COSEWIC
Assessment and Status Report

on the

Peacock Vinyl Lichen
Leptogium polycarpum

in Canada

SPECIAL CONCERN
2011

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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Peacock Vinyl Lichen— Photograph by Tim Wheeler. Reproduced by permission.

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COSEWIC
Assessment Summary

Assessment Summary – May 2011

Common name
Peacock Vinyl Lichen

Scientific name
Leptogium polycarpum

Status
Special Concern

Reason for designation
This jellyskin lichen, endemic to western North America, reaches the limit of its northern distribution in Canada where it is known from only 13 locations in the coastal forests of southwestern British Columbia with one isolated location in Haida Gwaii. This lichen grows on deciduous trees, especially Bigleaf Maple and Red Alder. Almost 1000 individuals of this lichen are known but confined to only 67 trees. In addition to stochastic events, threats to this sensitive lichen include air pollution from industrial and agricultural activities, forestry and associated infrastructure as well as seasonal drought due to climate change.

Occurrence
British Columbia

Status history
Designated Special Concern in May 2011.

COSEWIC
Executive Summary

Peacock Vinyl Lichen
Leptogium polycarpum

Wildlife species description and significance

The Peacock Vinyl Lichen (*Leptogium polycarpum*) is a distinctive tree-dwelling "jellyskin" lichen characterized by leafy lobes that are medium-sized lobes and have a dark bluish upper surface bearing numerous button-like fruit bodies containing sexual spores termed ascospores. The production of four spores per ascus is unusual for this genus in which eight is the normal number.

Distribution

The Peacock Vinyl Lichen is endemic to western North America, where it occurs from northern California (40°N) northward to southern British Columbia (51°N) in summer-dry coastal regions. There is one outlying population (52°N) at Haida Gwaii (formerly known as the Queen Charlotte Islands).

Habitat

In Canada, the Peacock Vinyl Lichen occurs at low elevations on the branches and (mossy) trunks of deciduous trees, particularly Bigleaf Maple and Red Alder, in rather well-lit, mid-successional stands. At most locations its host trees are rooted in nutrient-rich soils derived from marine sediments deposited during the Pleistocene. Generally, the Peacock Vinyl Lichen grows on epiphytic moss mats which appear to promote its establishment and maintenance. At two locations, it colonizes trees near the spray of waterfalls from which it seems to benefit.

Biology

Sexual reproduction in the Peacock Vinyl Lichen depends upon on the production and dissemination of fungal spores from the lichen fruit body. This means there is a requirement for thallus resynthesis at each generation which presumably accounts for the sporadic distribution of this lichen. As a "jellyskin" lichen, in which the photopartner is a cyanobacterium, the Peacock Vinyl Lichen is further restricted by the requirement for the tree bark on which it grows to be base-rich. Only a few trees appear to satisfy this requirement in coastal B.C., where bark is leached by the heavy winter rains.

Population sizes and trends

The Peacock Vinyl Lichen has been documented in Canada from 20 locations, 11 of which were reported for the first time in surveys carried out in 2009. Of the nine "historical" locations, six were revisited in 2009, though only two of these were found still to support the Peacock Vinyl Lichen. The loss of this species from four locations, formerly known to support it may be due to the enhanced growth of mosses as a consequence of forest succession. It is currently extant at only 13 locations, with a total of 970 thalli distributed on 67 trees. A majority of these thalli, and about half of all host trees, are concentrated in only three locations. The other locations support only small numbers of the Peacock Vinyl Lichen on only one or a few trees. Whether this species is in decline in Canada at the present time is unclear.

Threats and limiting factors

This lichen grows most commonly in association with Bigleaf Maple and in woodlands, which include at least 5% maples, and which are in the narrow, low-elevation coastal strips. This includes the lower Fraser Valley where there has been a decline in lichen diversity over the past 20 years with the replacement of rare lichens, including cyanolichens, by a flora that is typical of nutrient-rich habitats. The likely causes are nitrogenous aerosols from intensive pig and poultry operations as well as some air pollution from the city of Vancouver. Seven of the 13 locations for the Peacock Vinyl Lichen are on Crown land and so could be vulnerable to habitat loss as a result of forestry or other human activity. Forest-dwelling lichens like the Peacock Vinyl Lichen are subject to stochastic events leading to habitat loss over a large areas. These events include wildfires, insect attacks or storms. As the Peacock Vinyl Lichen has only been found to date on 67 trees in 13 locations, stochastic events can have a serious effect on the population. The principal threat to the Peacock Vinyl Lichen, in the medium to long term, is increased seasonal drought due to climate change. This could result in additional stress to this lichen, which requires humidity and liquid water for photosynthesis, growth and reproduction. Stress can reduce the frequency of resynthesis and establishment of the lichen and could cause a rapid decline in its abundance.

Protection, status, and ranks

Five of the 13 Canadian locations currently known are situated in permanently designated protected areas. However, it only occurs on more than five trees at one of these locations. The Peacock Vinyl Lichen has not yet been accorded conservation status in the United States.

TECHNICAL SUMMARY

Leptogium polycarpum
Peacock Vinyl Lichen Leptoge à quatre spores
Range of occurrence in Canada (province/territory/ocean): B.C.

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(2008) is being used)	10-20 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence	86,820 km², including three locations of unknown status
Index of area of occupancy (IAO)	64 km², including three locations of unknown status
Is the total population severely fragmented?	Unlikely in the sense that the 2008 IUCN guidelines discuss severe fragmentation. Fragmentation in the general sense occurs in part, as a result of the disjointed spatial apportioning of conditions suitable for establishment
Number of "locations∗"	20, including three locations of unknown status. Extant at 13 locations.
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	No, except perhaps in areas subject to housing development or air pollution.
Is there an [observed, inferred, or projected] continuing decline in number of populations?	Probably not

∗ See definition of location.

Is there an [observed, inferred, or projected] continuing decline in number of locations?	Probably not
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Probably not
Are there extreme fluctuations in number of populations?	Possible, but not yet documented
Are there extreme fluctuations in number of locations∗?	Probably not
Are there extreme fluctuations in extent of occurrence?	Probably not
Are there extreme fluctuations in index of area of occupancy?	Probably not

Number of Mature Individuals (in each population)

Population	N Mature Individuals
	Refer to Appendix Table 1
Total	970 – During surveys 960 thalli found in 2009, 10 more known from a previous record.

