COSEWIC
Assessment and Status Report

on the

Seaside Bone Lichen
Hypogymnia heterophylla

in Canada

NOT AT RISK
2022

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:

COSEWIC. 2022. COSEWIC assessment and status report on the Seaside Bone Lichen *Hypogymnia heterophylla* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 46 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

Previous report(s):

COSEWIC. 2008. COSEWIC assessment and update status report on the seaside bone *Hypogymnia heterophylla* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 20 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

COSEWIC. 1996. COSEWIC assessment and status report on the Seaside Bone Lichen *Hypogymnia* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 36 pp.

Production note:
COSEWIC would like to acknowledge Curtis Björk for writing the status report on Seaside Bone Lichen (*Hypogymnia heterophylla*), in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by David Richardson, Co-chair of the COSEWIC Mosses and Lichens Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur L’hypogymnie maritime (*Hypogymnia heterophylla*) au Canada.

Cover illustration/photo:
Seaside Bone Lichen — Photograph by Curtis Björk.

Catalogue No. CW69-14/60-2022E-PDF
ISBN 978-0-660-44297-6

COSEWIC
Assessment Summary

Assessment Summary – May 2022

Common name
Seaside Bone Lichen

Scientific name
Hypogymnia heterophylla

Status
Not at Risk

Reason for designation
This leafy lichen is endemic to western North America, and in Canada was once thought to occur only on the southern tip of Vancouver Island. Two additional subpopulations have since been found, one farther north on Vancouver Island and the other on Haida Gwaii, significantly expanding its previously known range and ecological amplitude. Surveys since the last assessment have revealed that there are between 600,000 and 3,000,000 thalli, a 30-fold increase in the known population. In view of this new information, this lichen is assessed as “Not at Risk”. Threats include fires, housing developments, human intrusion, and pollution, but the overall impact is considered to be low. The effects of storms and summer droughts on this species could not be quantified but are unlikely to have a significant near-term impact on the very large population.

Occurrence
British Columbia

Status history
Designated Special Concern in April 1996. Status re-examined and designated Threatened in April 2008. Status re-examined and designated Not at Risk in May 2022.

COSEWIC
Executive Summary

Seaside Bone Lichen
Hypogymnia heterophylla

Wildlife Species Description and Significance

Hypogymnia heterophylla (Seaside Bone Lichen) is a large lichen with hollow, inflated, mostly ascending-spreading lobes that are irregular in width and which usually bear lateral lobules. The lichen is epiphytic and can grow to be 8 cm or more in diameter. The lichen has a whitish upper surface and black lower surface. Seaside Bone Lichen is locally abundant. It occurs in three areas in coastal British Columbia, where it represents the northernmost extension of a more widespread population that also occurs on the west coast of the United States.

Distribution

Seaside Bone Lichen is endemic to western North America. It is known from British Columbia in Canada and from California, Oregon, and Washington in the United States. In BC, it occurs on the southern tip of Vancouver Island, at Kennedy Lake on the western side of Vancouver Island, and on northern Graham Island, in the archipelago of Haida Gwaii.

Habitat

Seaside Bone Lichen occurs as an epiphyte, mostly on Shore Pine and Douglas-fir in open-canopy forest and on solitary trees along marine shores where ventilation is sufficient to dry the thalli and underlying substrates rapidly after rain. A small number of thalli have been observed on lignum of wooden fences near colonized trees.

Biology

Seaside Bone Lichen is a lichen that has a green alga as its photosynthetic partner. Asexual reproductive structures are lacking although very local dispersal may be possible following fragmentation of thalli. The main reproductive structures are apothecia produced by the fungal partner. These contain ascospores that are ejected at maturity and dispersed by wind and rain. Formation of a new thallus requires contact of the germinated spore with a suitable algal partner. Longevity of the thalli is unknown but is at least a decade.

Population Sizes and Trends

There are three subpopulations of Seaside Bone Lichen in Canada. The total number of thalli in the subpopulations is estimated at between 600,000 and three million on about 30,000 trees. Nearly all of the known thalli occur in Canada in a small area on southern Vancouver Island, on promontories between Sooke and Victoria. A smaller subpopulation of the lichen, consisting of a few hundred thalli, has been discovered on the margin of Kennedy Lake on the west coast of Vancouver Island. A third very small subpopulation with fewer than 100 thalli has been found on Haida Gwaii, near the village of Masset. The trends in population size are unknown, but future declines are, in the absence of major climate alterations, likely to be small. The apparent increase in the size of the known Canadian population since the last assessment in 2008 is a result of greater search effort and understanding of the ecology of this species, rather than an increase in the population.

Threats and Limiting Factors

The threats assessment indicated that the overall threat, to the current very large population of the Seaside Bone Lichen, was low. The impact of housing development, human intrusion and air pollution is likely negligible. The effects of storms and summer drought could not be quantified for this lichen, which is believed to be resistant to these threats as it is most common on coastal promontories. The Seaside Bone Lichen may be affected by fires, which are likely to increase in number as a result of climate change. Fires can lead to the loss of lichen thalli through mortality of host trees. However, the frequency and impact of fires, in the areas where the lichen is most abundant, are likely to be low. Finally, most of the Canadian population of Seaside Bone Lichen occurs at sites that have protected-area designations and are within a restricted geographic area, on the southern tip of Vancouver Island.

Protection, Status and Ranks

Seaside Bone Lichen is currently ranked by NatureServe globally as G4 (Apparently Secure) (2017) and nationally as N2 (Imperilled) in Canada. As of April 2019, it has been ranked S2 (Imperilled) and is Red-listed by the British Columbia Conservation Data Centre. However, the new data in this current report have not been incorporated into subnational or national ranks. Seaside Bone Lichen was assessed as Threatened by COSEWIC in 2008 and is listed under the Government of Canada's *Species at Risk Act* (SARA). It has not been assessed by the International Union for the Conservation of Nature (IUCN).

TECHNICAL SUMMARY

Hypogymnia heterophylla

Seaside Bone Lichen

Hypogymnie maritime

Range of occurrence in Canada: British Columbia

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	10–25 years based on the time taken for a spore to germinate and grow into a lichen that forms reproductive apothecia.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	N/A No data available to estimate continuing decline.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown The current number of known thalli is much higher than previously estimated and is a result of search efforts between 2013 and 2020.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown but no changes in overall population numbers are projected over the next 10 years or three generations. Most known thalli are found in protected areas. The impact of longer-term threats such as climate change is uncertain.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown at present.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	N/A
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	29,770 km^2
Index of area of occupancy (IAO) (Always report 2x2 grid value).	60 km^2

Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	3 to 9 At least nine based local threats to the six locations at the southern end of Vancouver Island, two at Kennedy Lake, and one on Haida Gwaii. Three locations based on the possible impact of climate change affecting the three subpopulations (southern Vancouver Island, Kennedy Lake and Haida Gwaii). (see **Locations**)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Possibly: a projected decline could occur because the very small subpopulation on Haida Gwaii is susceptible to anthropogenic threats.
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Possibly: if the very small population on Haida Gwaii is affected by anthropogenic threats.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No In the past, however, there may have been suitable habitat near the City of Victoria that has been lost as a result of urbanization and associated air pollution
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 website and IUCN for more information on this term.

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N thalli observed or estimated**
Vancouver Island	
Albert Head	6 (2013)
East Sooke Park	500,000-2,000,000 (2018)
Rocky Point (incl. adjacent islands)	100,000-1,000,000 (2017-2018)
Sheringham Point	100s -1000s (2020)
Kennedy Lake Provincial Park	500
Haida Gwaii	
Masset	35-65 (2018)
Canadian Total	**600,000 - 3,000,000**

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	No

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

Was a threats calculator completed for this species? Yes (on March 12, 2020), overall threat calculated as low.

i. 7.0 Natural system modifications (Fire and fire suppression) (low)
ii. 11.0 Climate change (not quantified)
iii. 11.4 Storms and flooding (not quantified)
iv. 9.5 Airborne pollutants (negligible)
v. 1.1 Housing & urban areas (negligible)
vi. 6. Human intrusions and disturbance (negligible)

What additional limiting factors are relevant?
Restricted area of suitable habitat.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Ranked in Washington State as S3 (Sensitive). No status has been assigned in California or Oregon,
Is immigration known or possible?	Possibly but unlikely. The small spores from US occurrences, located >50 km from Canada, could provide a source of new thalli in suitable habitats.
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes

Are conditions deteriorating in Canada?	Possibly due to fire, climate change, housing developments and air pollution.
Are conditions for the source population deteriorating?	Unknown.
Is the Canadian population considered to be a sink?	No
Is rescue from outside populations likely?	Possibly from the Olympic Peninsula or Puget Sound, a minimum distance of 50 km.

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC Status History: Designated Special Concern in April 1996. Status re-examined and designated Threatened in April 2008. Status re-examined and designated Not at Risk in May 2022.
Reason for designation This lichen is endemic to the Pacific Coast of North America, and southwest Vancouver Island represents the northern limit of its range. The species' survival depends on early to intermediate seral shore pine forests along the sea coast. The populations appear to be stable, but have a restricted occurrence and the species is known from only four locations. Severe winter storms, which are anticipated to increase, are the main threat to the species.

Status and Reasons for Designation:

Status: Not at Risk	**Alpha-numeric codes**: Not applicable
Reasons for designation: This leafy lichen is endemic to western North America, and in Canada was once thought to occur only on the southern tip of Vancouver Island. Two additional subpopulations have since been found, one farther north on Vancouver Island and the other on Haida Gwaii, significantly expanding its previously known range and ecological amplitude. Surveys since the last assessment have revealed that there are between 600,000 and 3,000,000 thalli, a 30-fold increase in the known population. In view of this new information, this lichen is assessed as "Not at Risk". Threats include fires, housing developments, human intrusion, and pollution, but the overall impact is considered to be low. The effects of storms and summer droughts on this species could not be quantified but are unlikely to have a significant near-term impact on the very large population.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable as long term trends in population size have not been documented.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Does not meet criteria as there is no data to project declines. IAO meets threshold for Endangered. However, given the limited current threats, the concept of location may not apply. The lichen is not severely fragmented, although one subpopulation is very small and susceptible to anthropogenic threats.
Criterion C (Small and Declining Number of Mature Individuals) Not applicable as there are >10,000 mature individuals and no data on decline of the population.

Criterion E (Quantitative Analysis): Not Done.

PREFACE

Since the previous status report (COSEWIC 2008), the number of *Hypogymnia heterophylla* thalli Canada (previously estimated at about 1000) has increased substantially due to additional search effort and understanding of the ecology of this lichen. The estimated number of thalli is now 600,000–3,000,000, but almost all of them are in a very restricted area of southern Vancouver Island. In 2018, a small number of thalli, fewer than 100, were found in northern Haida Gwaii, far north of the previously known geographical range of the species. In 2020, a third subpopulation was found at Kennedy Lake, on the western coast of Vancouver Island with a few hundred thalli.

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
(2022)

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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Seaside Bone Lichen
Hypogymnia heterophylla

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2022

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific name: *Hypogymnia heterophylla* L. Pike

Synonyms: None

English common name: Seaside Bone Lichen

Other common names: Seaside Tube Lichen

French common name: Hypogymnie maritime

Family name: Parmeliaceae

Major group: Lichens; fungal (Ascomycete).

