RECOVERY PLAN FOR BOREAL FELT LICHEN *(ERIODERMA PEDICELLATUM)* IN NOVA SCOTIA

A recovery plan adopted by the Nova Scotia Department of Lands and Forestry

2020 - 2025

Recommended citation:

Nova Scotia Department of Lands and Forestry. 2020. Recovery Plan for Boreal Felt Lichen (*Erioderma pedicellatum*) in Nova Scotia [Final]. *Nova Scotia Endangered Species Act Recovery Plan Series*.

Cover illustration: Boreal felt lichen (*Erioderma pedicellatum*). Photo credit: Alain Belliveau

Adoption of a Recovery Plan per Section 15(9) of the Endangered Species Act

Species:

Boreal Felt Lichen (*Erioderma pedicellatum*)

Reference:

Environment Canada. 2007. Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic Population, in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. viii + 31 pp.

Environment and Climate Change Canada. 2018a. Amended Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. viii + 48 pp.

Environment and Climate Change Canada. 2018b. Action Plan for the Boreal Felt Lichen (*Erioderma pedicellatum*) (Atlantic population) and Vole Ears Lichen (*Erioderma mollissimum*) in Canada [Proposed]. Species at Risk Act Action Plan Series. Environment and Climate Change Canada, Ottawa. v + 41 pp.

Whereas a Species at Risk Act Recovery Strategy has been prepared for this species by Environment Canada, and that plan has been reviewed by members of the applicable Nova Scotia Recovery Team and determined to fulfil the requirements of Section 15(4) of the Endangered Species Act as they pertain to Nova Scotia, the above-named recovery plan and action plan shall be adopted in lieu of a Nova Scotia Recovery Plan subject to the following:

Date of Adoption: 27 September 2020

Expiry/renewal Date: 27 September 2025

Conditions:

1. Adoption of this recovery plan will be reviewed 5 years from the Date of Adoption.

2. Final versions of ECCC (2018a) and ECCC (2018b) will be automatically adopted

once finalized. They have been reviewed and approved by Nova Scotia and the consultation period has elapsed.

3. Only elements of this plan that are relevant to Nova Scotia and are in accordance with the Endangered Species Act (Nova Scotia) shall be used. This includes the following sections of the reports:

   Environment and Climate Change Canada (ECCC 2007): 1. Background, 2. Recovery, Appendix C.

   Environment and Climate Change Canada (ECCC 2018a): 3. Species Information, 4. Threats, 5. Population and Distribution Objectives, 6. Broad Strategies and General Approaches to Meet Objectives, 7. Critical Habitat, 8. Measuring Progress, 9. Statement on Action Plans, 10. References, 11. Personal Communications, Appendix A, Appendix B, Appendix C.

   Environment and Climate Change Canada (ECCC 2018b): 1. Recovery Actions, 2. Evaluation of Socio-economic Costs and Benefits, 3. Measuring Progress, 4. References

4. The Nova Scotia Lichens Recovery Team explicitly endorsed the adoption of critical habitat as described in these Recovery strategies and Action plan in lieu of core habitat and that core habitat be described as laid out in Section 7 (ECCC 2018a) and Boreal Felt Lichen-specific elements in Section 1.3 (ECCC 2018b).

5. Should any additional requirements be identified, the Nova Scotia Department of Lands and Forestry may prepare an addendum to this plan under the Endangered Species Act.

Approved:

Donna Hurlburt, Manager of Biodiversity

Date:

27 September 2020

Appendix A:

Environment Canada. 2007. Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic Population, in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. viii + 31 pp.

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic Population, in Canada

Boreal Felt Lichen, Atlantic Population

May 2007

Environment Canada Environnement Canada

Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (www.sararegistry.gc.ca/the_act/default_e.cfm) spell out both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (www.sararegistry.gc.ca/) and the Web site of the Recovery Secretariat (www.speciesatrisk.gc.ca/recovery/).

Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic Population, in Canada

May 2007

Recommended citation:

Environment Canada. 2007. Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic Population, in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. viii + 31 pp.

Additional copies:

Additional copies can be downloaded from the SARA Public Registry (www.sararegistry.gc.ca/).

Cover illustration: Boreal felt lichen on balsam fir, eastern shore, Nova Scotia. Photo by Robert Cameron.

Également disponible en français sous le titre
« Programme de rétablissement de l'érioderme boréal (*Erioderma pedicellatum*), population de l'Atlantique, au Canada »

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DECLARATION

This recovery strategy has been prepared in cooperation with the jurisdictions responsible for the boreal felt lichen. Environment Canada has reviewed and accepts this document as its recovery strategy for the boreal felt lichen, as required under the *Species at Risk Act*. This recovery strategy also constitutes advice to other jurisdictions and organizations that may be involved in recovering the species.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives.

This recovery strategy will be the basis for one or more action plans that will provide details on specific recovery measures to be taken to support conservation and recovery of the species. The Minister of the Environment will report on progress within five years.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment Canada or any other jurisdiction alone. In the spirit of the Accord for the Protection of Species at Risk, the Minister of the Environment invites all responsible jurisdictions and Canadians to join Environment Canada in supporting and implementing this strategy for the benefit of the boreal felt lichen and Canadian society as a whole.

RESPONSIBLE JURISDICTIONS

Federal:
Environment Canada
Canadian Wildlife Service – Atlantic Region

Provincial:
Nova Scotia Department of Natural Resources
New Brunswick Department of Natural Resources

AUTHOR

This recovery strategy has been prepared by Crystal L. Doggett from the Mersey Tobeatic Research Institute.

CONTRIBUTORS

The development of this strategy was led and funded by Canadian Wildlife Service – Atlantic Region (Environment Canada) and the Nova Scotia Department of Natural Resources, in cooperation with the New Brunswick Department of Natural Resources. Staff from these agencies invested a great deal of time in the development of this document. The Recovery Team for the Atlantic population of boreal felt lichen has contributed extensively to the writing of this recovery strategy. The members of the Recovery Team include Robert Cameron (Co-chair), Nova Scotia Department of Environment and Labour; Mark Elderkin (Co-chair), Nova Scotia Department of Natural Resources; Andrew Boyne, Environment Canada; Sherman Boates, Nova Scotia Department of Natural Resources; David Richardson, Saint Mary's University; Wolfgang Maass, Retired Research Scientist; Tom Neily, Independent Consultant; Francis Anderson, Independent Consultant; Heather Stewart, Nova Scotia Community College; Pascal Giasson, New Brunswick Department of Natural Resources; and Stephen Clayden, New Brunswick Museum (Observer). Other contributors include Ian DeMerchant, Canadian Forest Service; Tracey Inkpen, Environment Canada; Kim Mahwinney, Environment Canada; Julie McKnight, Environment Canada; Carolyn Seburn, Environment Canada; and Kamila Tomcit, Nova Scotia Department of Environment and Labour.

STRATEGIC ENVIRONMENTAL ASSESSMENT

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below.

This recovery strategy will clearly benefit the environment by promoting the recovery of the boreal felt lichen (Atlantic population). The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to the following sections of the document in particular: Description of the species, Description of the biological needs of the species, Examples of activities that are likely to result in the destruction of the critical habitat, and Effects on other species.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* **[Subsection 2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry:
www.sararegistry.gc.ca/plans/residence_e.cfm

PREFACE

The boreal felt lichen (Atlantic population) is under the management jurisdiction of provincial governments. The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered, or threatened species. The boreal felt lichen was listed as Endangered under SARA in January 2005 and under the Nova Scotia *Endangered Species Act* in 2003. The Canadian Wildlife Service – Atlantic Region (Environment Canada) and the Nova Scotia Department of Natural Resources led the development of this recovery strategy, in cooperation with the New Brunswick Department of Natural Resources. The strategy meets SARA requirements in terms of content and process (Sections 39–41). It was developed in cooperation or consultation with:

- Aboriginal groups –
  Confederacy of Mainland Mi'kmaq
  Maritime Aboriginal People's Council
  MAWIW council
  Millbrook First Nation
  Native Council of Nova Scotia
  New Brunswick Aboriginal People's Council
  Union of New Brunswick Indians
  Union of Nova Scotia Indians

- Environmental non-government groups –
  The Nature Conservancy of Canada, Atlantic Region
  The Nature Trust of New Brunswick

- Industry –
  Bowater
  H.J. Crabbe & Sons Ltd.
  J.D. Irving Ltd.
  Neenah Paper
  New Brunswick Federation of Woodlot Owners
  Nova Scotia Power
  Southern New Brunswick Forest Products Marketing Board
  StoraEnso North America
  York-Sunbury-Charlotte Forest Products Marketing Board

- Other
  Fundy National Park
  New Brunswick Department of Tourism and Parks
  Roosevelt Campobello International Park
  One private landowner

EXECUTIVE SUMMARY

Boreal felt lichen (*Erioderma pedicellatum*) is an endangered cyanolichen. This foliose lichen is most often found on balsam fir in cool, humid, oceanic climates. In 1902, the first sighting of boreal felt lichen in the world occurred on Campobello Island in New Brunswick, but the lichen has not been seen there since. The only known extant sites of the Atlantic population of boreal felt lichen occur in Nova Scotia.

Although 46 sites of boreal felt lichen had been documented in Nova Scotia between 1980 and 1995, only 1 of these sites remained by 2006. Using a geographic information system (GIS) algorithm, the Nova Scotia Department of Environment and Labour located a new site in 2004. In the interim, the algorithm has led researchers to discover seven more sites. As of March 2006, there were nine known occupied sites hosting a total of 31 boreal felt lichen thalli and many sites identified as potential habitat that had yet to be surveyed.

The Atlantic population of boreal felt lichen faces complex threats to its survival: the lichen is cryptic and difficult to identify; the size of the known population is small; air pollution, which contributed to the extirpation of boreal felt lichen from New Brunswick, is both locally occurring and transported from the United States; the species lacks charisma; and there is still much unknown about the species and its habitat. Yet there are also encouraging results from the GIS habitat algorithm, cooperative efforts with forestry companies, and the formation of a Recovery Team for the lichen.

The overall goal of this recovery strategy is a self-sustaining population of boreal felt lichen, Atlantic population, with no reduction of current range. The recovery activities endorsed in this recovery strategy will be carried out in part or in whole within the next five years (2006–2011). The objectives of the recovery strategy are to 1) maintain thalli and habitat at sites where boreal felt lichen is known to occur; 2) mitigate threats to boreal felt lichen; and 3) undertake research to fill knowledge gaps and refine the identification of critical habitat.

These objectives will be achieved through recovery actions that are delineated as research, monitoring, management, education, or stewardship. Recovery actions include the following:

Research

- Determine the life cycle, growth rate, life history, genetic diversity, population dynamics, and minimum viable population size.
- Identify critical habitat (features and characteristics of habitat that are limiting to the species' ability to recover).
- Identify sources of air pollution and the lichen's sensitivity to specific pollutants.
- Identify practices to mitigate human disturbances in and surrounding boreal felt lichen habitat.
- Explore methods of population and habitat enhancement.

Monitoring
- Monitor known occupied sites.
- Monitor threats.
- Monitor habitat characteristics at historical and unoccupied suitable habitat.

Management
- Manage boreal felt lichen habitat at a landscape scale.
- Review forestry management practices as they pertain to boreal felt lichen recovery.

Education
- Provide accessible, high-quality educational materials.
- Raise profile among pollution reduction programs.

Stewardship
- Foster cooperative relationships with landowners, foresters, industry, and volunteers.

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1. BACKGROUND

1.1 Species Assessment Information from COSEWIC

Date of Assessment: May 2002

Common Name: Boreal felt lichen (Atlantic population)

Scientific Name: *Erioderma pedicellatum*

COSEWIC Status: Endangered

Reason for Designation: A population restricted to regions with a cool, humid, oceanic climate, highly sensitive to atmospheric pollutants such as acid precipitation. It has experienced a dramatic decline of over 90% in occurrences and individuals over the last two decades due, in particular, to air pollution and other sources of habitat loss and/or degradation. Extirpation of the few remaining individuals at three sites is imminent.

Canadian Occurrence: New Brunswick, Nova Scotia

COSEWIC Status History: Designated Endangered in May 2002. Assessment based on a new status report.

1.2 Description

1.2.1 Description of the species

Lichens are distinct symbiotic organisms made up from the association of microscopic algae or cyanobacteria and filamentous fungi. Boreal felt lichen (*Erioderma pedicellatum*) is a foliose cyanolichen, with distinctive upturned edges that reveal white undersides. The range of colour of the lichen is determined by the hydration of the lichen body called the thallus. It appears bluish grey when moist and dark grey to greyish brown when dry. Boreal felt lichen most commonly measures 2–5 cm in diameter, although it can be up to 12 cm in diameter. This lichen has a generation time of approximately 30 years. Boreal felt lichen is vulnerable to atmospheric pollution. The habitat for boreal felt lichen occurs in cool, moist, maritime climates. New evidence suggests that the genus may be among the oldest of foliose lichens, perhaps well over 400 million years old (Maass and Yetman 2002).

Special significance

Boreal felt lichen has been coined the “panda bear” of the lichens, acting as a symbol of the immediate and very real threat to the world’s boreal forests (Maass and Yetman 2002). The ability of this species to indicate fluctuations in local air quality makes it valuable as an environmental indicator. Boreal felt lichen appears to have a unique and complex relationship with the liverwort *Frullania tamarisci* ssp. *asagrayana* (discussed in section 1.2.2), which scientists are only beginning to understand.

Global status

- IUCN (International Union for Conservation of Nature and Natural Resources) Red List of Threatened Species: Critically Endangered (Scheidegger 2003)
- NatureServe Global Conservation Status Rank: G1G2Q (Critically Imperiled/ Imperiled; Q = questionable taxonomy) [1]
- Rounded global status[2]: G1 (Critically Imperiled)

Provincial status

- New Brunswick: None
- Newfoundland and Labrador: Vulnerable (boreal population)
- Nova Scotia: Endangered

Populations and distribution

There are two Canadian populations of boreal felt lichen: the boreal population (Newfoundland and Labrador) and the Atlantic population (Nova Scotia and New Brunswick). The 2002 Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Report for boreal felt lichen attributes the distinction to "the fact that they occur in different ecological regions and are subject to different degrees of risk" (Maass and Yetman 2002: p. vii). The Atlantic population is currently found only in Nova Scotia and is believed to be extirpated from New Brunswick.

Boreal population of boreal felt lichen

COSEWIC lists the boreal population of boreal felt lichen as a species of Special Concern, although it is the largest and healthiest known population in the world. Newfoundland and Labrador's population is found mainly in the Avalon Forest and Maritime Barrens ecoregions in the southern half of the island of Newfoundland. The Newfoundland and Labrador Department of Environment and Conservation (2006) is currently preparing a draft management plan for the boreal population of boreal felt lichen. Although the boreal population faces a different degree of vulnerability to threats compared with the Atlantic population, this recovery strategy will provide a valuable tool for recovery planning for both populations.

This document and the recovery strategies discussed within it pertain to the Atlantic population of boreal felt lichen. For more information about the boreal population, consult the COSEWIC Status Report on boreal felt lichen (Maass and Yetman 2002) or visit www.sararegistry.gc.ca/.

Historic distribution of the global population of boreal felt lichen

The first recorded collection of boreal felt lichen occurred in 1902 on Campobello Island, New Brunswick, while the second record of boreal felt lichen was from Norway in 1938 (Clayden

[1] For more information see www.natureserve.org
[2] This value uses an algorithm to evaluate Conservation Status Ranks and systematically produces easier to interpret values without qualifiers or ranges (e.g. G1G2 becomes G1)

1997). Boreal felt lichen has likely been extirpated from Sweden and Norway (Goward *et al*. 1998). Significant efforts by researcher Wolfgang Maass yielded numerous new sites in both Nova Scotia and Newfoundland and Labrador (boreal population) during the 1980s.

Historic distribution of the Atlantic population of boreal felt lichen

Maass and Yetman (2002) recorded 46 sites with a total of 169 boreal felt lichen thalli in Nova Scotia between 1980 and 1995 (Figure 1). Surveying from 1995 to 2002 resulted in the location of only 13 boreal felt lichen thalli at 3 of the original 46 sites, suggesting a population decline (Maass and Yetman 2002). By March 2006, only one of the original sites supported boreal felt lichen.

Although the earliest recorded collection of boreal felt lichen in Canada was from New Brunswick, it is the only observation of the species in the province (Clayden 1997). Moreover, the possibility of finding new occurrences of boreal felt lichen in New Brunswick is believed to be low, given the apparent absence of indicator or associated cyanolichen species on conifers along the Bay of Fundy coast (New Brunswick Department of Natural Resources 2006). The Recovery Team is prepared to initiate recovery actions if there are reports of boreal felt lichen or its indicator species in the province.

Current distribution of the Atlantic population of boreal felt lichen

The only known extant sites of the Atlantic population of boreal felt lichen occur in Nova Scotia. As of March 2006, only 1 of the 46 Nova Scotia locations of boreal felt lichen identified by Maass and Yetman (2002) retained the lichen, but 8 new locations (all unknown when the 2002 COSEWIC Status Report was written) have been identified using habitat suitability maps and systematic surveying (Figure 2; Cameron and Neily 2006).

Figure 1. Distribution of the Atlantic population of boreal felt lichen prior to 1995 (from Maass and Yetman 2002).

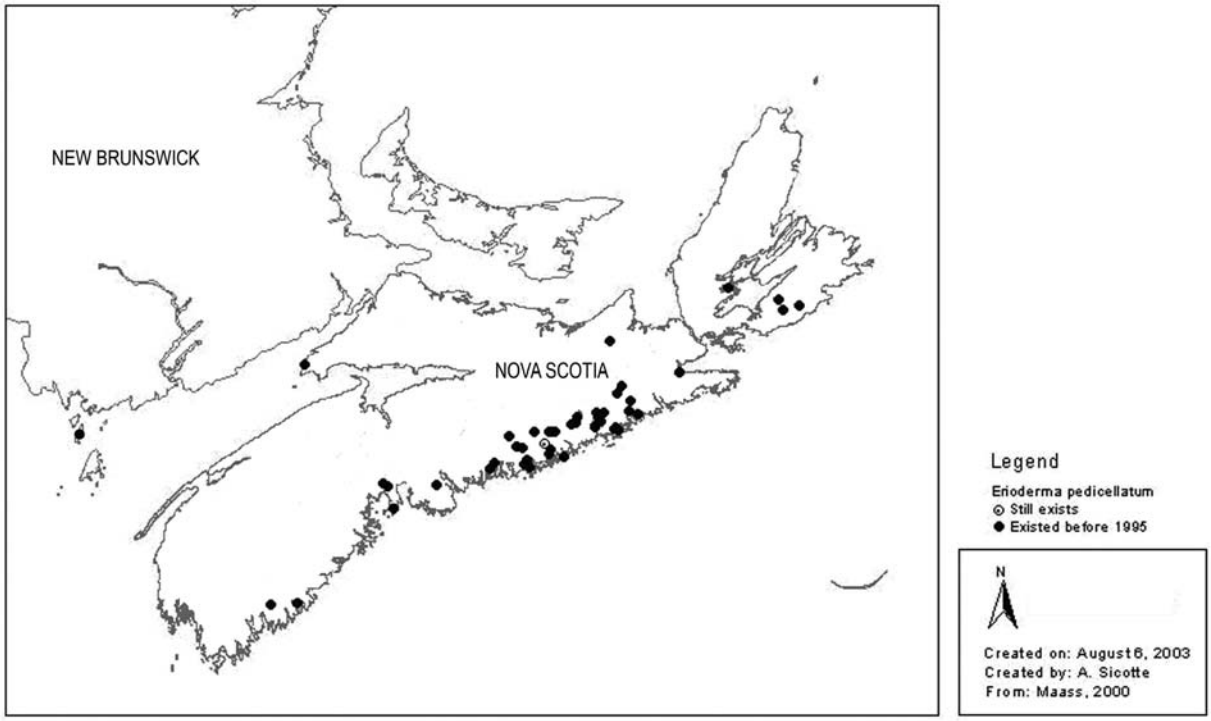
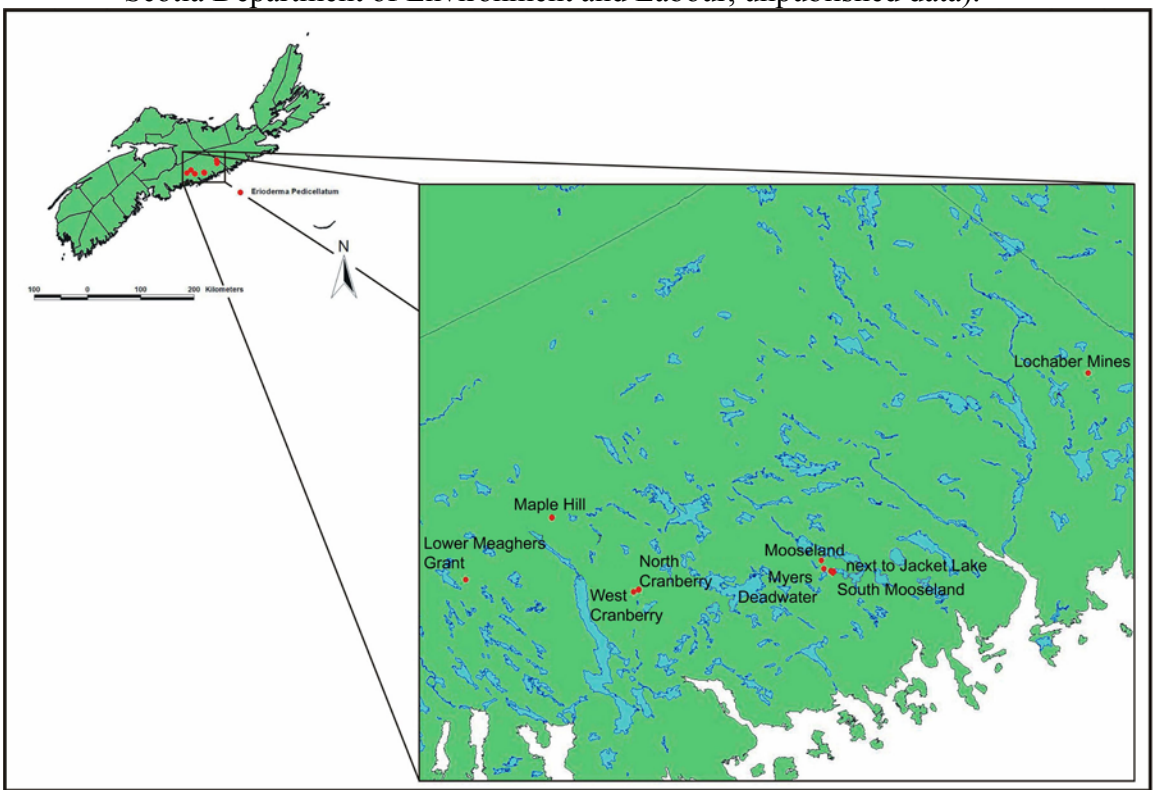


Figure 2. Distribution of the Atlantic population of boreal felt lichen as of March 2006 (Nova Scotia Department of Environment and Labour, unpublished data).