Quantitative Analysis

Probability of extinction in the wild is at least	Unknown

Threats (actual or imminent, to populations or habitats)

Climate change, urbanization, air pollution, resource extraction

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Common in southwestern Washington State and adjacent Oregon.	
Is immigration known or possible?	Possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes, but future climate change could change this
Is rescue from outside populations likely?	Yes, but the degree of "rescue" would be determined by local climatic conditions

Current Status

COSEWIC:
Special Concern (2011)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern.	N/A

Reasons for designation:

This jellyskin lichen, endemic to western North America, reaches the limit of its northern distribution in Canada where it is known from only 13 locations in the coastal forests of south western British Columbia with one isolated location in Haida Gwaii. This lichen grows on deciduous trees, especially Bigleaf Maple and Red Alder. Almost 1000 individuals of this lichen are known but confined to only 67 trees. In addition to stochastic events, threats to this sensitive lichen include air pollution from industrial and agricultural activities, forestry and associated infrastructure as well as seasonal drought due to climate change.

∗ See definition of location.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable, no data on population decline.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets EN B2 (AO < 500 km²) but does not meet threshold for subcriterion 'a' (#locations/fragmentation), subcriterion 'b' (continuing decline) or subcriterion 'c' (fluctuation).
Criterion C (Small and Declining Number of Mature Individuals): Not applicable – although meets EN for population size (# individuals < 2500), it does not meet the subcriterion thresholds for C1 of C2 (no evidence of continuing decline).
Criterion D (Very Small or Restricted Total Population): Meets criterion for TH D1 (# of individuals < 1000; actual = 970 thalli) but there is a possibility that additional sites may be found for the lichen following further search effort; therefore, it was decided not to invoke this criterion.
Criterion E (Quantitative Analysis): Not available.

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
(2011)

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.

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

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Leptogium polycarpum

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

Scientific name: *Leptogium polycarpum* P.M. Jørg. & Goward
Bibliographic citation: Ann. Bot. Fennica 150: 75-78. 1994.
Pertinent synonyms: none.
Common name: The Peacock Vinyl Lichen, Leptoge à quatre spores
Family name: Collemataceae
Major group: lichens, lichenized fungi

Leptogium is a cosmopolitan genus comprised of roughly 180 species. Sixty species are known to occur in North America (Esslinger 2009), of which 30 have been reported from Canada and 20 from British Columbia.

Leptogium polycarpum is a highly distinctive species characterized by its numerous apothecia containing four spores per ascus. The first specimen that could be assigned to this species was collected by John Macoun in 1914. Later a specimen collected by Otto and Ahti (1967) was erroneously assigned to *L. corticola* (Taylor) Tuck., an eastern North American species having eight spores per ascus. Noble (1982) was the first to recognize *L. polycarpum* as an undescribed species of *Leptogium* and it was formally named by Jørgensen and Goward (1994).

Morphological description

Leptogium polycarpum (Figure 1) is a loosely-attached foliose “jellyskin” lichen that is 2-5 (occasionally 7) cm in diameter. The lobes are 5-10 mm wide, rounded, and more or less translucent when wet. The upper surface is pale to dark greyish or sometimes brown, shiny, hairless, scarcely wrinkled when dry, and bears numerous, partly sunken, button-like apothecia 0.2-0.5 mm across. The internal portions of the thallus are dark, rather translucent when moist, less than 200µm thick, and under the microscope can be seen to consist of threadlike fungal strands and olive green cyanobacterial cells (*Nostoc*). The lower surface is paler than the upper surface, and is either naked or else bears sparse tufts of white hairs. The apothecia contain asci which contain 4 spores per ascus that are ellipsoid, brickwall-like (muriform), and 100-125µm long x 12-15µm wide. No secondary substances have been reported for *L. polycarpum*. Illustrations are found in Jørgensen and Goward (1994), p. 76; Brodo *et al.* (2001), p. 409; McCune and Geiser (2009), p.180.

Figure 1. *Leptogium polycarpum*: Habit. Photograph by Tim Wheeler. Reproduced by permission.

The rock-dwelling forms of *Leptogium polycarpum* are not known in Canada, but in the U.S. this form might be confused with *Leptogium platinum.* However, the latter species has a finely wrinkled upper surface which bears lobules and the apothecia contain asci with 8 spores per ascus.

Population spatial structure and variability

No information is currently available.

Designatable units

Only one designatable unit is currently recognized for *L. polycarpum*. There is no evidence for genetic or ecological differentiation of the species through its Canadian range.

Special significance

Leptogium polycarpum is a western North American endemic lichen that reaches its northern limits in southern coastal British Columbia. Its reliance on dispersal by means of sexual spores imposes a requirement for resynthesis at each generation. This in turn implies a high degree of sensitivity to climate change (see Limiting Factors and Threats, below), with a potential for rapid reduction in population size and numbers. The presence of cyanobacteria as the photosynthetic partner confers the ability to fix atmospheric nitrogen. During thallus drying and wetting cycles, a proportion of this may benefit other organisms in the immediate vicinity.

DISTRIBUTION

Global range

In western North America, *Leptogium polycarpum* occurs from coastal areas eastwards to the foot of the Coast Ranges (Figure 2). Within this area it extends southward to northern California (40°N) and northward to the north coast of British Columbia (52°N). Brodo *et al.* (2001) mapped *L. polycarpum* as occurring also in southeast Arizona, but this is based on a mapping error (I.M. Brodo pers. comm. 2009).