Bibliographic citation: Mycotaxon 16 (1): 157 (1982)

Morphological Description

Hypogymnia heterophylla (see photo on the front of this report) is a macrolichen having dorsiventrally differentiated lobe surfaces with a hollow interior. The lobes grow from a single original attachment point on bark or sometimes wood surfaces and are initially closely appressed to the substratum and relatively broad. Later, upward growing lobes give the mature thallus a shrubby (fruticose) appearance. As a result, relatively large clumps are formed that can be up to 8 cm long (Brodo *et al.* 2001). The lobes are uneven in width, having expanded and constricted portions. The branching is irregular. Lobules are common along the margins of the lobes. The upper surface is whitish; the lower surface is blackish. The hollow interior has a black "floor" and a blackish "ceiling". Some thalli (especially those on lignum) may have lobes that lie flat against substratum and may be broader and/or more numerous than usual. Thalli of *H. heterophylla* on this substratum have a brownish pigmentation that is rare on thalli colonizing trees (Figure 1). Lobules are sometimes scarce which can make it more difficult to recognize *H. heterophylla* when it grows with other *Hypogymnia* species but chemical tests can be used to confirm identification.

The circular brown apothecia, from which spores are ejected and which provide the means of reproduction, are produced mostly on the larger ascending lobes (see photo on the front of this report). All healthy, mature thalli bear apothecia. Ascospores are produced by the apothecia as the result of sexual fertilization followed by meiosis and a mitosis to produce eight spores that are ejected into the air. The ascospores are colourless, simple, and broadly elliptical in shape (6-7 by 3.5-4 microns).

Pycnidia are also present, appearing as small black dots. They produce conidiospores, which bud off from microscopic fungal hyphae. Conidiospores may act as spermatia, which fertilize recipient trichogynes enabling the formation of ascospore-bearing apothecia (Honegger 1984; Nash 2008).

The photobiont is a microscopic single-celled alga, *Trebouxia*, which occurs just below the upper surface of the lobes. *Trebouxia* is a genus of unicellular green algae consisting of about 20 species (Friedl and Budel 2008). Formation of a new thallus requires the fungal hyphae, which grow from the ascospores, to make contact with and envelop a compatible strain of *Trebouxia*. The details of the thallus-formation in *H. heterophylla* are unknown.

Chemistry

The characteristic secondary metabolite chemistry includes atranorin, physodalic acid, physodic acid, and protocetraric acid. The spot-test reactions are cortex K+ yellow; medulla KC+ orange-red and PD+ yellow becoming red (Goward 1994). The upper cortex contains atranorin and chloroatronorin. The medulla contains physodic acid and protocetraric acid plus unknown C7 (UV+, minor but constant component, occasionally with unknown C10 and 3-hydroxyphysodic acid (McCune 2004).

Many other lichens in the genus *Hypogymnia* occur in British Columbia. Of these, roughly half are sorediate or isidiate (i.e., they have asexual propagules that are made up of both fungal and algal symbionts). Of the apothecia-producing species in British Columbia, *Hypogymnia inactiva* and *H. imshaugii* most resemble *H*. *heterophylla* but can be distinguished on the basis of morphology and chemical tests. Some *H. heterophylla* thalli may appear similar to *H. apinnata* and *H. enteromorpha*. Again, photographs and keys using taxonomic characters and chemical tests are available to distinguish all the above species (Goward 1994; McCune 2004, 2009). There is considerable variability in the general appearance of *H. heterophylla*, but the majority of thalli are recognizable with the naked eye and a hand lens (see cover picture). Chemical spot tests, thin layer chromatography, etc., can be used to confirm the identification of problematic specimens.

Figure 1. Variation in the appearance of *Hypogymnia heterophylla*. Upper left: Vancouver Island (the common morph); upper right: Mendocino County, California (a form with some lobes that are more flattened against the host and others ascending). The lower photo is from Haida Gwaii, showing the brownish form found on lignum. Photos by Curtis Björk.

Population Spatial Structure and Variability

Hypogymnia heterophylla occurs in Canada in three subpopulations. Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (IUCN 2001). The distance between the three subpopulations of this lichen is such that it is most unlikely that genetic exchange or spores are carried from the occurrences in southern Vancouver Island to the ones at Kennedy Lake and on Haida Gwaii or vice versa (Figure 2).

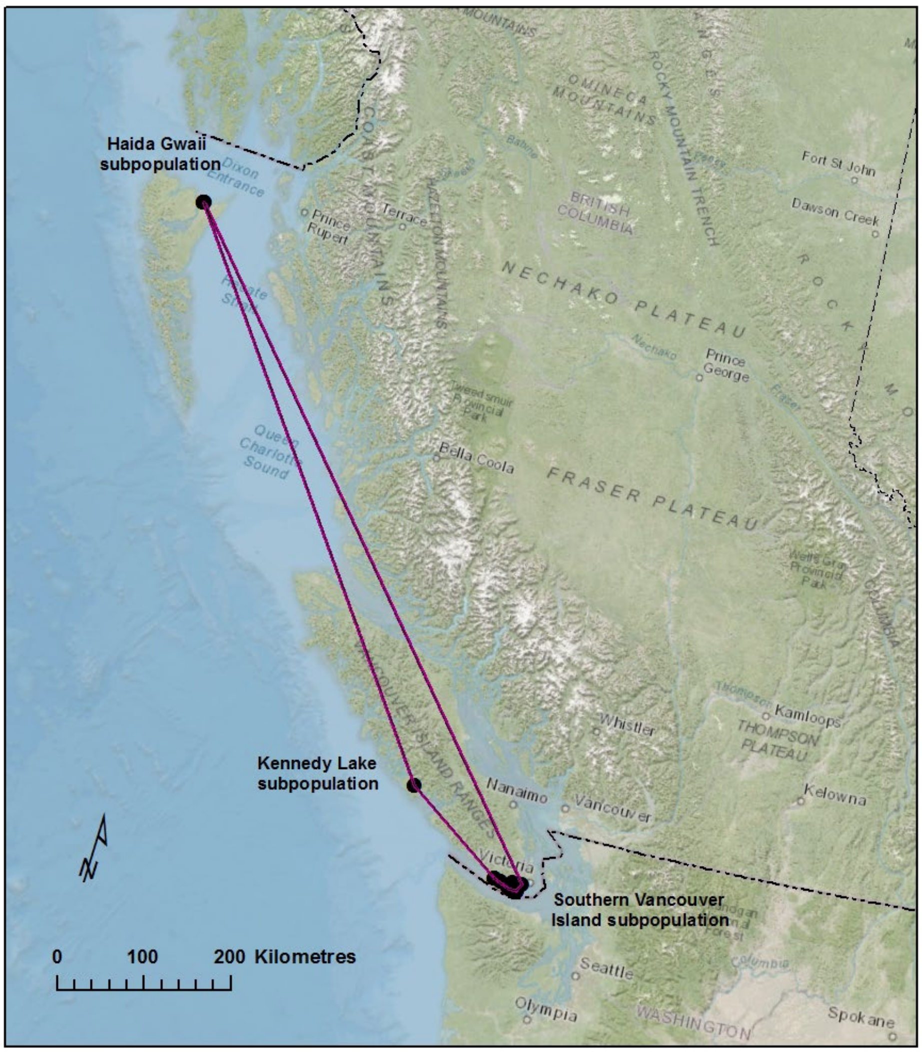

Figure 2. Canadian occurrences of *Hypogymnia heterophylla* showing the estimated extent of occurrence (EOO) (red line). See Figures 3 and 4 for more details. The three subpopulations are the cluster of occurrences on southern Vancouver Island, the one at Kennedy Lake, and the one on Haida Gwaii. Map from COSEWIC Secretariat.

The subpopulation on southern Vancouver Island (Figure 3) is by far the largest and includes East Sooke Park where the lichen is abundant as well as the adjacent Rocky Point area to the east, and Albert Head to the north east. On southern Vancouver Island, *H. heterophylla* is often the dominant epiphyte, covering a large percentage of twig surfaces on Shore Pine (*Pinus contorta* var. *contorta*) and Douglas-fir (*Pseudotsuga menziesii*). Along the south to southwest shorelines of East Sooke Park and Rocky Point, the thalli are extremely numerous with 100–1000 thalli (or more) per tree. Around the periphery of these main areas, there are relatively few scattered thalli on trees growing on the most windblown promontories.

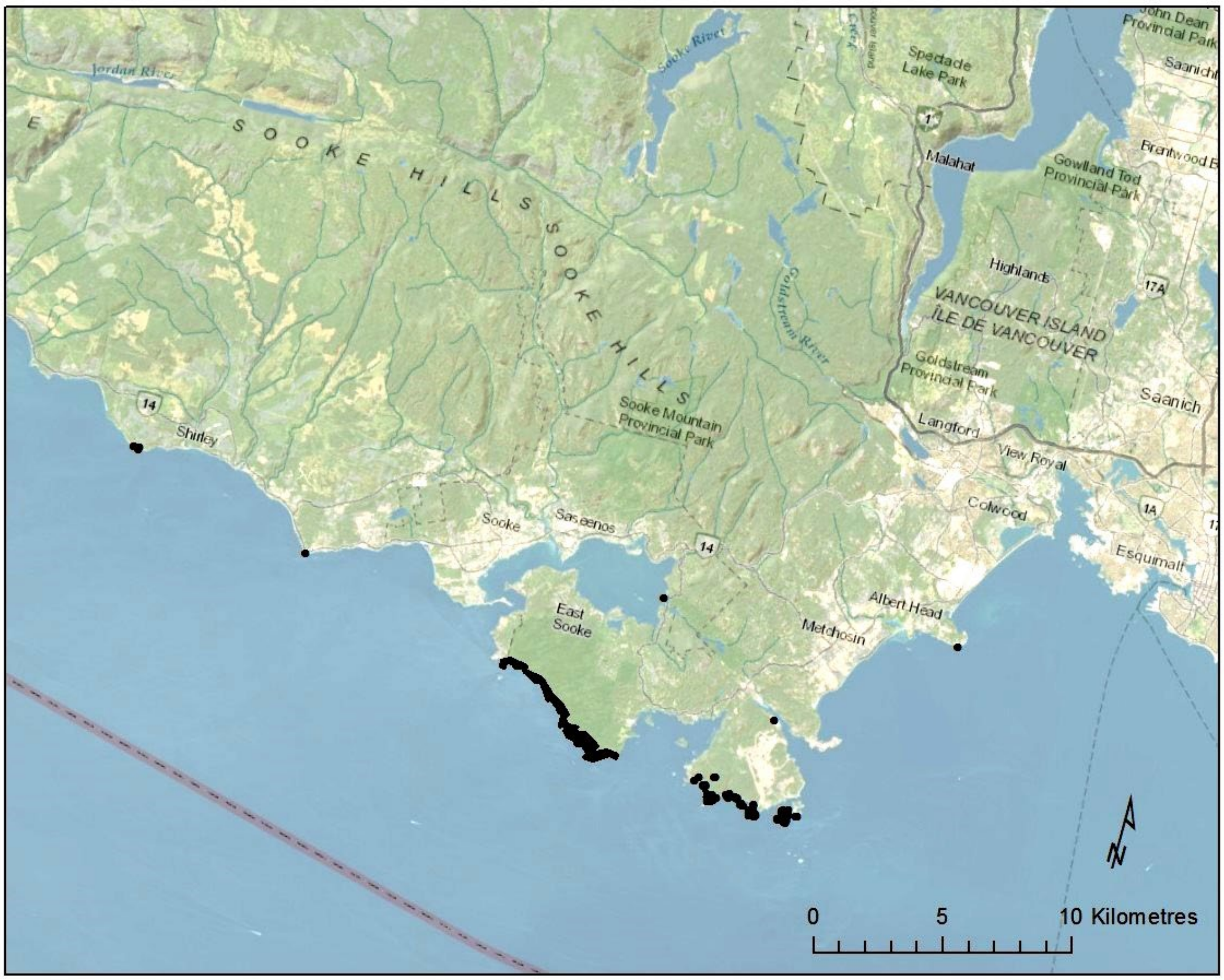

Figure 3. A distribution map for the known occurrences of *Hypogymnia heterophylla* (black dots) on southern Vancouver Island, British Columbia, Canada. Map from COSEWIC Secretariat.

