MANAGEMENT PLAN FOR THE BLUE FELT LICHEN (*Pectenia plumbea*) IN NOVA SCOTIA

A report prepared for the Nova Scotia Department of Natural Resources

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Cover illustration: Blue Felt Lichen at Misery Lake, Nova Scotia. Photographer: Colin Chapman-Lam

PREFACE

Blue Felt Lichen was assessed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in November 2010 and listed under Schedule 1 of the Species at Risk Act (S.C. 2002, c. 29) in June 2017. A status report update is presently under review. The species was assessed as Vulnerable in Nova Scotia in 2013 and listed under Nova Scotia's *Endangered Species Act* in 2017. Blue Felt Lichen was included in a Multi-species Action Plan for Kejimkujik National Park and National Historic Site of Canada in 2017, and a federal management plan was approved in 2022. The Provincial Lichen Act received Royal Assent in 2022, establishing *Pectenia plumbea* as Nova Scotia's official provincial lichen.

Under the *Nova Scotia Endangered Species Act (2007)*, a Management Plan is defined as "…*a statement of needs and actions to be undertaken to keep a vulnerable species from becoming at increased risk.*"

The objectives and actions identified in this Management Plan are based upon the best available information on the species and is subject to modifications and/or revisions as new information becomes available. Management of Vulnerable species at risk is a shared responsibility and the collaborative approach emphasized in this document is reflective of this. Implementation of the actions and approaches identified in this plan are subject to budget constraints, appropriations, and changing priorities.

ACKNOWLEDGEMENTS

The province contracted Colin Chapman-Lam and James Churchill to develop the draft Management Plan in consultation with the Recovery Team responsible for this species. Input was provided by many individuals and the Management Plan was reviewed by the Recovery Team.

Provincial Lichens Recovery Team:

- Frances Anderson
- Rob Cameron
- Sean Haughian
- Julie McKnight
- Tom Neily
- Brad Toms

Additional experts contacted:

- Alain Belliveau, Acadia University
- Fiona Brooks, Atlantic Canada Conservation Data Centre
- Harold Clapp, unaffiliated
- Iain Crowell, Atlantic Canada Conservation Data Centre
- Adam Durocher, Atlantic Canada Conservation Data Centre
- John Gallop, Nova Scotia Department of Environment and Climate Change
- Mark McGarrigle, Nova Scotia Department of Natural Resources
- Troy McMullin, Canadian Museum of Nature
- Jaimee Morozoff, Nova Scotia Nature Trust
- Jonathan Riley, Parks Canada
- Dwayne Sabine, New Brunswick Department of Natural Resources and Energy Development
- Doug Van Hemessen, Nature Conservancy of Canada

The Department would like to thank these individuals and/or organizations for their contributions to the recovery of species at risk in Nova Scotia.

EXECUTIVE SUMMARY

The Blue Felt Lichen is a large, blue-grey leafy lichen. It has a scallop-like shape, with crescent shaped curves and longitudinal ridges on the upper surface. The main body (thallus) sits on top of a thick, beard-like, blue-black fungal mat that often protrudes beyond the margin. Blue Felt Lichen occurs near the Atlantic Ocean, the Mediterranean Sea, the Baltic Sea and the Black Sea in North America, Europe, and north Africa. It is estimated that more than 99.9% of North America's population occurs in Canada, and that roughly half of Canada's population occurs in Nova Scotia. Blue Felt Lichen requires a mild climate with high rainfall or fog, often near wetlands. It grows on the bark of trees in mature to old-growth forests with relatively limited air pollution. Blue Felt Lichen was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Special Concern and is listed as Vulnerable and Special Concern under Nova Scotia's *Endangered Species Act* and the federal *Species at Risk Act*, respectively. It was designated Nova Scotia's official provincial lichen in 2022.

Blue Felt Lichen has several recognized threats that are ongoing in Nova Scotia. Forestry is the primary threat to the species, which can result in direct removal of host trees. Resource extraction also has the potential to be a significant threat especially if legislative changes permit more mining in areas important for the species. Industrial activities occurring adjacent to Blue Felt Lichen occurrences, or in substantial portions of the landscape cause decline in habitat quality through edge effects, drying, and altered hydrological regimes. Climate change and severe weather are expected to exacerbate the impacts of forestry and resource extraction. Edge effects make trees more vulnerable to windthrow during strong storms, which are expected to increase in frequency and severity with climate change. Climate projections also indicate that habitat will shift northeastward under a high emissions scenario, with areas of suitable climate becoming restricted to Cape Breton and limited portions of Guysborough County by the 2080s.

The short-term management objective for Blue Felt Lichen in Nova Scotia is to maintain its Index of Area of Occupancy to allow time for conservation prioritization. Long-term management objectives are to limit the decline in the number of functional individuals (measured as the number of host trees) to <10%, maintain or increase the number of individuals within priority sites, and maintain the Extent of Occurrence within Nova Scotia. Management actions include establishing protected areas for Blue Felt Lichen and its habitat, pursuing inventory and monitoring priorities, encouraging and maintaining protection on Crown land, encouraging protection and stewardship on private woodlots, adding emphasis for Blue Felt Lichen in policies that protect species at risk lichens and their habitat, and supporting research initiatives to address threats and limiting factors.

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1. NSSARWG and/or COSEWIC ASSESSMENT SUMMARY*

Assessment Summary: November 2010

Common Name: Blue Felt Lichen

Scientific Name: *Pectenia plumbea* (= *Degelia plumbea*)

Status: Special Concern (COSEWIC), Vulnerable (NSSARWG)

Reason for Designation: Within Canada, this lichen occurs only in the Atlantic region. It is very rare in New Brunswick and PEI, uncommon in Newfoundland, but more frequent in Nova Scotia. It grows as an epiphyte, predominantly on hardwoods in high humidity woodlands and is vulnerable to disturbance that leads to a reduction in habitat humidity. The species is also very sensitive to acid rain. Forest harvesting and resource extraction threaten the species through direct removal or through the creation of an edge effect, leading to reduced humidity within the stand. In Newfoundland, the browsing of the lichen's host tree by a high density of moose is also of concern. Air pollution is a threat, especially in New Brunswick, but also in Nova Scotia.

Occurrence: New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador

Nova Scotia Occurrence: All counties

Status History: Designated Special Concern in November 2010 in Canada and as Vulnerable in Nova Scotia in 2013.

* The following definitions are applicable in this section and elsewhere: NSSARWG (Nova Scotia Species at Risk Working Group); COSEWIC (Committee on the Status of Endangered Wildlife in Canada); NSESA (Nova Scotia Endangered Species Act); SARA (Species at Risk Act).

2. SPECIES STATUS INFORMATION

Blue Felt Lichen (*Pectenia plumbea*) was first assessed by COSEWIC as Special Concern in 2010. It was added to Schedule 1 of the *Species at Risk Act* (SARA) in 2017. Roughly half of the Canadian population occurs within Nova Scotia (S. Haughian pers. comm. Jan 2025). Blue Felt Lichen was designated as Vulnerable in Nova Scotia in 2013 and listed under the Nova Scotia *Endangered Species Act* in 2017. The status from the COSEWIC assessment (Special Concern) was adopted in New Brunswick, with a provincial assessment to be completed beyond 2028 (New Brunswick Species at Risk Public Registry 2025). Blue Felt Lichen is listed as Vulnerable in Newfoundland and Labrador (Newfoundland and Labrador 2015).

Table 1. NatureServe conservation status ranks for the Blue Felt Lichen in Canada (NatureServe 2025; CESCC 2022)*.