1.2.2 Description of the biological needs of the species

Biological needs, ecological role, and limiting factors

Life cycle

The life cycle of boreal felt lichen is not yet completely understood. In 1996, Christoph Scheidegger hypothesized that the life cycle of boreal felt lichen was linked to the ecological cycle of balsam fir (*Abies balsamea*) habitat (Clayden 1997; Maass and Yetman 2002). His hypotheses were that there is only one generation of *Erioderma* thalli per successional cycle of the balsam fir stand; that the growth rate of boreal felt lichen accelerates during the overmature to decaying phase of the forest (a phase lasting approximately 15–25 years) as a result of advantageous light conditions created by canopy gaps left by dead and decaying trees; that the lichen then releases spores to adjacent younger fir stands; and that a new cycle of boreal felt lichen begins within a few hundred metres of the initial population.

Reproduction and symbiosis

Lichens are formed by the association of a fungus with a bacterium. The bacterium is responsible for producing food for the organism through photosynthesis (Brodo *et al.* 2001). Boreal felt lichen is a cyanolichen, which means that its photosynthetic partner, or photobiont, is a cyanobacterium. *Scytonema* is the cyanobacterium associated with boreal felt lichen. Lichens are named for the mycobiont, the fungal partner, so *Erioderma pedicellatum* is the name that represents both the fungal partner and the lichen. Reproduction of the lichen is achieved sexually, initiated by the chance contact between a group of fungal spores and a strand of *Scytonema* (Maass and Yetman 2002).

While *Scytonema* can grow and reproduce independently, there is no evidence that the mycobiont, *Erioderma pedicellatum*, grows independently (R. Cameron pers. comm. 2006). If the mycobiont does grow independently, it would be theoretically possible for the lichen to regenerate spontaneously after being absent for a period of time, but only if there are *Erioderma pedicellatum* spores available (R. Cameron pers. comm. 2006). *Erioderma pedicellatum* produces spores only when in partnership with *Scytonema* (R. Cameron pers. comm. 2006).

The symbiosis between the photobiont and the mycobiont is complex; owing to the energy consumed by the initial joining of the partners, it is expected that the initial rate of growth is slower than when the lichen becomes visible at 2–3 mm in diameter. Preliminary results of linear growth rate investigations suggest that it takes 7–13 years for thalli to reach maturity once established, but these results are based on only 11 thalli (Cameron and Neily 2006). A more precise understanding of growth rate should emerge with more research.

An intriguing aspect of boreal felt lichen is its relationship with a liverwort, *Frullania tamarisci* ssp. *asagrayana*. The co-occurrence of boreal felt lichen and *Frullania*, coupled with the known occurrence of *Scytonema* within the water sacs of *Frullania*, has led some to suggest that the moisture-rich water sacs of *Frullania* act as a nursery to the lichenization of boreal felt lichen (Scheidegger 1996; Maass and Yetman 2002).

Limiting factors

Boreal felt lichen is biologically limited by the following factors: its globally limited distribution and small population size; its relationship with *Frullania tamarisci* ssp. *asagrayana*; its requirement for bark substrates of a specific acidity; the nature of its life cycle (boreal felt lichen does not produce any type of joint fungal–bacterial propagule; therefore, it must reestablish itself each generation from its separate components); and its apparent hypersensitivity to acidification of its substrates and/or to direct adverse effects of air pollutants such as nitrogen oxides and sulphur dioxide. It is necessary to determine whether or not the quality or quantity of forest habitat available is inherently limiting to boreal felt lichen recovery.

Habitat needs

Boreal felt lichen is relatively specialized in its habitat requirements. Thalli are typically found on north-facing trunks of mature and overmature balsam fir trees (Maass and Yetman 2002; Richardson and Cameron 2004). Suitability of the habitat for occupation by the lichen may be increased if the forest is located on slopes with northern or northeastern exposure. The high relative humidity of these habitats may also be suitable for growth of companion indicator species of beard and hair lichens, such as *Usnea* species, *Alectoria sarmentosa*, and *Bryoria* species (S.R. Clayden pers. comm. 2006). Other characteristics of known sites include cool, moist habitat conditions that remain relatively constant throughout the year, such as those adjacent to *Sphagnum*-rich wetlands that can maintain moisture levels during periods of drought (Maass and Yetman 2002). In Nova Scotia, boreal felt lichen has occasionally been found living on white spruce (*Picea glauca*) and red maple (*Acer rubrum*) substrates in mixedwood stands (Maass and Yetman 2002).

Limited observations suggest that boreal felt lichen most often occurs within 25 km of the sea coast at an elevation up to 500 m above sea level. Forest habitat is described by researchers as having low open crown closure due to natural forest dynamics. Many factors that affect the suitability of habitat for boreal felt lichen are not precisely known, including the temperatures and level of humidity that must be maintained within the habitat and the levels to which the lichen can withstand pollutants such as sulphur dioxide and nitrogen oxides. Regardless, clean air and clean water sources are considered important aspects of boreal felt lichen habitat. Thus, there is some critical but as yet undetermined distance surrounding boreal felt lichen habitat that is essential to the lichen's survival. Structural and functional features of forest habitat believed to be important include moisture retention, forest integrity (total cover, degree of fragmentation or patch continuity, age, composition, etc.), protection from weather events that may cause blowdowns, and the ability to intercept some local air pollution.

Indicator species

Coccocarpia palmicola and *Lobaria scrobiculata* (also cyanolichens) usually occur with boreal felt lichen and may be used as indicator species (Cameron and Richardson 2006).

1.3 Threats

Boreal felt lichen is cryptic and difficult to identify. The species lacks charisma, and there is still much unknown about the species and its habitat. Although these threats may be reduced somewhat through education and research, they contribute to the lichen's vulnerability to physical threats. Physical threats to boreal felt lichen and its habitat are discussed below.

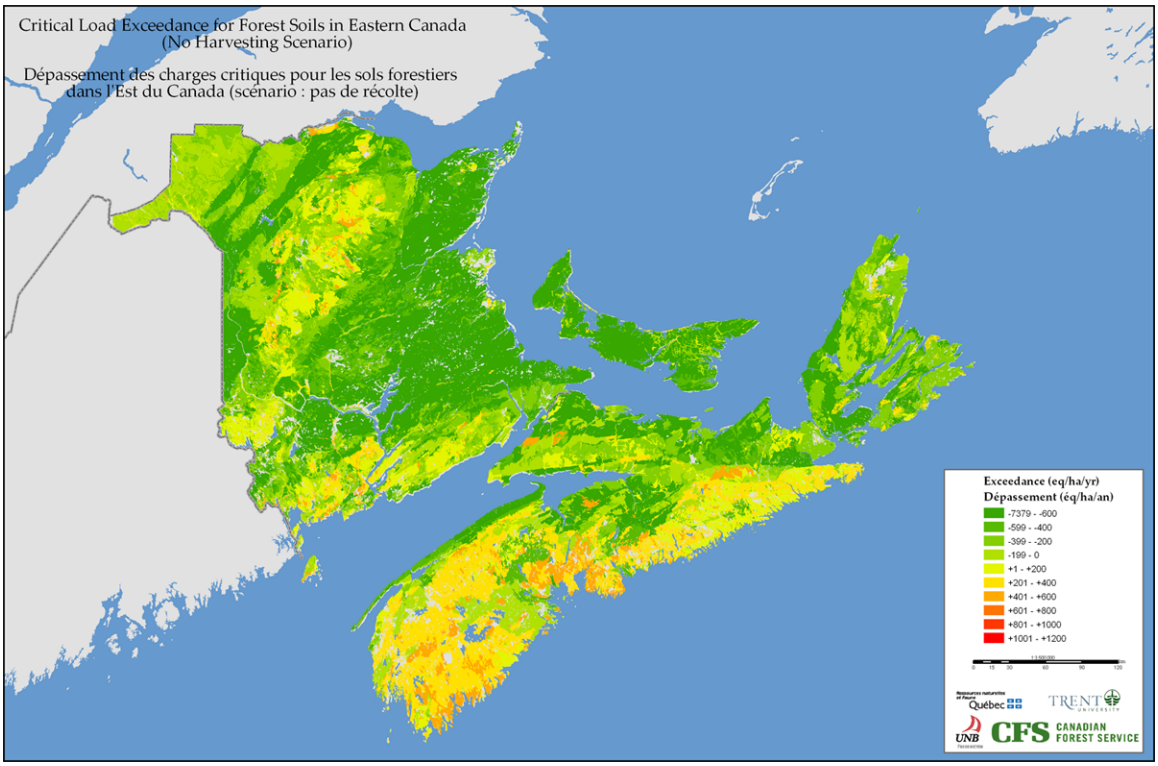
1.3.1 Acid precipitation/air pollution

Acid precipitation is destructive to boreal felt lichen in two ways: it causes immediate damage to the thallus through the uptake of air pollutants (cyanolichens' nitrogen-fixing enzyme is known to be intolerant of sulphur dioxide), the suggested cause of damage to the holdfast mechanism (observed by W. Maass); and it further acidifies the naturally acidic substrates on which the lichen lives, thereby reducing the buffering capacity of the lichen (Maass and Yetman 2002).

The decline in lichen populations has been documented to have occurred in the 1980s (Maass and Yetman 2002), despite the fact that emissions of sulphur dioxide in Canada and the United States actually decreased over this time due to government actions to reduce acid rain (Environment Canada 2004a). This raises the possibility that the lichen or its associated species are also being impacted by other air pollutants, such as nitrogen oxides (T. Inkpen pers. comm. 2006).

The amount of acid deposition that an area can tolerate is known as its critical load. It is calculated as acid equivalents per hectare per year (eq/ha per year). Most of Nova Scotia is highly or extremely acid sensitive (Figure 3). Airflow dynamics carry air pollutants originating from cities such as Boston and New York along the northeast Atlantic coast, as well as pollutants from coal-burning electricity generating stations in the midwestern United States. These pollutants, in addition to local pollution sources, result in acidified precipitation (Beattie *et al.* 2002; Richardson and Cameron 2004). Acid fog is created by the collision between the cold air masses over the Gulf of Maine and the Bay of Fundy and the warm, humid, pollutant-bearing air masses coming upward along the Atlantic coast (Cox *et al*. 1989). Investigation is required to pinpoint local sources.

Figure 3. Critical load exceedance for forest soils in eastern Canada (no harvesting scenario).



Boreal felt lichen populations in Nova Scotia occur in coastal areas subject to extended periods of acid fog, which increases the severity of the threat of acid precipitation to the lichen. The disappearance of boreal felt lichen from New Brunswick has been attributed to the impacts of acid precipitation (New Brunswick Department of Natural Resources 2006).

Initiatives to reduce acid precipitation are already in place through international actions under the Canada–United States Air Quality Agreement and domestic actions under the Canada-wide Acid Rain Strategy for Post-2000 (both documents available at www.ec.gc.ca). It is a recovery priority to better understand the impact of air pollution and acid precipitation on boreal felt lichen. Specific actions to help mitigate this threat are described in more detail in the Recovery section (section 2) and include identifying sources of air pollution and the lichen's sensitivity to specific pollutants; identifying both local and transboundary sources to determine their relative threats; determining practices to mitigate human disturbances in and surrounding boreal felt lichen habitat; monitoring threats (e.g., acid deposition); and alerting those implementing pollution reduction programs to boreal felt lichen so the species may be used to support their programs.

1.3.2 Forest management

Besides acid precipitation, forest practices are considered the other major threat to the Atlantic population of boreal felt lichen. Forest practices may cause fragmentation, alter the age structure, and simplify the biodiversity of forest stands. In Nova Scotia, even-aged management for spruce-dominated forest stands predominates (Canadian Council of Forest Ministers 2005). Entire

locations of boreal felt lichen may be destroyed by large-scale clearcutting, particularly if the presence of boreal felt lichen has not been identified.

The effect of forest fragmentation on epiphytic lichens has been the subject of much work (Esseen and Renhorn 1998; Rheault *et al*. 2003; Pykala 2004; Richardson and Cameron 2004). When lichens are suddenly at the edge of a forest or in a fragmented forest, there is a reduction in dispersal ability and opportunity to recolonize in cutover areas (Rheault *et al.* 2003). Large-scale logging also greatly reduces the ability of a forest stand to buffer against times of low humidity (Maass and Yetman 2002). Some researchers suggest that this was the cause of boreal felt lichen extirpation from Vãrmland, Sweden, where logging took place in the immediate vicinity of the park where boreal felt lichen thalli were known to occur (Maass and Yetman 2002).

In 2005, at the oldest known boreal felt lichen site in Nova Scotia, a lone thallus on the west side of the site was lost to a blowdown (Cameron and Neily 2006). Although blowdowns are not an infrequent event, an adjacent clearcut (estimated to have occurred in 2000 or 2001) likely increased the vulnerability of this site to blowdowns and drought.

In Nova Scotia, harvested stands are usually replanted with unsuitable phorophytes that have more acidic bark than balsam fir, such as black spruce (*Picea mariana*), white spruce, red spruce, and Norway spruce (*Picea abies*) (Canadian Council of Forest Ministers 2005). Even-aged tree plantations are also not favourable to the establishment of new colonies of *Scytonema*, *Frullania*, or juvenile boreal felt lichen because of their low light conditions (Maass and Yetman 2002).

Communication and information sharing with the forestry industry in Nova Scotia are keystones to recovery efforts. Efforts made to alleviate the threat posed to boreal felt lichen by forestry management will be outlined in greater detail in the Recovery section (section 2) and include reviewing literature and best management practices for forest management as they pertain to boreal felt lichen; communicating with stakeholders to develop practical forest practices and recommendations for areas surrounding the lichen and its potential habitats; developing a voluntary stewardship agreement for use with landowners; and offering training to volunteers and foresters to identify boreal felt lichen and potential habitat.

1.3.3 Pest control and the use of harmful aerial sprays

The COSEWIC Status Report for boreal felt lichen outlines the threat posed to a boreal population colony by trichlorfon, a spray reagent approved and considered to eliminate the yellow-headed spruce sawfly (*Pikonema alaskensis*) in 1998 (Maass and Yetman 2002). Because the thallus of boreal felt lichen does not repel water well, the liquid chemical is able to access and damage the cellular membranes of the lichen (Maass and Yetman 2002). Although a far less harmful agent was chosen (azadirachtin, an extract from the Indian neem tree (*Azadirachta indica*)), Maass and Yetman (2002) suggested that trichlorfon would most likely have decimated the area colonies.

There are no records of either of these agents being used in Nova Scotia (W. Fanning, NSDNR, pers. comm. 2006), but trichlorfon was used in New Brunswick in the 1970s (Mitchell and Roberts 1984). The most recent record of its use in New Brunswick was in a small-scale

experiment in 1996 (N. E. Carter, NBDNR, pers. comm. 2006). Both provinces scrutinize all decisions surrounding the use of aerial sprays.

It is often difficult to predict the relative threats to boreal felt lichen of the aerial spray and the pest itself, and every situation may be different (Maass and Yetman 2002). Awareness of any potential pests in the vicinity of boreal felt lichen sites and participating in consultations to deal with such pests will ensure that boreal felt lichen will be considered when deciding whether, where, and what to spray. Environmental protection agencies must be informed of boreal felt lichen's presence so it will be protected from such threats.

1.3.4 Climate: Droughts, hurricanes, forest fires, global warming

Based on field observations, boreal felt lichen cannot endure the desiccation that accompanies extreme weather events such as droughts and hurricanes (Maass and Yetman 2002). A severe storm in Guysborough County, Nova Scotia, created a windfall that destroyed one of the boreal felt lichen populations discovered in the 1980s (Maass and Yetman 2002).

Forest fires may directly destroy boreal felt lichen, and they may also have indirect effects, because nitrogen-fixing lichens (including all cyanolichens) downwind of forest fire smoke can be destroyed by the small concentration of sulphur dioxide contained in the smoke (Maass and Yetman 2002).

Although it is difficult to quantify the effects of global warming on lichens, it is expected that they include reductions in range distributions (Maass and Yetman 2002). Lichens with affinities to particular tree species and lichens that require cool, moist habitats, such as boreal felt lichen, may be particularly sensitive to climate change (Maass and Yetman 2002).

Climatic changes are occurring, and boreal felt lichen may be susceptible to damage from these threats. The best protection against climatic threats that can be offered is to maintain a protective area around lichen sites and to monitor the effects of these events to guide future management decisions. To reduce the impact of climatic threats to boreal felt lichen, human disturbances in and surrounding boreal felt lichen habitat must be mitigated.

1.3.5 Effects of herbivory on the growth of balsam fir seedlings

The 2002 COSEWIC Status Report for boreal felt lichen (Maass and Yetman 2002) discusses the effects of moose browsing on balsam fir, but all observations were reported from Newfoundland and Labrador. In the vicinity of the known Atlantic population locations, there are no recorded observations of moose browsing on balsam fir seedlings. Moose are present throughout both New Brunswick and Nova Scotia, but the mainland population of moose in Nova Scotia is provincially endangered. Any measures to protect boreal felt lichen must carefully consider implications for moose recovery on mainland Nova Scotia. At present, it will be adequate to monitor lichen sites for evidence of herbivory.

1.3.6 Microfauna herbivory

The COSEWIC Status Report for boreal felt lichen recorded that mites and snails have both been observed browsing on boreal felt lichen, and it suggests that they pose only a very minor threat to boreal felt lichen populations (Maass and Yetman 2002). When the Lower Meaghers Grant site was visited in 2004, a boreal felt lichen thallus at the site was being heavily grazed by gastropods (Cameron and Neily 2006). A collected specimen was later identified as *Arion subfuscus*, a non-native introduction from Europe (Cameron and Neily 2006). It is not clear whether this single instance could be considered a population-level threat. Any additional observations of grazing will be recorded and assessed for evidence that such grazing requires further study or action.

1.3.7 Land development

The development of land for activities such as industry, residences, forestry, and agriculture creates disturbance and landscape alterations and also provides access to remote areas for people (Maass and Yetman 2002). The level of threat to boreal felt lichen from land development fluctuates as new sites are discovered and accessibility to sites changes. Boreal felt lichen habitat is protected by the federal *Species at Risk Act* and the Nova Scotia *Endangered Species Act* (NSESA). Specific actions to mitigate this threat include the identification of critical habitat, education, and voluntary stewardship agreements.

1.4 Knowledge Gaps

Knowledge gaps for boreal felt lichen include detailed information on its life cycle, growth rate, life history, genetic diversity, population dynamics, minimum viable population size, sensitivity to individual air pollutants and acid deposition, and sensitivity to specific forest practices. Critical habitat and the importance of unoccupied potential habitat must also be determined. The characteristics and quality of habitat required by boreal felt lichen and the relevant scale of threats to its habitat are not known; it is also not known how these threats to its habitat limit the species' ability to recover.

2. RECOVERY

2.1 Recovery Feasibility

Recovery of the Atlantic population of boreal felt lichen is believed feasible, although the challenges are formidable and the results of overcoming them uncertain. The Atlantic population of boreal felt lichen has an extremely small population size, with only nine sites known as of March 2006 and a total of 31 thalli (Cameron and Neily 2006). The small population size limits the ability of experimental studies to generate meaningful results. With a 30-year generation time, positive results of recovery efforts may not be apparent in the short term. Air pollution originating from coal-burning electricity generating plants and urban centres in the U.S. Midwest is believed to have been a significant factor in the disappearance of boreal felt lichen from New Brunswick (New Brunswick Department of Natural Resources 2006). There are significant challenges associated with reducing air pollution, especially outside Canada.

Although air pollution and forestry management practices are considered the most significant threats, the location and investigation of new discoveries of occupied boreal felt lichen sites may indicate that the additional threats listed in section 1.3, such as herbivory and land development, must be actively mitigated. The impact of droughts, hurricanes, and forest fires can be swift and irrevocable for boreal felt lichen. It is also difficult to predict the presence of a pest that may cause boreal felt lichen to be threatened by a chemical pesticide or herbicide.

Overcoming some of these challenges is possible. A coarse quality filter approach to identifying potential habitat in the form of a habitat algorithm is in development. The geographic information system (GIS) algorithm has identified approximately 188 000 ha within Nova Scotia that may represent suitable habitat (Cameron and Neily 2006). Because eight of the known occupied sites that have been identified since 2004 were located using habitat suitability mapping (Cameron 2004), more sites may be discovered as they are surveyed and as the algorithm is further developed and verified. Two of the known occupied sites have both juvenile and mature thalli, indicating that reproduction is occurring (Cameron and Neily 2006).

Air pollution and forestry management practices have the most potential to harm boreal felt lichen. Air pollutants such as sulphur dioxide and nitrogen oxides are a threat to the health of many other species, including humans, which has resulted in a greater awareness of the problem. Boreal felt lichen benefits from pollution prevention campaigns and industrial technologies to reduce emissions. The forestry industry has already taken an interest in the protection of this lichen, and its input will lead to practical recommendations for forestry practices in the vicinity of boreal felt lichen habitat and unoccupied potential sites.