The Kennedy Lake subpopulation has been found at two sites, one on the shore of the lake and the second on a small island in the lake and consists of a few hundred thalli (Figure 2). The Haida Gwaii subpopulation of *H. heterophylla* at Masset is small and on widely spaced Shore Pine trees within the golf course (Figure 4). There are fewer than 100 thalli with most of the pines bearing fewer than ten thalli. Thalli also occurred on a short length of wooden fence rails on the perimeter of the site. The golf course in Masset was originally built by the Department of National Defence in the 1970s along with most of the rest of the infrastructure.

The question is how the Haida Gwaii subpopulation (Figure 4) became established so far north of the other occurrences of *H. heterophylla.* The first possibility is that the small number of *H. heterophylla,* at this one occurrence on Haida Gwaii, represent a remnant subpopulation from the distant past when forest conditions were more open and the climate more conducive to the lichen's growth. Evidence for this comes from palaeoecological studies of late-glacial sediments which indicate that Shore Pine forests were growing on Haida Gwaii about 13,500 C years ago (16,400 years BP) (Lacourse 2005). A second possibility is that that *H. heterophylla* was accidentally introduced to Haida Gwaii through the importation of Shore Pines for planting the golf course or on split-rail fence posts from southern British Columbia or USA. There is no firm evidence for this, but during the period when housing was laid out in the town, each circle of houses was named after trees. Some of the trees that were planted were not native to the area. However, Shore Pines and Lodgepole Pines (*Pinus contorta*) grow naturally in the area and these may well have been used for planting the golf course (Jarvis pers. comm. 2020). The final explanation may be that this species requires well ventilated sites with high illumination and periods of summer drought. This combination would not historically have been present at Masset on Haida Gwaii. However, the construction of the golf course essentially created an anthropogenically modified habitat. The pines which were planted on the golf course provided the needed host trees in the required open habitat. It is remarkable that lichen ascospore dispersal to this site could have occurred from southern Vancouver Island c. 800 km to the south.

It is unlikely that the species occurs in the intervening mid- to north coast section of coastal British Columbia, between Haida Gwaii and Vancouver Island, because these areas lack the dry open woodland on the coastal fringe. This is the possible reason why *H. heterophylla* has not been found in the intervening area (Coxson pers. comm. 2020). However, in 2020, a new occurrence was found on the west coast of Vancouver Island on the shore of Kennedy Lake and on a nearby small island, both over 100 km north of the subpopulation on the southern tip of Vancouver Island (Figure 2).

Figure 4. The Haida Gwaii occurrence of *Hypogymnia heterophylla* (marked in green, top) at Masset, the Canadian Forces (LEITRIM) Base (outlined in red), Haida Gwaii.

Designatable Units

The three Canadian subpopulations of *H. heterophylla* are about 870 km apart (Figure 2), one on the north coast (Haida Gwaii) and the other, larger one on southern Vancouver Island and immediately adjacent islets. The three subpopulations are treated as a single designatable unit despite the distance separating them (COSEWIC 2019). Both are within the Pacific National Ecological Area and there appears to be no significant difference in morphology or chemistry. However, no molecular work has been undertaken on specimens from the subpopulations to discover if they are genetically distinct.

Special Significance

Hypogymnia heterophylla is a North American endemic lichen that occurs in Canada on Vancouver Island and Haida Gwaii, British Columbia. This represents the northern limit of its geographical distribution (Figure 2 and 5). Climate change and associated wildfires in California are likely to have a greater impact on this lichen in the United States than in Canada. As a result, the species may decline in the southern part of its range, and its range may contract northward to Canada where the climate is less arid.

DISTRIBUTION

Global Range

Hypogymnia heterophylla is endemic to the Pacific coast of western North America, including California, Oregon, and Washington (Figure 2 and 5). It is the most common species of *Hypogymnia* on the coast of northern California where it is one of the dominant species, covering whole trees, particularly *Pinus contorta* in dune areas. It is also common in coastal conifer forests and woodlands in Oregon, but it rapidly diminishes in abundance northwards in Washington (McCune pers. comm. 2021). There is a report of this lichen being found in Alaska at Stikine River near Shakes Slough (CNALH 2019). The specimen, at the University of Alaska Museum (ALA Herbarium), has been examined and found to be another species, probably *H. apinnata* (Geiser pers. comm. 2019). In Canada, *Hypogymnia heterophylla* occurs in southern British Columbia (Figure 2) and as far north as Haida Gwaii.

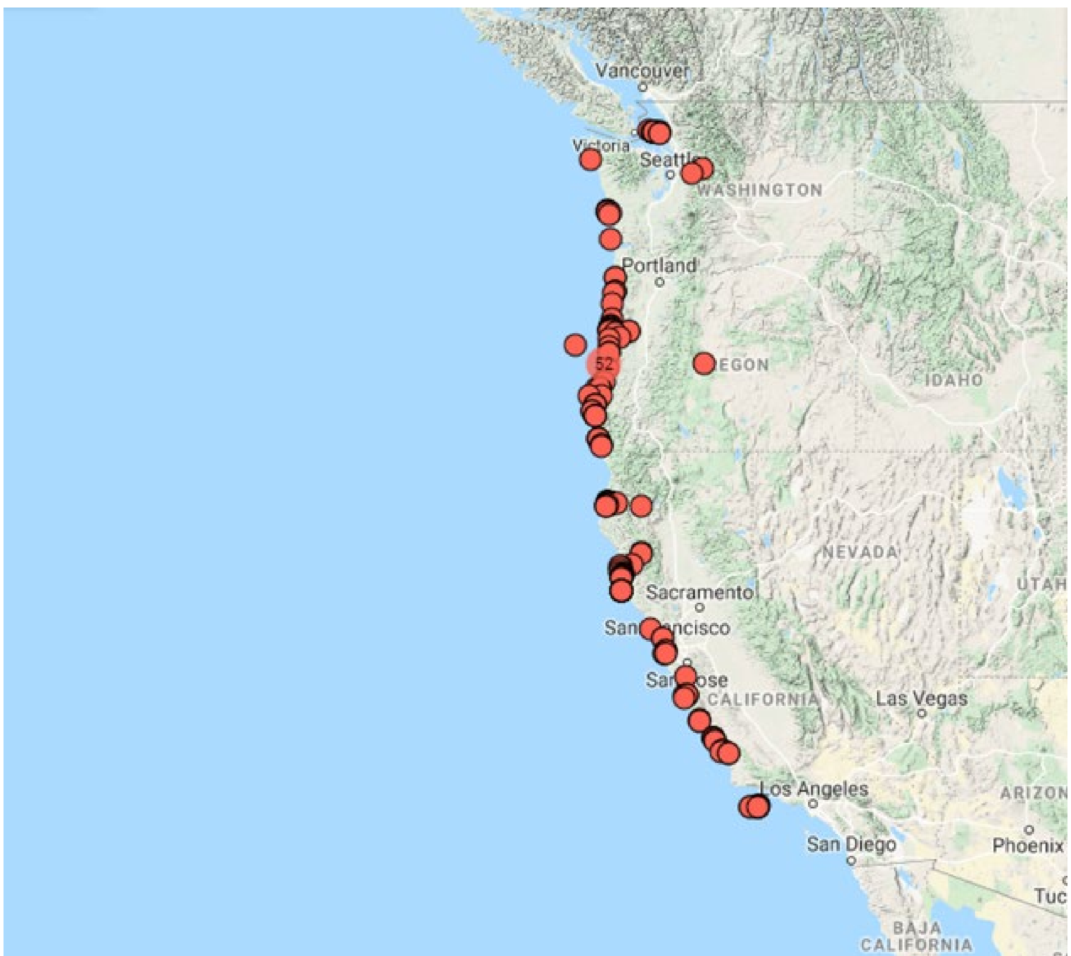

Figure 5. Records of *Hypogymnia heterophylla* (red circles) in the USA. Consortium of North American Lichen Herbaria (2019).

Canadian Range

There are three subpopulations of *Hypogymnia heterophylla* in Canada, all in British Columbia. The series of occurrences near Victoria on Vancouver Island are close enough to each other that ascospore and genetic exchange between them is likely (Figure 2) and so are considered one subpopulation. The second subpopulation is over 100 km north of Victoria on the western side of Kennedy Lake (Figure 2) and on a nearby island. An even greater distance separates this occurrence from the one on Haida Gwaii (Figure 4). The distance between the three subpopulations is such that it is most unlikely that genetic exchange or spores are carried from the occurrences on Vancouver Island to the one on Haida Gwaii or vice versa.

Extent of Occurrence and Area of Occupancy

The current extent of occurrence (EOO) of *Hypogymnia heterophylla* was calculated as 29,770 km^2 using the convex hull method and minimum convex polygon (Figure 2). The current index of area of occupancy (IAO) is 60 km^2, based on its occurrence in fifteen 2 x 2 km grid cells. There is a possibility of a decline in EOO and in the number of subpopulations because of the very small number of thalli on Haida Gwaii which may be susceptible to anthropogenic threats.

Search Effort

Lichen records have been collected from all parts of British Columbia for many decades. However, *H. heterophylla* was only described in 1982 and the search effort for the 2008 *H. heterophylla* report (COSEWIC 2008) focused on relocating the previous known occurrences. The areas surveyed included Sheringham Point, Bentinck Island, and East Sooke Regional Park in the areas of Pike's Point to Iron Mine Bay, and Aldridge Point to Beechy Head. The search effort for *H. heterophylla* for the current report (conducted between 2013 and 2018 with some more recent searches) focused on coastal promontories along the shoreline between Victoria and Sheringham Point, some 50 km to the west, on Vancouver Island. Searches were concentrated in areas of windblown rocky coastline where trees are widely spaced and in forests with an open canopy.

A total of 758 hours was devoted to search effort for the present report (Table 1), including areas previously searched for *H. heterophylla* (COSEWIC 2008). See **Sampling Effort and Methods** (below) for search methods. Search effort at the historical Sheringham Point occurrence was limited because accessibility to this area was initially limited as the lots were on private land and housing development was in progress. Later, it proved possible to make a more detailed exploration of this area on 12 June 2020. Sheringham Point, Otter Point, and Roche Cove were visited by Jenifer Penny and Ryan Batten. Samples were collected and coordinates mapped where *H. heterophylla* was found (Penny 2020, Appendix 3). The lichen was re-found at three areas on the lighthouse property and on the adjacent areas which are in the process of being transferred to the T'Sou-ke First Nation. A large occurrence of *H. heterophylla* was found on these adjacent parcels (Figure 6).