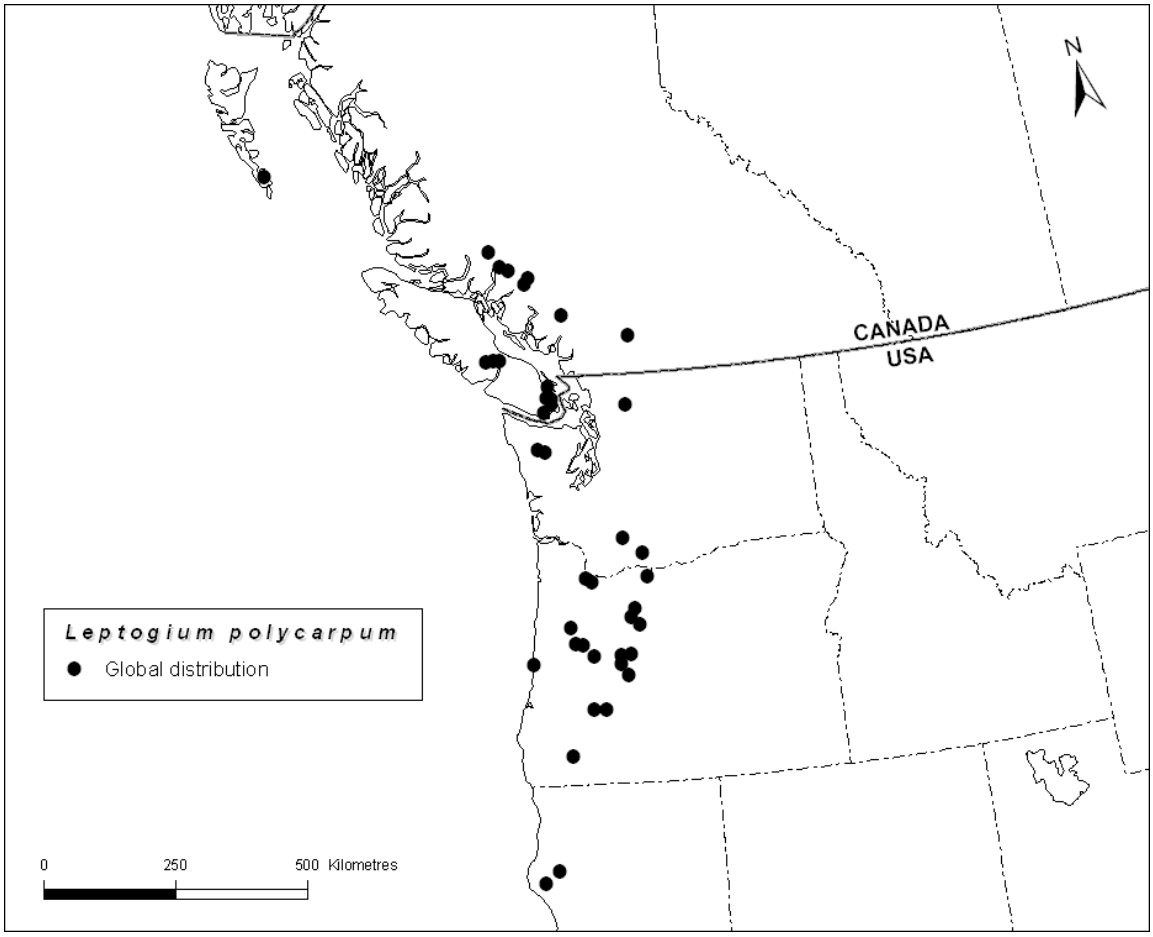

Figure 2. Global distribution of *Leptogium polycarpum*.

Canadian range

Leptogium polycarpum is restricted in Canada to coastal British Columbia (Figure 3), where it occurs from southern Vancouver Island north along the mainland inlets to the Homathko Valley (51°N). It extends eastward in the main valleys through the Coast Range. *Leptogium polycarpum* does not extend beyond the range of Bigleaf Maple (*Acer macrophyllum*) except for the outlying population on South Moresby Island (52°N) on Haida Gwaii (formerly known as the Queen Charlotte Islands).

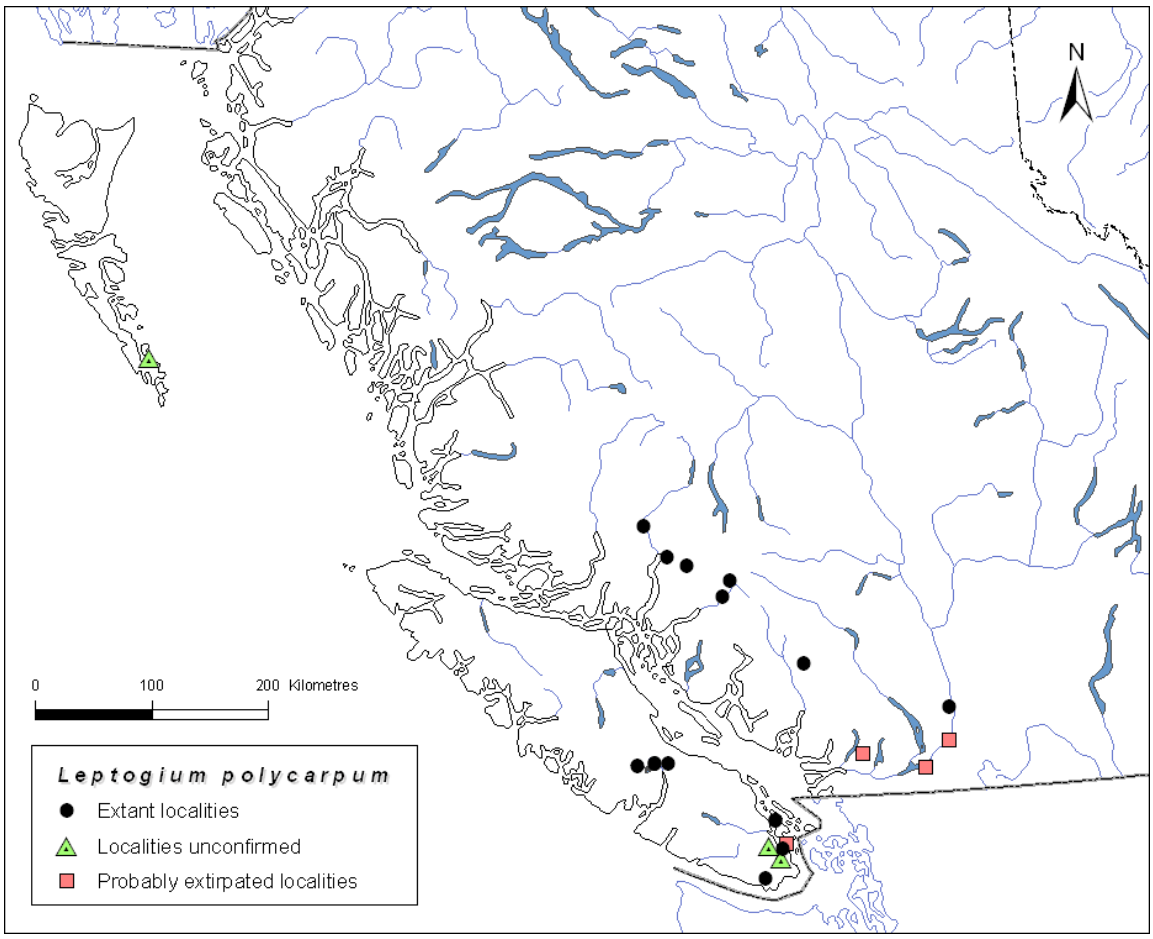

Figure 3. Canadian distribution of *Leptogium polycarpum.* Information about two historical locations (1 & 6, Table 1) was not detailed enough to allow a detailed search for this lichen and so are designated unconfirmed in the figure above.

In the main portion of its range, *L. polycarpum* occurs at low elevations, usually between sea level and about 400m. It is restricted to maritime regions subject to Mediterranean-type climates characterized by warm, dry summers and mild, wet winters. In the northern part of its range, it occurs rarely in locations exposed to appreciable amounts of moisture during the summer months.

HABITAT

Habitat requirements

In Canada, *L. polycarpum* appears to establish exclusively on trees. Most records come from the trunks and branches of deciduous trees, especially Bigleaf Maple (*Acer macrophyllum*) and Red Alder (*Alnus rubra*), but also on Arbutus (*Arbutus menzeisii*), Black Cottonwood (*Populus trichocarpa*) and Garry Oak (*Quercus garryana*) (Table 1). Only at Location 12 has *L. polycarpum* been collected on a conifer, i.e., the branches of Western Hemlock (*Tsuga heterophylla*) growing within the dripzone (*sensu* Goward and Arsenault 2000) of Black Cottonwood, where it can be enriched by leachates derived from the leaves. In many locations this species does not colonize tree bark per se; rather it grows among tree-dwelling moss mats which may help to buffer it against rapid drying after rain. As a rule, tree bark is only colonized in humid microsites.