Global (G) Rank[a]	National (N) Rank[b]	Subnational (S) Rank[c]
G4G5 (last reviewed 2024)	N3 (last reviewed 2023)	S3 (last reviewed 2022)

[a] G-Rank – Global Conservation Status Rank, G1 = Critically Imperiled; G2 = Imperiled; G3 = Vulnerable; G4 = Apparently Secure; G5 = Secure
[b] N-Rank – Provide ranking for each province the species is found in. National Conservation Status Rank, N1 = Critically Imperiled; N2 = Imperiled; N3 = Vulnerable; N4 = Apparently Secure; N5 = Secure
[c] S-Rank – Sub-national (provincial or territorial) ranks, S1 = Critically Imperiled; S2 = Imperiled; S3 = Vulnerable; S4 = Apparently Secure; and S5 = Secure. B = breeding; and U = Unrankable.
*A full list of definitions can be found in Definitions of NatureServe Conservation Status Rankings at http://help.natureserve.org/biotics/Content/Record_Management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm

3. SPECIES INFORMATION

3.1. Species Description

Blue Felt Lichen is a large, blue-grey leafy lichen. It has a scallop-like shape, with crescent shaped curves and longitudinal ridges on the upper surface. The main body (thallus) sits on top of a thick, beard-like blue-black fungal mat that often protrudes beyond the margin. Fruiting bodies are often present and consist of red-brown buttons that darken with age. Blue Felt Lichen thalli can grow up to ten centimetres in diameter. In Nova Scotia it primarily grows on old deciduous trees, but it has been found on moss-covered rock once (COSEWIC 2010). It is a long-lived species with generation lengths estimated to be around 20 years (COSEWIC 2010; see Yahr et al. 2024 for additional definitions and examples).

3.2. Population and Distribution

3.2.1. Global Distribution

Blue Felt Lichen occurs near the Atlantic Ocean, the Mediterranean Sea, the Baltic Sea and the Black Sea in North America, Europe and Africa. It occurs across Europe from the Azores, the Canary Islands, Madeira, the British Isles, Scandinavia, the Iberian Peninsula, in and around the Mediterranean and as far east as Turkey, Ukraine and Georgia. In northern Africa it is known from Tunisia, Algeria and Morocco. In North America it is known from the United States and Canada (ECCC 2022).

Within the United States, Blue Felt Lichen is known from only two, near-coastal, locations in Maine – Mount Desert Island and near Cobscook Bay State Park. Despite

searches on some nearby islands no additional locations have been found (ECCC 2022).

3.2.2. Canadian Range

It is estimated that more than 99.9% of North America's population occurs in Canada (ECCC 2022). Within Canada, Blue Felt Lichen is known only from Atlantic Canada. As of 2021, there were an estimated 5,000 thalli spanning 1,147 known host trees comprising 425 sites (i.e., clusters of host trees separated by 1 km, as per ECCC 2022) spanning New Brunswick, Prince Edward Island, Newfoundland and Nova Scotia (S. Haughian pers. comm. Jan 2025; Figure 1). Since 2021, approximately 983 new records have been reported, including records from the Atlantic Canada Conservation Data Centre (AC CDC 2025), iNaturalist (2025) and amateur and professional lichen surveyors (Harold Clapp, Brad Toms - Mersey Tobeatic Research Institute, Alain Belliveau - E.C. Smith Herbarium, James Churchill - Lobaria Consulting; pers. comm. Jan 2025). More than 50 different observers have contributed Blue Felt Lichen occurrence records (B. Toms pers. comm. Jan 2025).

Approximately 13 sites (95 individual trees) are known from New Brunswick where the species occurs only in nearshore areas of the Bay of Fundy and on the island of Grand Manan.

Despite considerable search effort for rare and at-risk lichen species on Prince Edward Island (Troy McMullin and the AC CDC) there are only two known sites (comprising one occupied tree each) of Blue Felt Lichen, both within the Miscouche Swamp. The first site was discovered in 2020 (Colin Chapman-Lam, Chapman-Lam et al. 2021) and the second site was discovered in 2024 (Iain Crowell, AC CDC 2025).

Approximately 30 sites (314 individual trees) are known in Newfoundland from five major areas: the Avalon Peninsula, Terra Nova National Park, south of Gander Lake, Conne River and near South Branch.

To estimate the probability of occurrence across the Blue Felt Lichen's range, a MaxEnt Species Distribution Model (SDM) was generated using observations available as of 2021 (Haughian 2021; Figure 2). The initial model included 23 climatic variables (ClimateNA; based on 1981 to 2010 climate normals), seven tree-species composition variables (National Forest Inventory), two hydrology variables (National Hydrographic Network) and a road density variable (National Road Network; Haughian 2021). Model selection was carried out using backwards stepwise selection from an initial model containing all variables. The final model included 6 variables and had a mean training AUC (Area Under the Curve) of 0.800 (±0.005) and a mean test AUC of 0.767 (±0.048). The variables *Degree days below zero* and *climatic moisture deficit* were of high importance in the model, *annual heat-moisture index* and *mean summer precipitation* were of moderate importance and *prevalence of balsam fir* and *local road density* were

of lowest importance. The model showed the probability of occurrence to be highest in near-coastal areas of Atlantic Canada predominantly in southwest Nova Scotia, and along the Atlantic Coast of Nova Scotia and Newfoundland. Areas of moderate probability of occurrence include central Nova Scotia, western Cape Breton, southwest coastal New Brunswick, the Acadian Peninsula in New Brunswick and central Newfoundland. New occurrences found since 2021 likely would not greatly influence the broadscale patterns of the predictive surface given most new Blue Felt Lichen were found near previously known occurrences, or in areas the SDM already predicts to have high probability of occurrence (S. Haughian pers. comm Jan 2025).

Probability of occurrence in Atlantic Canada was also projected across three time periods (2025, 2055, 2085) under two different Representative Concentration Pathways (RCP 4.5 – a moderate greenhouse gas emissions scenario and RCP 8.5 – a high greenhouse gas emissions scenario; Haughian 2021). Projections generally suggest a northeastern shift in the probability of occurrence in the region over time. Probability of occurrence is projected to increase in Cape Breton and Newfoundland over this period, with areas of moderate or high probability of occurrence being almost entirely constrained to Guysborough County, Cape Breton Island and Newfoundland by 2085 under RCP 8.5.

3.2.3. Nova Scotia Range

The vast majority of Canada's Blue Felt Lichen records are from Nova Scotia. As of 2021, over 2,600 thalli had been recorded from 467 sites (ECCC 2022). Since 2021, approximately 983 new Blue Felt Lichen records have been reported. The species occurs in all 17 counties and is most frequently reported within 30 km of the Atlantic, Fundy, Northumberland or Bras d'Or Lake coasts. Approximately 62% of all records are from three regions: near Shelburne (799 trees), near Digby (460 trees) and on Marble Mountain Cape Breton (616 trees). It is rarely reported from Cumberland (apart from in, and near, Cape Chignecto Provincial Park), Colchester, Pictou, Antigonish, Hants and Kings counties and from the interior of mainland Nova Scotia. Approximately 80% of records submitted since 2021 occur in the Bras d'Or Lake Watershed of Cape Breton and in Shelburne and Digby Counties; high counts at these sites are likely the result of both high Blue Felt Lichen abundance and high search effort.