Cooperative research with managers of the boreal population should enable a number of the knowledge gaps to be filled, resulting in an increased capacity to make management decisions for the Atlantic population. Recovery efforts for boreal felt lichen are seldom invasive or stressful for the species and result in only a low impact on the surrounding environment. If the impact and level of threat posed by acid precipitation and air pollution decrease or do not drastically increase, recovery of the Atlantic population is feasible

2.2 Recovery Goal

The overall goal of this recovery strategy is a self-sustaining population of boreal felt lichen, Atlantic population, with no reduction of current range. The size required for a self-sustaining population cannot be determined at this time due to limitations of the available data.

2.3 Recovery Objectives

The short-term objectives of the recovery strategy for the Atlantic population of boreal felt lichen in Canada from 2006 to 2011 are to:

1) maintain thalli and habitat at sites where boreal felt lichen is known to occur (currently nine sites with a total of 31 thalli);
2) mitigate threats to boreal felt lichen; and
3) undertake research to fill knowledge gaps and refine the identification of critical habitat.

2.4 Broad Strategy to Be Taken to Meet Recovery Objectives

The recovery strategies outlined in this section (Table 1) will facilitate the achievement of the recovery objectives. Recovery strategies will be identified as research, monitoring, management, education, or stewardship. To enable evaluation of recovery efforts, short-term recovery goals have been set and appear at the conclusion of sections 2.4.1 through 2.4.5, under the heading "Outcomes and deliverables by or before 2011." An action plan associated with this recovery strategy will include a detailed and prioritized schedule for these activities (section 2.8).

Table 1. Tabular summary of recovery approaches for the Atlantic population of boreal felt lichen.

Priority[a]	Broad approach/strategy	Objective addressed	General steps	Effect
	RESEARCH			
Urgent	• Determine life cycle, growth rate, life history, genetic diversity, population dynamics, and minimum viable population size	3	• Collaborate with researchers studying boreal population • Design and prioritize experimental studies	Increases knowledge base, guides recovery actions and management decisions
Urgent	• Identify critical habitat	1, 3	• Map habitat suitability to search for potential sites • Identify critical habitat	Increased capacity to protect and enhance habitat
Necessary	• Identify sources of air pollution and the lichen's sensitivity to specific pollutants	2	• Consult national and provincial monitoring programs to identify point sources	Guides management and recovery efforts
Secondary	• Identify practices to	3	• Model historical, current, and	Guides

Priority[a]	Broad approach/strategy	Objective addressed	General steps	Effect
	mitigate human disturbances to boreal felt lichen habitat		potential regional distribution in relation to climate and site factors • Interpretation/reconstruction of historical trends in acidification	enhancement and recovery efforts
Secondary	• Explore methods of population and habitat enhancement	3	• Consult current research on thallus transplantation • Determine feasibility for transplanting within the Atlantic population • Identify other possibilities for enhancement	Potential for population augmentation/ expansion
	MONITORING			
Urgent	• Monitor occupied sites	All	• Develop reliable, repeatable, long-term monitoring tools and techniques to locate, monitor, and assess	Enables evaluation of recovery efforts and guides recovery efforts
Urgent	• Monitor threats	All	• Assess use of available monitoring of threats by other researchers or government departments	Enables evaluation of recovery efforts and guides recovery efforts
Secondary	• Monitor habitat characteristics	All	• Develop monitoring tools and techniques to assess habitat parameters of sites, such as humidity, forest composition, and age structure, and, at the landscape level, monitor changes in balsam fir and age structure	Enables evaluation of recovery efforts and guides recovery efforts
	MANAGEMENT			
Urgent	• Manage boreal felt lichen habitat at landscape scale	All	• Locate boreal felt lichen sites • Communicate with landowners of occupied sites	Helps to maintain current distribution
Secondary	• Review forest management practices as they pertain to boreal felt lichen recovery	All	• Review literature and best management practices as they pertain to boreal felt lichen • Communicate with	Helps maintain existing sites and potential future sites

Priority[a]	Broad approach/strategy	Objective addressed	General steps	Effect
			stakeholders to develop feasible forestry practices and recommendations for the area surrounding the lichen and potential habitats	
	EDUCATION			
Necessary	• Provide high-quality educational materials	All	• Assess current boreal felt lichen communications materials • Reprint and design necessary materials • Create a basic web site • Distribute communications materials	Raises the public profile of boreal felt lichen
Necessary	• Raise profile among pollution reduction programs	2	• Inform organizers of appropriate air pollution reduction campaigns about boreal felt lichen with the intention that they might use the species as another example of the consequences of air pollution	Indirect action to reduce air pollution
	STEWARDSHIP			
Necessary	• Foster cooperative relationships with landowners, foresters, industry, and volunteers	All	• Develop an identification training workshop • Develop a voluntary stewardship agreement	Increases capacity of recovery efforts beyond researchers

[a] Priorities are defined as follows: Urgent = top priority action, without which population will decline; Necessary = action needed to evaluate and guide recovery actions; Secondary = action beneficial if urgent actions are already under way.

2.4.1 Research

Actions completed or under way

Habitat suitability mapping

The predictive habitat model for boreal felt lichen used by Robert Cameron has identified approximately 188 000 ha of habitat in Nova Scotia at 24 000 sites (R. Cameron pers. comm. 2006). This is a coarse filter approach, which is undergoing further development and verification. An improved method of distinguishing balsam fir stands from black spruce stands on aerial photographs is under development and is expected to increase the predictive ability of the algorithm (R. Cameron pers. comm. 2006). Both Stora Enso North America and Bowater Mersey

Paper Company have incorporated the algorithm into their planning strategies (R. Cameron pers. comm. 2005).

Air quality research

The Nova Scotia Department of Environment and Labour is currently undertaking an airshed management framework. The first phase will consist of information gathering (local emission sources need to be identified, qualified, and characterized) and gap analysis. This information will serve as inputs into future airshed modelling.

Once key pollution variables (types, levels, etc.) have been determined and the variables and their importance relative to other boreal felt lichen habitat requirements established, future airshed modelling may give an assessment of which airsheds are best to sustain the lichen. The Nova Scotia Department of Environment and Labour has also completed a provincial lichen air quality monitoring program using permanent sampling plots. This project will measure the effects of air pollution on lichens and may help determine problem areas for boreal felt lichen.

Actions to be initiated

Determine life cycle, growth rate, life history, genetic diversity, population dynamics, and minimum viable population size

The small number of known sites and thalli in the Atlantic population of boreal felt lichen is unlikely to provide enough data to allow the determination of boreal felt lichen life cycle, growth rate, life history, genetic diversity, population dynamics, and minimum viable population size. Collaborative research with individuals and agencies working in Newfoundland and Labrador on the boreal population of boreal felt lichen would strengthen the validity of these experimental studies. The population of boreal felt lichen in Newfoundland and Labrador makes it feasible to undertake experimental studies that would yield a better understanding of areas where there are current knowledge gaps at the population level.

Some of the priority topics for collaborative research in Newfoundland and Labrador and Nova Scotia include assessment of the genetic relationships between the Atlantic and boreal populations of boreal felt lichen, dispersal ability, age to maturity, reproductive life span, growth rate, survivorship of maturity classes, minimum viable population, habitat requirements for all stages of life, whether the population is affected by small population dynamics, the feasibility of *ex situ* propagation and a transplant program, the significance of *Frullania*, and substrate types and characteristics in boreal felt lichen thalli initiation.

Identify critical habitat

For both occupied and unoccupied habitat, the relevant scale for protection and biological requirements as they limit recovery need further research and assessment. Once scalar issues of habitat are resolved and clarified, landscape- and province-level analysis (such as GIS) will be undertaken to understand the quality and quantity of habitat necessary for species recovery. Critical habitat must be identified to ensure an adequate understanding of boreal felt lichen's

habitat needs and to activate the protection and enforcement available through the *Species at Risk Act*. Detailed information on the identification of critical habitat is given in section 2.5.

Identify sources of air pollution and the lichen's sensitivity to specific pollutants

It is important to identify the lichen's sensitivity to specific types and levels of pollutants and under what conditions (timing, duration, life stage of exposure, etc.) these pose the greatest threat. Monitoring local air quality in and around areas where differences in abundance have been noted will provide valuable information to aid this investigation. By identifying local point sources of air pollution coupled with atmospheric conditions, it will be possible to consider the impact of these point sources on the location and survival of boreal felt lichen. There may also be some value in comparing historical levels of pollutants in Nova Scotia and New Brunswick with boreal felt lichen distributions.

Identify practices to mitigate human disturbance to boreal felt lichen habitat

Occupied sites will be monitored for evidence of past or present forest practices to determine how the practices may have impacted the lichen and its habitat. In association with the research necessary to determine critical habitat, a prescribed distance surrounding occupied sites of boreal felt lichen that should be only minimally impacted will be established. In addition, an optimum distance will be determined for use as a recommendation in stewardship agreements, which would likely be a more generous distance than that indicated as critical habitat (and protected by legislation). The purpose of the recommendation is to increase recovery potential and provide the opportunity to monitor adjacent stands for new colonization. Additional practices to mitigate human disturbance will be identified, related to thinning and selective cut tolerances of boreal felt lichen, blowdown reduction guidelines, and road construction for lands surrounding critical habitat.

Explore methods of population and habitat enhancement

To reestablish previously occupied habitat, transplantation may be required. Because the Atlantic population is so small, transplanting thalli from this population is not recommended. Transplanting experiments with individuals from the boreal population may be appropriate. Once a successful technique is developed in Newfoundland, transplanting individuals from the Atlantic population may be considered. More discussion about transplantation and its role for the Atlantic population is required. Other habitat characteristics of boreal felt lichen may also be considered in relation to methods to enhance and restore boreal felt lichen, such as *Frullania* transplantation.

Outcomes or deliverables by or before 2011

- Results of research incorporated into a revised recovery strategy, which should provide insight into the potential for restoring boreal felt lichen and its habitat.
- Evaluation of which pollutants cause the greatest threat to boreal felt lichen.
- Outstanding research topics prioritized and listed in action plan (see section 2.8).
- Critical habitat definition refined.
- Guidelines developed for protecting boreal felt lichen habitat through voluntary actions (for use in habitat stewardship agreements).

- Habitat parameters necessary to determine unoccupied sites with potential boreal felt lichen habitat identified.
- Five unoccupied sites identified with suitable habitat for boreal felt lichen where landowners could be approached to enter into voluntary agreements to protect potential habitat for the species.

2.4.2 Monitoring

Actions to be initiated

Monitor occupied sites

As boreal felt lichen sites are identified, continued monitoring will be necessary to assess the success of recovery efforts and gather data to support research. Monitoring will assess the overall condition of the thalli, habitat characteristics, and apparent threats (see next section). Monitoring the health and succession of individual thalli and colonies as well as the long-term habitat conditions would also address some research questions. Monitoring methods will be determined after reviewing protocols from existing programs, such as the Ecological Monitoring and Assessment Network of Environment Canada.

Monitor threats

Information on monitoring air pollution, acid deposition, and meteorological events is available through federal and provincial environment departments and should be assembled and interpreted as it relates to the recovery of boreal felt lichen. In addition, it will be necessary to undertake focused air quality monitoring around boreal felt lichen sites. Other threats, such as forestry activity and gastropod grazing, will have to be monitored directly.

Monitor habitat characteristics

Microhabitat parameters such as humidity, forest composition, forest age structure, indicator species, and herbivory should be monitored at occupied boreal felt lichen sites to better define what boreal felt lichen needs to survive. It would also be useful to monitor these parameters at unoccupied sites and compare them with those at occupied sites to understand habitat preference throughout the lichen's life cycle and to model predictions about a site's ability to support the lichen through time. This kind of analysis might help determine, for example, if boreal felt lichen occurs in even-aged forests with frequent stand initiating events or if it is generally in uneven-aged forests with infrequent disturbance events. Permanent air quality sampling plots managed by the Nova Scotia Department of Natural Resources since 1965 may provide some insights into the impact of air quality on the distribution and abundance of boreal felt lichen.

Outcomes or deliverables by or before 2011

- Boreal felt lichen monitoring program in place, with distribution and abundance data recorded in the Atlantic Canada Conservation Data Centre database.
- A process for archiving data from threat and habitat monitoring developed.

2.4.3 Management

Actions completed or under way

Conservation and management

Efforts are under way to determine the effects of pollution and forestry management on cyanolichens (Richardson and Cameron 2004). Management options that have been identified include enhancing propagule spread, transplantation, limiting the effects of acid rain, and changing forestry practices (Richardson and Cameron 2004).

Recovery leadership

In September 2004, an organizational meeting was held to facilitate the formation of a Recovery Team for the Atlantic population of boreal felt lichen. The province of Nova Scotia chairs the Recovery Team. The team is made up of government representatives from Nova Scotia and New Brunswick, lichen experts, and academia. More members are being added to the team to ensure that all relevant experts are represented. In the unlikely event that boreal felt lichen is rediscovered in New Brunswick, members of the Recovery Team are prepared to initiate recovery actions in that province. The Recovery Team is also coordinating a program to monitor the status of cyanolichens in Nova Scotia.

Actions to be initiated

Manage boreal felt lichen at landscape scale

Management decisions on boreal felt lichen will be based on two factors: the protection of occupied sites and the protection of a network of unoccupied sites that, on the basis of habitat/vegetation characteristics and consistency with predictive algorithms, may be capable of supporting boreal felt lichen. The latter sites could provide areas for the introduction or relocation of boreal felt lichen in the event that known sites are deemed to be at significant risk. These unoccupied sites may also provide opportunities for protection through stewardship initiatives.

Using habitat suitability mapping, more boreal felt lichen sites are likely to be discovered and protected through legislation and stewardship initiatives. Efforts to communicate with landowners and promote stewardship are as important as legislative protection of habitat. The experience and knowledge of landowners will be important in making management decisions.

Review forest management practices as they pertain to boreal felt lichen recovery

Because boreal felt lichen is an arboreal lichen, forest management practices are important to recovery efforts. A review of literature and best forestry management practices for boreal felt lichen will provide a baseline for discussions with foresters regarding how they can support boreal felt lichen recovery efforts. A review of literature exploring links between acid deposition and forestry practices as they pertain to forest health and productivity outcomes is also very relevant to understanding the dynamics of boreal felt lichen habitat. It will be necessary to

determine best practices for forest management: in the vicinity of boreal felt lichen sites, in unoccupied potential sites, and to maintain balsam fir across the landscape. These practices would be outlined in voluntary stewardship agreements.

Outcomes or deliverables by or before 2011

- Habitat suitability mapping algorithm used to identify 250 sites with potential habitat, which will then be surveyed for boreal felt lichen.
- Best forestry practices developed for boreal felt lichen sites and their surrounding area, as well as for unoccupied potential habitat.

2.4.4 Education

Actions completed or under way

Capacity building

In 2002–03, funding from the Government of Canada's Habitat Stewardship Program for Species at Risk was granted to the Nova Scotia Department of Natural Resources for a project entitled "Building Stewardship Capacity for the Boreal Felt Lichen (*Erioderma pedicellatum*) in Atlantic Canada." This project included a two-day workshop and the creation and distribution of a brochure and identification card for boreal felt lichen. The project laid a foundation for the initial steps towards recovery of the boreal felt lichen (MacGregor *et al.* 2003).

Identification workshop

In 2004, a workshop was given to Stora Enso North America by Robert Cameron of the Nova Scotia Department of Environment and Labour to explain how to identify boreal felt lichen and its habitat. Additional workshops should be organized, particularly with other forestry companies.

Actions to be initiated

Provide high-quality educational materials

A brochure and identification card (created as part of the "Building Stewardship Capacity for the Boreal Felt Lichen (*Erioderma pedicellatum*) in Atlantic Canada" project) are the only communications materials currently available to the public. They provide identification characteristics and other general species information. These will be assessed to see if any changes are needed and, if necessary, will be reprinted. Materials necessary to support stewardship activities, such as presentations, identification workshop materials, and a basic web site, will be designed. Boreal felt lichen lacks charisma and is not well known, but the right educational materials and delivery may induce the interest of industry, foresters, students, and naturalists and stimulate them to search for the lichen.

Raise profile among pollution reduction programs

Boreal felt lichen will benefit from reductions in air pollutants such as sulphur dioxide and nitrogen oxides. It is not reasonable to initiate a massive campaign to reduce local and transboundary sources of pollution for boreal felt lichen. Instead, the organizers of appropriate-scale pollution reduction programs should be informed of the boreal felt lichen so that they can use it as a case study to support their programs.

Outcomes or deliverables by or before 2011

- Educational materials developed or refined.
- Basic web site on boreal felt lichen developed, outlining general species information, identification characteristics, stewardship opportunities, and a summary of recovery efforts.
- At least four pollution prevention programs contacted and provided with boreal felt lichen resources.

2.4.5 Stewardship

Actions completed or under way

Both Stora Enso North America and Bowater Mersey Paper Company have incorporated the algorithm used for the habitat suitability mapping for boreal felt lichen into their planning strategies. This cooperation in searching for new locations has led to improvements in the predictive ability of the algorithm.

Actions to be initiated

Foster cooperative relationships with landowners, foresters, industry, and volunteers

A boreal felt lichen identification workshop will be further developed. Training will allow participants to recognize potential habitat, search for the lichen, and identify it. Workshop participants will be given an opportunity to practise their skills, which will enable them to assist with any of the activities listed above under "Monitoring."

Stewardship is a key component of the recovery of any species at risk that uses habitat on private lands. A stewardship agreement template will be drafted. The agreement will identify the area the steward agrees to protect, suggest the best management practices the steward should use, and list the activities the steward should avoid within that area to support recovery efforts for the lichen. Stewards will include landowners of occupied and unoccupied potential boreal felt lichen sites. These agreements will be voluntary and flexible.

Education and stewardship initiatives are closely linked. It is likely that the educational activities from the previous section will motivate some concerned citizens to take actions that support recovery efforts, by searching for the boreal felt lichen, reducing their contribution to air pollution, or simply telling others about the lichen.

Outcomes or deliverables by or before 2011

- Voluntary stewardship agreements with landowners of occupied and unoccupied habitat prepared.
- Identification workshops held for volunteers, landowners, and foresters upon request.
- Stewardship program developed to communicate the importance of the lichen and ensure that educational materials are available to all stakeholders.

2.5 Critical Habitat

2.5.1 Identification of boreal felt lichen critical habitat

Suitable habitat mapping provides convincing evidence that more sites of the Atlantic population will be found. Current population size and distribution of the lichen must first be determined to adequately describe critical habitat. Ecological requisites and physical attributes of critical habitat in Nova Scotia require further study. Critical habitat is described in this document to the extent possible given the best information available at present, including the locations of the nine known sites.

Critical habitat description

The existing boreal felt lichen sites share the following habitat characteristics:

- They occur within 25 km of the sea coast at an elevation up to 300 m above sea level.
- They are in forested habitats with low open crown closure due to natural forest dynamics.
- They are found typically in balsam fir stands, on north-facing trunks of mature and overmature trees.
- The habitat is cool and moist and remains relatively constant throughout the year.
- The surrounding forest provides moisture retention, forest integrity, protection from weather events that may cause blowdowns, and the ability to intercept some local air pollution.
- They are often located on or at the base of slopes with northern or northeastern exposure.

Identification of critical habitat sites

The federal *Species at Risk Act* defines critical habitat as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species." Information on the implications of the identification of critical habitat is provided in Appendix B.

Under the NSESA, the province of Nova Scotia may identify "core habitat", which is defined in the act as "specific areas of habitat essential for the long-term survival and recovery of endangered or threatened species". The process for identifying core habitat is not yet developed as the emphasis as been on other existing and tested tools for habitat protection. As yet, it is still unclear how the identification of critical habitat under SARA will impact the listing of "core habitat" under the NSESA and vice versa.

As of March 2006, nine sites occupied by boreal felt lichen have been identified, eight of which were unknown when the species' status was assessed by COSEWIC in 2002, and all of which are within 60 km of each other in eastern Halifax County, Nova Scotia (Cameron and Neily 2006). Eight of these sites are on provincial land and one is on private land. Figure 2 shows the general location of known sites of boreal felt lichen. Appendix C, giving the coordinates and directions to the boreal felt lichen sites, has been removed from the public document to protect the species and its habitat.

There is some anecdotal evidence that this forest area surrounding each boreal felt lichen site plays an important role in maintaining the microclimate necessary for the lichen. This area surrounding the boreal felt lichen sites is also identified as critical habitat. It is difficult to determine an exact distance, because this distance may differ for each site based on factors such as topography, forest condition, tree age and health, and soil properties, such as drainage, moisture, and texture.

In 1998, Robertson recommended that a buffer of at least 20 m be observed for the boreal (Newfoundland) population of boreal felt lichen (Robertson 1998). Newfoundland and Labrador's management plan for boreal felt lichen (Newfoundland and Labrador Department of Environment and Conservation 2006) provides guidance to be employed by forest practitioners on a case-by-case basis in the absence of detailed researched management strategies. The recommended practices include placing a 100-m buffer around large (10 or more thalli) sites and a 30-m buffer around small (fewer than 10 thalli) boreal felt lichen sites. Recent studies on other groups of lichens (fruticose) suggest that edge effects caused by forest harvesting can occur up to 50 m into the uncut forest (Esseen and Renhorn 1998; Rheault *et al.* 2003).

Based on these findings, and as recommended by the Recovery Team, a 100-m radius surrounding each occupied boreal felt lichen site is included in the identified critical habitat. Further studies to determine the relevant scales for protection and biological limitations for boreal felt lichen will be used to determine if this distance is adequate. The schedule of studies for critical habitat will include developing a better understanding of the importance of adjacent balsam fir stands for boreal felt lichen reproduction.

If new occurrences are confirmed and documented, the Recovery Team will recommend that the site(s) be identified as critical habitat for boreal felt lichen. If boreal felt lichen no longer occupies a site, the area will be reevaluated to determine if it is critical habitat.

This identification of critical habitat, although incomplete, offers protection to the known sites of the Atlantic population of boreal felt lichen. Results from the activities listed in the schedule of studies (section 2.5.3) will make this definition more complete and precise and will be included in an action plan (see section 2.8).