Table 1. Summary of the locations of Canadian populations of *Leptogium polycarpum* and their historical and current status.

Location	Area	Ownership Threats	Years Reported	Original population size (no. of thalli)	Population size (2007-2009) (no. of thalli)	Population trend (Population threat)
Location 1	Vancouver Island, Victoria area: "Sidney"	Unknown. Location uncertain, but probably on private land.	19 Aug1914	Unknown	Unknown	Not revisited, probably extirpated by urbanization
Location 2	Haida Gwaii, Jedway area: along road to foot of Harriet Harbour	Gwaii Haanas National Park	26 July 1967	Unknown	Unknown	Not revisited. Competition from mosses
Location 3	Lower Fraser Valley, Hope: east side of town	Precise location uncertain but probably private land.	2 Sept 1969	Unknown	Probably extirpated	Searched for but not found. Habitat probably destroyed by urbanization.
Location 4	Lower Mainland, Chilliwack area Bridal Veil Falls	Bridal Veil Falls Provincial Park.	28 Sept 1978	Unknown (but few)	Probably extirpated	Searched for but not found. Presumably extirpated by air pollution from nearby farms.
Location 5	Gulf Islands, Saltspring Island: Cranberry Road, base of Mt. Maxwell	Private landholding.	7 Sept 1989, 12 May 2009	Unknown	50 thalli (4 trees: *Alnus*)	Revisited and refound: population decline: competition by mosses, housing development
Location 6	Vancouver Island, Victoria area: old farm	Private landholding.	1975 (specimen misplaced)	Unknown	Unknown	Searched for but location not refound.
Location 7	Vancouver Island, Shawnigan Lake area: Old Baldy Mountain	Unknown	17 June 1975	Unknown	Unknown	Not revisited.

Location	Area	Ownership Threats	Years Reported	Original population size (no. of thalli)	Population size (2007-2009) (no. of thalli)	Population trend (Population threat)
Location 8	Lower Fraser Valley, Haney area: Evans Creek	Golden Ears Provincial Park.	12 February 1978	Unknown	Probably extirpated	Revisited but not refound: population apparently lost to forest succession.
Location 9	Vancouver Island, Port Alberni area Sproat Lake	Sproat Lake Provincial Park.	31 Aug 1997, 16 May 2009	Unknown	10 thalli (2 trees: deciduous)	Revisited and refound: competition from epiphytic mosses.
Location 10	Coast Ranges, Upper Toba Valley	Crown land.	13 June 2009	100 thalli (1 tree: *Alnus*)	100 thalli (1 tree: *Alnus rubra*)	N/A: visited only once. Competition from epiphytic mosses. Logging
Location 11	Coast Ranges, Toba Valley: Toba logging camp	Crown land.	14 June 2007	10 thalli (1 tree: *Alnus*)	10 thalli (1 tree: *Alnus rubra*)	N/A: visited only once. Competition from epiphytic mosses. Logging.
Location 12	Coast Ranges, Bute Inlet area Southgate Valley	Crown land.	13 August 2007	75 thalli (1 tree: *Tsuga*)	75 thalli (1 tree: *Tsuga heterophylla*)	N/A: visited only once. Competition from epiphytic mosses. Logging.
Location 13	Fraser Canyon, Yale area: near Sailor Bar Tunnel	Crown land.	7 May 2009	15 thalli (4 trees: *Acer*)	15 thalli (4 trees: *Acer macrophyllum*)	N/A: visited only once. Wildfire, tree fall from winter windstorms
Location 14	Vancouver Island, Sooke area: Ayum Creek	Ayum Creek Regional Park Reserve.	11 May 2009	300 thalli (10 trees: *Acer*)	300 thalli (10 trees: *Acer macrophyllum*)	N/A: visited only once.
Location 15	Vancouver Island Victoria area: Saanich Peninsula	John Dean Provincial Park	15 May 2009	10 thalli (2 trees: *Quercus*)	10 thalli (2 trees: *Quercus garryana*)	N/A: visited only once. Wildfire, tree fall from winter windstorms.
Location 16	Vancouver Island, Port Alberni area: Sproat Lake, Taylor Arm	Taylor Arm Provincial Park.	16 May 2009	35 thalli (3 trees: *Acer*)	35 thalli (3 trees: *Acer macrophyllum*)	N/A: visited only once. Competition from epiphytic mosses.
Location 17	Vancouver Island, Port Alberni: Meconella Ridge trail	Crown land.	17 May 2009	15 thalli (4 trees: *Acer*)	15 thalli (4 trees: *Acer macrophyllumr*)	N/A: visited only once. Competition from epiphytic mosses.
Location 18	Coast Ranges, Whistler area: Brandywine Falls	Brandywine Falls Provincial Park.	20 May 2009	100 thalli (5 trees: *Acer*)	100 thalli (5 trees: *Acer macrophyllum*)	N/A: visited only once: secure. Tree fall from winter windstorms.
Location 19	Coast Ranges Bute Inlet area: Southgate Valley	Crown land.	14 Sept. 2009	200 thalli (20 trees: *Alnus, Acer glabrum*)	200 thalli (20 trees: *Alnus rubra, Acer glabrum*)	N/A: visited only once, but population may have been reduced by adjacent clearcutting.
Location 20	Coast Ranges, Bute Inlet area: Homathko Valley near Brew Creek	Crown land.	15 Sept. 2009	50 thalli (10 trees: *Alnus*)	50 thalli (10 trees: *Alnus rubra*)	N/A: visited only once. Competition from epiphytic mosses.

Like other “jellyskin” lichens, *L. polycarpum* requires substrates with a pH above 5.0. At most locations it appears to be restricted to trees rooted in nutrient-rich soils, especially old marine sediments, though in some cases the sediments are overlain by talus from nearby cliffs. It is not known to occur on trees that grow in soils derived from acidic bedrock. *Leptogium polycarpum* often grows in the company of other cyanolichens including *Lobaria pulmonaria* and especially *Peltigera collina*. To date, *L. polycarpum* has only been found within the lower canopy of its host trees.

Leptogium polycarpum occurs in young to mid-seral maple and Red Alder forests rooted in nutrient rich soils. It appears to be absent from old growth forests although two collections (locations 13 and 18) have been from very old Bigleaf Maple growing on open talus slopes. It tends to be associated with forest openings, though in a few cases rather shady microsites are colonized. Such sites receive better illumination during the winter months when the leaf canopy has fallen. At two locations (19 and 20), *L. polycarpum* occurs on deciduous trees growing within the outer spray zones of waterfalls where it may benefit from enhanced wetting during freshet (Appendix 1).