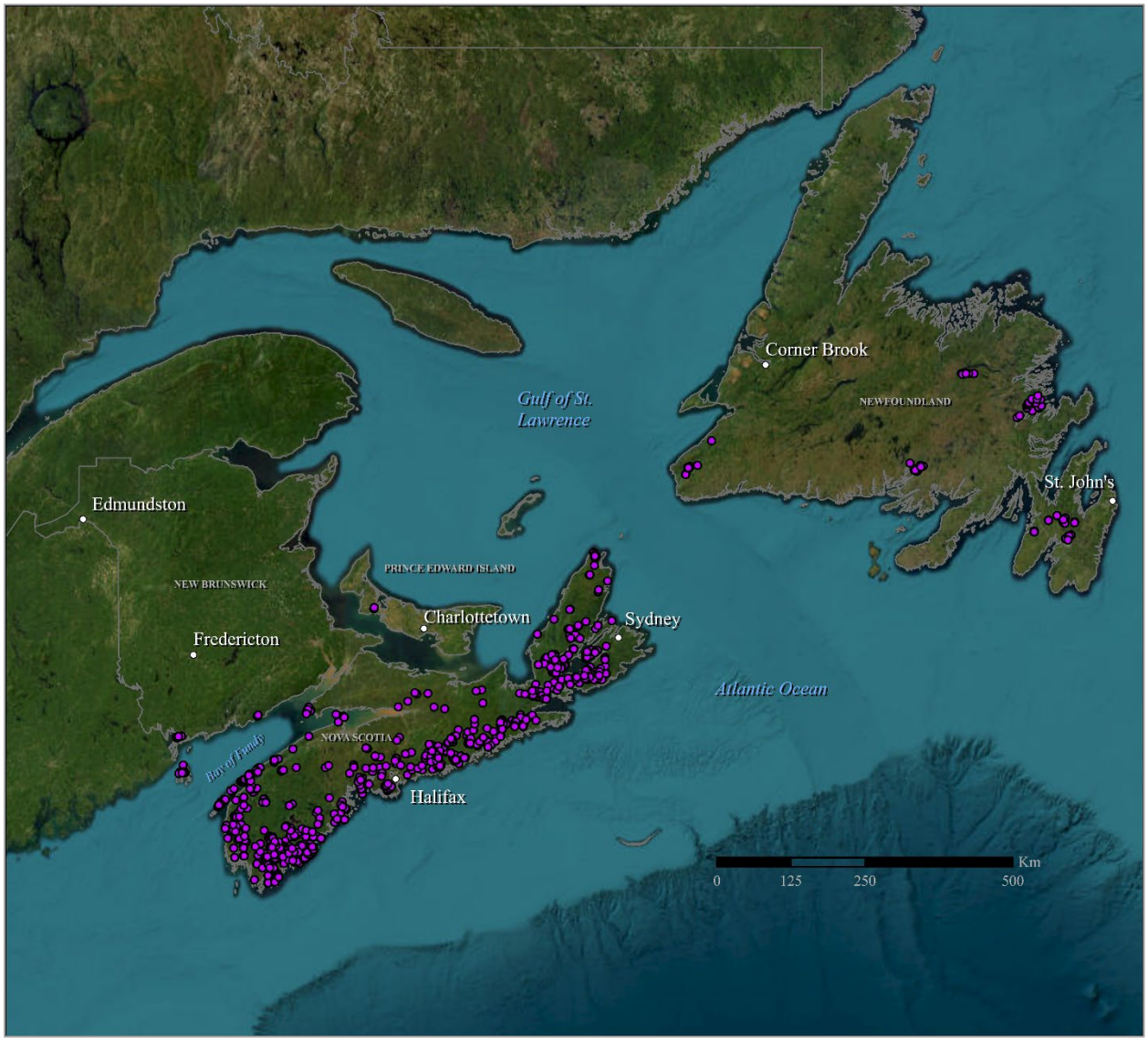

Figure 1. Known occurrences of Blue Felt Lichen in Atlantic Canada (as of February 2025).

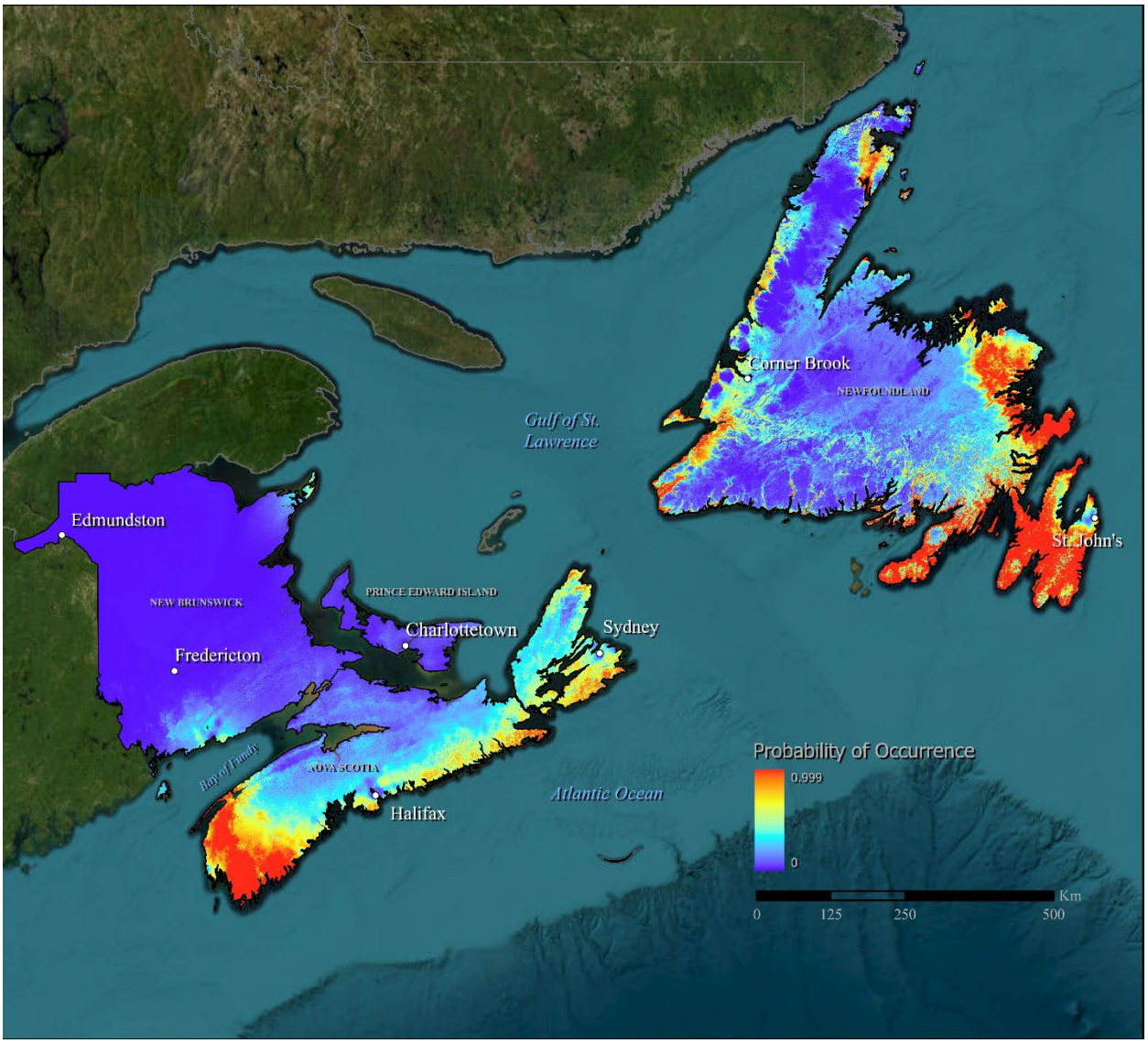

Figure 2. Blue Felt Lichen Species Distribution Model (SDM) generated from occurrence data up to 2021 (Haughian 2021). Probability of occurrence is shown using a 2 standard deviation stretch and ranges from 0-0.999. See text for more-detailed methods.

Population Size and Trends

Using occurrence data up to 2021, the number of thalli and the number of host trees of Blue Felt Lichen were estimated based on the relationship between probability of occurrence (from the SDM) and the mean number of observed thalli/trees corrected for the amount of old hardwood habitat or forested wetland habitat in each province (Haughian 2021). The total Canadian population was estimated to be 8,580 ± 1,847 thalli across 2,633 ± 709 host trees. Using an estimated ratio of adult to juvenile thalli in the population (3.5:1), the estimated population of mature thalli was 6,673 ± 1,319. For

Nova Scotia, population size was estimated to be 3,051 thalli on 1,182 host trees across 357 sites (S. Haughian pers. comm. Jan 2025).