2.5.2 Examples of activities that are likely to result in the destruction of critical habitat

Boreal felt lichen is highly cryptic and difficult to identify, and the habitat in which it occurs likely has some combination of physical and/or functional factors that are as yet poorly understood or unknown. With this clarification, federal policy (Environment Canada 2004b) defines an activity as detrimental to critical habitat when it alters the conditions of an area identified as critical habitat to the extent to which the capacity of that critical habitat to contribute to the survival or recovery of the species would be compromised.

Human activities likely to result in the destruction of critical habitat are modifications to the physical attributes of critical habitat, such as forest composition, microclimate environment, chemical composition of air or water, topography, geology, soil conditions, vegetation, and surface or ground hydrology.

2.5.3 Schedule of studies

The results for the following schedule of studies will be included in an action plan which will provide a more complete and precise definition of critical habitat (section 2.8).

Study to be undertaken	Should the results of these actions be incorporated in the action plan?	Specific steps	Timeline
Determine distribution and abundance	Yes	• Identify key habitat characteristics necessary for boreal felt lichen	Preliminary complete, ongoing, summary by 2007
		• Develop habitat suitability mapping	Preliminary algorithm currently in use
		• Improve predictive ability of mapping algorithm to extent possible	Under way, completion by 2009
		• Set schedule to survey sites identified as most likely potential habitat	Under way, completion by 2011
		• Locate, monitor, and assess health of sites	Under way, completion by 2011
Improve knowledge base and understanding of habitat needs, characteristics, and threats	Yes	• Interpretation/reconstruction of historical trends in acidification	Complete by 2008
		• Scheduled monitoring of sites to assess presence and level of threats and changes in habitat conditions	Summary of monitoring available by 2010
		• Research/assess scale for protection and biological requirements as they limit recovery (occupied and unoccupied habitat)	Complete by 2010

Study to be undertaken	Should the results of these actions be incorporated in the action plan?	Specific steps	Timeline
		• Following above: landscape- and province-level analysis (GIS, etc.) to understand quality/quantity of habitat necessary for species' recovery	Complete by 2010
		• Confirm or adjust recommendation of 100 m of critical habitat surrounding boreal felt lichen sites	Complete by 2009
		• Determine microhabitat requirements	Complete by 2009
		• Determine extent of impacts of airborne pollutants, acid rain	Complete by 2009
Improve understanding of dispersal dynamics, reproduction requirements	Yes	• Collaborate with boreal population research	Continuous
		• Determine importance of balsam fir stands adjacent to occupied sites	Preliminary study by 2010
		• Determine importance of unoccupied potential habitat	Preliminary study by 2010
		• Determine landscape-level relationships and requirements	Preliminary study by 2010
Further identify activities likely to result in the destruction of critical habitat	Yes	• Review compiled critical habitat data	2007–2011
		• Augment current list as necessary	2011

2.6 Effects on Other Species

It is very likely that the results of recovery efforts for boreal felt lichen will benefit other cyanolichens and species with similar habitat needs. Restriction or alteration of forest management practices harmful to boreal felt lichen could have an indirect positive impact on plants and/or animal species in the vicinity. There will be an environmental impact from boreal felt lichen recovery efforts in terms of increased foot traffic to lichen sites, but this is not likely to be a significant impact.

2.7 Recommended Scale for Recovery

At present, a single-species approach will be pursued for the boreal felt lichen. However, in the future, it may be appropriate to move to a multispecies approach encompassing other rare cyanolichens (such as *Erioderma mollissimum*) if they are deemed "at risk" and require the intervention of recovery efforts to ensure their survival.

2.8 Action Plan

Two action plans will be developed for Boreal Felt Lichen.

Implementation Action Plan

An action plan outlining how this recovery strategy will be implemented will be posted on the *Species at Risk Act* Public Registry within two years of the recovery strategy being posted on the registry. This will include a detailed and prioritized schedule for the implementation of the activities outlined in section 2.4 *Broad strategy to be taken to meet recovery objectives*.

Critical Habitat Action Plan

A second action plan which will provide a more complete and precise definition of critical habitat based on the results of activities outlined in the schedule of studies (section 2.5.3) will be posted on the *Species at Risk Act* Public Registry within six years of the recovery strategy being posted on the registry.

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[3] The letter contained Dr. Scheidegger's ideas about the complex reproductive strategies of *Erioderma*, about the limited life span of its thalli, and about its life cycles being intimately tied to certain ecological stages in growth of coniferous trees within a more or less undistributed forest environment.

APPENDIX A: GLOSSARY OF TERMS

cyanolichen – lichen whose photosynthetic partner is a cyanobacterium (also called blue-green alga)

epiphyte – a lichen that grows on or is attached to another living plant

foliose – flattened and leaf-like in appearance

mycobiont – fungal partner that joins with a bacterium to form a lichen

phorophyte – the host of an epiphyte

photobiont – photosynthetic partner (bacterium) that joins with a fungal partner to form a lichen

thallus (plural form: *thalli*) – name for the vegetative lichen body

APPENDIX B: IMPLICATIONS OF CRITICAL HABITAT IDENTIFICATION

Section 58. (1) of the *Species at Risk Act* (SARA) states that "…no person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species…." This prohibition is enacted if:

(a) the critical habitat is on federal land (which includes the internal waters of Canada, the territorial sea of Canada, and reserves and any other lands that are set apart for the use of a band under the *Indian Act*), in the exclusive economic zone of Canada, or on the continental shelf of Canada;
(b) the listed species is an aquatic species; or
(c) the listed species is a species of migratory birds protected by the *Migratory Birds Convention Act, 1994*.

Based on the recommended definition of critical habitat above, Section 58. (1) prohibitions would not immediately be enacted on the critical habitat of Boreal Felt Lichen as none of the known sites occur on federal lands. Legal protection of the critical habitat would be governed by provincial or municipal legislation. Prohibitions under SARA at these sites would come into effect only if it was deemed that these sites were not "effectively protected" by provincial legislation or other means, and then would require that the federal cabinet make an order to do so. This would require consultation with the province and the landowners.

The enactment of prohibitions protecting critical habitat does not automatically prohibit specific activities. Only activities that destroy the habitat would be prohibited. On federal lands, regulations may be enacted to legislate what can and cannot be done on critical habitat, including when and how activities must be conducted.

Information about what is being done to protect critical habitat must be published in the Public Registry every six months until the critical habitat is protected or no longer needs to be protected.

APPENDIX C: SPECIFIC LOCATION OF KNOWN OCCUPIED SITES AS OF MARCH 2006

[Appendix C, which gives the coordinates and directions to the boreal felt lichen sites, has been removed from the public document to protect the species and its habitat.]

Appendix B:

Environment and Climate Change Canada. 2018a. Amended Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. viii + 48 pp.

PROPOSED

Species at Risk Act
Recovery Strategy Series

Amended Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada

Boreal Felt Lichen, Atlantic population

2018

Government of Canada
Gouvernement du Canada

Canada

Recommended citation:

Environment and Climate Change Canada. 2018. Amended Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. viii + 48 pp.

For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Boreal Felt Lichen on Balsam Fir, eastern shore, Nova Scotia. Photo by Robert Cameron, used with permission

Également disponible en français sous le titre
« Programme de rétablissement modifié de l'érioderme boréal (*Erioderma pedicellatum*), population de l'Atlantique, au Canada [Proposition] »

ISBN
Catalogue no.

[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

Amended Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada (2018)

The Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada (Environment Canada 2007) was posted on the Species at Risk Public Registry in June 2007.

Under Section 45 of the *Species at Risk Act* (SARA), the competent Minister may amend a recovery strategy at any time. This Amended Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada (hereafter, "Amended Recovery Strategy") is for the purposes of:

- Amending all sections of the Recovery Strategy for the Boreal Felt Lichen, Atlantic population, in Canada, based on the most current information

- Refining and updating critical habitat throughout the species' recent range in Nova Scotia

Since 2007, when the Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada was written, the Guidelines for Completing Federal Recovery Strategy Templates (part of a series of SARA Implementation Guidance documents) have been updated considerably. Hence, this Amended Recovery Strategy has been updated in accordance with the most recent Recovery Strategy Template and the associated guidelines.

This Amended Recovery Strategy replaces the 2007 Recovery Strategy for the Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population, in Canada.

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Boreal Felt Lichen, Atlantic population, (hereafter Boreal Felt Lichen) and has prepared this recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Provinces of New Brunswick and Nova Scotia as per section 39(1) of SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of Boreal Felt Lichen and Canadian society as a whole.

This amended recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Acknowledgments

This amended recovery strategy was prepared by Brad Toms (Mersey Tobeatic Research Institute), Julie McKnight (Environment and Climate Change Canada – Canadian Wildlife Service) and Rob Cameron (Nova Scotia – Environment) with extensive input from Mark Elderkin (Nova Scotia Department of Natural Resources). Maureen Toner (New Brunswick Department of Natural Resources), Claudia Hanel (Newfoundland and Labrador Department of Environment and Conservation), and André Arsenault (Natural Resources Canada – Canadian Forest Service) provided detailed comments on this amended recovery strategy. The efforts and contributions of the Nova Scotia Cyanolichen Recovery Team are gratefully acknowledged. Appreciation is also extended to Dave Andrews (Environment and Climate Change Canada – Canadian Wildlife Service) for producing the maps in this document.

Executive Summary

Boreal Felt Lichen (*Erioderma pedicellatum*) is a leafy cyanolichen, with distinctive upturned edges that reveal white undersides.

A small population of Boreal Felt Lichen is found in cool, humid coastal coniferous forests in Nova Scotia. The lichen has not been recorded in New Brunswick since the early 20th century (Cameron et al. 2009). The species is listed as Endangered on Schedule 1 of the federal *Species at Risk Act* (SARA).

One of the most important requirements for cyanolichens is the need for a clean environment including pollutant-free air and precipitation that is free of acidifying contaminants. Acid precipitation may negatively impact the colonisation and survival of Boreal Felt Lichen in areas that receive significant and continued acid deposition. In addition to air-borne pollutants, Boreal Felt Lichen is threatened by logging and wood harvesting, invasive non-native species, climate change and severe weather, roads, and housing and urban areas.

The recovery of Boreal Felt Lichen is considered feasible. There are several unknown factors associated with the feasibility of recovering Boreal Felt Lichen. Despite these unknowns, and in keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA.

The population and distribution objectives are to ensure the species' known extent of occurrence (i.e., the area that encompasses the geographic distribution of the population) and the health of the population are not impacted by human-induced habitat deterioration or loss (i.e., through biological resource use (of the species' host tree), transportation and service corridors, or residential and commercial development). Broad strategies to be taken to address the threats to the survival and recovery of Boreal Felt Lichen are presented in the section 6.2: Strategic Direction for Recovery.

Critical habitat necessary for the survival or recovery of Boreal Felt Lichen is updated in section 7.1. Critical habitat for Boreal Felt Lichen is partially identified in this document based on the best available data. As more information becomes available, additional critical habitat may be identified.

One or more action plans for Boreal Felt Lichen will be posted on the SAR Public Registry within the three years following the posting of this amended recovery strategy.

Recovery Feasibility Summary

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, there are unknowns regarding the feasibility of recovery of Boreal Felt Lichen. In keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be technically and biologically feasible. This recovery strategy addresses the unknowns surrounding the feasibility of recovery.

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Unknown. While most of the known individuals in Nova Scotia are mature and have reproductive structures (apothecia), data suggest that reproductive rates may not be high enough to sustain or improve the population (R. Cameron pers. comm.).

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Unknown. It is unknown whether sufficient suitable habitat is available to support the species, or could be made available through habitat management or restoration. Air pollution and forestry management practices are the primary threats to Boreal Felt Lichen habitat. Although habitat still exists in the form of mature/over-mature forests, air pollution affects this habitat by reducing a phorophyte's (i.e., host tree) bark buffering capacity and increasing its acidity (Farmer et al. 1991). Some habitat exists within protected areas free from development impacts but these areas are still subject to air-borne pollution.

Beneficial forest management practices that protect lichens have emerged and have received some support from the industry in recovery work on Boreal Felt Lichen. These may lead to practical recommendations for best management practices in the vicinity of Boreal Felt Lichen habitat and unoccupied potential sites.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Unknown. Cyanolichens are extremely sensitive to air-borne pollutants and acid precipitation (Richardson 1992, Richardson & Cameron 2004) due to their reliance on air-borne nutrients and water, as well as lack of protective structures (Richardson & Cameron 2004). Sulphur dioxide dissolved in precipitation, water films, or within moist lichen thalli is highly toxic to cyanolichens and is most toxic under acidic conditions. Boreal Felt Lichen may benefit from pollution prevention campaigns and industrial technologies that reduce emissions. Although there have been significant declines in air-borne pollutants in Atlantic Canada over the last two decades, acid rain and acid fog from transboundary pollution are still negatively impacting the environment (Canadian Council of Ministers of the Environment, 2011, 2013, Cox et al. 1989) and preliminary

estimates indicate that over 38% of Nova Scotia's upland forest receives acid deposition in excess of critical loads (i.e., the amount of acid deposition that a habitat can tolerate without being significantly harmed) (Canadian Council of Forest Ministers 2006).

Formal and informal partnerships with industry, scientists, municipal governments, federal/provincial governments, conservation organizations, land owners, and the public may help achieve the long-term conservation and recovery of Boreal Felt Lichen. Some sites with Boreal Felt Lichen are protected under legislation (e.g., *Nova Scotia Special Places Act*, *Wilderness Areas Protection Act*). Forest management tools are under development.

International agreements, national commitments, forest certification initiatives, and legislation may all contribute to sustainable forestry practices and the conservation of Boreal Felt Lichen through threat reduction/mitigation. In some areas, the forestry industry has taken an interest in the protection of Boreal Felt Lichen, and their input has led to practical recommendations for beneficial management practices in the vicinity of Boreal Felt Lichen habitat and unoccupied potential sites.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Yes. Some success has been achieved in transplanting Boreal Felt Lichen (Boreal population) in Newfoundland and Labrador (The Gossan 2010). It is reasonable to assume that with further refinement this recovery technique may be a viable option for Boreal Felt Lichen, should it be required.

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2014 (No Change)

Common Name (population): Boreal Felt Lichen (Atlantic population)

Scientific Name: *Erioderma pedicellatum*

COSEWIC Status: Endangered

Reason for Designation: This species is believed to be extirpated from New Brunswick, and the remaining population in Nova Scotia is small. Intensive monitoring efforts over the past ten years indicate that both the number of occurrences and number of individuals are declining. These declines are projected to continue in the future. The main threats include habitat loss and deterioration as a result of forest harvesting, air pollution, climate change, and predation by introduced slugs.

Canadian Occurrence: NB, NS

COSEWIC Status History: Designated Endangered in May 2002. Status re-examined and confirmed in November 2014.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

In the first status report for the species (Environment Canada 2002), more than 95% of the global population was thought to occur in Canada. Since 2002, the lichen was found in Alaska and Siberia. If the Alaskan population estimates are accurate, it is possible that only 10-20% of the global total population of the lichen occurs in Canada (COSEWIC 2014).

Table 1. Description of various conservation status ranks for Boreal Felt Lichen (NatureServe 2014).

	G- Rank[a]	N-Rank[b]	S-Rank[c]	COSEWIC Status	SARA Status
Boreal Felt Lichen (*Erioderma pedicellatum*) (Atlantic population)	G1 G2Q	N1N2	NB: SH NS: S1S2	Endangered	Endangered

[a] G-Rank — Global Conservation Status Rank: G1 = species is critically imperiled; G2 = species is imperiled; and Q = questionable taxonomy.

[b] N-Rank — National Conservation Status Rank: N1 = population within Canada is Critically Imperiled; N2 = population within Canada is Imperiled.

[c] S-Rank —sub-national (provincial or territorial) ranks: S1 = Critically Imperiled; S2 = Imperiled; SH = species occurred historically in the province, and there is some possibility that it may be rediscovered.

Boreal Felt Lichen (*Erioderma pedicellatum*), Atlantic population (hereafter Boreal Felt Lichen), is listed as Endangered under the New Brunswick *Species at Risk Act* and the Nova Scotia *Endangered Species Act*.

3. Species Information

3.1 Species Description

Lichens are distinct symbiotic organisms made up from the association of microscopic algae or cyanobacteria and filamentous fungi. Boreal Felt Lichen is a leafy lichen, with distinctive upturned edges that reveal white undersides. The range of colour of the lichen is determined by the hydration of the lichen body called the thallus. It appears bluish-green when moist and dark grey to greyish-brown when dry. The photosynthetic symbiont in Boreal Felt Lichen is a cyanobacterium. Boreal Felt Lichen most commonly measures 2-5 cm in diameter, although it can be up to 12 cm in diameter. The surface of mature thalli[4] develops many red/brown apothecia (fruiting bodies). Soredia/isidia (vegetative propagules) are not present. This lichen has a generation time of approximately 20 to 30 years. Evidence suggests that the genus may be among the oldest of foliose lichens, perhaps well over 400 million years old (Maass and Yetman 2002).

3.2 Species Population and Distribution

Boreal Felt Lichen historically occurred in Europe (Norway and Sweden) and North America (New Brunswick) and persists in Nova Scotia and Newfoundland. New populations have been discovered recently in Alaska (Nelson et al. 2009, Stehn et al. 2013) and Russia (COSEWIC 2014).

In Canada, there are two populations of Boreal Felt Lichen. The Boreal population in Newfoundland, conservatively estimated to be 15,000 mature thalli, is considered to be relatively large and all potential suitable habitat has not been searched (COSEWIC 2014). The Atlantic population was extirpated from Campobello Island, New Brunswick and it has not been recorded in New Brunswick since the early 20th century (Cameron et al. 2009). The Atlantic population in Nova Scotia was estimated to be 317 thalli (19 of which are juveniles) (COSEWIC 2014). Currently, Boreal Felt Lichen is known to be extant at 54 sites and there are another 14 sites where the species is no longer present but conditions remain suitable for its growth (MTRI unpublished data). The population is distributed within 25 km of the Atlantic Ocean and occurs in Shelburne, Queens, Halifax, Guysborough, Richmond, and Cape Breton Counties (Figure 1). While many new sites have been found since the original federal recovery strategy (Environment Canada 2007), declines at known sites continue to occur. The 10 year decline for the species was estimated at 34% (COSEWIC 2014).

[4] The body of a plant that does not have leaves, stems and roots.

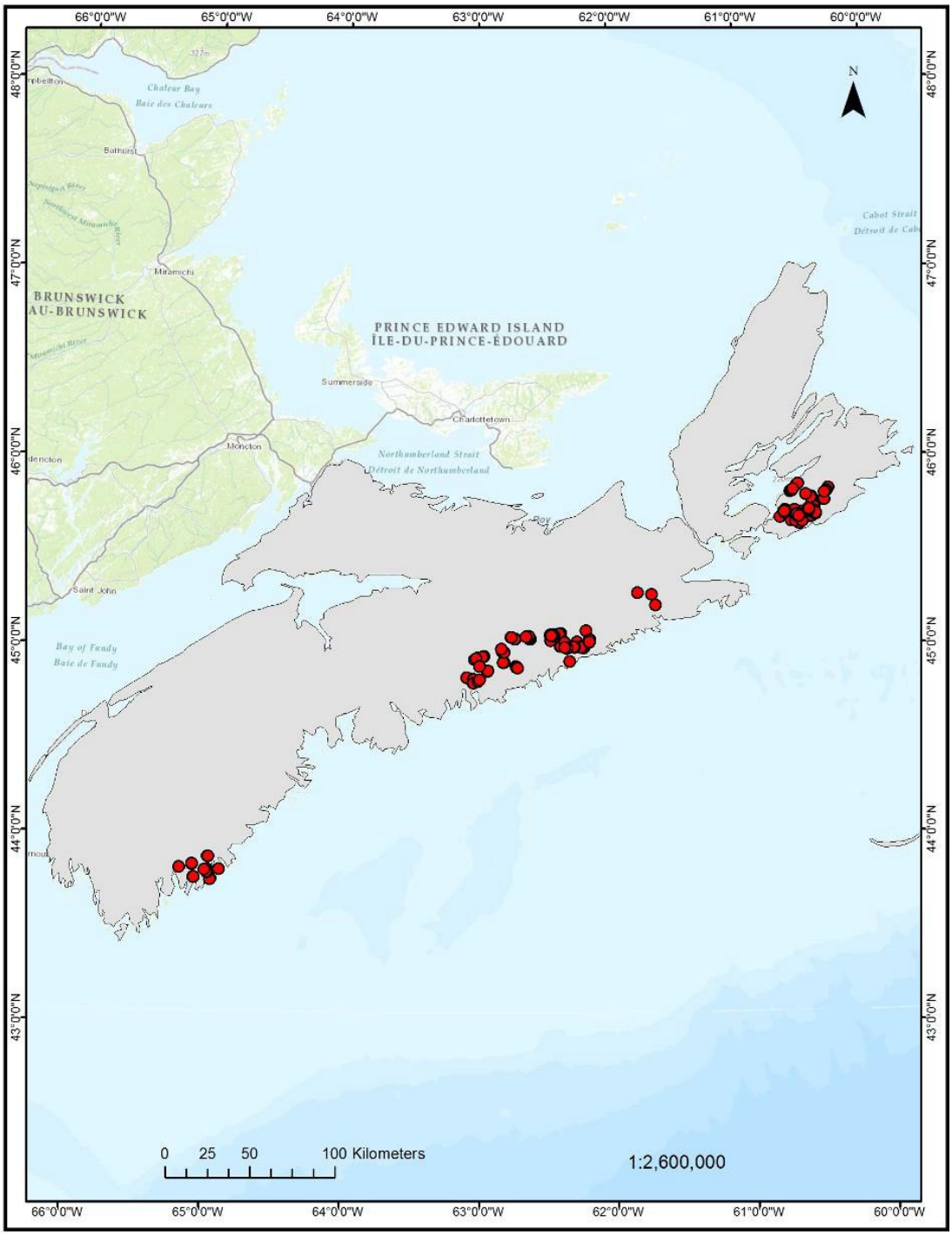

Figure 1. Boreal Felt Lichen distribution in Nova Scotia (2003-2015). Note that some plotted points overlap.

