goward 01-401	
		Seaside fringe forest in sheltered bay on exposed outer coast	July 24, 2001	
		On twigs of *Picea sitchensis*		
UBC	21	Canada, British Columbia, Vancouver Island, Lawrence Island	T. Goward 02-067	
		Seaside fringe forest of small unindented island on exposed outer coast	June 12, 2002	
		On twigs of *Picea sitchensis*		
UBC	18	Canada, British Columbia, Vancouver Island, Folger Island	T. Goward 02-151	
		8 km west of Bamfield. Sheltered shoreline; north temperate subzone of CWH	June 19, 2002	

Specimen Location	Abundance (no. of thalli/ locality)	Locality Habitat Substrate	Collector Collecting # Date	
		On twigs of *Picea sitchensis*		