Table 1. Targeted search effort in 2013-2018: Effort shown as an estimate of person-hours in each potential habitat.

Year	Site	Surveyors	Effort*
2013	Albert Head	Björk & Batten	100
2016	Mary Hill	Björk	80
2016-2018	Rocky Point	Björk	250
2018	East Sooke Park	Björk	40
2018	Sheringham Point	Björk	1
2018	Masset	Björk	30
2017-2018	Esquimalt Harbour	Björk	100
2018	Between Sooke & Sheringham Point	Björk	4
2018	Nanaimo area	Björk	150
2018	Tlell area, Haida Gwaii	Björk	3

The Haida Gwaii subpopulation (Figure 4) was surveyed using the same methods as for the sparser portions of the Vancouver Island subpopulation. Little suitable habitat was found within the area surveyed that was within the boundaries of the CFB Esquimalt Masset (Leitrim) Base.

Hypogymnia heterophylla was not found at many other sites surveyed, including NRCan/CFB Esquimalt: East Ballenas Island, Belmont Park, Canadian Forces Maritime Experimental and Test Ranges (CFMETR), Colwood, Dockyards, Heal's Rifle Range, Mary Hill (although the species may occur at the adjacent prison site), Naden, Nanaimo Rifle Range, Nanoose TX, Royal Roads, Signal Hill, Winchelsea Islands, and Yarrows. The lichen was not found during searches at other sites in the region, where suitable habitat possibly occurred. These areas where no *H. heterophylla* was found included the Nanaimo-Parksville area (CFB Esquimalt, Ballenas Island and southeast of that, Winchelsea Islands; south of Ballenas Island is CFMETR, and to the west of that is Nanoose TX. Heal's Rifle Range). Other surveys covered Cattle Point, Chinese Cemetery, Gordon Head, Island View Beach, Mayne Island, Pedder Bay, Saltspring Island, and South Pender Island. This species has very specific ecological requirements that limit its colonization (see **Habitat**).

HABITAT

Habitat Requirements

Hypogymnia heterophylla is nearly always found on the trunks and branches of conifer trees. In Canada, it occurs mostly on mid- to late-seral Shore Pine and Douglas-fir trees, but on rare occasions it has been found on Sitka Spruce (*Picea sitchensis*) and Scouler's Willow (*Salix scouleriana*). It also occurs occasionally on wooden fence rails. The great majority of individuals in Canada occur within 1 km of marine shores, but some colonies occur on trees growing on rocky, windblown areas further from the ocean.

The host trees for *H. heterophylla* have a widespread distribution on Vancouver Island. However, to be suitable for colonization, the trees need good ventilation, high light levels, and to be in proximity to the ocean. Favourable conditions occur on rocky promontories and islands within the Mediterranean climate provided by southwestern Vancouver Island (Meidinger and Pojar 1991). This narrow specificity in microclimatic niche is likely a limitation for this species. At sites further north on Vancouver Island which are not in the rain-shadow of the Olympic Mountains in Washington, the open forest is replaced by closed canopy forests. These extend to the ocean-front with its cooler-wetter hypermaritime climate (Meidinger and Pojar 1991). Interestingly, the anthropogenically derived habitat on the Masset golf course recreates conditions of an open well-ventilated forest canopy, in an area that would otherwise be a wet closed-canopy forest.

It is possible that *H. heterophylla* receives some nutritional requirement from salt-spray, and so is absent from closed forests that salt-spray does not penetrate. Salt is needed for the synthesis of chloroatranorin, one of the secondary compounds that occurs in this species (McCune 2004).

At East Sooke Park and Rocky Point, *H. heterophylla* thalli are limited to the most wind-exposed areas. Where the forest canopy provides shelter from wind and breezes, mosses and liverworts are prevalent and the lichen abundance and diversity is lower. This also applies to bays and the leeward sides of promontories which are sheltered from the wind. In areas protected from the wind, thalli dry more slowly after rainfall. *Hypogymnia heterophylla* and associated lichens such as *Ramalina menziesii* probably require rapid drying after rain. Slow drying may lead to fungal-mediated decay or an imbalance in metabolic activity between symbionts in this lichen, but this has not yet been investigated.

In summary, the lichen flora of British Columbia has been extensively surveyed. *H. heterophylla* has very specific ecological requirements that limit its colonization of trees to southern Vancouver Island, Kennedy Lake and Haida Gwaii (see **Habitat**). The lichen appears to require proximity to the sea and well ventilated sites with high illumination (see **Population Spatial Structure and Variability**).

Habitat Trends

With ongoing climate change, a loss of tree cover may be expected in some areas of the Vancouver Island subpopulation of *H. heterophylla* in the coming decades.

This may be due to drought or fire. Already, many of the pines on rocks above the high tide line have succumbed to drought in recent years (many hundreds or a few thousand trees). However, most of the shoreline pines remain alive despite the droughts. Only the trees that are rooted in minimal soil have died. This may have been caused by drought or a combination of drought, salt-spray, and seawater during extremely high tides or storm surges. Fires on both Haida Gwaii and southern Vancouver Island where subpopulations of *H. heterophylla* occur are rare compared with more inland areas of British Columbia, as are ground-lightning strikes. The distance of occurrences from roads and developed areas makes it unlikely that anthropogenically caused fires would be a threat to the Vancouver Island subpopulation of this lichen.

BIOLOGY

Life Cycle and Reproduction

Little is known about reproduction in *H. heterophylla.* It reproduces by ascospores that must land on a suitable substratum to germinate, but their longevity under natural conditions is unknown. The emerging hyphae need to contact a compatible strain of the green alga *Trebouxia* (Hauck *et al*. 2007) to reconstitute the symbiosis, and form a new thallus. The generation time is 10-25 years based on the fact that it is estimated to take 10-25 years for a spore to germinate and grow into a lichen large enough to form reproductive apothecia. Generation times for the leafy lichen *Lobaria* are calculated to be 15-22 years but longer for crust lichens with estimates of 25 to 30 years (Larssen and Gauslaa 2009; Lattman *et al*. 2009). The germination of a spore at a site where a suitable alga is present is an infrequent event, but this is offset by the many spores from the numerous fruit bodies (apothecia) on each thallus. The lichen also produces conidiospores that are involved in fertilizing trichogynes and this leads to the formation of the apothecia (Honegger 1984; Nash 2008). However, this process has not been investigated in *H. heterophylla*. Soredia and isidia that provide the means for effective asexual reproduction and distribution in many lichens are not formed by *H. heterophylla*. It is very likely that *H. heterophylla* thalli live for at least a decade, although there have been no studies that document this. The minimal viable population size is unknown. The longevity of *H. heterophylla* thalli likely exceeds a decade based on the size of large thalli and the likely annual growth of established thalli of about 5-8 mm, but this has not been studied in *H. heterophylla*. The frequency of establishment from ascospores to form new thalli is another unknown feature for this lichen.

Physiology and Adaptability

Nothing is known about the physiology of *H. heterophylla*, although the ecophysiology of other species of the genus, particularly *H. physodes,* has been studied (Farrar 1978; Dahlman *et al.* 2003). Nash and Sigal (1979) report a distinct reduction in photosynthesis in *H. "enteromorpha*" that was subjected to short term fumigations with ozone. However, the lichen samples for this study were collected outside the known ranges of either *H. enteromorpha* or *H. heterophylla,* and therefore probably represent another species such as *H. imshaugii*. The authors characterize the species as of intermediate sensitivity to this pollutant. They speculate that the lichen may receive some degree of protection by virtue of its unbroken (i.e., non-soredia-bearing) cortex. Notwithstanding these observations, *H. "enteromorpha"* is said to be showing "marked signs of deterioration" in portions of California having elevated oxidant levels (COSEWIC 1996).

Dispersal and Migration

While *H. heterophylla* has no specialized means of asexual reproduction, fragmentation and re-attachment of thallus lobes probably leads to very local dispersal (Heinken 1999). The ascospores ejected from apothecia of forest-dwelling lichens are dispersed by air currents (Werth *et al.* 2007). However, dispersal distance in forest dwelling lichens is limited but a number of factors enhance the possibility for long-distance dispersal (Ronnas *et al*. 2017). The fact that *H. heterophylla* thalli grow on isolated, wind-exposed trees, and the small size of the subglobose ascospores (about 3 by 6 microns), means that the ejected ascospores are likely to be carried away by the wind and long-distance dispersal of *H. heterophylla* is possible. However, for successful establishment of a new thallus, it is necessary for the ascospores to land on a suitable substratum, germinate, and make contact with compatible strains of algae (*Trebouxia*).

Interspecific Interactions

No specific interactions are known for *H. heterophylla,* but a number of lichens are found growing in the same habitat with *H. heterophylla* including *Lecanora expallens, Parmelia* spp., *Pyrrospora quercina, Ramalina menziesii*, *Usnea* spp., and other *Hypogymnia* spp.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Field surveys for *H. heterophylla* were conducted on foot, with the exception of searches for potential habitats done by car from roads between Sheringham Point and Sooke. Search effort focused on Shore Pine stands on rocky promontories close to the ocean, and to a lesser degree within less optimal habitats such as open-canopy windblown forest on somewhat deeper soils. Survey paths and observation points were documented using a Garmin GPS. Data collection was done using the British Columbia standard

Conservation Data Centre's Rare Plant Sighting Form (Anon. 2019) and included number of thalli, survey area, survey habitat, other associated lichen species, observed threats, and supporting trees.

Surveys were conducted using two different approaches: (1) All individual trees within areas having suitable habitat were searched for epiphytic thalli; or (2) in areas where there were too many *H. heterophylla*-supporting trees to allow per-tree thallus counts, stand perimeters were mapped and abundance of thalli was estimated at the stand level.

For method (1) the assessments included recording of per-tree data, namely: the tree species, whether or not the tree was alive or dead, and estimates of the number of thalli supported, using the following scale: 1-5, 6-10, 11-20, 21-100, 101-500, 500+ thalli/tree. (Table 1,2,3 and Appendix 2). This method was used at 1) Rocky Point - Destruction Range; 2) Rocky Point - Area C; and 3) Rocky Point – Bentinck.

For method (2) the perimeter of stands, in which all trees appeared to have large numbers of *H. heterophylla* thalli, was established by walking around the edge of each stand, thus creating a GPS-referenced perimeter track. Where the perimeters of stands could not be traversed on foot, polygon boundaries were established based on the estimated position and extent of occurrence of habitat where *H. heterophylla* thalli occurred. Polygons were established by examining Google Earth images. This approach was used for sparse-canopy windblown conifer stands, where trees were contorted by the winds. When establishing the perimeter tracks for each such stand, trees visible from the track and located within the delineated stand were visually examined to estimate the number of thalli. Likewise, thallus abundance was examined for all trees along survey tracks within stand interiors. Visual estimates were made from the base to the top of the canopy in stunted shoreline trees. At distances further from the oceanfront, trees were often too tall to allow for an accurate estimation of thalli in the upper canopy. In such cases, estimates were made by examining the upper branches of wind-thrown trees that had fallen recently, in order to assess the number of thalli in the upper canopy.