A population trend analysis was conducted using change in count data from a small number of repeatedly visited sites and by assessing loss of occurrences through forest removal in the 10 years prior to 2021 (using satellite imagery and the Global Forest Watch Tree Cover Loss dataset; Hansen et al. 2013). Trend analysis revealed small, short-term, population increases inside protected areas and small, short-term, population declines outside of protected areas. These short-term Blue Felt Lichen losses were projected over a three-generation time period (60 years) using the IUCN population reduction calculator. Over this time period it was projected that there would be a loss of 26.8% of thalli and a loss of 21.5% of host trees (S. Haughian, pers. comm. Jan 2025). It is expected that new reports of Blue Felt Lichen (since 2021) would not significantly impact population or trend estimates as the majority of host trees found occur near previously known occurrences or in areas the SDM already predicts to have high probability of occurrence (S. Haughian pers. comm. Jan 2025).

3.3. Species Needs

Biotic and abiotic habitat requirements of the Blue Felt Lichen are summarized here. For more-detailed needs of the Blue Felt Lichen refer to COSEWIC (2010) and Environment and Climate Change Canada (2022). Habitat and climate/environmental requirements include:

- Macro- and micro-climates with high rainfall throughout the year, cool summers and moderate winters
- Large amounts of moisture through cloud, fog and rain (often in excess of 1200 mm annually)
- Topographic and land cover features that trap moisture such as valleys, gullies, wetlands, streams, vernal pools, seeps, lakes, bays and inlets.
- Hardwood or mixed-wood forests characterized by:
    - Increased light levels in winter and shade during summer
    - Mature or over-mature, coarse-barked trees
    - Multiple successional stages that can allow Blue Felt Lichen to disperse and colonize new trees when stands become too dense or host trees fall
    - Minimal anthropogenic edge which can negatively impact survival and recruitment through drying, altered light regimes and increased windfall
- Areas relatively free from air pollution and acid rain (especially sulphur dioxide and nitrogen oxides)
    - Continued and significant exposure to acidified air and precipitation can lead to unfavourable host tree bark pH and negatively impact colonization and thallus survival (especially young thalli).
- A source of suitable strains of *Nostoc* cyanobacteria in the environment.

There is evidence that habitats in Nova Scotia are recovering from acidification, or that it may no longer be an issue. Haughian and Harper (2025 in review) examined trees in several swamps and found bark pH was typically between 5.0–6.5, above the levels that start negatively impacting cyanolichens.

4. THREATS

4.1. Threat Assessment

The Blue Felt Lichen threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threat classification system (IUCN 2012) and uses the provisional COSEWIC threat assessment (S. Haughian pers. comm. Jan. 2025). Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (in this case, the province of Nova Scotia). Limiting factors are not considered during this assessment process. For purposes of the threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in Section 4.2 *Description of Threats*.

Table 2**.** Threat calculator assessment.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
1	Residential & commercial development	Low	Small	Extreme	High	
1.1	Housing & urban areas	Low	Small	Extreme	High	Ongoing residential development.
1.2	Commercial & industrial areas					Not applicable
1.3	Tourism & recreation areas					Not applicable
2	Agriculture & aquaculture					
2.1	Annual & perennial non-timber crops					Not applicable
2.2	Wood & pulp plantations					Not applicable
2.3	Livestock farming & ranching					Not applicable

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
2.4	Marine & freshwater aquaculture					Not applicable
3	Energy production & mining	Low	Small	Extreme	High	
3.1	Oil & gas drilling					Not applicable at present but would present some threat if the ban on fracking is lifted.
3.2	Mining & quarrying	Low	Small	Extreme	High	The draft threats assessment determined this threat to be low across Blue Felt Lichen's Canadian range based on the small scope of known projects. However, the scope for Nova Scotia may be medium given recent emphasis on resource extraction from the House and focus maps that overlap with >10% of the known provincial population. Goldboro gold mine expansion is expected to impact >200 thalli.
3.3	Renewable energy	Negligible	Negligible	Extreme	Moderate	Wind farm construction, resulting in deforestation and increased edge effects within and adjacent to project footprint. Associated roads assessed under 4.1, biomass harvesting assessed under 5.3.
4	Transportation & service corridors	Low	Small	Moderate	High	
4.1	Roads & railroads	Low	Small	Moderate	High	New roads and expansion of existing roads; edge effects and effects on hydrology.
4.2	Utility & service lines	Low	Small	Moderate	High	Not applicable
4.3	Shipping lanes					Not applicable

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
4.4	Flight paths					Not applicable
5	Biological resource use	High	Large	Serious	High	
5.1	Hunting & collecting terrestrial animals					Not applicable
5.2	Gathering terrestrial plants					Not applicable
5.3	Logging & wood harvesting	High	Large	Serious	High	May remove occupied host trees or reduce the number of trees available for colonization. ECCC (2022) speculated that harvesting may increasingly occur on private lands due to a shortage of supply and adoption of the SMP on Crown lands. Approximately 72% of known host trees are on private land (S. Haughian pers. comm. 2025).
5.4	Fishing & harvesting aquatic resources					
6	Human intrusions & disturbance					
6.1	Recreational activities					
6.2	War, civil unrest, & military exercises					
6.3	Work & other activities					

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
7	Natural system modifications					
7.1	Fire & fire suppression	Low	Small	Serious	Moderate	The recent Shelburne fire (2023) led to habitat loss and reduction in habitat quality. Nine of the 17 host trees within the fire's footprint were lost. Drier conditions caused by future climate warming are expected to increase frequency of fires and the extent of the landscape that is susceptible to burning (Taylor and MacLean 2024). Although mostly outside the wildfire footprint, additional Blue Felt Lichen are expected to be directly or indirectly (via air pollution from smoke) impacted by the 2025 Long Lake Complex Wildfire.
7.2	Dams & water management/use					
7.3	Other ecosystem modifications					
8	Invasive & other problematic species, genes & diseases	Low	Small	Moderate	High	
8.1	Invasive non-native/alien species/diseases	Low	Small	Moderate	High	Browse from invasive slugs, although less impacted than other at-risk lichen species.
8.2	Problematic native species					
8.3	Introduced genetic material					
8.4	Problematic species/diseases of unknown origin					
8.5	Viral/prion-induced diseases					

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
8.6	Diseases of unknown cause					
9	Pollution	Low	Large	Slight	High	
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	Low	Large	Slight	High	Cyanolichens are extremely sensitive to air pollution and acid precipitation. Acid precipitation may overcome the buffering capacity of host tree's bark making it unsuitable for colonization by cyanolichens or for the growth of the cyanobacterium which must be present for the fungal spores to associate with in each generation to form a new thallus. Recent evidence suggests that habitats in Nova Scotia are recovering from acidification, or that it may no longer be an issue (Haughian and Harper 2025 in review). Lichens in the path of wildfire smoke may be susceptible to loss.
9.6	Excess energy					
10	Geological events					
10.1	Volcanoes					
10.2	Earthquakes/tsunamis					

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
10.3	Avalanches/landslides					
11	Climate change & severe weather	Medium -- Low	Pervasive	Serious - Slight	High	
11.1	Habitat shifting & alteration	Medium – Low	Pervasive	Serious - slight	High	By the 2080s, under a moderate emissions scenario (RCP 4.5), habitat suitability will decline in southwest Nova Scotia and shift to the northeast; under a high emissions scenario (RCP 8.5), habitat is projected to be unsuitable in all areas of the province except for Cape Breton and parts of Guysborough County.
11.2	Droughts					
11.3	Temperature extremes					
11.4	Storms & flooding	Low	Small	Extreme	High	Increasing storm frequency will increase the frequency and intensity of windthrow, leading to loss of host trees. Microclimate changes (e.g., drier conditions) are also expected.
12	Other options					
12.1	Other threat					

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g.,, if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g.,, timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11-30%; Small = 1-10%; Negligible < 1%).

[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11-30%; Slight = 1-10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2. Description of Threats

Biological resource use – Logging & wood harvesting (High)

Blue Felt Lichen and its habitat are often threatened by tree harvesting. Logging can result in direct loss of trees hosting the species; this has been observed or inferred through satellite imagery interpretation at several locations within Nova Scotia (Toms 2021; S. Haughian pers. comm. Jan 2025). Forestry also produces significant changes to microclimate through edge effects. Creation of forest edges can increase wind and drying effects, alter light levels, increase local temperatures, and increase the incidence of tree blowdown (Aragón *et al.* 2010; Cameron 2006; Cameron *et al*. 2013; Harper *et al*. 2005). Young Blue Felt Lichen thalli are especially sensitive to these changes, making it more difficult for existing occurrences to persist or for successful colonization to occur (COSEWIC 2010). Cyanolichen growth and abundance can be suppressed at distances of 80–120 m from clearcut edges (Gauslaa et al. 2018; Haughian and Harper 2018). If forestry cutting cycles are too short, this can reduce the amount of old forest leading to a reduction in suitable habitat in the landscape.