3.3 Needs of Boreal Felt Lichen

In Nova Scotia, Boreal Felt Lichen requires cool, humid, forests containing Balsam Fir (*Abies balsamea*). Historically, in Nova Scotia, it was found on other tree species (Black Spruce (*Picea mariana*), White Spruce (*Picea glauca*), Red Maple (*Acer rubrum*), White Birch (*Betula papyrifera*) but recently has only been observed on Balsam Fir. It is typically found on mature trees on north or northeastern exposure in or adjacent to sphagnum-rich wetlands within 25 km of the Atlantic Ocean and < 200 m above sea level. A wetland is land that is either periodically or permanently saturated with water and sustains aquatic processes (interpreted from the Nova Scotia Wetland Conservation Policy 2011; refer to Appendix C for the provincial definition).

Cyanolichens are particularly sensitive to air-borne pollutants such as sulphur dioxide, nitrogen oxides, and Acid Rain (Hawksworth and Rose 1970, Gilbert 1986, Sigal and Johnston 1986, Hallingback 1989, Richardson and Cameron 2004). The decline of Boreal Felt Lichen in Atlantic Canada has been at least partially attributed to acid rain and air-borne pollutants (Mass and Yetman 2002).

Boreal Felt Lichen is biologically limited by the following factors: its globally limited distribution and small population size; its requirement for bark substrates of a specific acidity; the nature of its life cycle (Boreal Felt Lichen does not produce any type of joint fungal–bacterial propagule; therefore, it must re-establish itself each generation from its separate components); its apparent hypersensitivity to acidification of its substrates and/or to direct adverse effects of air pollutants such as nitrogen oxides and sulphur dioxide; and increasing evidence that it requires a very specific microclimate (Power unpublished data). At this time, it is necessary to determine whether or not the quality or quantity of forest habitat available is inherently limiting to Boreal Felt Lichen recovery.

4. Threats

4.1 Threat Assessment

The Boreal Felt Lichen threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. 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 the section Description of Threats.

Table 2. Threat Calculator Assessment (COSEWIC 2014)

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
1	Residential & commercial development	Low	Small	Serious	High
1.1	Housing & urban areas	Low	Small	Serious	High
3	Energy production & mining	Negligible	Negligible	Extreme	Moderate
3.1	Oil & gas drilling	Negligible	Negligible	Unknown	Moderate
3.2	Mining & quarrying	Negligible	Negligible	Extreme	Moderate
3.3	Renewable energy	Negligible	Negligible	Extreme	Moderate
4	Transportation & service corridors	Low	Restricted	Moderate	High
4.1	Roads & railroads	Low	Restricted	Moderate	High
5	Biological resource use	High	Large	Extreme	High
5.3	Logging & wood harvesting	High	Large	Extreme	High
6	Human intrusions & disturbance	Negligible	Negligible	Negligible	High
6.3	Work & other activities	Negligible	Negligible	Negligible	High

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
8	Invasive & other problematic species, genes & diseases	Medium - Low	Pervasive	Moderate – Slight	High
8.1	Invasive non-native/alien species/diseases	Medium - Low	Pervasive	Moderate – Slight	High
8.2	Problematic native species[e]	High	Pervasive	Serious	Moderate
9	Pollution	High - Medium	Large	Serious – Moderate	High
9.5	Air-borne pollutants	High - Medium	Large	Serious – Moderate	High
11	Climate change & severe weather	High - Low	Large - Small	Extreme	High
11.1	Habitat shifting & alteration	High - Low	Large - Small	Serious – Slight	High
11.4	Storms & flooding	Low	Small	Extreme	High

[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 3-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.

[e] = Problematic native species was not calculated by COSEWIC (2014). New information regarding this threat has become available. The impact of this threat was calculated by R. Cameron

4.2 Description of Threats

Threats with low to high impact are listed as above in the threat calculator assessment table (Table 2) and are described in more detail below.

1.1 Housing & urban areas and 4.1 Roads & railroads: The level of threat to Boreal Felt Lichen from land development fluctuates as new sites are discovered and accessibility to sites changes. The development of land for activities such as industry, residences, forestry, and agriculture creates disturbance, landscape alterations, and affects micro-climates of nearby forests. New road development may alter landscape hydrology (Cameron 2006) and also provides access to remote areas (Maass and Yetman 2002).

5.3 Logging & wood harvesting: In addition to acid precipitation, forestry activities are considered the other major threat to the Atlantic population of Boreal Felt Lichen. Forest practices such as clear cutting or harvesting on a large scale may cause fragmentation, alter the age structure of potential Boreal Felt Lichen habitat, and simplify the biodiversity of forest stands.

Entire locations of Boreal Felt Lichen may be destroyed by large-scale clear cutting, particularly if the presence of Boreal Felt Lichen has not been identified. The effect of forest fragmentation on epiphytic lichens, like Boreal Felt Lichen, has been the subject of some work (e.g., Esseen and Renhorn 1998, Rheault et al. 2003, Pykala 2004, Richardson and Cameron 2004, Cameron et al. 2013a, and Cameron et al. 2013b). When lichens are suddenly at the edge of a forest or in a fragmented forest, there is a reduction in dispersal ability and opportunity to recolonize in cutover areas (Rheault et al. 2003). Adjacent harvesting can increase the lichen's exposure to the drying effects of sun, wind, and temperature (Hunter 1990, Cameron et al. 2013a) and greatly reduce the ability of a forest stand to buffer against periods of low humidity while at particular seral stages (Maass and Yetman 2002). Such effects have been shown to negatively impact lichens within 50 m of an edge (Eseen and Renhom 1998, Rheault et al. 2003). Some researchers suggest that this was the cause of Boreal Felt Lichen extirpation from Vãrmland, Sweden, where logging took place in the immediate vicinity of the park where Boreal Felt Lichen thalli were known to occur (Maass and Yetman 2002).

In 2005, at the oldest known Boreal Felt Lichen site in Nova Scotia, a lone thallus on the west side of the site was lost to a blowdown (Cameron and Neily 2008). Although blowdowns are not infrequent events, an adjacent clear cut (estimated to have occurred in 2000 or 2001) likely increased the vulnerability of this site to blowdowns and drought.

In Nova Scotia, harvested stands are often replanted with unsuitable phorophyte species that have more acidic bark than Balsam Fir, such as Black Spruce, White Spruce, Red Spruce (*Picea rubens*), and Norway Spruce (*Picea abies*) (Canadian Council of Forest Ministers 2005). Even-aged tree plantations are also not favourable to the establishment of new colonies of *cyanobacteria* or *Rhizonema* (a genus of photosynthetic cyanobacteria), *Frullania* (a type of liverwort), or juvenile Boreal Felt

Lichen because of their low light conditions (Maass and Yetman 2002). Results from a recent habitat supply model (Cameron et al. 2013b) suggest that predicted suitable habitat for Boreal Felt Lichen in Nova Scotia is being harvested faster than stands can regenerate and Cameron et al. (2013b) projected a 25% decline in the amount of suitable habitat between 2005 and 2055 if harvesting continues at the same levels.

8.1 Invasive non-native/alien species/diseases: Many groups of arthropods including mites, springtails, and slugs are known to graze on mosses, bark, and lichens (COSEWIC 2014). The effects of browsing on Boreal Felt Lichen are evident at some sites and may pose a serious problem for the lichen in Nova Scotia. Evidence of gastropod grazing on Boreal Felt Lichen was recorded in Nova Scotia (Cameron 2009) and between 2004 and 2013, 24% (n=449) of lichens monitored showed evidence of grazing. Three species of gastropods were found feeding on cyanolichens (Cameron 2009): *Pallifera dorsalis*, a small native gastropod; and *Arion subfuscus* and *Deroceras reticulatum*, larger aggressive species introduced from Europe (Davis 1992). Mollusc grazing can play an important part in shaping the epiphytic vegetation of deciduous forests and juvenile thalli seem to be at particular risk (Asplund and Gauslaa 2008). A Boreal Felt Lichen thallus near Lower Meaghers Grant was in the process of being heavily grazed by gastropods during a site visit in 2004 (Cameron and Neily 2008). A collected specimen was later identified as *Arion subfuscus*, a non-native introduction from Europe (Cameron and Neily 2008).

8.2 Problematic native species: Spruce Budworm (*Choristoneura fumiferana*) is one of the most damaging natural pests of mature softwood forests in eastern Canada (NRCAN 2014). The insect's preferred host is Balsam Fir (Miller 1963) and severely defoliated trees will die within three to four years. Outbreaks are projected to occur in the near future as part of the insect's natural outbreak cycle (COSEWIC 2014).

9.5 Air-borne pollutants: Cyanolichens are extremely sensitive to air-borne pollutants and acid precipitation due to their reliance on air-borne nutrients and water, as well as their lack of protective structures (Richardson and Cameron 2004). Sulphur dioxide dissolved in precipitation, water films, or within moist lichen thalli is highly toxic to cyanolichens and is most toxic under acidic conditions. Sulphur dioxide and nitrogen oxides emitted during the high temperature burning of coal or oil remain in the atmosphere for relatively long periods of time before being washed out by rain and forming acid rain. Acid precipitation is destructive to Boreal Felt Lichen in three ways: it causes immediate damage to the thallus through uptake of air pollutants which is suggested to be the cause of damage to the holdfast mechanism (observed by W. Maass); it affects the cyanolichen nitrogen fixing enzyme which is intolerant of sulphur dioxide; and it further acidifies the naturally acidic substrates (Maass and Yetman 2002).

Although there have been significant declines in air-borne pollutants in Atlantic Canada over the last two decades, acid rain and acid fog from transboundary pollution are still negatively impacting the environment (Canadian Council of Ministers of the Environment, 2011, 2013, Cox et al. 1989). The amount of acid deposition that an area

can tolerate is known as its critical load. Nova Scotia has among the lowest critical load thresholds in eastern Canada (Nova Scotia Environment 2015) and at present, it is predicted that many areas in New Brunswick and Nova Scotia receive acid deposition in excess of critical loads (Environment Canada 2004). Airflow dynamics carry air pollutants originating from cities along the northeastern United States and southern Ontario (COSEWIC 2014). These pollutants, in addition to local pollution sources, result in acidified precipitation (Beattie et al. 2002, Richardson and Cameron 2004). Acid fog is created by the collision between cold air masses over the Gulf of Maine and the Bay of Fundy and warm, humid, pollutant-bearing air masses coming upward along the Atlantic Coast (Cox et al. 1989). Acid fog is additionally problematic for the species as it envelops the lichen for extended periods of time (Cox et al. 1998, Kouterick et al. 1998), thus increasing exposure. Future industrial developments may further negatively impact the species and its habitat.

The disappearance of Boreal Felt Lichen from New Brunswick has been attributed to the impacts of acid precipitation (New Brunswick Department of Natural Resources 2006).

11.1 Habitat shifting and alteration and 11.4 Storms & flooding: Forest fires may directly destroy Boreal Felt Lichen. They may also have indirect effects because nitrogen-fixing lichens (including all cyanolichens) downwind of forest fire can be destroyed by the small concentration of sulphur dioxide in the smoke (Maass and Yetman 2002).

Although it is difficult to quantify the effects of climate change on lichens, it is expected that they include reductions in range distributions (Maass and Yetman 2002). Lichens with affinities to particular tree species and lichens that require cool, moist habitats, such as Boreal Felt Lichen, may be particularly sensitive to climate change (Maass and Yetman 2002). If predicted changes occur with shifting tree species (Auclair 1987, Auclair et al. 1992, Braathe 1995) as a result of climate change, species like Boreal Felt Lichen that depend on a particular tree species could be negatively affected. Modelling by Bourque et al. (2010) suggests that Balsam Fir may retreat to the coolest portions of Nova Scotia and the area occupied by Balsam Fir will decline by over 90% by 2100 as a result of a changing climate. This would severely limit the available habitat for Boreal Felt Lichen as Balsam Fir is currently its only known host.

Based on field observations, Boreal Felt Lichen cannot endure the heat-induced desiccation that accompanies extreme weather events such as droughts and hurricanes (Fos et al. 1999, Maass and Yetman 2002). Boreal Felt Lichen is also susceptible to high winds which could cause tree falls (Boyce 1988). A severe storm in Guysborough County, Nova Scotia, created a windfall that destroyed one of the Boreal Felt Lichen occurrences discovered there in the 1980s (Maass and Yetman 2002). Recent analysis indicates that fog frequency has declined along the Atlantic coast of Nova Scotia (Beauchamp et al. 1998, Muraca et al. 2001). Boreal Felt Lichen, like several other cyanolichens that mainly occur in coastal fog forests, is very drought–sensitive, and could be negatively impacted if a decline in fog continues.

5. Population and Distribution Objectives

The objectives of this strategy are to ensure the species' known extent of occurrence (i.e., the area that encompasses the geographic distribution of the population) and the health of the population is not impacted by human-induced habitat deterioration or loss (i.e., through biological resource use (of the species' host tree), transportation and service corridors, or residential and commercial development).

Habitat suitability modeling (Cameron and Neily 2008) and recent discoveries of Boreal Felt Lichen suggest that its population size and distribution is likely larger than is currently known. Between 2003 and 2012, only 17% (832 polygons searched of 13,852 predicted polygons) of predicted habitat was searched for Boreal Felt Lichen (COSEWIC 2014).

Proposed recovery actions and existing legislation may be insufficient to prevent the loss of Boreal Felt Lichen from Nova Scotia via air-borne pollutants, including acid rain/fog.

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Actions Already Completed or Currently Underway

In Nova Scotia, lichen inventories, surveys, pre-harvest forest surveys, and opportunistic searching have been ongoing since 2003. Informal outreach has been underway since 2006.

A habitat suitability model, developed in 2006 (Cameron and Neily 2008) and refined in 2010, is used in Crown land harvest planning and environmental assessments to mitigate impacts to potential habitat and guide searches for new Boreal Felt Lichen sites.

The Nova Scotia Department of Natural Resources has developed a Special Management Practice for Boreal Felt Lichen which protects a 100 m forested 'no take' buffer. There is also a requirement for pre harvest surveys on Crown land where harvest blocks overlap with the predictive habitat model.

All Boreal Felt Lichen sites were monitored annually until 2012 when it became unfeasible to reach all sites each calendar year. A collaborative study investigating the influence of harvest regimes on temperature and humidity at Boreal Felt Lichen sites was initiated in 2013 by the Nova Scotia Department of Natural Resources, Mersey Tobeatic Research Institute, Environment Canada (now Environment and Climate Change Canada), and Nova Scotia Environment and is ongoing. A

Nova Scotia Department of Natural Resources study investigating habitat characteristics and forest ecosystem classification is ongoing in Richmond County.

The Nova Scotia Department of Natural Resources undertook an extensive study with available GIS data to determine if predictive habitat model improvement could be completed. Results suggest the current model cannot be improved given the available data, but more research is needed to statistically test explanatory variables. Monitoring data collected over the last 10 years provides a rich database for analyses of population dynamics. For example, annual population rate of change has been calculated and a deterministic population model developed. Other valuable analyses that can be done using these data are juvenile and adult growth and survival rates and generation time analysis.

There are other recovery and guidance documents pertaining to cyanolichens in Atlantic Canada that propose additional activities and measures that may be pertinent for the conservation of Boreal Felt Lichen: the *Recovery Strategy for the Vole Ears Lichen,* (Environment Canada 2014), the *Management Plan for the Blue Felt Lichen [DRAFT]* (Environment and Climate Change Canada, in prep), the *Management Plan for the Boreal Felt Lichen, Boreal population* (Environment Canada 2010), a *Five Year Management Plan for the Boreal Felt Lichen in Newfoundland and Labrador* (Keeping and Hanel 2006), and *Endangered Boreal Felt Lichen Special Management Practices* (Nova Scotia Department of Natural Resources 2012).

6.2 Strategic Direction for Recovery

Table 3. Recovery Planning Table

Threat or Limitation	Priority[a]	Broad Strategy to Recovery	General Description of Research and Management Approaches
All	High	Law and policy	• Engage in existing pollution reduction programs for local and transboundary pollution and greenhouse gasses • Review and revise beneficial management practices (BMPs)/ Special Management Practices (SMPs) for the species and habitat, where necessary • Engage forest certification systems to implement voluntary standards and codes governing private sector practice that are beneficial for the species • Monitor and enforce compliance with relevant laws, policies, and regulations, and voluntary standards and codes
All	Medium-High	Education and awareness, stewardship, and partnerships	• Foster cooperative relationships with landowners, foresters, industry, and volunteers to maintain habitat • Promote volunteer participation in surveys and monitoring • Promote ecosystem conservation through forest certification, if deemed effective for recovery of the species • Promote compliance with Federal, Provincial, and Municipal Acts and Policies as well as BMPs/SMPs that protect the species and its habitat • Promote the species as an indicator of healthy coastal rain forests
Logging and wood harvesting, Storms and flooding, Invasive non-native/alien species/diseases, Housing and urban areas	Medium	Habitat and species protection and management	• Conserve habitat for the species • Prevent gastropods from ascending phorophytes • Develop a protocol for transplanting cyanolichens if a phorophyte is lost

Threat or Limitation	Priority[a]	Broad Strategy to Recovery	General Description of Research and Management Approaches
Knowledge gaps	High	Monitoring and Research	• Implement inventory and monitoring protocols • Determine the necessity of protecting suitable unoccupied habitat for connectivity and colonisation
	Low-Medium		• Research (Appendix B)

[a] "Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.

6.3 Narrative to Support the Recovery Planning Table

Law and policy

Boreal Felt Lichen will benefit from reductions in air-borne pollutants such as sulphur dioxide and nitrogen oxides. It is not feasible to initiate a massive campaign to reduce local and transboundary sources of pollution specifically for the benefit of lichens. Instead, partnerships should be strengthened with government departments to encourage compliance with the *Canadian Environmental Protection Act* and to continue implementing the Canada-Wide Acid Rain Strategy for Post-2000, the Nova Scotia Energy Strategy, the Nova Scotia Climate Change Action Plan, the Newfoundland and Labrador Climate Change Action Plan, and the New Brunswick Climate Change Action Plan.

Special Management Practices (SMPs) were developed for Boreal Felt Lichen in Nova Scotia and apply to provincial Crown lands (Nova Scotia Department of Natural Resources 2012). These SMPs require expert-conducted pre-cut surveys on all areas predicted with a high potential for Boral Felt Lichen occurrence (by the Boreal Felt Lichen habitat model (Cameron and Neily 2008)). Currently, a 100 m forested buffer is enacted and maintained around each Boreal Felt Lichen phorophyte and, where the phorophyte occurs within, or immediately adjacent to, a wetland, a forested buffer of 20 m or greater must be maintained around the perimeter of the delineated wetland. As part of these SMPs, maintenance inspections are to be conducted on all harvested Crown lands at sites which overlap areas with predicted high potential for Boreal Felt Lichen to ensure maintenance of forested buffers around the phorophyte and wetland (Nova Scotia Department of Natural Resources 2012).

The Canadian government supports third-party forest certification as a tool to promote modern sustainable forest management (Canadian Council of Forest Ministers 2015). Thirty-five percent of Nova Scotia is Crown land (Nova Scotia Department of Natural Resources 2013) which can now only be leased for forestry by third-party forest-certified industrial partners (J. Weldon-Genge pers. comm.). Certification standards include precautionary measures to identify and conserve endangered species such as Boreal Felt Lichen and their habitats.

Education and awareness, stewardship, and partnerships

Efforts to communicate with landowners, resource users, developers, land managers, and other stakeholders to promote stewardship and private land conservation are an important part of conserving habitat. It will be necessary to liaise with stakeholders regarding beneficial practices for forest management in the vicinity of Boreal Felt Lichen sites, in unoccupied potential sites adjacent to critical habitat, and to maintain Balsam Fir across the landscape. The experience and knowledge of stakeholders will be important in making management decisions on private and public lands. Protected areas, as well as private lands conserved through private land conservation

mechanisms also have a role to play in the conservation of lichens and should be pursued where feasible.

Cyanolichens can be difficult to identify and often take considerable effort to study and learn, but the right educational materials and delivery may pique the interest of industry, foresters, land managers, students, and naturalists. Identification workshops and seminars for various cyanolichens species will provide a foundation for initial steps towards recovery.

Boreal Felt Lichen is often found in association with other lichens at risk and can be an indicator of a rich lichen community. Boreal Felt Lichen can also be an indicator of the health of Atlantic coastal rain forests.

Habitat and species protection and management

Habitat conservation is required for the survival and recovery of this lichen and to that end, occupied habitat should be secured where possible. Efforts to communicate with landowners and promote stewardship may prove as important as legislation for the recovery of the species' (see previous section).

Gastropods will ascend trees to graze lichens. The climbing of trees can be prevented by a variety of devices such as collars, tapes and traps. These devices can be applied to phorophytes to determine the most effective method to prevent gastropod access to Boreal Felt Lichen. Given the very specific microclimate requirements of the species, research is required to understand the implication (e.g., to the pH of the substrate) of attaching structures to the phorophyte. Research to this end should be undertaken.

Researching a successful protocol for transplanting cyanolichens to nearby host trees when a parent tree is threatened by uncontrollable factors (e.g., storms, blow-downs) may be necessary for the maintenance of this lichen at some sites. Transplantation may also provide a means for rescuing rare populations or maintaining the species' range, but would only be considered in exceptional circumstances. Some success has been achieved in transplanting Boreal Felt Lichen, Boreal population in Newfoundland and Labrador (The Gossan 2010).

Monitoring and research

Monitoring is necessary to evaluate the success of recovery efforts. Monitoring with established protocols will assess the abundance, overall condition of the thalli, habitat characteristics, and apparent threats. Monitoring the health and succession of individual thalli and colonies as well as the long-term habitat conditions will also address some research questions.

Since the distribution-prediction model suggested that other Boreal Felt Lichen locations may exist, continued lichen inventories are necessary to gain accurate distribution

information for the species. Where appropriate, the model results can be used to prioritize new survey locations.