A polygon boundary was established for intensively surveyed areas that used method (2). Based on visual surveys made along tracks, an estimate was made of the overall number of thalli per tree at the stand level (Table 3). Thallus counts (and associated waypoints) were not recorded for individual trees on the survey tracks as the consistent (and very high) abundance of thalli on trees would have made individual tree measurements in these areas too time-consuming.

The number of trees per stand was subsequently estimated using high-resolution satellite imagery from Google Earth, with some increase in the estimate allowing for the estimated abundance of sub-canopy young trees that would not appear in this imagery. To estimate the number of thalli within each of these stands, the estimated per-tree number of thalli was multiplied by the estimated number of trees within the stand.

The Haida Gwaii subpopulation (Figure 4) was located during an unrelated species inventory. Once it was located, the subpopulation was surveyed using method 1 as for the sparser portions of the Vancouver Island subpopulation. Little suitable habitat was found within the inventory bounds (which corresponds to the boundaries of the CFB Esquimalt Masset (Leitrim) Base).

Abundance

The surveys done for the last status report (COSEWIC 2008) on this lichen focused on visiting known occurrences that had been surveyed for the first status report (COSEWIC 1996) to see if there had been declines in the number of thalli. It was found that the population was stable and, at the time, it was estimated that the number of *H. heterophylla* thalli at the visited sites in Canada was approximately 1000 (Table 2) (COSEWIC 2008). At that time, it was thought that the Canadian population comprised more than 50% of the world total of this lichen. However, following more extensive surveys, the current population estimate for this lichen is between 600,000 and three million. It is also now known to be abundant in Northern California and Oregon (McCune 2021).

Table 2. Previously reported occurrences and estimated number of thalli of *Hypogymnia heterophylla* in Canada (from COSEWIC 2008).

Occurrence	Estimated number of thalli
Pike's Point and Iron Mine Bay areas	
East Sooke 1	>100
East Sooke 2	>100
East Sooke 3	>100
Aldridge Point area to Beechy Head	
East Sooke 4	>100
East Sooke 5	>100
Bentinck Island	
Bentinck Island 6	>10
Bentinck Island 7	>10
Bentinck Island 8	>100
Bentinck Island 9	>100
Sheringham Point	
Sheringham Point 10	>100

The surveys for NRCan/CFB Esquimalt revealed the presence of a great many more thalli than was previously documented in Canada. The outer coast of East Sooke Park and the Church Hill to Swordfish Island area of Rocky Point together supported a very large lichen subpopulation in which tens of thousands of trees each supported large numbers of *H. heterophylla* thalli, estimated at a minimum of 500 thalli per tree (Table 3). Trees along the tracks within this area appeared to be encrusted with *H. heterophylla*. Additional thalli were found at Albert Head, southern Vancouver Island.

Table 3. Estimated or observed number of thalli for *Hypogymnia heterophylla* in British Columbia.

Geographic location	Number of trees within polygons (where applicable)	Minimum number of thalli on individually surveyed trees	Maximum number of thalli on individually surveyed trees (value if using high range estimates)	Mean number of thalli on individually surveyed trees (value if using high range estimates)	Total number of thalli, observed or estimated. (value if using high range estimates)
Albert Head [a.]	n/a	n/a	n/a	n/a	6 observed (2013) [g.]
East Sooke Park [b.]	20,000	25	1,000	~500	500,000 to 2,000,000 estimated (2018) [h.]
Roche Cove, Sooke Basin	n/a	n/a	n/a	n/a	2 (2020)
Masset [c.]	n/a	n/a	n/a	n/a	35-65 observed (2018) [g.]
Rocky Point (Swordfish Island and Church Hill) [d.]	10,000	100	1,000	~500	100,000 to 1,000,000 estimated (2017-2018) [h.]
Rocky Point (Destr. Range, Bentinck, Area C) [e.]	n/a	n/a	n/a	n/a	5588 observed (2017-2018) [g.]
Sheringham Point [f, i]	n/a	n/a	n/a	n/a	100's, possibly 1000's above beach – western parcels

a. See Figure 7.
b. See Figure 7.
c. See Figure 4
d. See Figure 7.
e. See Figure 7.
f. See Figure 6.
g. Individual thalli counted on trees (see method 1 - **Sampling Effort and Methods**).
h. Estimate based on visual surveys from tracks (see method 2 - **Sampling Effort and Methods**).
i. Estimate from data collected by Batten & Penny on field visit in 2020 to sites that match the original field labels from the 2006 survey (COSEWIC 2008; Penny 2020)

The Rocky Point area was where *H. heterophylla* was most abundant in British Columbia with an estimated 100,000-1,000,000 thalli. More scattered thalli of *H. heterophylla* occurred all along the more exposed coastline of the southern shore from northwest of Church Hill to Bentinck Islands, and on a rocky peak inland. The areas that were intensively surveyed between 2016–2018 included the Metchosin area, Vancouver Island, and Mary Hill (where no *H. heterophylla* thalli were found) as well as Rocky Point, the Demolition Area, Mainland areas, and Bentinck and Swordfish islands.

A new subpopulation of *H. heterophylla* was discovered in 2020 in Kennedy Lake on the west coast of Vancouver Island more than 100 km north of the subpopulation near Victoria on the southern tip of the island. This new occurrence consisted of two sites close together near the shore of the lake and the second on a nearby small island. The estimated number of thalli was about 500.

The Haida Gwaii subpopulation was surveyed using the same methods as for the sparser portions of the Vancouver Island subpopulation and the total number of thalli was estimated to be between 35 and 65 thalli.

Fluctuations and Trends

Fluctuations and trends are unknown for *H. heterophylla* as the previous baseline population data were not based on sufficient search effort. The previous estimate of the number of *H. heterophylla* thalli in Canada was approximately 1000 (Table 2) (COSEWIC 2008). The current population estimate for this lichen is between 600,000 and 3,000,000 thalli which reflects an increase in search effort rather than population size.

Rescue Effect

The nearest subpopulations of *H. heterophylla* outside of Canada occur in Washington State, in the vicinity of Puget Sound and Juan de Fuca Strait at least 50 km away. It is possible that ascospores could be carried by wind from Washington to southern Vancouver Island, but would require a suitable host tree and presence of a compatible alga for the formation of a new thallus. Thus, the frequency of rescue is probably low.

THREATS AND LIMITING FACTORS

The overall Threats Calculator impact for *H. heterophylla* was low, and all the threats were assessed as unknown, negligible, or low impact.

<u>7.0 Natural system modifications (Threats Calculator Assessment – Low)</u>

7.1 Fire & fire suppression (Threats Calculator Assessment – low)

The coastal Shore Pine and Douglas-fir stands that provide habitat for *H. heterophylla* are seldom affected by stand-destroying fires. One reason is that the rocky substrates and generally open canopies at these sites are not conducive to fire spread. This is reflected by the generally non-serotinous cones of Shore Pines in coastal British Columbia (Lotan 1976). These same factors (open rocky shoreline habitats) generally preclude competition from other forest tree species in these rocky shoreline habitats (Wheeler *et al.* 1985).

The conclusion by those on the Threats Calculator Assessment was that risk from fires, storms and drought to *H. heterophylla* was low to negligible. However, there is uncertainty on this issue, as this low threat assessment differs from that of the recovery strategy for this species (Environment and Climate Change Canada. 2017).

11.0 Climate change & severe weather (Threats Calculator Assessment – Not quantified)

A risk to *H. heterophylla* is posed by future climate change that may result in increasingly intense winter storms and more severe summer droughts. For the Vancouver Island subpopulation, the climate change projections to the year 2050, relevant to *H. heterophylla*, include drier summers (18% less precipitation for summer months) and longer periods without rain (9–37% increase in duration of drought periods). In addition, more days above 25 °C are projected (18–40% increase) and more extreme winter storms are predicted (Spittlehouse 2008; Capital Regional District 2017). Similar changes are predicted for the entire British Columbia coast that includes Haida Gwaii (Pacific Climate Impacts Consortium 2019). However, there is considerable uncertainty with respect to the severity and timing of these changes (Environment and Climate Change Canada 2017). As a result, the impact of climate change could not be quantified during the Threats Calculator Assessment (Appendix 1). However, unusually long summer droughts have been observed to cause mortality of isolated pines along rocky marine shores on Vancouver Island. Many of the pines on rocks above the high tide line have succumbed to drought in recent years (several hundreds to a few thousand trees). These trees, however, comprise a very small proportion of the total number of trees colonized by *H. heterophylla*. Trees on deeper soils are not likely to die from prolonged droughts as they have more moisture available to them during drought periods.

It is important to note that *H. heterophylla* occurs at the northern edge of its range in North America. The relatively warm, summer-dry climate of southeastern Vancouver Island and the Gulf Islands has favoured its establishment well north of its main range in coastal Oregon and California (Environment and Climate Change Canada 2017).

Ventilation seems to be the main ecological requirement for *H. heterophylla*. The regional climate in coming decades is unlikely to change and prevailing winds will continue to be from the Pacific Ocean in the region occupied by *H. heterophylla.* However, there may be a progressive weakening of the Hadley circulation in the northern hemisphere, which may affect prevailing winds in this area (Hartmann 2016; Hu *et al.* 2018). If this happens, there may not be sufficient ventilation for this lichen to thrive in many of the habitats now occupied.

The death of Shore Pines growing on bedrock, and hence loss of a substratum for *H. heterophylla*, was a concern for this species at Rocky Point (COSEWIC 2008). However, *H. heterophylla* is now known to be very abundant in the open-canopy windblown forest on somewhat deeper soils (e.g., as at East Sooke Park and Rocky Point), where drought-induced pine death is far less likely. Thus, the loss of a small number of shore-line pines is of less concern than previously thought. Indeed, the open-canopy conifer forests and scattered pines suitable for *H. heterophylla* could become more common to the north of their present position with a warming and drying climate. This may result in the current closed-canopy forests with their humid climates becoming more open and available for colonization by the lichen.

11.4 Storms & flooding (Threats Calculator Assessment – Not quantified)

With climate change, more frequent and stronger winter storms may cause more blow-down of trees that support *H. heterophylla*. Beckmann *et al.* (1997) note that an increased frequency of extreme storm events is expected along the British Columbia coast (Environment and Climate Change Canada 2017). However, the areas of Haida Gwaii and Vancouver Island where the species occurs are usually windy. Therefore, significantly more severe storms would be required to blow down a large portion of the colonized trees. Severe storms may well occur (Mitchell *et al.* 2001) but, if not too extensive, may help to keep the canopy open in the forests further from the coast and facilitate colonization by *H. heterophylla*. The large increase in the known population of *H. heterophylla* is concentrated at two areas of southern Vancouver Island and so could be susceptible to stochastic events (e.g., like the storm that occurred in Stanley Park a few years ago that caused massive and totally unexpected blowdowns). The question is are such events likely to occur in the next three generations? There is uncertainty on this issue.

9.0 and 9.5 Pollution and Airborne pollutants (Threats Calculator Assessment – Negligible)

The lichen flora from Victoria north to near Campbell River, through the Gulf Islands north to the southern Discovery Islands has been affected by air pollution. *Hypogymnia heterophylla* is widespread south of the US border, in the Pacific Northwest, along the coast (Figure 5). Air quality and its impact on lichens has been assessed in this area (Geiser and Neitlich 2007). Air quality was found to be worst around towns and cities such as Bellingham, Seattle, and Portland, but better along the coast where the lichen occurs. Further south in California, a similar pattern is found (Sigal and Nash 1983). Pollution in the form of sulphur dioxide, acid rain, and metal-rich particulates from these US cities and from the city of Victoria could have an impact on *H. heterophylla.* However, where this lichen occurs on southern Vancouver Island, the prevailing winds are onshore which tends to push air pollution away from the colonized areas.