Climate change and severe weather – Storms and flooding (Medium-Low)

Extreme wind events may cause the direct loss of trees colonized by Blue Felt Lichen or create more edge habitat and associated microclimate changes (discussed above). Forest edges are particularly vulnerable to this threat, exacerbating changes adjacent to Blue Felt Lichen occurrences caused by tree harvesting and other anthropogenic disruptions. Windthrow has led to the loss of Blue Felt Lichen host trees in New Brunswick (COSEWIC 2010) and the loss of other rare cyanolichen occurrences in Nova Scotia and Newfoundland (ECCC 2022).

Residential and commercial development - Housing and urban areas (Low)

Residential land development creates local and landscape alterations, permanently removes habitat, and affects the microclimates of nearby forests. Ongoing expansion of housing and cottages in Nova Scotia is considered to have a low impact on Blue Felt Lichen.

Energy production and mining – Mining and quarrying (Low federally, possibly Medium in NS)

Mining and quarrying can cause direct loss of trees hosting Blue Felt Lichen or indirectly harm them through adjacent land clearing and subsequent edge effects. Recent expansions and new projects in Nova Scotia have impacted some Blue Felt Lichen occurrences, but the overall impact has been assessed as Low in the threats assessment. Future mining may present an increased impact to the Nova Scotia population, and impact level may be Medium. There has been recent emphasis on promoting resource extraction projects in the House, and resource extraction focus maps in Digby and Yarmouth Counties overlap with approximately >10% of the known provincial population (B. Toms pers. comm. Mar. 2025).

Environmental assessments are required before some projects begin. For example, three Blue Felt Lichen host trees were discovered in the footprint of the Touquoy Gold project (COSEWIC 2010), with two of them lost to expansion (S. Haughian pers. comm. Jan 2025). Over 200 thalli are also threatened by a mine in Goldboro that has been approved for development (McCallum Environmental Ltd. 2022). Some direct loss of trees and reduction in habitat quality could also result from mining and quarrying undertakings that do not trigger environmental assessment (e.g., pits and quarries smaller than 4 ha in size; Government of Nova Scotia 2022).

Transportation and service corridors – Roads and railroads (Low)

Construction and expansion of roads usually involve tree removal, reducing the number of trees available to be colonized. It can also affect the microclimate of adjacent or nearby forests by concentrating water flow and diverting natural water drainage systems (Cameron 2006). This can change the moisture regimes in nearby wetlands making them less suitable for lichens such as Blue Felt Lichen that require high humidity. One Blue Felt Lichen thallus was translocated to avoid the impacts of a highway expansion project near Wellington, NS (see Section 6.1 *Actions Completed or Underway*). New roads provide access to previously remote areas that could facilitate the expansion of development in cottage country (COSEWIC 2002). Vehicular traffic on new roads can also introduce dust and local sources of airborne pollutants (see *Pollution – Air-borne pollutants*).

Invasive and other problematic species and genes – Invasive non-native/alien species (Low)

Grazing from gastropods is a threat to several rare lichens in Atlantic Canada, including Blue Felt Lichen. Two European slugs (*Arion subfuscus* and *Deroceras reticulatum*) have been found feeding on several rare cyanolichens in Nova Scotia, including the Boreal Felt Lichen (*Erioderma pedicellatum*) and White-rimmed Shingle Lichen (*Fuscopannaria leucosticta*) (Cameron 2009; COSEWIC 2014; COSEWIC 2019). Climate change has led to favourable conditions for gastropods and increased grazing on lichens reportedly contributing to the extirpation of Yellow Specklebelly Lichen (*Pseudocyphellaria crocata*) in southwest Norway (Gauslaa 2008). However, the impact of grazing gastropods on Blue Felt Lichen populations in Nova Scotia has not yet been studied. Anecdotally, grazing appears to be less common on Blue Felt Lichen than on Boreal Felt Lichen (COSEWIC 2010).

Pollution – Air-borne pollutants (Low)

Cyanolichens are particularly sensitive to air pollution and acid precipitation (Cameron and Richardson 2006; Henderson 2000). Acid rain and emissions of sulphur dioxide and nitrogen oxides can acidify tree bark over time. These conditions can then interfere with nitrogen fixation and nutrient uptake, hindering lichen growth and establishment (Bertuzzi and Tretiach 2013; Nieboer et al. 1984; Maass 1999).

Climate change and severe weather – Habitat shifting and alteration (Low)

The general climate change trends for Atlantic Canada include warmer weather and increased precipitation (Vincent et al. 2018), with many species expected to shift their ranges northwards (Vasseur and Catto 2008). A national SDM for Blue Felt Lichen (Haughian 2021) projected the areas of habitat suitability for Blue Felt Lichen in Nova Scotia will shift northward in the long-term (within 60 years or 3 generations). The degree of habitat shifting and alteration will depend on the levels of emissions reductions achieved. If greenhouse gas emissions peak in the 2050s, much of Nova Scotia will continue to have a suitable climate for Blue Felt Lichen. With no reductions in emissions, habitat suitability will decline dramatically across the province, with only parts of Cape Breton remaining suitable. Successful dispersal into, and occupation of new areas, of the province depends on species needs being met in these new locations (see above; e.g., suitable host trees, moisture regimes, and suitable photobionts).

Natural system modifications – Fire and fire suppression (Low)

Increases in the length and severity of summer drought is expected to increase the risk and severity of fires in Nova Scotia (COSEWIC 2021). The largest wildfire in Nova Scotia's recorded history occurred in Shelburne County in 2023 which resulted in the destruction of about 50% of Blue Felt Lichen occurrences in the fire footprint (B. Toms, pers. comm. Jan 2025). Lichens that survived the fire appeared to be in areas with higher local moisture than those that were destroyed (B. Toms pers. comm. Jan 2025).

5. MANAGEMENT OBJECTIVE(S)

The following are management objectives for Blue Felt Lichen

1. Maintain Index of Area of Occupancy from 2025 in the short-term (5 years)
2. Long-term (20 years) decline in the number of host trees limited to <10% (COSEWIC criterion C1 threshold for Threatened)
3. Maintain or increase the number of host trees in priority sites in the long-term (20 years)
4. Maintain Extent of Occurrence from 2025 in the long-term (20 years)

Rationale

Blue Felt Lichen is widespread in Nova Scotia, with more than 467 sites distributed across much of the province (see Section 3.2 *Population and Distribution*). It may not be feasible to maintain the entire size and distribution of the population as its primary threats are ongoing (see Section 4 *Threats*). Management should prioritize sites that have outsized significance in the long-term persistence of Blue Felt Lichen in Nova

Scotia. Determining such priority sites is a recommended management action (Section 6.2 and 6.3). In the meantime, a precautionary approach to preserving the population should be implemented in the short-term (five years). Maintaining Blue Felt Lichen's Index of Area of Occupancy[1] (IAO) at 2025 levels would help preserve its diversity and extent in Nova Scotia while providing time to determine all priority sites for conservation (management objective 1).