Habitat trends

Leptogium polycarpum has been documented in Canada from 20 locations (Table 1) of which 11 were discovered during surveys conducted in 2009 by T. Goward and C. Björk. Of the nine other historical locations, six were revisited during the same surveys, though only two were found still to support *L. polycarpum*. Logging does not appear to have been a contributing factor in these declines. *Leptogium polycarpum* is unusual among rare epiphytic macrolichens in its preference for mid-seral stands rather than on old-growth. Trees in mid-seral stands tend to grow relatively rapidly, hence the within-stand environmental conditions sooner or later exceed the ecological tolerance of *L. polycarpum*. The loss of this species from locations formerly supporting it is thus to be expected. However, the loss of *L. polycarpum* from two locations can partly be attributed to human activity: first in the form of urbanization, and second as a result of elevated atmospheric nitrogen associated with intensive agriculture (see Threats section below).

In this report, “location” is defined as a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon under consideration. Populations situated more than 1 km apart are treated as separate locations.

BIOLOGY

Life cycle and reproduction

No studies have yet been undertaken on the life cycle of *L. polycarpum*. The lack of asexual reproductive propagules means that there is an exclusive reliance on sexual ascospores for reproduction and dispersal. Thus, thallus resynthesis has to occur at each generation. No data are available on generation time in this species but research on other cyanolichens suggests it is probably in the range of 10-20 years (Larsson and Gauslaa, 2011).

Physiology and adaptability

The distributional ecology of *L. polycarpum* is profoundly affected by two physiological requirements common to all lichens having a cyanobacterium as photopartner. The first of these is a requirement for water in the liquid form (water vapour alone is sufficient to trigger photosynthetic activity in many lichens, but not in "jellyskin" lichens). The requirement for liquid water restricts *L. polycarpum* to habitats subject to frequent wetting by rain or heavy dew – at least during cool periods suitable for growth. The second requirement is for a base-rich substratum, usually with a pH > 5 (Gauslaa 1985, 1995). This limits the tree-dwelling *L. polycarpum* to deciduous host trees which have a relatively high bark pH. This is particularly important in coastal British Columbia where heavy winter rains promote the loss of accumulated bark nutrients through leaching (Farmer *et al.* 1991). The bark of conifers is generally too acidic to support this or other species of "jellyskin" lichens. These two factors account for much of the restricted ecological distribution observed for *L. polycarpum*.

Dispersal

The production of numerous apothecia containing ascospores in *L. polycarpum* ensures efficient dispersal in this species. Fungal spores may remain viable in the airborne state for some time. However, spore dispersal is only one part of successful establishment at a new location. It is essential that the dispersed spores are able to germinate, find a compatible photosynthetic partner (*Nostoc*) and, ultimately, resynthesize a new lichen. Some cyanolichens are highly specific with respect to the strains of cyanobacteria that are required for successful thallus formation (Myllys *et al.* 2007). Such conditions are demanding, complex and limiting and likely account for the sporadic distribution of this lichen throughout its range.

Interspecific interactions

In common with most epiphytic lichens, *L. polycarpum* appears to be weakly competitive. In spite of this, *L. polycarpum* has the ability to persist for extended periods on the epiphytic moss mats on which it is commonly found. Observations indicate that eventually the mosses grow and exclude this and most other lichens from the branches and trunks of host trees. In the short term, however, it seems that moss mats actually benefit *L. polycarpum*, possibly by preventing it from drying too rapidly.

POPULATION SIZES AND TRENDS

Sampling effort and methods

Coastal British Columbia has been the focus of considerable attention by lichenologists (Figure 4) who have explored both old growth stands and, especially in the south, younger second-growth forests dating from logging activities early in the 20th century. Willa Noble, over a period of some five years during the 1970s, conducted a thorough inventory of the lichens of southeastern Vancouver Islands and the adjacent Gulf Islands (Noble 1982). She collected 5,500 specimens that included a total of 448 species from 114 genera. She surveyed much of the potential habitat for *L. polycarpum.* Noble collected what she recognized as an undescribed species, and it was named and described by Trevor Goward and Per Magnus Jørgensen in 1994. Since then Goward has travelled widely in British Columbia looking for this lichen (T. Goward, unpublished collections). Others too have undertaken major inventories, e.g. on Haida Gwaii (the Queen Charlotte Islands) (Brodo 1995), and Saltspring Island (Bird and Bird 1973). In 1970, Karl Ohlsson spent several weeks collecting along the British Columbia coast (Ohlsson 1973). In early 1990s, T. Goward examined 145 coastal and inland rainforests for rare cyanolichens (Goward 1994). Since then he has continued to conduct lichen surveys within the potential range of *L. polycarpum*, including southwest Vancouver Island, central Vancouver Island, northern Vancouver Island, the Terrace area, the Kispiox Valley and South Moresby with the aim of finding further occurrences of this lichen (Goward and Spribille 2005). Other lichenologists, especially Curtis Björk have also sought this species in the Homathko, Southgate and Toba valleys, as well as the Vancouver region. Where it has been found in these valleys, it is at sites that have been very rich in other rare lichens and vascular plants.