It is possible that the historical range of *H. heterophylla* formerly extended to Victoria, but air pollution from the expanding city could have eliminated the species from promontories in and close to the city. Unfortunately, there are no historical collections of the species from the Victoria area that might confirm this (CNALH 2019).

6.0 Human intrusions & disturbance (Threats Calculator Assessment – Negligible)

The Sheringham Point area on Vancouver Island has recently been subject to residential developments that may have led to the loss of some thalli from the general area (Figure 6). However, the lichen is still common in this area based on observations of abundance on remaining trees at Sheringham Point (Penny 2020). The other occurrences on the island are mainly in protected areas. As a result, the threat from developments was assessed as negligible (see Threats Calculator in Appendix 1). Some of the private lands surrounding the historic Sheringham Point Lighthouse occurrence, near where thalli were first found, have been developed for residential housing. There have also been some housing developments along the coast in the vicinity of other known sites but there are insufficient data to assess future trends. However, with an increase in development on private lots, there is a possibility for disturbance to host trees. Branches on one host tree were cut on the lighthouse property to build a trail, but the staff have been notified and they will be cautious in the future (Penny 2020).

There is also concern that Department of National Defence (DND) lands on which the lichen grows may be threatened by development that could affect a significant portion of the Canadian population. There is no current direct threat to the Rocky Point population, but the nearby Mary Hill location has been in the news due to a threat of development (Stiebel, 2018).

The Kennedy Lake subpopulation is in a remote area and unlikely to be affected by anthropogenic influences.

6.1 Recreational Activities (Threats Calculator Assessment – Negligible)

The Haida Gwaii subpopulation could also be affected by human intrusion as it occurs within a golf course. Maintenance of the site could lead to the cutting of host trees. The removal of the wooden fence rails that support a minority of *H. heterophylla* thalli at the site could also affect this small subpopulation.

The greatest portion of the Vancouver Island subpopulation of *H. heterophylla* occurs within East Sooke Regional Park. The trails in the park are popular with hikers, but most of the *H. heterophylla* occurrence can only be accessed by a relatively rugged and remote trail system that is less commonly used than the easier, shorter trails in the park. Hikers may break off twigs and branches supporting *H. heterophylla*, but the relatively few thalli removed will not be significant in the context of such a large total number of thalli.

Figure 6. Sheringham Point Area Survey in 2020. Blue stars mark where *Hypogymnia heterophylla* was found.

8.1 Invasive non-native/alien species/diseases (Threats Calculator Assessment – Not quantified)

Invasive plant species are not an immediate concern for *H. heterophylla* except Ivy (*Hedera helix*), which can smother supporting trees and prevent lichen colonization except on the highest limbs. However, the relatively open-canopy, windblown forests and scattered trees on which *H. heterophylla* grows are not likely to be overgrown by Ivy.

<u>2.0 Agriculture & aquaculture (Threats Calculator Assessment – Not quantified)</u>

Livestock grazing occurs over large areas of the Masset Canadian Forces Base (Leitrim property) on Haida Gwaii. However, no cattle were observed on the golf course which surrounds the *H. heterophylla* subpopulation on Haida Gwaii. Grazing or removal by cattle rubbing will not affect this lichen much because it grows on trees.

Limiting Factors

Hypogymnia heterophylla requires open-canopy forests, or solitary conifers, in windblown sites near the ocean shore. The lichen appears to require rapid drying after rainfall events and wind-blown nutrients. Long-term survival requires formation of new colonies of *H. heterophylla* from ascospores and the presence of the alga *Trebouxia* on the trees. This requirement is likely to be satisfied as long as there are large populations of this lichen on southern Vancouver Island.

Number of Locations

The large subpopulation of *H. heterophylla* on the southern tip of Vancouver Island can be divided into at least six locations, on the basis of local threats at each of the promontories where the lichen is found (Table 3, Figure 3). The Masset, Haida Gwaii occurrence and that at Kennedy Lake, which could be divided into one on the island and on the shore, make up three more locations. Thus the total number of locations is at least nine. The promontories include East Sooke Park, Otter Point, Rocky Point, Albert Head, Roche Cove and Sheringham Point (Figure 6). The Haida Gwaii subpopulation at Masset is potentially threatened by recreational activities (including maintenance of the golf course), and the blow-down of trees supporting *H. heterophylla* during winter storms.

The southern Vancouver Island subpopulation and the subpopulations at Kennedy Lake and at Haida Gwaii of *H. heterophylla* are potentially threatened by climate change threats that include storm surges, high wind and fires. Thus in relation to climate change, the number of locations is the same as the number of subpopulations, and is three.

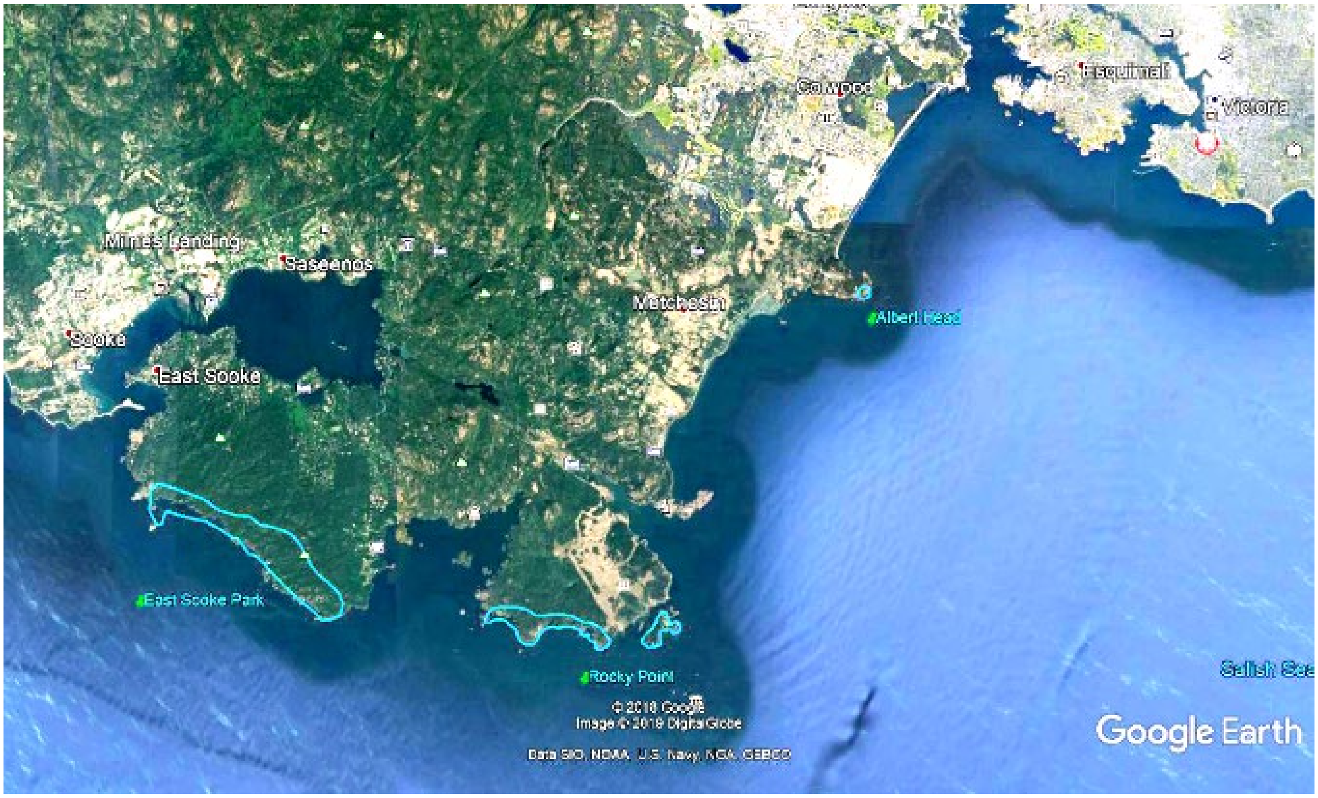

Figure 7. Promontories (East Sooke, Rocky Point, and Albert Head; see Table 3) are considered separate locations and could be affected by local threats. These Promontories are part of the southern Vancouver Island subpopulation of *Hypogymnia heterophylla* (blue outlines).

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Hypogymnia heterophylla was assessed as Threatened by COSEWIC in 2008 and is afforded legal status under the Government of Canada's *Species at Risk Act* (SARA). It has not been assessed by the International Union for Conservation of Nature (IUCN).

Non-Legal Status and Ranks

Hypogymnia heterophylla is currently ranked by NatureServe globally as G4 (Apparently Secure) (2017), and nationally as N2 (Imperilled) in Canada (NatureServe 2019). It has been ranked S2 (Imperilled) and Red-listed by the British Columbia Conservation Data Centre. However, the new data in this report have not been incorporated into subnational or national ranks. When updated in 2021, it is likely to be S3S4 (Vulnerable to apparently Secure) (British Columbia Conservation Data Centre 2019).

The ranking for *H. heterophylla* in California and Oregon is SNR (Unranked) and apparently not of conservation concern, but in Washington it is ranked as S3 (Vulnerable) (NatureServe 2019).

Habitat Protection and Ownership

A recovery strategy has been published (Environment and Climate Change Canada 2017). It recognizes seven occurrences on Vancouver Island which comprise one of the three subpopulations in Canada, Proposals for management are being prepared for Sheringham Point, Iron Mine Bay, Aldridge Point, Bentinck Island, Church Point, Christopher Point, and Albert Head.

With respect to the Sheringham Point occurrence of *H. heterophylla*, the area is excluded from further residential development as the 4.5 ha of land owned by the Department of Fisheries and Oceans around the lighthouse at Sheringham Point has been granted a Heritage status after submissions by the Sheringham Point Lighthouse Preservation Society (Anon. 2015; Watts 2015). A portion of the property is also being transferred to the T'Souke First Nation.

The Mine Bay and Aldridge Point occurrences comprise part of the larger occurrence in East Sooke Regional Park and are managed by the Capital Regional District. Although the Park Management Plan is not specific to *H. heterophylla*, it does address the conservation of natural habitats.

The Bentinck Island, Church Point, Christopher Point, and Albert Head occurrences are in the Rocky Point area and are on a military reserve that is used for training purposes. The National Defence liaison with Environment and Climate Change Canada is aware of the occurrences of *H. heterophylla* (as of 2015). These occurrences are mapped and communicated to site users. Range standing orders prohibit the cutting of trees. DND has undertaken proactive inventory work to ensure that knowledge of *H. heterophylla* occurrences is incorporated into decision making about removal of conifer trees to protect co-occurring vascular plant species at risk.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The report writer is grateful to COSEWIC for commissioning the status report for *Hypogymnia heterophylla.* NRCan, Department of National Defence, and the Interagency Recovery Fund, Environment and Climate Change Canada funded the lichen species inventory and surveys that allowed for the discovery of the Haida Gwaii subpopulation and the fuller characterization of the Vancouver Island subpopulation. The report writer is also thankful to Ryan Batten, Ian Cruickshank, and Andrew Simon for assistance in the field, to Jenifer Penny and Ryan Batten for information from fieldwork in 2020, and to Darwyn Coxson for help in completing the Draft Report.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Curtis Björk is a botanist and lichenologist with 25 years of field experience, and is co-curator of lichens at the herbarium UBC (Beaty Biodiversity Museum, Vancouver). He earned his MS in Botany from Washington State University in 2003, and currently manages Enlichened Consulting along with Trevor Goward. He has authored or co-authored numerous publications, including publications of a number of lichen and plant species new to science, and is currently co-authoring the Manual of Vascular Plants of British Columbia.