Under COSEWIC Criterion C, a wildlife species may be designated at-risk if it has a small and declining number of individuals (COSEWIC 2025). When dealing with tree-dwelling lichens, host trees are the recommended stand-in for individual because of the nature of the threats acting against them (functional individuals, Yahr et al. 2024). There is a small and declining number of mature Blue Felt Lichen host trees in Canada, but there is insufficient certainty in projected rates of decline to meet COSEWIC criteria for a Threatened species (S. Haughian pers. comm. Jan 2025). As of 2021, a total of 1,182 host trees (supporting 3,051 extant thalli) are estimated to occur in Nova Scotia (S. Haughian pers. comm. Jan 2025), and its total size is projected to be well within the COSEWIC threshold for a small population (<10,000 mature individuals under Criterion C). As such, it is likely that Blue Felt Lichen will remain at least Vulnerable while recognized threats persist in Nova Scotia. Management objectives should then focus on keeping Blue Felt Lichen from becoming Threatened by mitigating threats and limiting declines as much as possible (i.e., <10% decline in the total number of host trees in the long-term, Criterion C1; management objective 2).

Priority sites, as mentioned above, should be those that have an outsized role in the persistence of Blue Felt Lichen in Nova Scotia. These should be determined by the recovery team based on several considerations (see Sections 6.2 and 6.3). Management actions should aim to maintain or increase the number of functional individuals (host trees) at these sites in the long-term (20 years; management objective 3) because they will have the most influence on the overall population trend.

It is unlikely that Blue Felt Lichen's current IAO can be maintained in the long-term (20 years). Declines have been observed, and are projected, for Blue Felt Lichen sites that are not within protected areas (S. Haughian pers. comm. Jan 2025), and any sites (or IAO grid squares) with few individuals are intrinsically vulnerable to extirpation. However, maintaining Blue Felt Lichen's Extent of Occurrence[2] (EOO) in the long-term (management objective 4) is a coarser approach that can still help preserve the ecogeographic diversity of occupied sites and any potential local adaptations the species might have acquired throughout its range in Nova Scotia.

[1] The area occupied by the species, generalized to a 2 x 2 km grid.

[2] The overall range or distribution of the species.

6. GENERAL APPROACHES TO MANAGEMENT

6.1. Actions Completed or Underway

Many lichen surveys in Nova Scotia have focused on species at risk, from Wolfgang Maass' extensive work between the 1970s and early 2000s, to several ongoing monitoring and inventory initiatives. Targeted survey effort for Blue Felt Lichen has increased since being designated as a federal species at risk in 2010 (see previously discussed efforts in COSEWIC 2010). The following list is not exhaustive but is meant to highlight recent efforts and includes initiatives which either directly or indirectly benefit Blue Felt Lichen:

- Recent survey and monitoring efforts:
    - Ongoing species at risk lichen inventories continue to improve and support our understanding of Blue Felt Lichen's distribution, populations, and threats. Organizations and individuals involved in surveys and monitoring include both Community-Nominated Priority Places in Nova Scotia (Maliamu'kik Msit Ko'kqmanaq / Taking care of all our relations and Sikniktewaq / Chignecto Isthmus), Atlantic Canada Conservation Data Centre, Acadia University (Alain Belliveau), Canadian Parks and Wilderness Society (CPAWS), Mersey Tobeatic Research Institute (MTRI), Municipality of the District of Digby, NS Museum, NS Department of Natural Resources, and many citizen scientists.
    - MTRI has been conducting dedicated monitoring efforts noting survivorship, slug grazing, and necrosis (B. Toms pers. comm. Jan 2025). Brad Toms has also re-visited Blue Felt Lichen occurrences that were within the footprint of the 2023 Shelburne fire.
- The Nova Scotia Department of Natural Resources (2018) released updated Special Management Practices (SMP) for At-Risk Lichens on Crown lands. The SMP is primarily crafted around Boreal Felt Lichen (*Erioderma pedicellatum*) but also includes specific guidance for activities occurring near Blue Felt Lichen occurrences. The SMP outlines that no forest harvesting, mineral exploration, or road construction may be conducted within 100 metres of Blue Felt Lichen host trees, with some minor exceptions.
- Other recent policy changes around forestry on Crown lands are expected to benefit Blue Felt Lichen, including:
    - The updated Old-Growth Forest Policy (NS DNRR 2022) may provide some measure of protection given the species is often found in mature to old-growth forest and forested wetlands.
    - Recent changes to the Silvicultural Guide for the Ecological Matrix (SGEM; NS DLF 2021) state that no harvesting is permitted in forested wetlands on Crown land. Guidelines such as these must be followed for

lumber to be certified, and anecdotal evidence suggests the SGEM has made a positive difference (B. Toms pers. comm. 2025).

- Protected Areas and other similar initiatives have contributed extensively to species at risk conservation in recent years:
    - The province of Nova Scotia has set increasing targets for Protected Areas, first with its Parks and Protected Areas Plan (Province of Nova Scotia 2013) and most recently with the Collaborative Protected Areas Strategy (NS ECC 2023). The province has designated new Protected Areas and expanded existing Protected Areas, many of which encompass some Blue Felt Lichen occurrences. Species at risk lichens, including Blue Felt Lichen, are considered in plans for selecting new Protected Areas (J. Gallop pers. comm. Jan 2025).
    - Several Indigenous Protected and Conserved Areas (IPCAs) have been established or are under development in Nova Scotia (including the Eskasoni Hills IPCA), which also have potential to benefit Blue Felt Lichen.
    - CPAWS and MTRI have also been advocating for protection of special sites and pending Protected Areas based on conservation priorities including the presence of species at risk lichens (C. Miller, F. Brooks pers. comms. Jan 2025).
    - Key Biodiversity Areas (KBAs) are a tool for identifying sites that contribute to the persistence of biodiversity and although designation provides no specific management or regulation it can be used to inform protected area and land use planning, stewardship, biodiversity monitoring, and regulatory approaches to conservation. Blue Felt Lichen was initially considered unlikely to meet KBA thresholds at a given site but is now being assessed based on new information received in January 2025. Blue Felt Lichen is found within 16 KBAs in NS that were designated and proposed for other species, including the cyanolichen hotspot from Middle Ohio to Port Joli (KBA Canada Secretariat 2025).
    - The Kespukwitk Conservation Collaborative is a collaborative partnership of Mi’kmaq First Nations, Indigenous organizations, non-government organizations, academic institutions, and federal and provincial government departments. Established in October 2017, the collaborative is working to conserve species at risk and biodiversity in the Kespukwitk/Southwest Nova Scotia Priority Place. One of their conservation targets is forested wetlands, which explicitly includes species at risk such as Blue Felt Lichen (Kespukwitk Conservation Collaborative 2025).
    - Multiple organizations in Nova Scotia have completed, or are completing, conservation prioritization strategies that help prioritize land in Nova Scotia for conservation efforts such as stewardship, protection or land securement. In these strategies, conservation value is influenced by the presence of species at risk or their habitat, including Blue Felt Lichen.

Organizations include the Southwest Nova Biosphere Reserve Association, Nature Conservancy of Canada, Nova Scotia Nature Trust, CPAWS and NS DNR.

- MTRI has been involved in extensive outreach actions from 2008 – present (B. Toms pers. comm. Jan 2025). Examples include in-person and virtual identification workshops with woodlot owners, NS Regional Biologists, Integrated Resource Management (IRM) staff, industry, pulp mill staff, and foresters. They have also created and distributed posters, species at risk guides, and ID cards. MTRI is also piloting a program, incentivizing private woodlot owners to maintain SAR habitat on their properties. At present, this includes two landowners with Blue Felt Lichen in their woodlots (B. Toms pers. comm. 2025).
- Several research projects have been underway in recent years:
    - Dr. Sean Haughian (Nova Scotia Museum) created a national species distribution model to support the COSEWIC status update for Blue Felt Lichen (Haughian 2021; see Section 3.2 *Population and Distribution*). The model is helpful for estimating the probability of occurrence of Blue Felt Lichen across the region, and determining population and trend estimates, but it is at too coarse of a spatial resolution to support fine-scale decision-making at the forest stand level (S. Haughian, pers. comm. Jan 2025).
    - One Blue Felt Lichen thallus was translocated to avoid the impacts of a transportation project near Wellington in 2021 (J. Gallop pers. comm. Jan 2025). Translocation has also been proposed for over 200 thalli in the footprint of a gold mine expansion near Goldboro, NS (McCallum Environmental Ltd. 2022). The effectiveness of Blue Felt Lichen translocation remains largely untested, and its long-term success is uncertain.
- A Multi-species Action Plan was developed for Kejimkujik National Park and National Historic Site (KNP & NHS) of Canada by the Parks Canada Agency (2017). No population and distribution objectives were set for KNP & NHS, but they noted their intention to continue to protect and maintain habitat and to assess threats. Conservation and recovery measures for species at risk lichens (including Blue Felt Lichen) focused on completing inventory work to refine population size and distribution information at Kejimkujik Seaside Adjunct. This work was considered complete after 157 search hours were completed in December 2018 (Parks Canada Agency 2022).
- Other recovery documents for cyanolichens in Atlantic Canada (e.g., ECCC 2018, EC 2011, EC 2010) may be consulted for additional completed, ongoing, or proposed actions that are relevant to Blue Felt Lichen (e.g., gathering data on airborne pollutants).