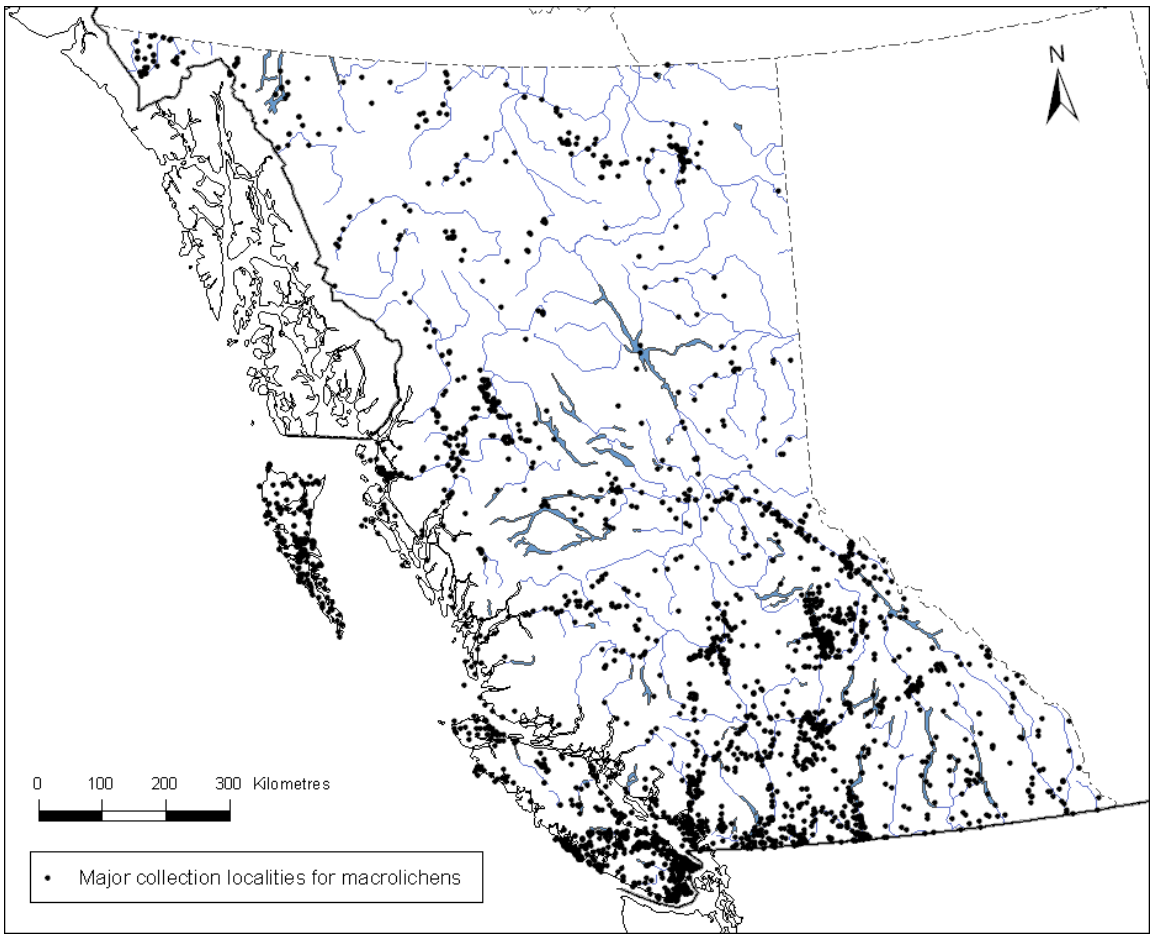

Figure 4. Major collection sites for macrolichens in British Columbia to 2009.

The objectives of the field studies that were done for this report were (1) to revisit as many as possible of the known locations of *L. polycarpum* to see if it still existed there, and (2) in the light of 20 years' experience looking for this lichen, to try to find and visit additional areas where this lichen might be present. This fieldwork followed a careful review of all known Canadian specimens of *L. polycarpum* (Table 1, Appendix 1). Over a period of 17 days, using resources provided by COSEWIC, T. Goward and C. Björk visited 40 possible locations throughout the known and predicted range of this species. It proved possible to visit six of the nine locations from which this species had previously been documented in Canada, i.e., locations 3, 4, 5, 6, 8, and 9 (Table 1). At least one hour of survey time was devoted to documenting its occurrence at each location. In addition to estimating the number of individual thalli present, the identity and number of trees supporting it were also noted. Although searched for, *Leptogium polycarpum* was not seen above the lowermost portions of the canopy.

Abundance

A total of 970 thalli of *L. polycarpum* were documented at 13 locations in 2009. Not all locations, however, supported this species in equal numbers. The two locations with the highest thallus abundance (locations 14 and 19) accounted for approximately 60% of all thalli, as compared with the combined total of 6% found at the five locations of lowest thallus abundance (Table 1). It is likely that further surveys of the remaining suitable habitat will discover additional populations that may bring the number of thalli to more than 1,000.

More important than the number of thalli of *L. polycarpum* present at a given location is the number of trees found to support it. At Location 10, for example, roughly 100 thalli have become established on the trunk of a large old Black Cottonwood. The loss of this single tree to a stochastic event such as insects, fungal attack, wind, or cutting could result in a reduction of about 12% of the known Canadian population of this lichen. Viewed statistically, *L. polycarpum* is much more secure in locations where small numbers of thalli occupy several host trees than in locations where it occurs in greater numbers, but on only a very few trees. In total only 67 trees were found to support *L. polycarpum* during the fieldwork in 2009 (Table 1); see also the following section.

Fluctuations and trends

Leptogium polycarpum has now been documented from 20 locations in Canada – up from nine historical locations prior to fieldwork undertaken in 2009 (Table 1). Six of the nine historical locations were revisited but only two locations were found still to support *L. polycarpum*. These figures would appear to indicate past or ongoing decline based on the loss of four locations. However, 11 new locations were found by Goward and Björk using their experience when visiting potentially suitable habitats for this lichen. More information about the dynamics and persistence of *L. polycarpum* populations is needed and will be gained if these sites are revisited after a decade to confirm the persistence, or otherwise of this lichen. The residence time for *L. polycarpum* at most locations is probably in the order of a single generation, perhaps 10 to 20 years. If so, then regional trends in abundance should not be judged in terms of its ability to persist at a particular location. One potentially useful approach might be to consider the number of host trees encountered per unit field effort and an estimate of the amount of suitable mid-seral stands of *Acer macrophyllum*. It follows that population fluctuation and trends in *L. polycarpum* cannot be accurately assessed at the present time.

Of the 13 locations currently known to support *L. polycarpum*, only three (locations 14, 19 and 20) involved more than 10 host trees. At other locations, this species occurred on five trees or fewer. Such a pattern is not unexpected in a sexual lichen like *L. polycarpum*, which must resynthesize a new thallus at each generation. Certainly it is consistent with the observation that young thalli of *L. polycarpum* are most frequently encountered in rather open forest types. In more sheltered forests, young thalli tend to be replaced by larger thalli: relicts, presumably, from a time when light conditions were more favourable to establishment. Thus its occurrence on only a few trees in most locations is probably indicative of a very brief establishment window, which effectively closes when the expanding forest canopy alters environmental conditions beyond the ability of this lichen to resynthesize.

Rescue effect

Fungal spores (including lichens) suspended in the upper atmospheric winds can remain viable for long periods (Muňoz *et al.* 2004). This observation is significant, firstly because *L. polycarpum* depends exclusively on ascospores for dispersal and establishment; and secondly because *L. polycarpum* is considerably more common in the American portion of its range, especially in western Oregon (McCune and Geiser 2009), than it is in Canada. It follows that any future decline in the Canadian population of *L. polycarpum* could sooner or later be offset by recruitment from locations farther south. However, such a rescue effect would depend on the continued existence in Canada of suitable host trees and the right environmental conditions that would allow the growth on the trees of the symbiotic cyanobacterium *Nostoc,* which is the key to successful resynthesis and establishment. Thus, the degree of rescue would be determined by local climatic conditions in Canada.