Appendix 1. Threats calculator assessment for *Hypogymnia heterophylla.*

Species or Ecosystem Scientific Name	*Hypogymnia heterophylla*			
Date:	2020-03-12			
Assessor(s):	Dave Fraser (Facilitator), David Richardson (Co-chair) M&L SSC: Darwyn Coxson, Jennifer Doubt, Karen Golinski, André Arsenault, Chris Deduke External experts: Brenda Costanzo, Ross Vennesland, Jenifer Penny			
References:	Original draft by C. Björk			
	Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	0	0
	D	Low	1	1
	Calculated Overall Threat Impact:		Low	Low
	Assigned Overall Threat Impact:		**D = Low**	
	Impact Adjustment Reasons:			
	Overall Threat Comments		10-25 years is generation time. For the purpose of the call, 20 years was used.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Only the occurrence at Sheringham Point is impacted. It was potentially reduced in the past, but it is unknown where the thalli were observed in 2006. They were seen again 2011/12 following some development in the area. The lots on either side of the lighthouse property are not currently developed and may have been the likely area searched in 2006 and potentially threatened by housing. However, Heritage status has been granted to the Sheringham Point Lighthouse Preservation Society so housing development will not receive approval. A development to the east may have destroyed some habitat (unclear since the 2006 observation was not precisely documented). Lichen thalli have also been overserved to the west of the lighthouse circa. 2012 (Batten pers. comm. 2020).
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						The golf course on Haida Gwaii, where the lichen occurs in low numbers, could be damaged and tourism is also a potential impact on the Vancouver Island sites. See note under fires and fire suppression.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						Livestock grazing occurs over large areas of the Masset Canadian Forces Base (Leitrim property) on Haida Gwaii. However, no cattle were observed on the golf course which surrounds the *H. heterophylla* subpopulation on Haida Gwaii. Grazing, or removal by rubbing of the lichen, is not likely to affect the lichen much because it grows on trees above ground level.
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors						
4.1	Roads & railroads						Only important in the Sheringham Point area if further housing development and associated roads are constructed.
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						Most of the areas where the Seaside Bone is found are in parks or are owned by DND and unlikely to be subject to logging and tree harvesting.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	This area is a popular one for walkers and tourists, but the areas where the lichen is abundant can only be accessed by rugged trails. Potentially harmful activities are limited to breaking off small twigs or branches.
6.2	War, civil unrest & military exercises						Several of the lichen populations are on land owned by DND but military exercises and other activities are unlikely to extend to areas very close to the seashore where the lichen is abundant.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.3	Work & other activities						
7	Natural system modifications	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	BC has suffered under some intense wildfire seasons in recent times. However, lightning strikes are rare and fires not likely to spread significantly even if started unintentionally by tourists, so the impact likely low.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species/diseases						Ivy is an invasive species that can cover and shade trunks and branches, but the lichen occurs on the dry Shore Pine habitat and Ivy prefers moister conditions and deeper soils.
8.2	Problematic native species/diseases						
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
9.1	Domestic & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Air-borne pollutants		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Air pollution from Victoria potentially harmful to the Seaside Bone Lichen, but prevailing wind from other directions.
9.6	Excess energy						
10	Geological events		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
10.1	Volcanoes						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10.2	Earthquakes/tsunamis		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	These could have an impact but the likelihood of an event is low over the next decade and also a significant proportion of the host trees and the lichens thereon are above the height likely to be affected by a tsunami.
10.3	Avalanches/landslides						
11	Climate change & severe weather						
11.1	Habitat shifting & alteration						This may have an impact but not over the next decade.
11.2	Droughts						Prolonged droughts are predicted but this lichen appears to be a drought-resistant species. The fate of host trees under the same scenario is also important, but shore pine is drought-resistant, as is Douglas-fir, but there are indications of issues in Oregon for the latter species due to a constant state of drought there.
11.3	Temperature extremes						Warmer conditions over the next decade may favour this lichen which colonizes trees along US coastal areas well south of Canada.
11.4	Storms & flooding						
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

Appendix 2. The estimated number of thalli of *Hypogymnia heterophylla* on host trees at surveyed Rocky Point sites using Method (1) (see Sampling Effort and Methods).

This appendix has been removed to protect precise location information. Please contact the COSEWIC Secretariat if you require this information.

Site	Month	Tree ID#	# thalli
Albert Head	17 Oct 2013	1339	6
Rocky Point, Destr Range	19 Mar 2017	1340	40
Rocky Point, Destr Range	19 Mar 2017	1341	11
Rocky Point, Destr Range	19 Mar 2017	1342	300-400
Rocky Point, Destr Range	19 Mar 2017	1343	2
Rocky Point, Destr Range	19 Mar 2017	1344	35
Rocky Point, Destr Range	19 Mar 2017	1347	2
Rocky Point, Destr Range	19 Mar 2017	1348	2
Rocky Point, Destr Range	19 Mar 2017	1349	1
Rocky Point, Destr Range	20 Mar 2017	1358	40
Rocky Point, Destr Range	20 Mar 2017	1359	100-200
Rocky Point, Destr Range	20 Mar 2017	1360	20+
Rocky Point, Destr Range	20 Mar 2017	1361	3+
Rocky Point, Destr Range	20 Mar 2017	1362	1
Rocky Point, Destr Range	20 Mar 2017	1363	200-300
Rocky Point, Destr Range	20 Mar 2017	1365	50-100
Rocky Point, Destr Range	20 Mar 2017	1366	7+
Rocky Point, Destr Range	20 Mar 2017	1367	2+
Rocky Point, Destr Range	20 Mar 2017	1368	100+
Rocky Point, Destr Range	20 Mar 2017	1369	50-100
Rocky Point, Destr Range	20 Mar 2017	1370	3+
Rocky Point, Destr Range	20 Mar 2017	1371	1
Rocky Point, Destr Range	20 Mar 2017	1372	50
Rocky Point, Destr Range	20 Mar 2017	1373	2
Rocky Point, Destr Range	20 Mar 2017	1374	100
Rocky Point, Destr Range	20 Mar 2017	1375	1+
Rocky Point, Destr Range	20 Mar 2017	1376	100's

Site	Month	Tree ID#	# thalli
Rocky Point, Destr Range	20 Mar 2017	1377	20+
Rocky Point, Destr Range	20 Mar 2017	1378	20+
Rocky Point, Destr Range	20 Mar 2017	1379	1
Rocky Point, Destr Range	20 Mar 2017	1380	50
Rocky Point, Destr Range	20 Mar 2017	1381	100
Rocky Point, Destr Range	20 Mar 2017	1382	20
Rocky Point, Destr Range	20 Mar 2017	1383	1
Rocky Point, Destr Range	20 Mar 2017	1384	1
Rocky Point, Destr Range	20 Mar 2017	1385	100-200
Rocky Point, Destr Range	20 Mar 2017	1386	1
Rocky Point, Destr Range	20 Mar 2017	1387	7
Rocky Point, Destr Range	20 Mar 2017	1388	5
Rocky Point, Destr Range	20 Mar 2017	1389	12
Rocky Point, Destr Range	20 Mar 2017	1390	9
Rocky Point, Destr Range	20 Mar 2017	1392	2
Rocky Point, Destr Range	20 Mar 2017	1393	1
Rocky Point, Destr Range	20 Mar 2017	1394	1
Rocky Point, Destr Range	20 Mar 2017	1395	6
Rocky Point, Destr Range	20 Mar 2017	1396	30
Rocky Point, Destr Range	20 Mar 2017	1397	20
Rocky Point, Destr Range	20 Mar 2017	1398	4
Rocky Point, Destr Range	20 Mar 2017	1399	3
Rocky Point, Destr Range	25 Mar 2017	1419	5
Rocky Point, Destr Range	25 Mar 2017	1420	4
Rocky Point, Destr Range	25 Mar 2017	1421	18
Rocky Point, Destr Range	25 Mar 2017	1422	5+
Rocky Point, Destr Range	25 Mar 2017	1423	7+
Rocky Point, Destr Range	25 Mar 2017	1424	1+
Rocky Point, Destr Range	25 Mar 2017	1425	1+
Rocky Point, Destr Range	25 Mar 2017	1426	50-100
Rocky Point, Destr Range	25 Mar 2017	1427	2+
Rocky Point, Destr Range	25 Mar 2017	1429	50+

Site	Month	Tree ID#	# thalli
Rocky Point, Destr Range	25 Mar 2017	1430	50-100
Rocky Point, Destr Range	25 Mar 2017	1431	50-100
Rocky Point, Destr Range	25 Mar 2017	1432	300+
Rocky Point, Destr Range	25 Mar 2017	1433	300+
Rocky Point, Destr Range	25 Mar 2017	1434	50+
Rocky Point, Destr Range	25 Mar 2017	1436	1
Rocky Point, Destr Range	25 Mar 2017	1437	19
Rocky Point, Destr Range	25 Mar 2017	1438	10+
Rocky Point, Destr Range	25 Mar 2017	1439	1+
Rocky Point, Destr Range	25 Mar 2017	1440	2+
Rocky Point, Destr Range	25 Mar 2017	1441	50+
Rocky Point, Destr Range	25 Mar 2017	1442	10+
Rocky Point, Destr Range	25 Mar 2017	1443	4
Rocky Point, Destr Range	25 Mar 2017	1444	5+
Rocky Point, Destr Range	25 Mar 2017	1445	15+
Rocky Point, Destr Range	25 Mar 2017	1446	1
Rocky Point, Destr Range	25 Mar 2017	1447	21
Rocky Point, Destr Range	25 Mar 2017	1448	6+
Rocky Point, Destr Range	25 Mar 2017	1449	1+
Rocky Point, Destr Range	25 Mar 2017	1450	20+
Rocky Point, Destr Range	25 Mar 2017	1451	20+
Rocky Point, Destr Range	25 Mar 2017	1452	5+
Rocky Point, Destr Range	25 Mar 2017	1453	10+
Rocky Point, Destr Range	25 Mar 2017	1454	30-500
Rocky Point, Destr Range	25 Mar 2017	1455	52
Rocky Point, Destr Range	25 Mar 2017	145	9
Rocky Point, Destr Range	25 Mar 2017	1457	6
Rocky Point, Destr Range	25 Mar 2017	1458	3
Rocky Point, Destr Range	25 Mar 2017	1459	100's
Rocky Point, Destr Range	25 Mar 2017	1437a	5-10
Rocky Point, Area C	20 Nov 2017	1460	4
Rocky Point, Area C	20 Nov 2017	1461	10-20