6.2. Recommended Management Actions

Table 3. Management actions and implementation schedule in support of objectives.

Management Actions	Threat(s) Addressed*	Priority**	Timeline
Habitat Protection, Monitoring, and Stewardship			
Establish protected areas or other effective conservation measures for Blue Felt Lichen and its habitat, especially for priority sites deemed critical for its persistence and for meeting management objectives (see Research and Knowledge Gaps below).	All	High	2030
Surveys and Monitoring			
Determine and pursue inventory survey priorities. E.g., complete censuses of most significant sites (see *Research and Knowledge Gaps* below); and add dedicated search effort in under-surveyed northern NS counties (Cumberland, Colchester, Pictou, and Antigonish).	All	High	2028
Continue existing monitoring programs. Continue monitoring existing translocation project.	All	High	Ongoing
Communication, Outreach, and Education			
Encourage protection in private woodlots through education and/or outreach with woodlot owners' associations.	5.3	Medium	2025-2030
Continue existing outreach and education programs as feasible.	All	Medium	Ongoing
Law, Policy, and Enforcement			
Include proximity to known Blue Felt Lichen locations and/or predicted habitat (see Research and Knowledge Gaps) as a trigger for surveys under the At-Risk lichen SMP.	3.2, 4.1, 5.3	High	2026
Create a working group to discuss best practices and circumstances under which translocation could be considered.		High	2026
Consider restoring Wetland of Special Significance designation for wetlands with Blue Felt Lichen.		High	2026
Improve monitoring for, and enforcement of, infractions to legislation and policies that protect Blue Felt Lichen and its habitat.		High	ongoing
Improve protections for old-growth forest (e.g., Old-Growth Forest Policy).		High	ongoing
Research to Address Knowledge Gaps			
Develop and implement framework to determine priority sites for conservation i.e., those that are most critical for the persistence of Blue Felt Lichen in NS. Criteria to consider include geographic representation, genetic diversity, size, habitat resilience to climate change, and ecological connectivity.	All	High	2025-2030
Research colonization and recruitment rates to determine if/how these can offset population decrease.	All	Medium	2025-2030
Create a fine-scale predictive habitat model to support surveys and decision-making.	All	Medium	2027
Research knowledge gaps such as lichen herbivory and photobiont source.	Knowledge gaps	Medium	2025-2030
Consider researching the delimitation of subpopulations (as defined by IUCN 2022) to support conservation planning.	Knowledge gaps	Low	2026

*Threat or Limitation should refer to the IUCN Threat Classification Table Rankings. Either the first level or second level threat ranking can be used depending on how the Broad Strategy affects the threat. Multiple threats can be addressed under a single Recovery Measure.
**Priority should be classified as High(H), Medium(M), or Low(L). "Priority" is a qualitative measure of the relative degree to which an approach will have a positive impact on the recovery objective. High priority conservation approaches are considered those most likely to have an immediate and/or direct influence on reaching the management objective for the species. Medium priority conservation approaches may have a less immediate or less direct influence on reaching the management objective but are still considered important measures to implement. Low priority conservation approaches will likely have an indirect or gradual influence on reaching the management objective and are more tied to increasing knowledge or public perception/education.

6.3. Narrative to Support the Management Actions Table

Habitat Protection, Management and Stewardship

Existing data show that Blue Felt Lichen populations within Protected Areas have increased slightly and they are projected to continue to do so in the future (S. Haughian pers. comm. Jan 2025). This highlights the important role that habitat protection will play in meeting the management objectives. On public lands, the Government of Nova Scotia is already considering the presence of species at risk including Blue Felt Lichen when determining where to establish new protected areas or to expand existing ones (see Section 6.1 *Actions Completed or Underway*). Priority sites for Blue Felt Lichen should be determined (see Research to Address Knowledge Gaps) and weighed in decision-making about new protected areas. Additional protection in the areas surrounding Blue Felt Lichen occurrences would also help preserve habitat integrity and microclimate and promote habitat connectivity (see Section 4.2 *Description of Threats*).

On private lands, land trusts can be encouraged to take action to conserve priority sites for Blue Felt Lichen. Strategies can include purchasing land for conservation, arranging for conservation easements, or engaging with landowners for stewardship (see also Communication, Outreach and Education).

Surveys and Monitoring

Although there has been some dedicated survey work for Blue Felt Lichen in Nova Scotia (discussed under Section 6), much of our knowledge about its distribution and abundance has been obtained incidentally during surveys for Boreal Felt Lichen or other cyanolichens (COSEWIC 2010; B. Toms pers. comm. Jan 2025). Inventory surveys should be pursued to fill knowledge gaps about Blue Felt Lichen in Nova Scotia, with priorities determined in consultation with regional lichen experts. Inventory survey priorities should include completing censuses of priority sites (discussed further in *Research and Knowledge Gaps* below) because they hold outsized importance for the persistence of the species in Nova Scotia. More complete census data can improve estimates of overall population sizes by clarifying habitat-density relationships. For example, a full census of the area of Marble Mountain (which supports at least 616 host

trees, or about 20% of the known provincial population) would help inform precise management and has the potential to add significantly to knowledge of the overall population size in Nova Scotia. Many parts of northern Nova Scotia have been under-surveyed for cyanolichens; additional inventory surveys would be helpful in Cumberland, Colchester, Pictou, and Antigonish counties (B. Toms pers. comm. Jan 2025; F. Brooks pers. comm. Jan 2025), and there is potential for some undiscovered, high-density populations between Digby and Clare and in the hardwood forests of western and northern Cape Breton (A. Belliveau pers. comm. Jan 2025).

It will be important to continue existing monitoring programs (discussed under Section 6.1 *Actions Completed or Underway*) to improve understanding of population trends and threats. Monitoring will be required to measure progress towards management objectives (discussed further under Section 7.2 *Monitoring*).

Communication, Outreach and Education

There are no requirements for pre-harvest lichen surveys for logging on private lands in Nova Scotia, highlighting the importance of outreach and education with private landowners. Protection in private woodlots can be encouraged through avenues such as the Woodlot Management Home Study series and outreach and workshops with woodlot owners' associations.

Existing outreach and education programs (discussed under Section 6.1 *Actions Completed or Underway*) should be continued with the goal of maintaining and increasing awareness among resource users, land managers, developers, and other stakeholders.

Law, Policy and Enforcement

The Special Management Practices (SMP) for At-Risk Lichens (NS DNR 2018) require pre-harvest lichen surveys on Crown lands. At present, surveys are only triggered when the footprint of a proposed activity intersects with potential Boreal Felt Lichen habitat (as predicted by a habitat model developed by Cameron and Neily 2008). Blue Felt Lichen has narrow habitat requirements (see Section 3.3 *Species Needs*) but occupies a broader range of habitats than Boreal Felt Lichen. The SMP would be more effective in protecting Blue Felt Lichen if surveys were also triggered by proximity to known Blue Felt Lichen locations and/or its potential habitat (see *Research and Knowledge Gaps*).