THREATS AND LIMITING FACTORS

The distribution of *L. polycarpum* largely coincides with forest stands containing Bigleaf Maples, with about half the thalli (460 thalli) and half the known sites being found on or in stands of this tree. Although *L. polycarpum* occurs mainly in mid-seral woodlands, it occasionally grows on large trees (locations 13 and 18, Appendix 1). Bigleaf Maples are not uncommon in the region but stands containing large trees comprise only a small proportion of maples on both Vancouver Island (2.4% of age classes) and the southwestern mainland (1.5% of age classes) (Peterson *et al.* 1999). Furthermore, woodlands that include more than scattered maples (at least 5%) are restricted to the narrow, low-elevation coastal strips in the extreme southwest of the province. These areas, e.g. in the lower Fraser Valley, are also where people prefer to live and farm and hence the woodlands have been fragmented.

In the lower Fraser valley which forms part of the range of this lichen, there has been a decline in lichen diversity over the past 20 years. There is some air pollution from the city of Vancouver but the replacement of rare cyanolichens by a lichen flora which is typical of nutrient-enriched habitats (T. Goward pers. obs.) indicates that the likely cause is nitrogenous aerosols from intensive pig and poultry operations. Such emissions are a threat to cyanolichens such as *L. polycarpum*, at least in portions of its range that are in the lower Fraser Valley. The disappearance *of L. polycarpum* from Location 4, where this rare lichen has been replaced by *Physcia adscendens* and other species typical of hypertrophicated habitats, is indicative of such aerosols and a rise in the levels of ammonia (van Herk 1999).

Seven of the 13 locations for the Peacock Vinyl Lichen are on Crown land and, as such, are vulnerable to habitat loss as a result of forestry or other human activity. Forest-dwelling lichens are subject to stochastic events leading to habitat loss. As mentioned earlier, these events could include wildfires, insect attacks or storms. To date *L. polycarpum* has only been found on 67 trees in 13 locations, so stochastic events can have a serious effect on the population of this lichen. At the present time logging is not a significant threat as *L. polycarpum* is most often found in mid-successional stands that are less sought after for forestry activities.

As a sexual species, *L. polycarpum* is highly sensitive to any factor that would compromise its ability to resynthesize at each generation. This need for resynthesis accounts, at least in part, for the sporadic distribution and narrow distributional ecology of this species. It makes *L. polycarpum* highly vulnerable to any environmental change that militates against successful resynthesis. As a result of such changes, this species could disappear from affected areas in as little as one or two generations.

The most serious threat to *L. polycarpum* in British Columbia over the medium and long term is climate change (Redding *et al.*, 2011, Rodenhuis *et al*., 2009).
The predicted trend in coastal areas is for warmer, drier, summers and heavier winter rains. Indeed it has been estimated that the rate of warming has been more than twice the global average and that annual precipitation, over the last 50-100 years, has increased by 20%, but at the same time there have been longer summer droughts (Anon. 2011). This lichen, like other cyanolichens, requires liquid water for photosynthesis and any factor that increases water stress like prolonged summer drought, is likely to adversely affect its establishment and growth. This could cause a rapid decline in the abundance of this lichen.

At the present time, *L. polycarpum* is restricted to trees growing below about 400m above sea level on nutrient-rich soils derived from Pleistocene marine sediments. Any warming or drying trend that required an upward retreat of *L. polycarpum* to cooler, more humid climates might carry it above the upper limits of the nutrient-rich soils upon which its host trees grow. This could result in the rapid disappearance of *L. polycarpum*.

PROTECTION, STATUS, AND RANKS

Legal protection and status

Leptogium polycarpum receives no legal protection at the present time – either in Canada or in the United States' portion of its range.

Non-legal status and ranks

Leptogium polycarpum has been assigned S2S3 status by the British Columbia Conservation Data Centre (BC CDC; Jenifer Penny pers. comm. 2009). In the U.S., it is not currently listed by the Oregon Natural Heritage Program or by its counterparts in Washington or California. It has likewise not yet been ranked by NatureServe, owing to inadequate information on its distribution.

Habitat protection and ownership

Five of the 13 locations currently supporting *L. polycarpum* in Canada are located in protected areas. One of these is a municipal park, Ayum Creek Regional Park Reserve, near Sooke. The others are provincial parks, as follows: John Dean Park, near Victoria; Taylor Arm and Sproat Lake Parks near Port Alberni, and Brandywine Park near Whistler. *Leptogium polycarpum* has been documented also at two additional provincial parks – Golden Ears Park near Maple Ridge, and Bridal Veil Falls Park near Chilliwack – but has seemingly disappeared in recent years owing to competition from mosses (part of natural forest succession) and air pollution, respectively. Most of the remaining locations are on Crown land, though Location 2, on South Moresby Island, is now in Gwaii Haanas National Park, whereas Location 5, on Saltspring Island, is located on private land.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Trevor Goward began studying lichens in 1976, while completing an undergraduate degree in French and Latin at Mount Allison University, New Brunswick. Since then he has developed and maintained a broad interest in lichen taxonomy and distributional ecology, and has written or co-authored five books on lichens and published about 70 papers in refereed journals. Currently a consulting lichenologist based out of Clearwater, British Columbia, Trevor maintains a special interest in the lichens of oldgrowth forests as well as in the ecology of rare lichens. In 1989, he was appointed as curator of lichens at UBC, a position he has held ever since. Most of his 30,000+ lichen collections are on deposit at the UBC herbarium. Trevor served on the lichen subcommittee of COSEWIC from 1995 to 2009.

Curtis Björk is a vascular botanist who took up the study of lichens in 1999. Born and raised in Washington, he received his B.A. in International Affairs at Eastern Washington University in 1995, and his M.S. in Botany at Washington State University in 2003. For the past 18 years, Curtis has worked as a botanical consultant over a wide area of the western U.S. and, more recently, in British Columbia. He has published 12 peer-reviewed papers, including on five vascular plants and four lichens new to science. His recent work has focused on vernal pool ecosystems, plant and lichen floristics and ecology, and biodiversity conservation. He is a Research Associate with the University of Idaho Herbarium.

COLLECTIONS EXAMINED

All known Canadian collections of *L. polycarpum* on deposit at public institutions have been examined in connection with this study. Specimens are listed in Appendix 1.

Appendix 1. Known Canadian collections of *Leptogium polycarpum.* Note in the location column, the location of each specimen in local or national herbaria is indicated.