It is important to identify the lichen's sensitivity to specific types and levels of pollutants and determine under what conditions (e.g., timing, duration, life stage of exposure) these pose the greatest threat. Through identification of local point sources of air pollution and atmospheric conditions, the impact of these point sources on the location and survival of cyanolichens can be assessed. Permanent lichen pollution sampling plots managed by Nova Scotia Environment may provide some insights into the impact of air quality on the distribution and abundance of cyanolichens.

Information regarding air-borne pollutants, acid deposition, and meteorological events is available through federal and provincial environment departments and should be assembled and interpreted as it relates to the recovery of cyanolichens. Other threats, such as forestry activity and gastropod grazing, will be researched and monitored directly.

Microhabitat parameters such as humidity, forest composition, forest age structure, and indicator species should be monitored at occupied sites to better define the conditions the species requires.

Other knowledge gaps to recovery that should be addressed, such as life cycle characteristics and dispersal distance, are identified in Appendix B.

7. Critical Habitat

The original recovery strategy identified critical habitat for Boreal Felt Lichen at nine sites. The lichen at one of the nine sites identified in the original recovery strategy was misidentified as Boreal Felt Lichen and as a result, the site is no longer identified as critical habitat.

Identification is considered to be partial at this time because additional information is required to determine whether the critical habitat identified below is sufficient to meet the population and distribution objectives.

Section 41(1)(c) of SARA requires that the recovery strategy include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. Critical habitat is identified in this document to the extent possible given the best available information. A schedule of studies was developed to provide the information necessary to completely identify the critical habitat sufficient to meet the population and distribution objectives.

7.1 Identification of the Species' Critical Habitat

The currently known Boreal Felt Lichen sites share the following biophysical attributes (Cameron and Power, unpublished data, COSEWIC 2014):

- they occur within 25 km of the Atlantic coast at an elevation less than 200 m above sea level;
- they have mature and overmature Balsam Fir tree trunks (i.e., mean standard age of 71.03 years but always > 50 years old and with significantly more dead trees) with *Frullania tamarisci* and very frequently have *Coccocarpia palmicola* growing on them;
- they occur in habitat that is cool and moist that remains relatively constant throughout the year (i.e., annual precipitation between 1200 and 1600 mm with a mean July temperature of less than 16°C and a mean January temperature that is not colder than -6°C);
- they have surrounding forest that is able to provide the constant humid environment that is required by intercepting wind and sunlight, provide protection from weather events that may cause blowdowns, and have the ability to intercept some local air pollution (i.e., distance between trees is a maximum of 5.55 m and crown closure is relatively open (mean = 31.72%));
- they have a floor of sphagnum moss and very often Cinnamon Fern *(Osmundastrum cinnamomeum)*; and
- they are most often located on or at the base of slopes with a north aspect (i.e., > 315 degrees and ≤ 44 degrees) and always within or adjacent to wetlands.

Critical habitat description

Critical habitat is identified in Figures 3-19. At each site, critical habitat for Boreal Felt Lichen is identified as:

- the substrata/phorophyte for growth of Boreal Felt Lichen (at present, only known to be trees and most sites are comprised of very few trees; often only one);
- the wetland (as determined through wetland boundary delineation) in which the substrata/phorophyte occurs, or is adjacent to (refer to Appendix C for the definition of a wetland and information on wetland delineation); and
- a critical function zone[5]. The critical function zone is necessary to maintain the hydrology of the wetland, microhabitat characteristics (especially moisture attributes) required for the survival of the lichen, and to allow for colonization. Based on the best available information, the critical function zone is identified as 500 m around the lichen and its substratum/phorophyte (based on work by Cameron et al. (2013b)) and an area around the wetland in which it occurs, or is adjacent to, dependent on wetland size as follows:
    - for wetlands smaller than 100 m^2, a critical function zone of 100 m radius surrounding the wetland is identified; and
    - for wetlands greater than 100 m^2, a critical function zone of 50 m surrounding the wetland is identified (see Figure 2).

[5] A critical function zone encompasses the area necessary to maintain biophysical functions and/or attributes directly related to the persistence of the lichen. It is not a buffer, but rather a functional extension of the wetland into adjacent lands.

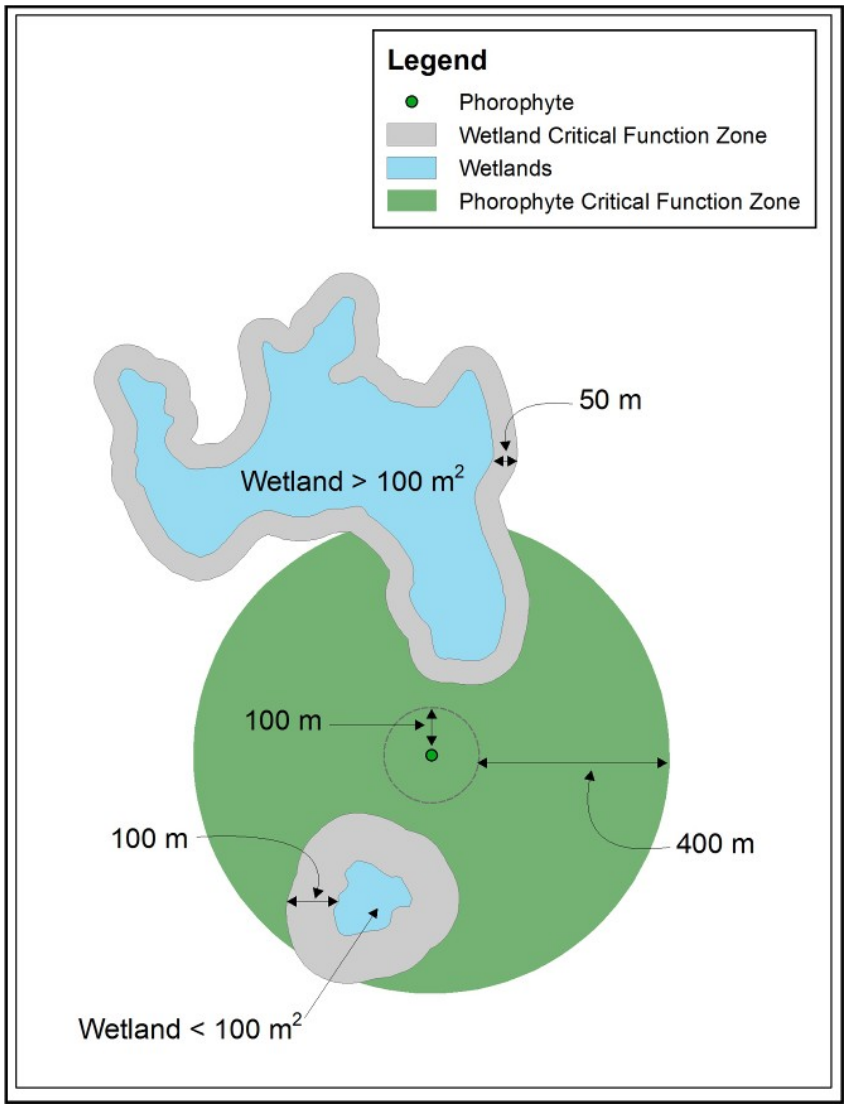

Figure 2. Simplified examples of critical habitat; all areas shaded in light grey or green and the wetland (in blue) are included as critical habitat.

Sites where Boreal Felt Lichen is thought to be lost since 2003 (the year data collection was standardized for the species) are identified as critical habitat as long as the necessary biophysical attributes are still present. This includes fifty-eight trees at 14 sites that have apparently lost their lichens to date but the necessary building blocks (cyanobacterium and filamentous fungi) may still be present at the site and able to colonize given intact biophysical attributes, and juveniles are difficult to inventory until they reach a certain size.

This is considered a partial identification of critical habitat because additional work is required to determine if the critical function zone is large enough to maintain wetland hydrology and essential microhabitat characteristics (see schedule of studies).

The areas containing critical habitat for Boreal Felt Lichen are presented in Figures 3-19. Critical habitat for Boreal Felt Lichen in Canada occurs within the shaded yellow polygons (units where the critical habitat criteria and methodology described in this section are met). The UTM grid overlay shown in the figures is a standardized national grid system that indicates the general geographic area containing critical habitat. More detailed information on the location of critical habitat to support protection of the species and its habitat may be requested, on a need-to-know basis, by contacting Environment and Climate Change Canada's Recovery Planning section at: ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

The identification of critical habitat for Boreal Felt Lichen is updated in this amended recovery strategy based on the best available information as of December 2015 and now includes 68 sites (Figures 3-19) representing 13,201 ha.

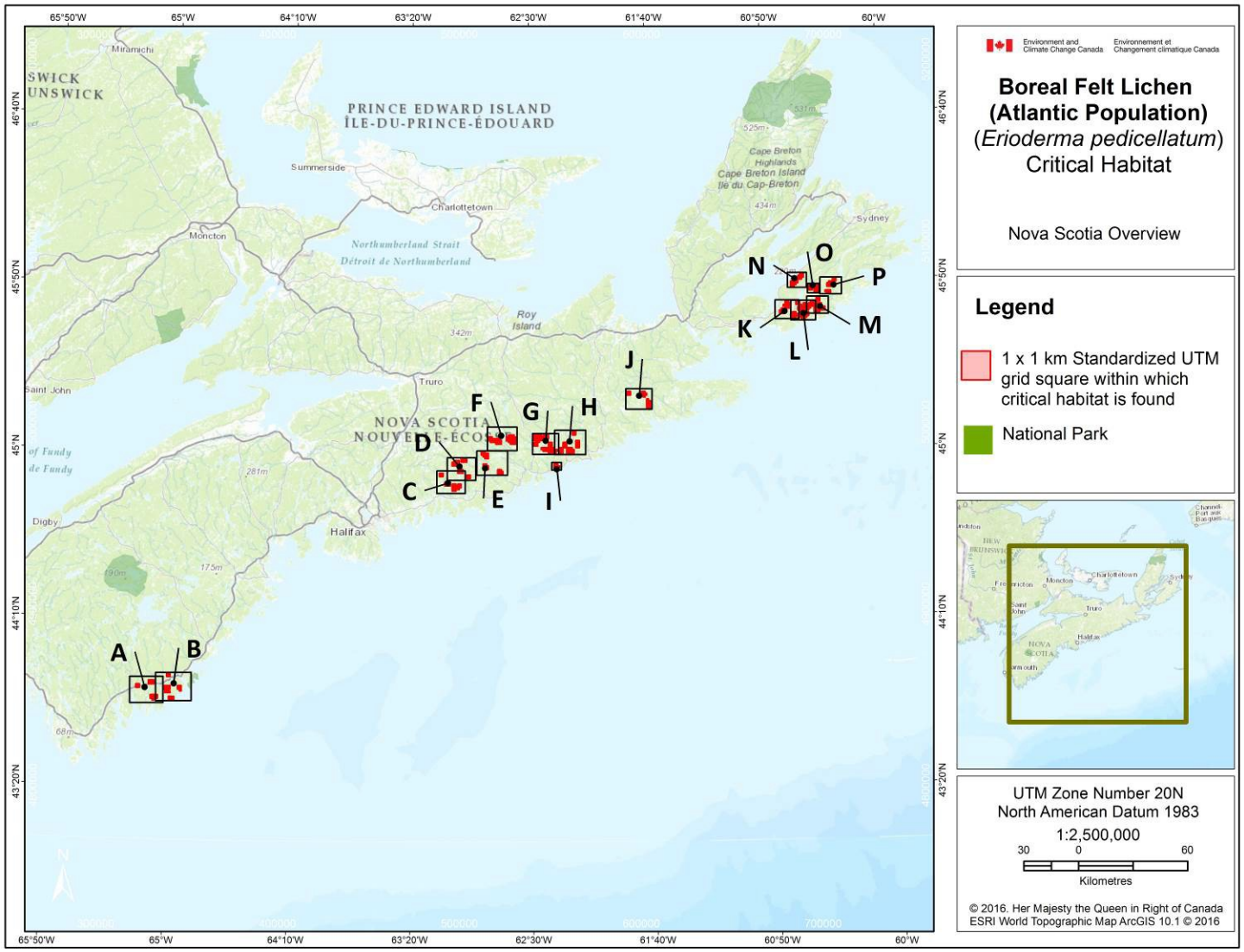

Figure 3. Overview map of critical habitat for Boreal Felt Lichen in Nova Scotia. Refer to figures 4-19 for detailed representations of critical habitat.

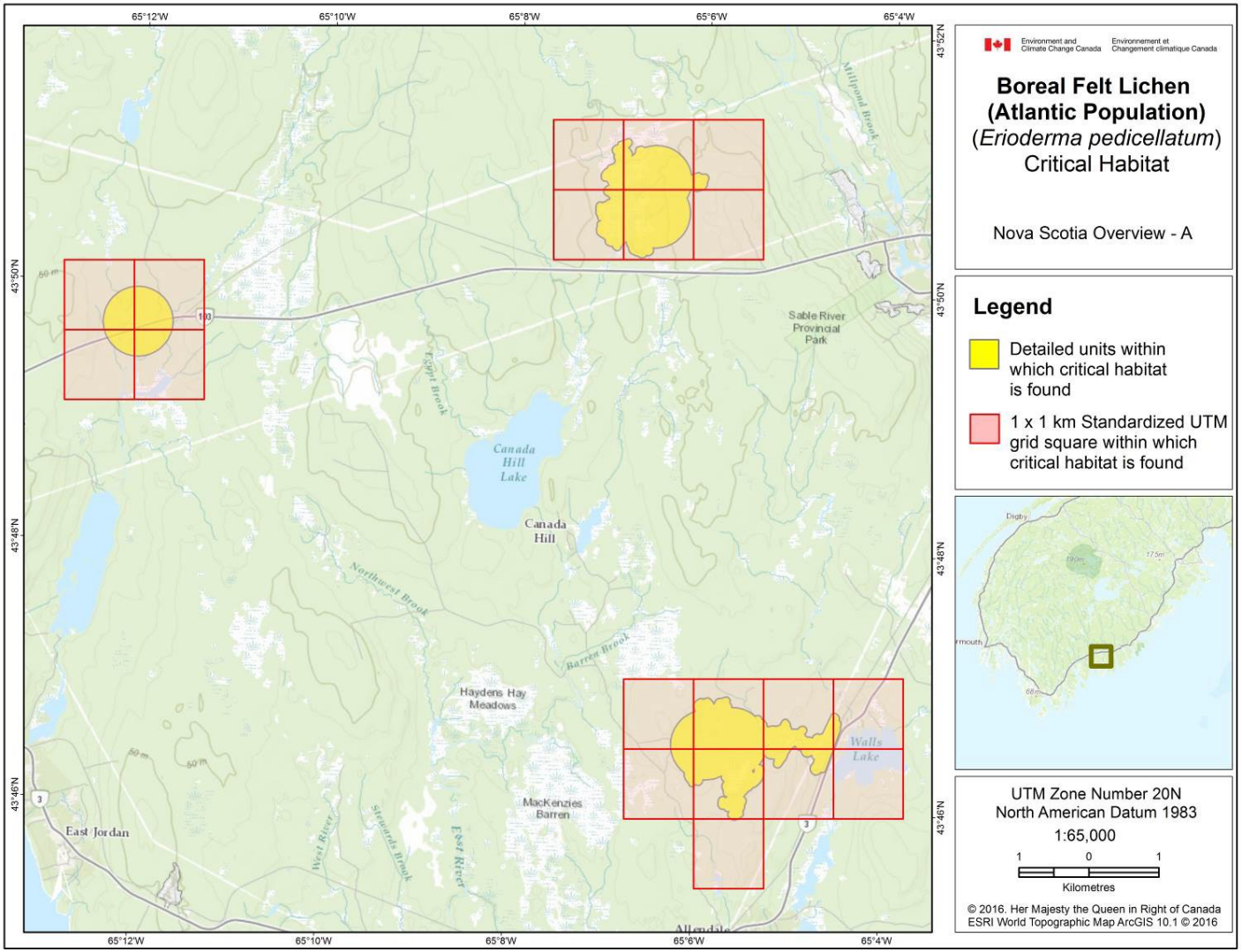

Figure 4. Critical habitat for Boreal Felt Lichen in Shelburne County (see Nova Scotia overview map area A) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

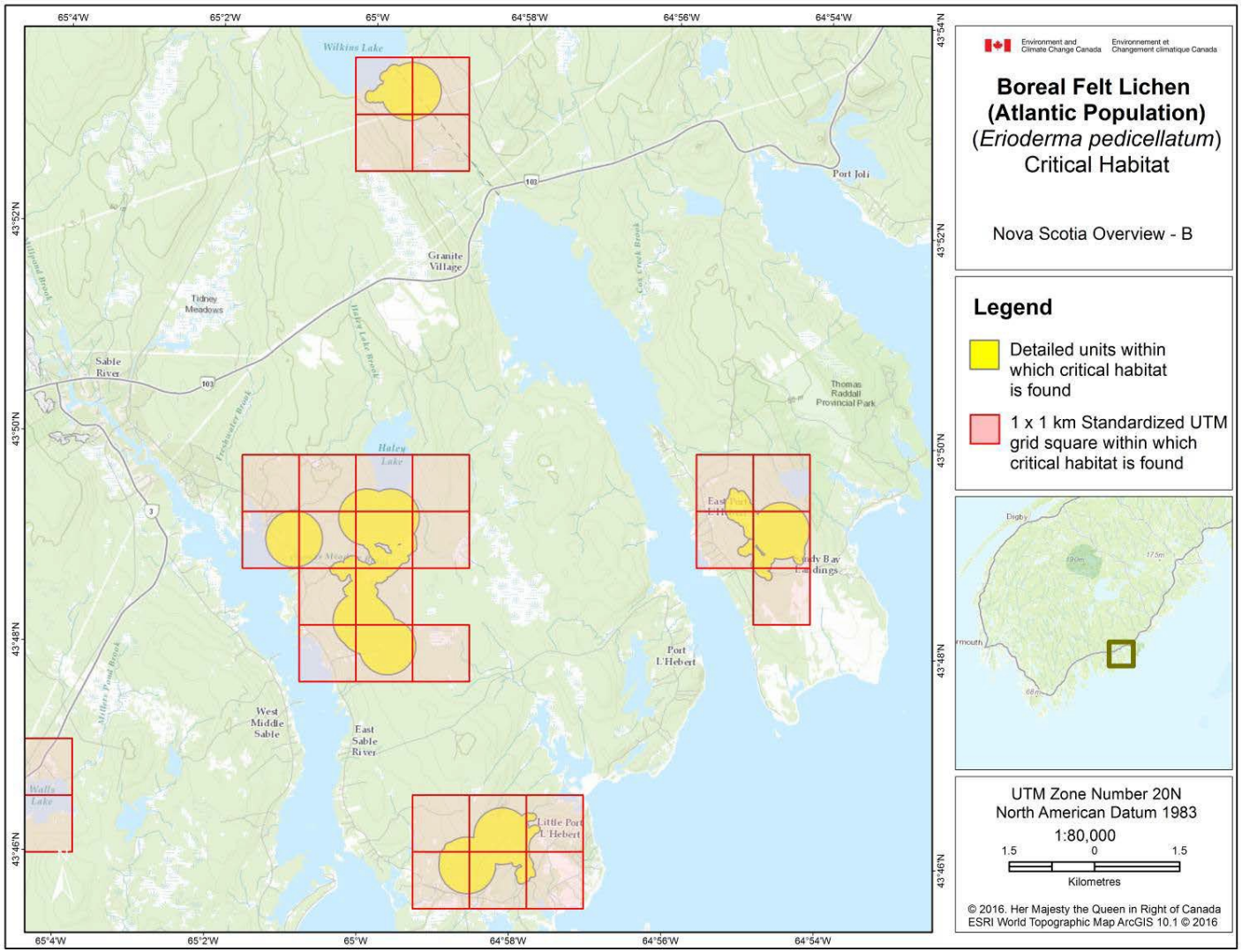

Figure 5. Critical habitat for Boreal Felt Lichen in Shelburne County (east) and Queens County (see Nova Scotia overview map area B) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

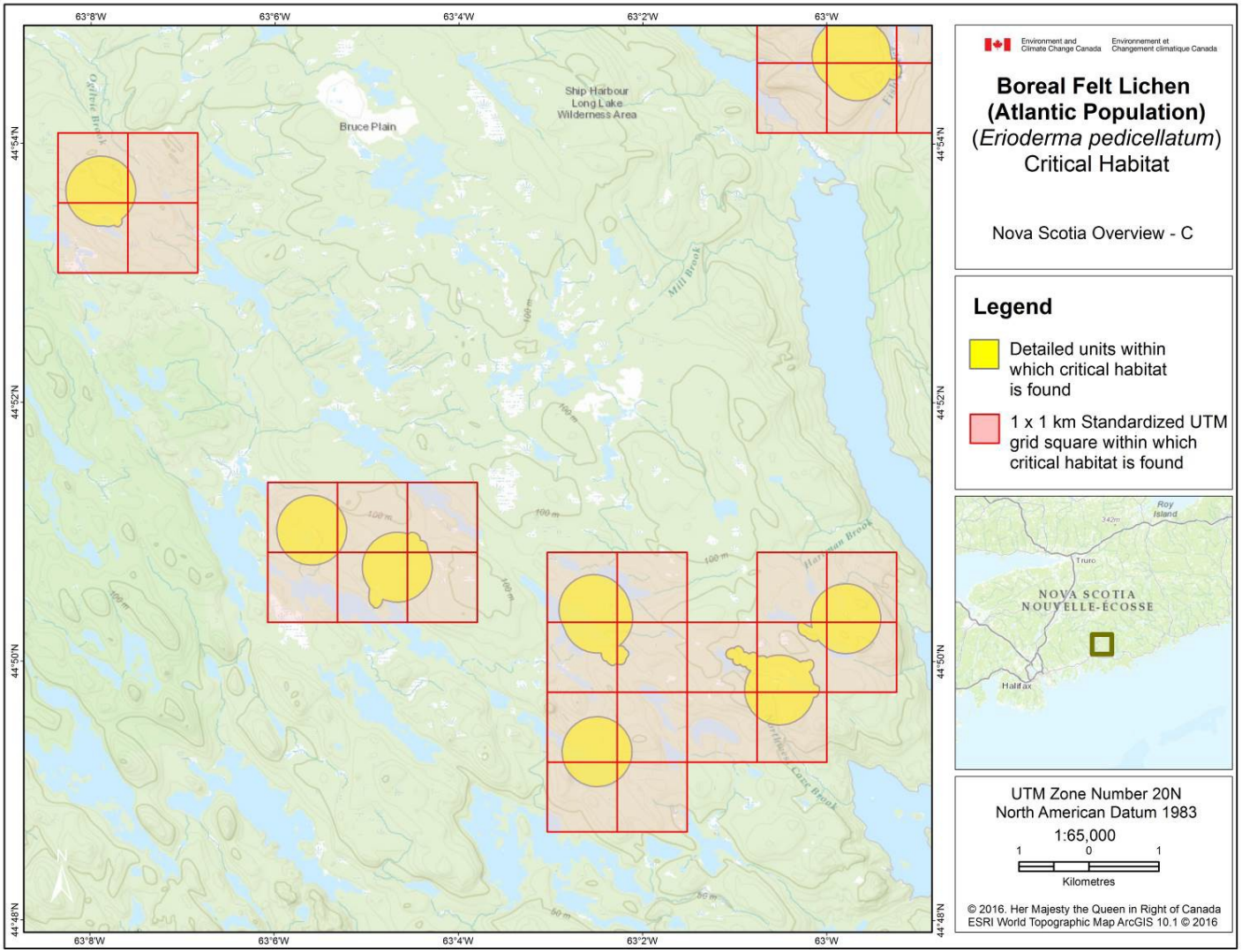

Figure 6. Critical habitat for Boreal Felt Lichen in Halifax County (see Nova Scotia overview map area C) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