Protections for old-growth forests could be strengthened to improve conservation impact for Blue Felt Lichen and other at-risk lichens. Challenges with the old-growth forest policy include: reliance on limiting criteria (e.g., tree age, diameter at breast height, and downed woody material) for designating old-growth forest that can fail to protect old forests that have old-growth forest values; the policy is not enacted as law; and, old-growth forest protections can be removed if the Minister deems it is in the public interest to do so. The latter has value when public safety or habitat recovery could be at risk, but

there should be limitations on removing protections for resource extraction and development.

The Silvicultural Guide for the Ecological Matrix (SGEM; NS DLF 2021) outlines that no harvesting is permitted in forested wetlands on Crown land. However, Blue Felt Lichen is often found at or near the edges of wetlands and would not always be protected by this directive. The SGEM could be strengthened by adding a no-harvest buffer around forested wetlands.

In recent years, Blue Felt Lichen has been detected within wetland complexes that overlap the project footprints of several projects requiring Environmental Assessments. Prior to 2023, detection of Blue Felt Lichen within such a wetland conferred Wetland of Special Significance (WSS) protections on the wetland; in 2023, this policy was clarified to apply only to species with Threatened and Endangered status under SARA (Gorman 2023). Restoring a Wetland of Special Significance designation for Blue Felt Lichen occurrences would help protect these occurrences and avoid potential declines in IAO. Designation and the associated protection would provide opportunity to determine whether newly discovered occurrences might be priority sites for conservation (see Sections 6.2 & 6.3) that could help meet long-term management objectives.

Recently, translocation of Blue Felt Lichen thalli has been proposed and used in Nova Scotia as a method to salvage individuals that would otherwise be destroyed by development (see Section 6.1 *Actions Completed or Underway*). As this action could have significant impacts on the management and conservation status of Blue Felt Lichen and other at-risk lichens its use requires careful discussion. A working group should be created to discuss best practices and circumstances under which translocation could be considered. Translocation of rare lichens has been used in some instances in Newfoundland (Jones and Goudie 2018), western Canada, and Europe (Kong et al. 2022) but there is limited information on its success. Translocation success has not been studied for Blue Felt Lichen. It will be important to monitor the Blue Felt Lichen thallus that was translocated because of a transportation project near Wellington, NS (see Section 6.1 *Actions Completed or Underway*).

Research to Address Knowledge Gaps

It may not be feasible to maintain all Blue Felt Lichen sites in the long-term as its primary threats are pervasive and ongoing. As such, it is vital to determine which sites are most critical for meeting management objectives for Blue Felt Lichen in NS (i.e., priority sites). This will require careful analysis, as Blue Felt Lichen sites are of various sizes occupying a variety of different habitats, landscapes, and ecoregions. A framework should be developed for determining priority sites for conservation. Factors to consider in the framework may include:

- Geographic representation (e.g., by ecoregion)
- Ecological representation (i.e., capturing habitat variability)
- Genetic diversity

- Number of mature individuals (overall and in relation to other criteria)
- Habitat resilience to climate change
- Health of mature individuals (absence of necrosis, grazing damage, and parasitic fungi)
- Strategic placement facilitating movement and dispersal
- Scientific value (e.g., occurrences that have been known for a long time provide opportunity to study long-term dynamics)

A high-precision predictive habitat model for Blue Felt Lichen could help inform management planning. For example, presence of areas with a high probability of occurrence (based on an SDM) could be an additional trigger for pre-harvest surveys under the SMP for At-Risk lichens (NS DNR 2018). This could protect more Blue Felt Lichen in the short-term and contribute to plans to meet long-term objectives (more discussion under *Law, Policy and Enforcement*). A model with a 30–50 m grain size would be appropriate for these purposes and should include ecological layers such as depth to water table (S. Haughian pers. comm. Jan 2025).

Herbivory by non-native slugs is a known threat to several cyanolichen species occurring in Nova Scotia (see Section 4.2 *Description of Threats*). Anecdotally, Blue Felt Lichen seems to be less impacted than Boreal Felt Lichen; however, this has never been studied for Blue Felt Lichen. The impact of slug herbivory on Blue Felt Lichen needs to be quantified so that it can be incorporated into management planning.

It is important to better understand Blue Felt Lichen colonization and recruitment rates to determine whether recruitment could help stabilize population and IAO; if recruitment rate into new sites is sufficiently high, it might help offset population decrease at known sites (S. Haughian pers. comm. 2025).

Blue Felt Lichen dispersal occurs almost exclusively via ascospores, meaning establishment at a new site is highly dependent on the local availability of a suitable photobiont (cyanobacterial partner). A recent study in nine Spanish forests found that the specific *Nostoc* strain in local Blue Felt Lichen was “hardly present” on bark but was present in another cyanolichen, *Dendriscocaulon umhausense* (Cardós et al. 2019). It concluded that Blue Felt Lichen establishment is likely dependent on the presence of this species as the only source of the appropriate photobiont. Photobiont source could be a similarly limiting factor in Nova Scotia for Blue Felt Lichen, and this should be studied (see Yahr et al. 2024 for other examples and further discussion).

Subpopulations are defined by IUCN (2022) as geographically distinct groups, between which there is little demographic or genetic exchange, typically one successful migrant individual or gamete per year or fewer. Dispersal distance remains a knowledge gap for most lichens, including Blue Felt Lichen. COSEWIC (2010) used several studies on dispersal in Lungwort Lichen (*Lobaria pulmonaria*) to hypothesize that Blue Felt Lichen dispersal is limited to approximately 230 m. However, a more recent genetic analysis showed that Lungwort Lichen frequently dispersed distances greater than 5 km (Ronnås

et al. 2017). Improved understanding of subpopulation delimitations and dispersal distances in Nova Scotia could help inform management decisions in the face of reduced habitat quantity or quality caused by threats such as climate change and forestry.

7. MEASURING PROGRESS

7.1. Performance Indicators

The performance indicators presented below provide a way to measure progress towards achieving the management objectives and monitoring the implementation of the Management Plan:

1. Short-term objective, measured in 2027 and 2030
    - No decline in Index of Area of Occupancy between 2025–2030

2. Long-term objectives, measured every five years between 2025–2045:
    - Decline in number of mature individuals limited to:
        - <2.5% by 2030
        - <5% by 2035
        - <7.5% by 2040
        - <10% by 2045
    - Maintain or increase number of mature individuals in priority sites
    - Extent of Occurrence maintained to year 20 of the Management Plan

7.2. Monitoring

Monitoring demographics (population and distribution) will be a challenge because of the numerous widespread occurrences within Nova Scotia (see Section 3.2 *Population and Distribution*). MTRI is working towards re-visiting occurrences that have not been monitored in several years (B. Toms pers. comm. Jan 2025); however, this will not be possible for all occurrences and overall progress towards management goals will likely need to be extrapolated. Each check-in should involve monitoring from all priority sites (discussed in Section 6.3 *Surveys and Monitoring; Research to Address Knowledge Gaps*) and as many other sites as feasible to represent different ecoregions and land tenures within Nova Scotia. Trends from the monitored sites can be extrapolated to sites not visited to estimate overall trends. Each check-in should also use resources such as Global Forest Watch Tree Cover Loss data to investigate whether any known occurrences have been logged.

Blue Felt Lichen has relatively stringent habitat needs (Section 3.3 *Species Needs*) and most of its threats are a result of impacts to its habitat. As such, there will be overlap between monitoring threats and habitat. The impacts of wood harvesting and resource extraction on Blue Felt Lichen habitat can be monitored every five years by conducting a GIS analysis with updated forestry layers (e.g., Global Forest Watch Tree Cover Loss or Canada Landsat Disturbance layers). Monitoring the impact of climate change on Blue Felt Lichen and its habitat is more challenging due to a paucity of information. In New Brunswick, Blue Felt Lichen occurrences in upland forest habitat appear to be exhibiting more necrosis and decline than those in forested wetlands (Watts 2022). It is speculated that local humidity from adjacent wetlands provides more of a microclimate buffer during periods of drought and extreme heat associated with climate change. Work in Nova Scotia should include occurrences in both habitat types to help monitor differences in climate resilience for Blue Felt Lichen. Additional data that may help inform this research include field observations on necrosis and darkening of apothecia.

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