Location Specimen	Abundance (no. of thalli/location)	Location Habitat Substrate	Collector Collecting# Date	Determined / Examined by
Location 1 Unknown UBC	Probably extirpated (0)	British Columbia, Vancouver Island: Sidney, "on Cedar bark" (actually on wood of deciduous tree).	John Macoun s.n. (UBC 4925) 19 Aug 1914	J.K. Merrill (as *L. pulchellum*); W.B. Noble (as not *L. corticola)*, T. Goward
Location 2 (1) UBC (2) CANL (3) U. of Bergen, Norway (B)	Unknown (N/A)	British Columbia, Haida Gwaii, South Moresby Island, near Jedway: along road to foot of Harriet Harbour: on *Populus* in *Picea-Tsuga-Alnus* stand at shore. Alt: 5m.	I.M. Brodo 12579 26 July 1967	I.M. Brodo, T. Goward
Location 3 CANL	Probably extirpated (0)	British Columbia, Lower Fraser Valley: Hope: East side of town in moss on *Acer* trunk in *Acer-Pseudotsuga* stand. Alt: 60m.	I.M. Brodo 15653 2 Sept 1969	I.M. Brodo
Location 4 UBC	Probably extirpated (0)	British Columbia, Lower Mainland, Chilliwack area: Bridal Falls: on *Acer* trunk in open deciduous forest. Alt: 90m	T. Goward 78-1084 28 Sept 1978	T. Goward
Location 5A Private B (University of Bergen, Norway)	Number of thalli not documented in 1989.	British Columbia, Gulf Islands, Saltspring Island: 5.5 km along Cranberry Road to Mt. Maxwell from Fulford-Ganges Road, on *Alnus rubra*. Alt: 340m	T. Tønsberg 12099 7 Sept 1989	T. Tønsberg
Location 5B UBC	50 thalli on 4 *Alnus rubra*	British Columbia, Gulf Islands, Saltspring Island: 5.5 km along Cranberry Road to Mt. Maxwell from Fulford-Ganges Road, on *Alnus.* Alt: 340m.	T. Goward 09-306 12 May 2009	T. Goward
Location 6 UBC	Unknown	British Columbia, Vancouver Island, Victoria area: Old farm: twice on *Quercus* and once each on *Acer macrophyllum* and *Arbutus menziesii* in *Pseudotsuga* forest on outcrop. Alt: 35m.	W.J. Noble 3694 1975 (specific date uncertain)	T. Goward

Location Specimen	Abundance (no. of thalli/location)	Location Habitat Substrate	Collector Collecting# Date	Determined / Examined by
Location 7 UBC	Unknown	British Columbia, Vancouver Island, Shawnigan Lake area: Old Baldy Mountain, on *Arbutus menziesii* in drainage areas near *Arbutus-Pseudotsuga* forest. Alt: 250m.	W.J. Noble 4411 17 June 1975	T. Goward
Location 8 UBC	Probably extirpated (0)	British Columbia, Lower Fraser Valley, Haney area: Evans Creek (West Canyon Trail): on tree trunk in 2nd mixed forest with *Acer macrophyllum* and *Alnus rubra*. Alt: 200m.	W.B. Schofield 67581 12 February 1978	T. Goward
Location 9A UBC	Number of thalli not documented in 1997.	British Columbia Vancouver Island, Port Alberni area: Sproat Lake: on branch of deciduous tree along road and near parking lot. Alt: 30-50m.	V. Miao TDI3740, TDI3805 31 Aug 1997	V. Miao, T. Goward
Location 9B UBC	10 thalli on 2 deciduous trees.	British Columbia, Vancouver Island Port Alberni area: Sproat Lake: on branch of deciduous tree along road and near parking lot. Alt: 30-50m.	T. Goward 09-457 16 May 2009	T. Goward
Location 10 UBC	100 thalli on 1 *Populus trichocarpa*.	British Columbia, Coast Ranges: upper Toba Valley: on moss over trunk of *Populus* in oldgrowth forest. Alt: 125m.	C.R. Björk 14486 13 June 2007	C.R. Björk, T. Goward
Location 11 UBC	10 thalli on 1 *Alnus rubra*.	British Columbia, Coast Ranges, Toba Valley: Toba logging camp: on trunk of *Alnus* in second-growth along an old logging road. Alt: 50m.	C.R. Björk 14444 14 June 2007	C.R. Björk, T. Goward
Location 12 UBC	75 thalli on 1 *Tsuga heterophylla*.	British Columbia, Coast Ranges, Bute Inlet: Southgate Valley, near mouth of Icewall Creek: on twigs of *Tsuga* in cottonwood dripzone, oldgrowth forest. Alt: 60m.	C.R. Björk 14720 13 August 2007	C.R. Björk, T. Goward
Location 13 UBC	15 thalli on 4 *Acer macrophyllum*.	British Columbia, Fraser Canyon: Yale area: just north of Sailor Bar Tunnel: on mossy branch of *Acer* in open forest and talus slopes. Alt: 150m.	T. Goward 09-194, C.R. Björk 18050 7 May 2009	T. Goward, C.R. Björk

Location Specimen	Abundance (no. of thalli/location)	Location Habitat Substrate	Collector Collecting# Date	Determined / Examined by
Location 14 UBC	300 thalli on 10 *Acer macrophyllum*.	British Columbia, Vancouver Island, Sooke area: Ayum Creek: Creekside conifer-*Acer* forest and open areas around lagoon: on trunk of old *Acer*. Alt: 10m.	T. Goward 09-227 11 May 2009	T. Goward
Location 15 UBC	10 thalli on 2 *Quercus garryana*.	British Columbia, Vancouver Island, Victoria: near summit Mt. Newton: on mossy branch of *Quercus*. Alt: 200-300m.	T. Goward 09-386 15 May 2009	T. Goward
Location 16 UBC	35 thalli on 3 *Acer macrophyllum*.	British Columbia, Vancouver Island, Port Alberni area: Sproat Lake, Taylor Arm Park: on mossy branch of *Acer* in parking area. Alt: 30-100m.	T. Goward 09-410, C.R. Björk 18353 16 May 2009	C.R. Björk, T. Goward
Location 17 UBC	15 thalli on 4 *Acer macrophyllum*.	British Columbia, Vancouver Island, Port Alberni: Meconella Ridge trail: on mossy branch and trunk of *Acer* in second-growth mixed forest and wooded outcrops, moderately calcareous. Alt: 150-220m.	T. Goward 09-475, 09-476 17 May 2009	T. Goward
Location 18 UBC	100 thalli on 5 *Acer macrophyllum*.	British Columbia, Coast Ranges, Whistler area: Brandywine Falls area, on south-facing talus slope shortly southeast of Brandywine Falls, on mossy trunks of *Acer* in open, dry talus vegetation. Alt: 450m.	C.R. Björk 18445 20 May 2009	C.R. Björk, T. Goward
Location 19 UBC	200 thalli on 20 *Alnus rubra* and *Acer glabrum*.	British Columbia, Coast Ranges: Bute Inlet: Southgate Valley, 4 km E of mouth of Southgate River: on *Alnus* and *Acer* in waterfall spray zone. Alt. 50m.	C.R. Björk 19781 14 Sept. 2009	C.R. Björk, T. Goward
Location 20 UBC	50 thalli on 10 *Alnus rubra*.	British Columbia, Coast Ranges, Bute Inlet: Homathko Valley, east side of valley across from Brew Creek: on *Alnus* in waterfall spray zone. Alt: 175m.	C.R. Björk 19836 15 Sept. 2009	C.R. Björk, T. Goward