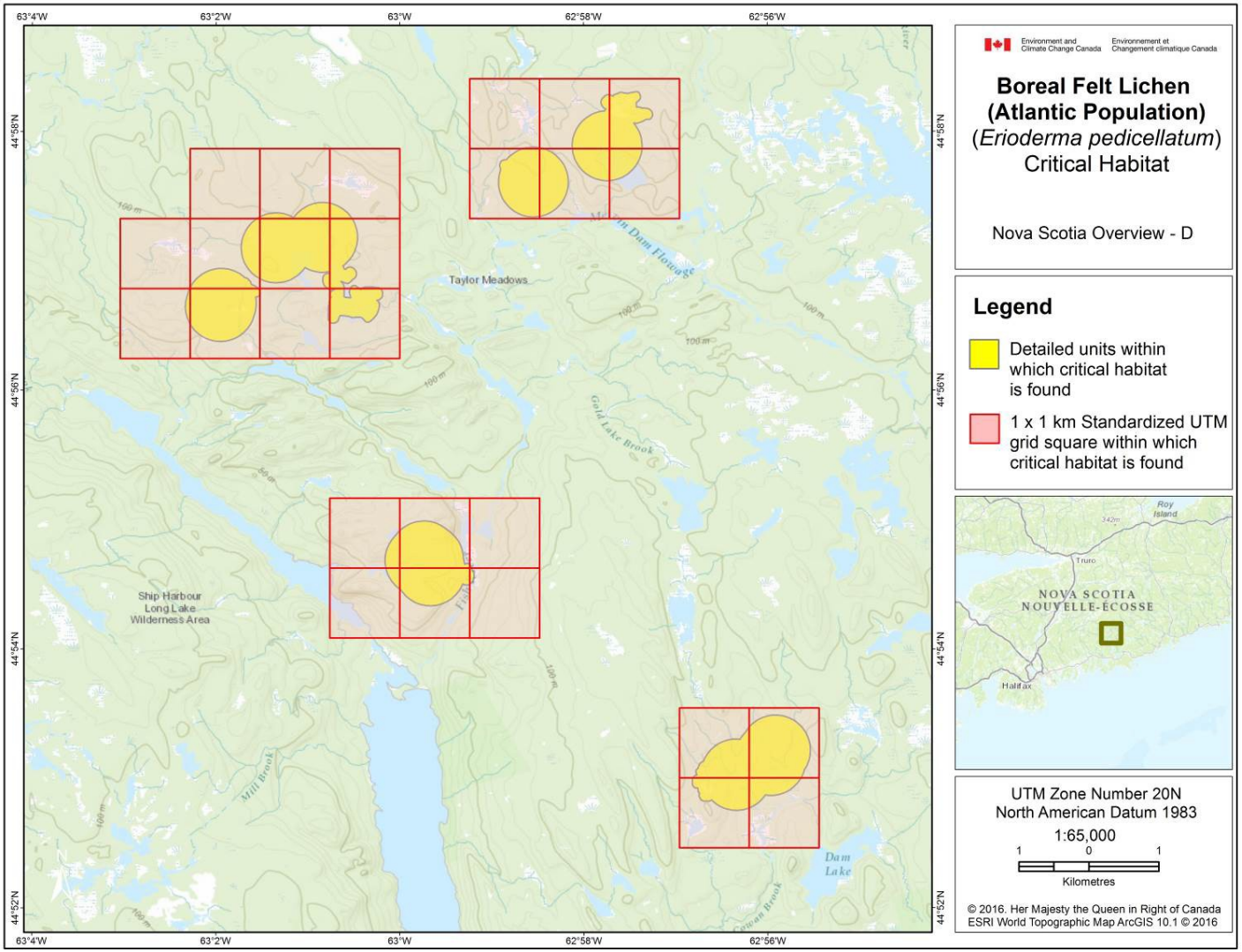

Figure 7. Critical habitat for Boreal Felt Lichen in Halifax County (see Nova Scotia overview map area D) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

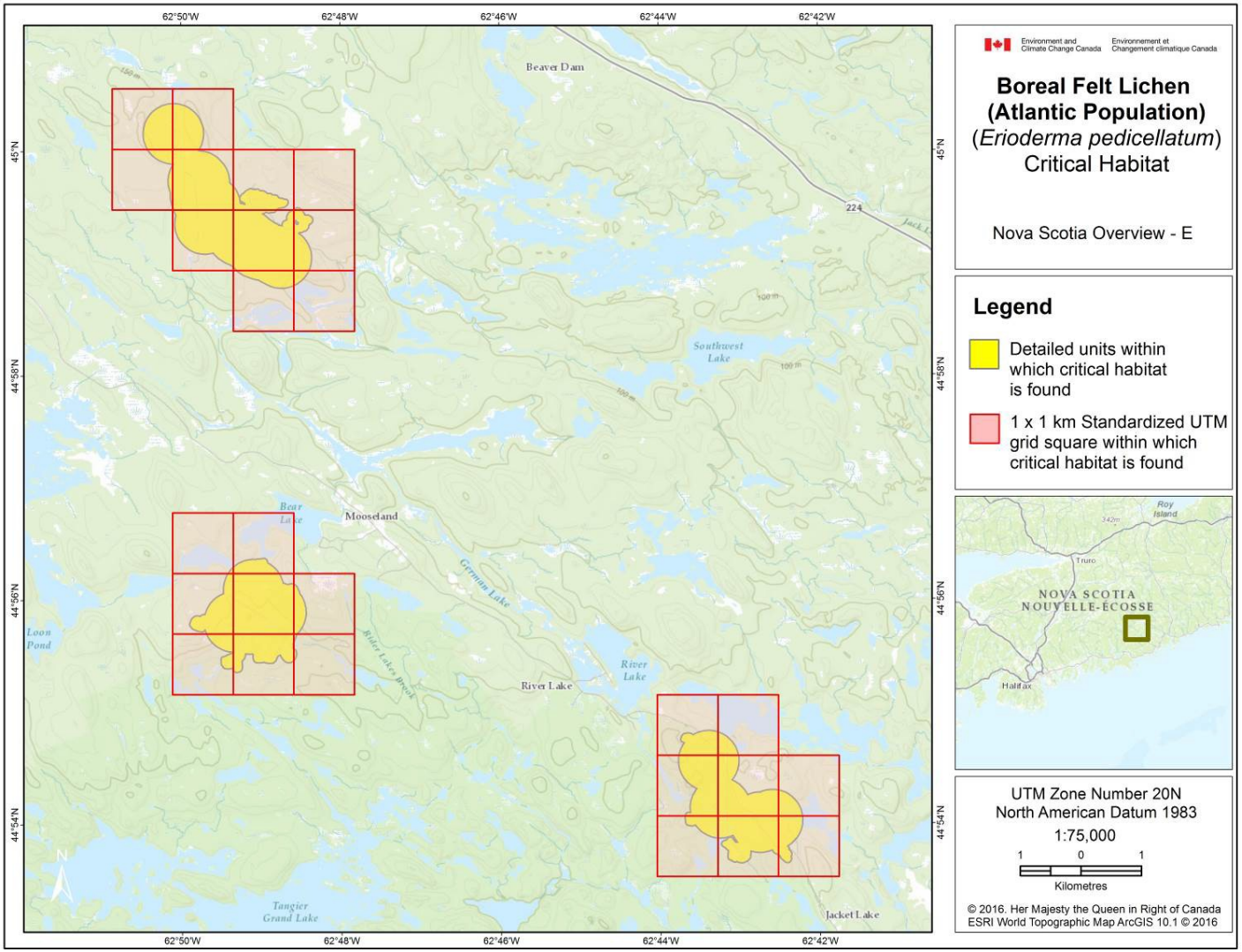

Figure 8. Critical habitat for Boreal Felt Lichen in Halifax County (see Nova Scotia overview map area E) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

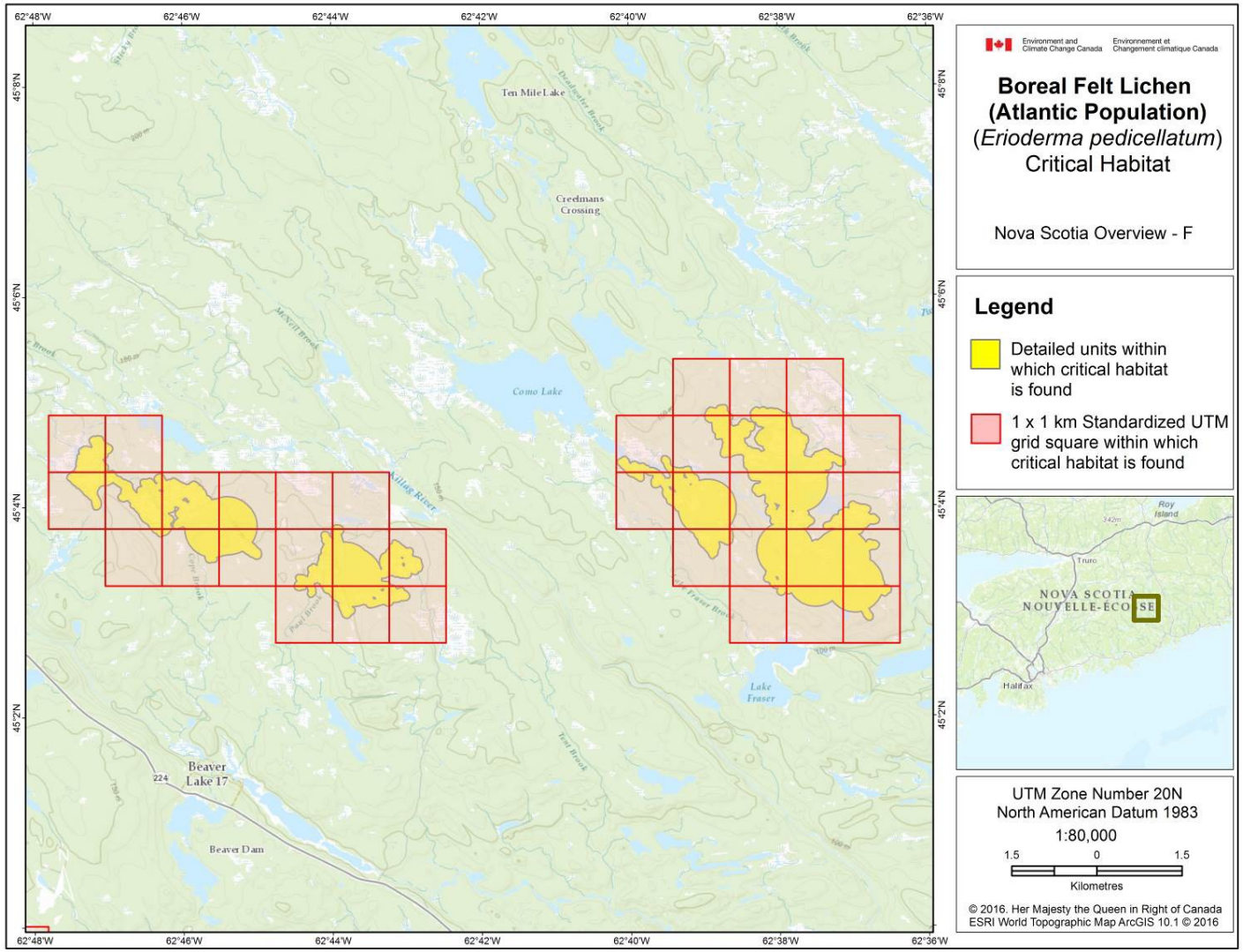

Figure 9. Critical habitat for Boreal Felt Lichen in Halifax County (see Nova Scotia overview map area F) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

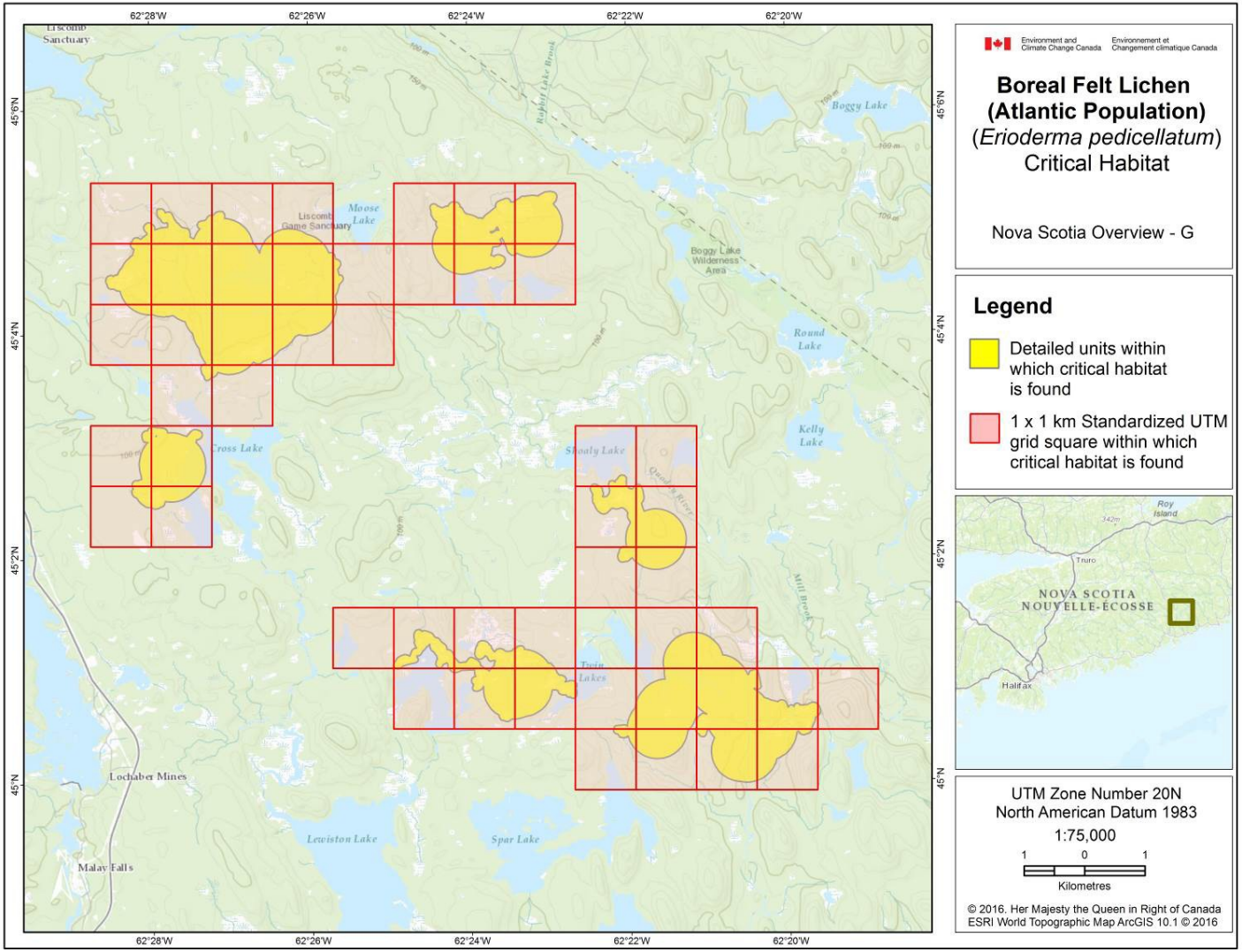

Figure 10. Critical habitat for Boreal Felt Lichen in Halifax County (see Nova Scotia overview map area G) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

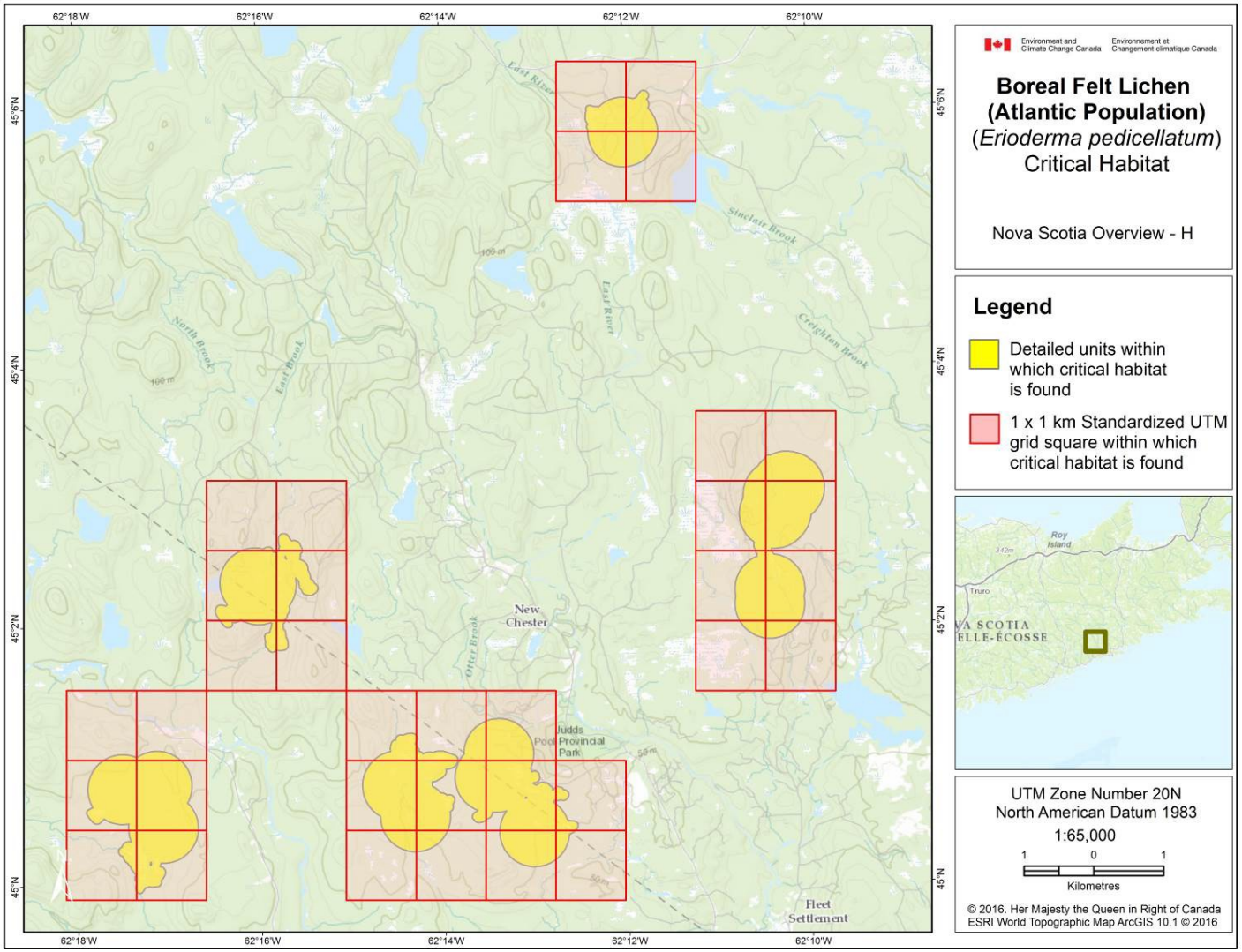

Figure 11. Critical habitat for Boreal Felt Lichen in Halifax County (east) and Guysborough County (see Nova Scotia overview map area H) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