Site	Month	Tree ID#	# thalli
Rocky Point, Area C	20 Nov 2017	1462	10-20
Rocky Point, Area C	20 Nov 2017	1463	5-10
Rocky Point, Area C	20 Nov 2017	1464	10-20
Rocky Point, Area C	20 Nov 2017	1465	5-10
Rocky Point, Area C	20 Nov 2017	1466	5-10
Rocky Point, Area C	20 Nov 2017	1467	4
Rocky Point, Area C	20 Nov 2017	1468	5-10
Rocky Point, Area C	9 Feb 2018	1469	1
Rocky Point, Area C	14 Feb 2018	1470	5-10
Rocky Point, Area C	14 Feb 2018	1471	10-20
Rocky Point, Area C	14 Feb 2018	1472	10-20
Rocky Point, Area C	24 Feb 2018	1473	1
Rocky Point, Area C	24 Feb 2018	1474	5-10
Rocky Point, Area C	24 Feb 2018	1475	10-20
Rocky Point, Area C	25 Feb 2018	1476	2
Rocky Point, Area C	25 Feb 2018	1477	2
Rocky Point, Area C	25 Feb 2018	1478	20-100
Rocky Point, Area C	25 Feb 2018	1479	1
Rocky Point, Area C	25 Feb 2018	1480	5-10
Rocky Point, Area C	25 Feb 2018	1481	20-100
Rocky Point, Area C	25 Feb 2018	1482	10-20
Rocky Point, Area C	25 Feb 2018	1483	10-20
Rocky Point, Area C	25 Feb 2018	1484	20-100
Rocky Point, Area C	25 Feb 2018	1485	5-10
Rocky Point, Area C	25 Feb 2018	1486	10-20
Rocky Point, Area C	25 Feb 2018	1487	10-20
Rocky Point, Area C	25 Feb 2018	1488	10-20
Rocky Point, Area C	25 Feb 2018	1489	10-20
Rocky Point, Area C	25 Feb 2018	1490	5-10
Rocky Point, Area C	25 Feb 2018	1491	5-10
Rocky Point, Area C	25 Feb 2018	1492	10-20

Site	Month	Tree ID#	# thalli
Rocky Point, Area C	25 Feb 2018	1493	5-10
Rocky Point, Area C	25 Feb 2018	1494	10-20
Rocky Point, Area C	25 Feb 2018	1495	5-10
Rocky Point, Area C	25 Feb 2018	1496	5-10
Rocky Point, Area C	25 Feb 2018	1497	10-20
Rocky Point, Area C	25 Feb 2018	1498	10-20
Rocky Point, Area C	26 Feb 2018	1499	5-10
Rocky Point, Area C	26 Feb 2018	1500	5-10
Rocky Point, Area C	26 Feb 2018	1501	1
Rocky Point, Area C	26 Feb 2018	1502	2
Rocky Point, Area C	27 Feb 2018	1503	5-10
Rocky Point, Area C	27 Feb 2018	1504	1
Rocky Point, Area C	27 Feb 2018	1505	5-10
Rocky Point, Area C	25 Jan 2018	1506	4
Rocky Point, Area C	25 Jan 2018	1507	4
Rocky Point, Area C	25 Jan 2018	1508	2
Rocky Point, Area C	26 Jan 2018	1509	3
Rocky Point, Area C	26 Jan 2018	1510	3
Rocky Point, Area C	26 Jan 2018	1511	1
Rocky Point, Area C	26 Jan 2018	1512	5
Rocky Point, Area C	26 Jan 2018	1513	2
Rocky Point, Area C	26 Jan 2018	1514	4
Rocky Point, Area C	26 Jan 2018	1515	2
Rocky Point, Area C	26 Jan 2018	1516	1
Rocky Point, Area C	26 Jan 2018	1517	5
Rocky Point, Area C	26 Jan 2018	1518	1
Rocky Point, Area C	26 Jan 2018	1519	5-10
Rocky Point, Area C	26 Jan 2018	1520	10-20
Rocky Point, Bentinck	29 Jan 2018	1521	2
Rocky Point, Bentinck	29 Jan 2018	1522	1

Site	Month	Tree ID#	# thalli
Rocky Point, Bentinck	29 Jan 2018	1523	4
Rocky Point, Bentinck	29 Jan 2018	1524	1
Rocky Point, Bentinck	29 Jan 2018	1525	10-20
Rocky Point, Bentinck	29 Jan 2018	1526	50-100
Rocky Point, Bentinck	29 Jan 2018	1527	1
Rocky Point, Bentinck	29 Jan 2018	1528	5-10
Rocky Point, Bentinck	29 Jan 2018	1529	5-10
Rocky Point, Bentinck	29 Jan 2018	1530	3
Rocky Point, Bentinck	29 Jan 2018	1531	4
Rocky Point, Bentinck	29 Jan 2018	1532	2
Rocky Point, Bentinck	29 Jan 2018	1533	5-10
Rocky Point, Bentinck	29 Jan 2018	1534	3
Rocky Point, Bentinck	29 Jan 2018	1535	2
Rocky Point, Bentinck	29 Jan 2018	1536	5-10
Rocky Point, Bentinck	29 Jan 2018	1537	10-20
Rocky Point, Bentinck	29 Jan 2018	1538	5-10
Rocky Point, Bentinck	29 Jan 2018	1539	20-100
Rocky Point, Bentinck	29 Jan 2018	1540	5-10
Rocky Point, Bentinck	29 Jan 2018	1541	10-20
Rocky Point, Bentinck	29 Jan 2018	1542	20-100
Rocky Point, Bentinck	29 Jan 2018	1543	1
Rocky Point, Bentinck	29 Jan 2018	1544	5-10
Rocky Point, Bentinck	29 Jan 2018	1545	5-10
Rocky Point, Bentinck	29 Jan 2018	1546	5-10
Rocky Point, Bentinck	29 Jan 2018	1547	1
Rocky Point, Bentinck	29 Jan 2018	1548	3
Rocky Point, Bentinck	29 Jan 2018	1549	2
Rocky Point, Bentinck	29 Jan 2018	1550	3
Rocky Point, Bentinck	29 Jan 2018	1551	3
Rocky Point, Bentinck	29 Jan 2018	1552	10-20

Site	Month	Tree ID#	# thalli
Rocky Point, Bentinck	29 Jan 2018	1553	5-10
Rocky Point, Bentinck	29 Jan 2018	1554	5-10
Rocky Point, Bentinck	29 Jan 2018	1555	10-20
Rocky Point, Bentinck	29 Jan 2018	1556	5-10
Rocky Point, Bentinck	29 Jan 2018	1557	10-20
Rocky Point, Bentinck	29 Jan 2018	1558	5-10
Rocky Point, Bentinck	29 Jan 2018	1559	5-10
Rocky Point, Bentinck	29 Jan 2018	1560	5-10
Rocky Point, Bentinck	29 Jan 2018	1561	20-100
Rocky Point, Bentinck	29 Jan 2018	1562	5-10
Rocky Point, Bentinck	29 Jan 2018	1563	5-10
Rocky Point, Bentinck	29 Jan 2018	1564	4
Rocky Point, Bentinck	29 Jan 2018	1565	1
Rocky Point, Bentinck	29 Jan 2018	1566	20-100
Rocky Point, Bentinck	29 Jan 2018	1567	5
Rocky Point, Bentinck	29 Jan 2018	1568	20-100
Rocky Point, Bentinck	29 Jan 2018	1569	5-10
Rocky Point, Bentinck	29 Jan 2018	1570	10-20
Rocky Point, Bentinck	29 Jan 2018	1571	10-20
Rocky Point, Bentinck	29 Jan 2018	1572	5-10
Rocky Point, Bentinck	29 Jan 2018	1573	10-20
Rocky Point, Bentinck	29 Jan 2018	1574	3
Rocky Point, Bentinck	29 Jan 2018	1575	5-10
Rocky Point, Bentinck	29 Jan 2018	1576	5
Rocky Point, Bentinck	29 Jan 2018	1577	5-10
Rocky Point, Bentinck	29 Jan 2018	1578	10-20
Rocky Point, Bentinck	29 Jan 2018	1579	10-20
Rocky Point, Bentinck	30 Jan 2018	1580	5-10
Rocky Point, Bentinck	30 Jan 2018	1581	5-10
Rocky Point, Bentinck	30 Jan 2018	1582	10-20

Site	Month	Tree ID#	# thalli
Rocky Point, Bentinck	30 Jan 2018	1583	2
Rocky Point, Bentinck	30 Jan 2018	1584	5-10
Rocky Point, Bentinck	30 Jan 2018	1585	1
Rocky Point, Bentinck	30 Jan 2018	1586	1
Rocky Point, Bentinck	30 Jan 2018	1587	5-10
Rocky Point, Bentinck	30 Jan 2018	1588	3
Rocky Point, Bentinck	30 Jan 2018	1589	3
Rocky Point, Bentinck	30 Jan 2018	1590	10-20
Rocky Point, Bentinck	30 Jan 2018	1591	10-20
Rocky Point, Bentinck	30 Jan 2018	1592	10-20
Rocky Point, Bentinck	30 Jan 2018	1593	10-20
Rocky Point, Bentinck	30 Jan 2018	1594	5-10
Rocky Point, Bentinck	30 Jan 2018	1595	10-20
Rocky Point, Bentinck	30 Jan 2018	1596	10-20
Rocky Point, Bentinck	30 Jan 2018	1597	5-10
Rocky Point, Bentinck	30 Jan 2018	1598	5-10
Rocky Point, Bentinck	30 Jan 2018	1599	10-20
Rocky Point, Bentinck	30 Jan 2018	1600	10-20
Rocky Point, Bentinck	30 Jan 2018	1601	1
Rocky Point, Bentinck	30 Jan 2018	1602	50-100
Rocky Point, Area C	15 Mar 2018	1603	5-10
Rocky Point, Area C	15 Mar 2018	1604	10-20
Rocky Point, Area C	15 Mar 2018	1605	5-10
Rocky Point, Area C	16 Mar 2018	1606	10-20
Rocky Point, Area C	16 Mar 2018	1607	5-10
Rocky Point, Area C	16 Mar 2018	1608	1
Rocky Point, Area C	16 Mar 2018	1609	1
Rocky Point, Area C	16 Mar 2018	1610	5-10
Rocky Point, Area C	17 Mar 2018	1611	2
Rocky Point, Area C	17 Mar 2018	1612	3

Site	Month	Tree ID#	# thalli
Rocky Point, Area C	17 Mar 2018	1613	5-10
Masset	17 Mar 2018	1614	1-5
Masset	17 Mar 2018	1615	5-10
Masset	17 Mar 2018	1616	1-5
Masset	17 Mar 2018	1617	1-5
Masset	17 Mar 2018	1618	1-5
Masset	17 Mar 2018	1619	1-5
Masset	17 Mar 2018	1620	5-10
Masset	17 Mar 2018	1621	10-20

Appendix 3. Additional areas Surveyed for *Hypogymnia heterophylla* in June and July 2020. The sites close to Victoria were searched by Jenifer Penny and colleagues. The sites on Kennedy Lake, British Columbia were discovered and surveyed by Ryan Batten.

This appendix has been removed to protect precise location information. Please contact the COSEWIC Secretariat if you require this information.

Areas/Directions
T'Sou-ke FN parcel, Sheringham Point
Sheringham Lighthouse property – just NE of lighthouse
Sheringham Lighthouse property – new trail
Otter Point Regional Park (new occurrence)
Roche Cove, Sooke
Kennedy Lake, Sand River Road
Mack Jack Rose's Island, Kennedy Lake