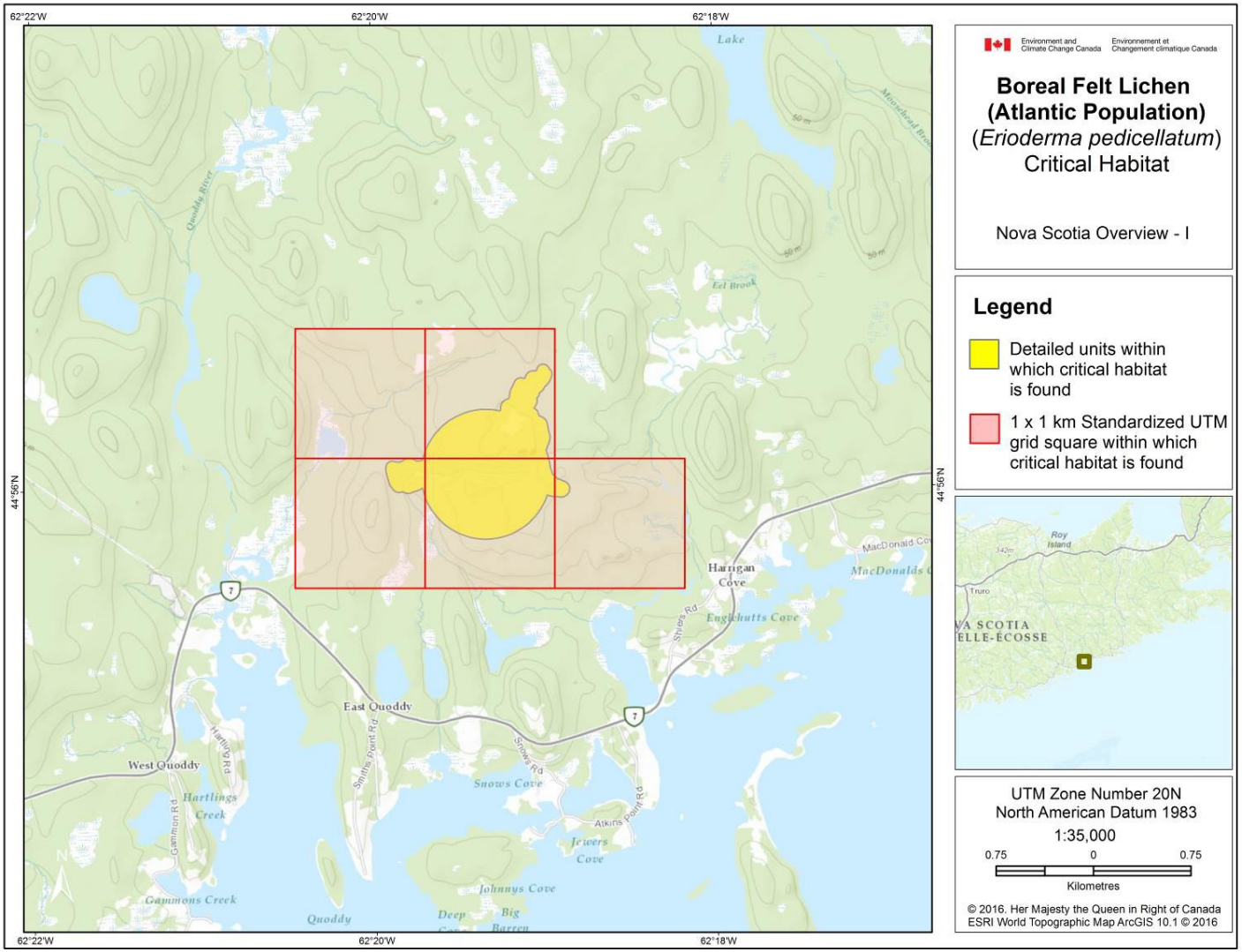

Figure 12. Critical habitat for Boreal Felt Lichen in Halifax County (see Nova Scotia overview map area I) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

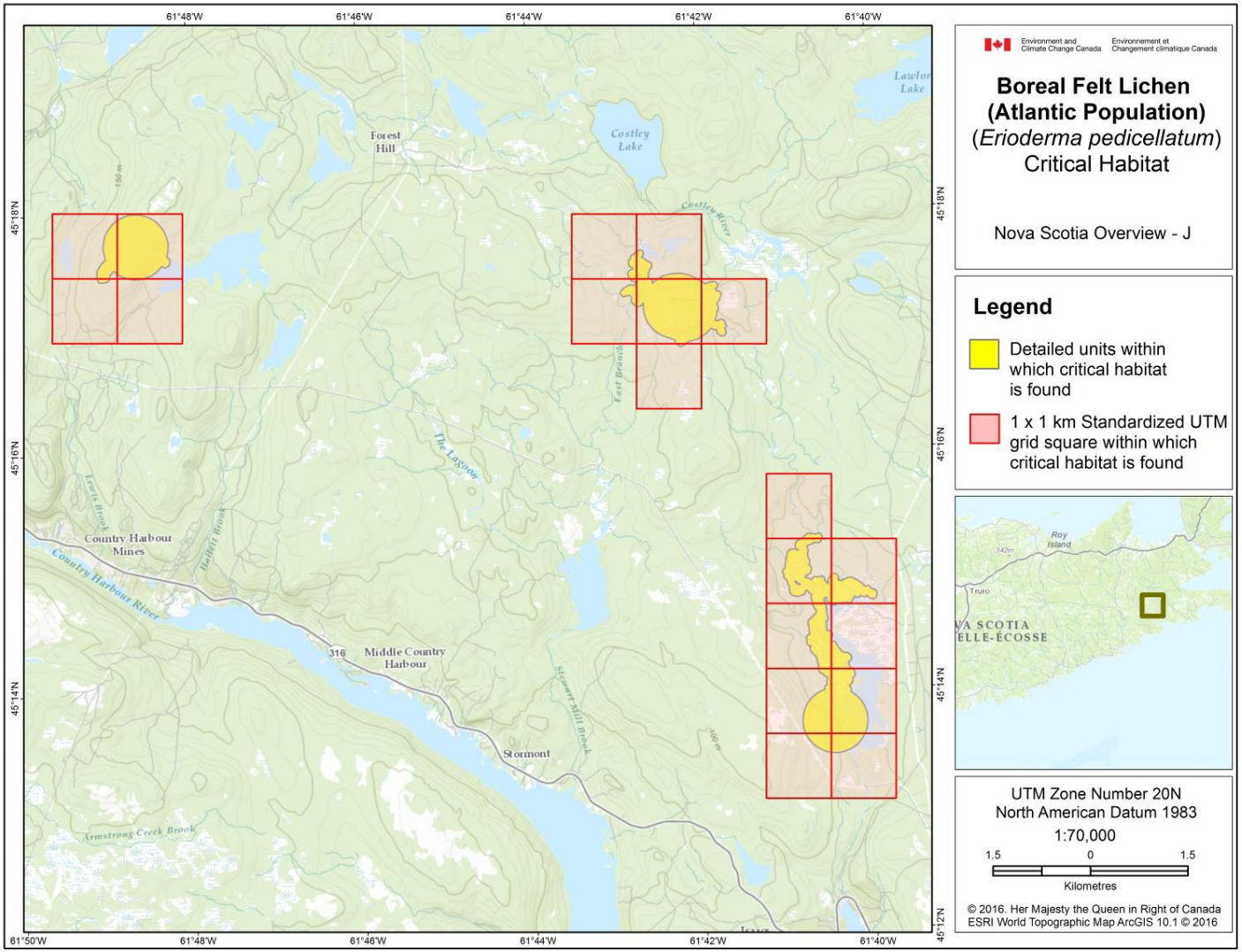

Figure 13. Critical habitat for Boreal Felt Lichen in Guysborough County (see Nova Scotia overview map area J) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

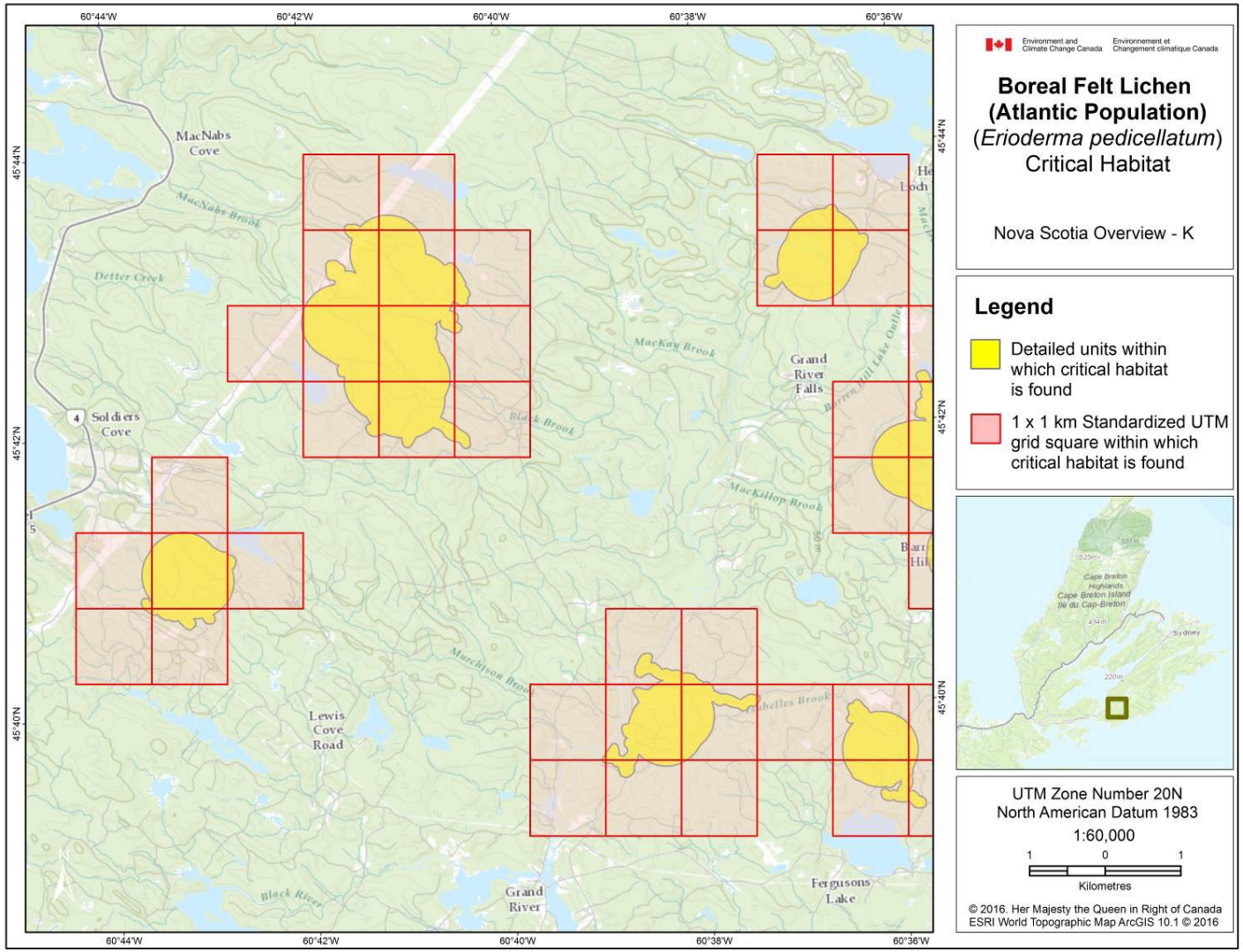

Figure 14. Critical habitat for Boreal Felt Lichen in Richmond County (see Nova Scotia overview map area K) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

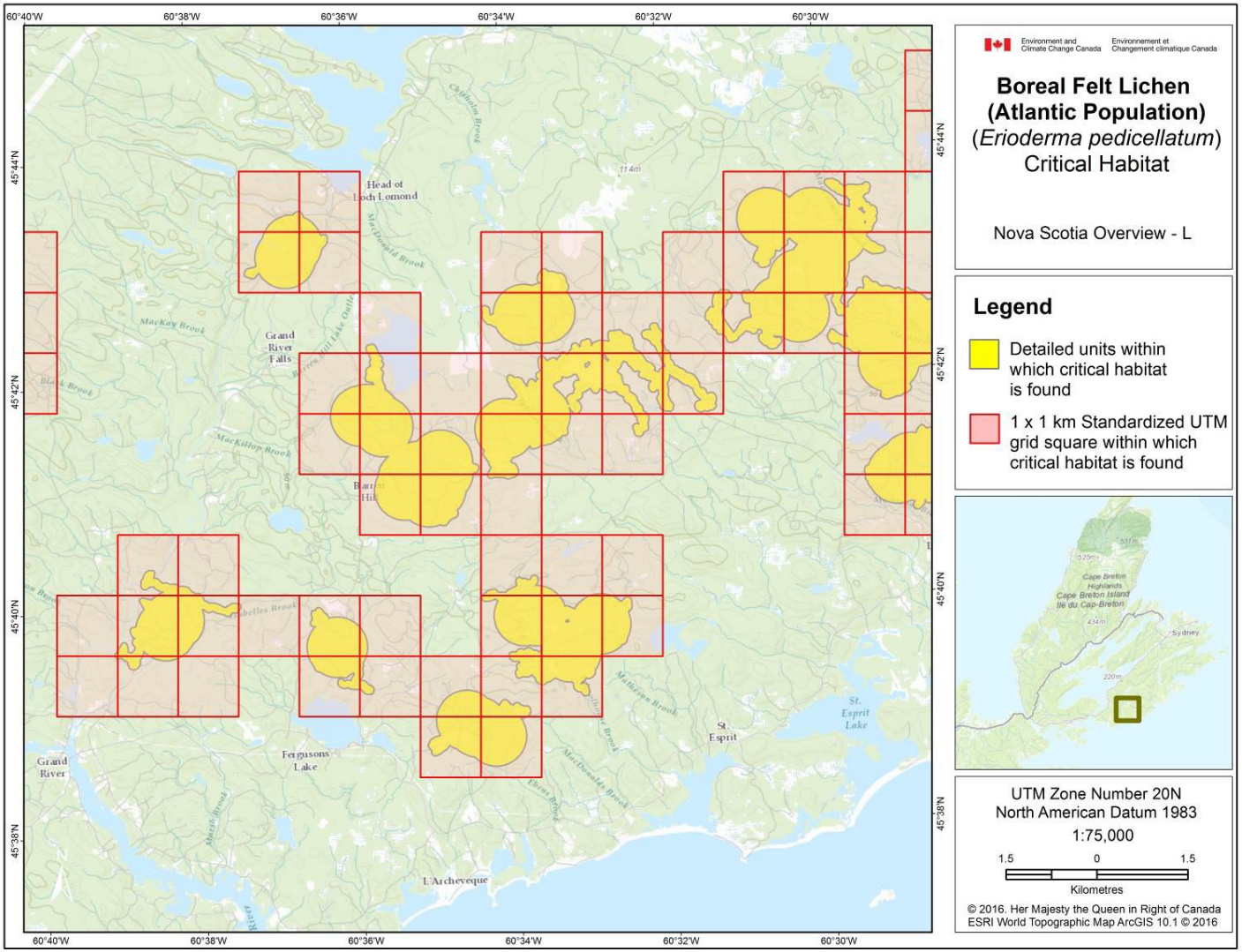

Figure 15. Critical habitat for Boreal Felt Lichen in Richmond County (see Nova Scotia overview map area L) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

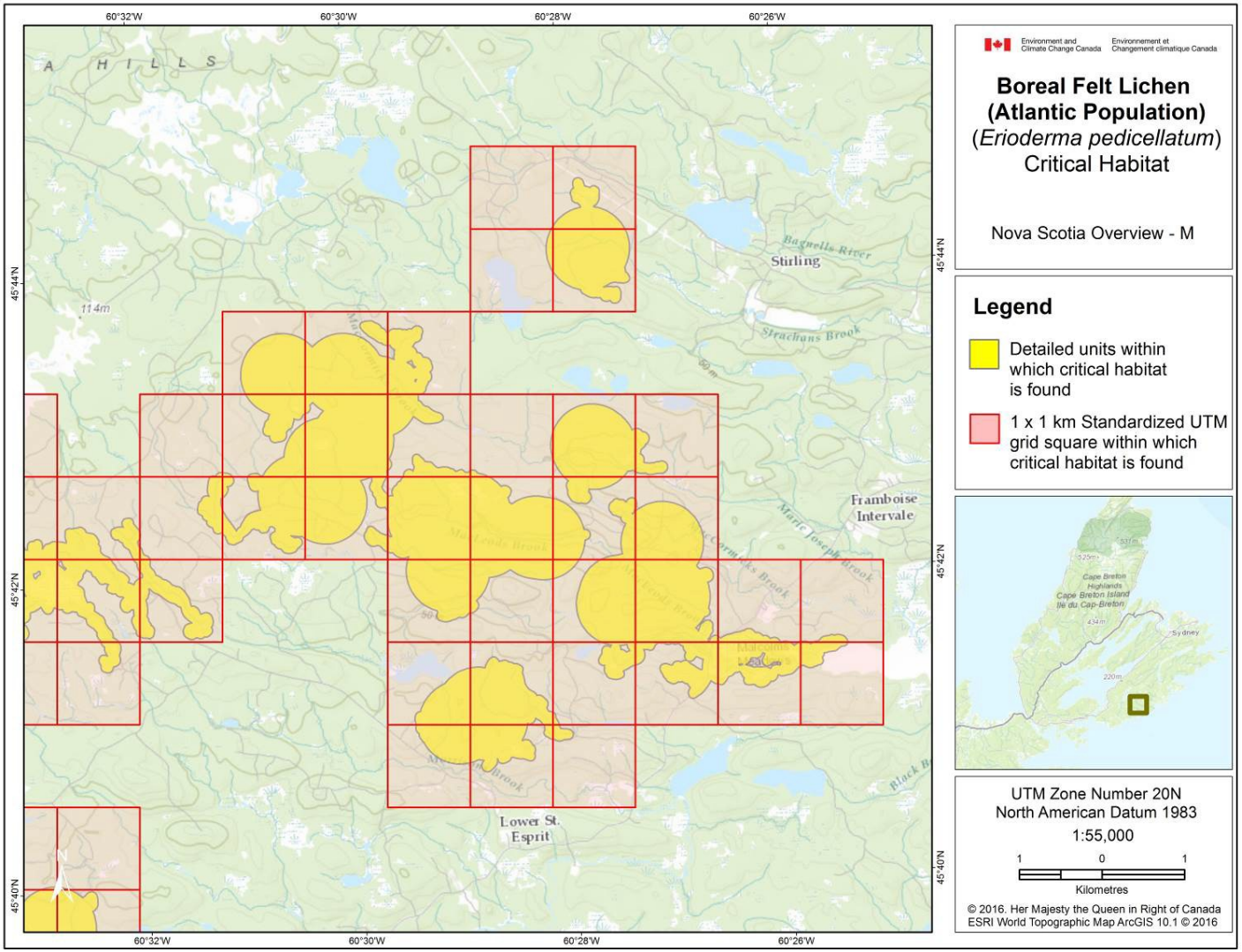

Figure 16. Critical habitat for Boreal Felt Lichen in Richmond County (see Nova Scotia overview map area M) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

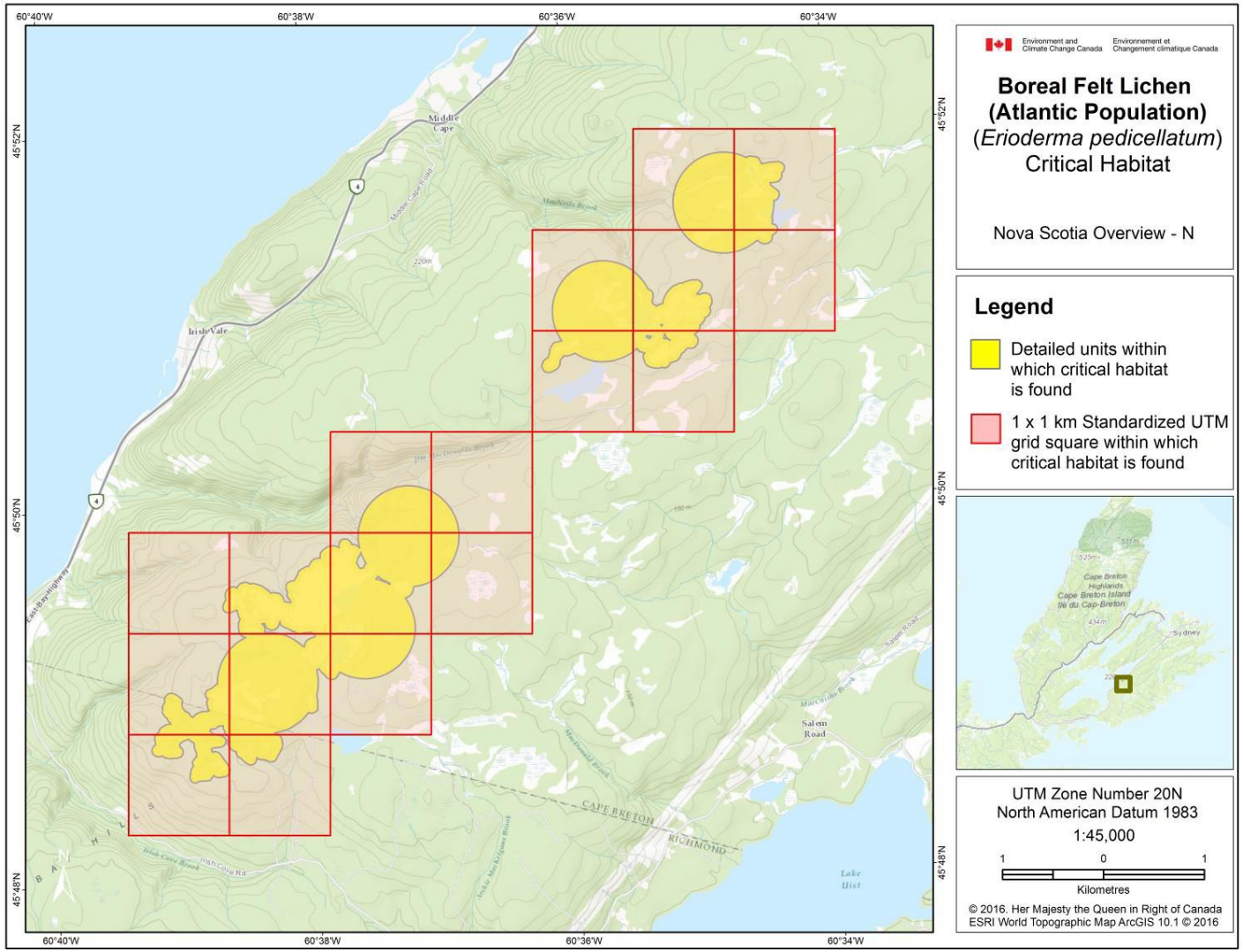

Figure 17. Critical habitat for Boreal Felt Lichen in Richmond and County (east) and Cape Breton County (see Nova Scotia overview map area N) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

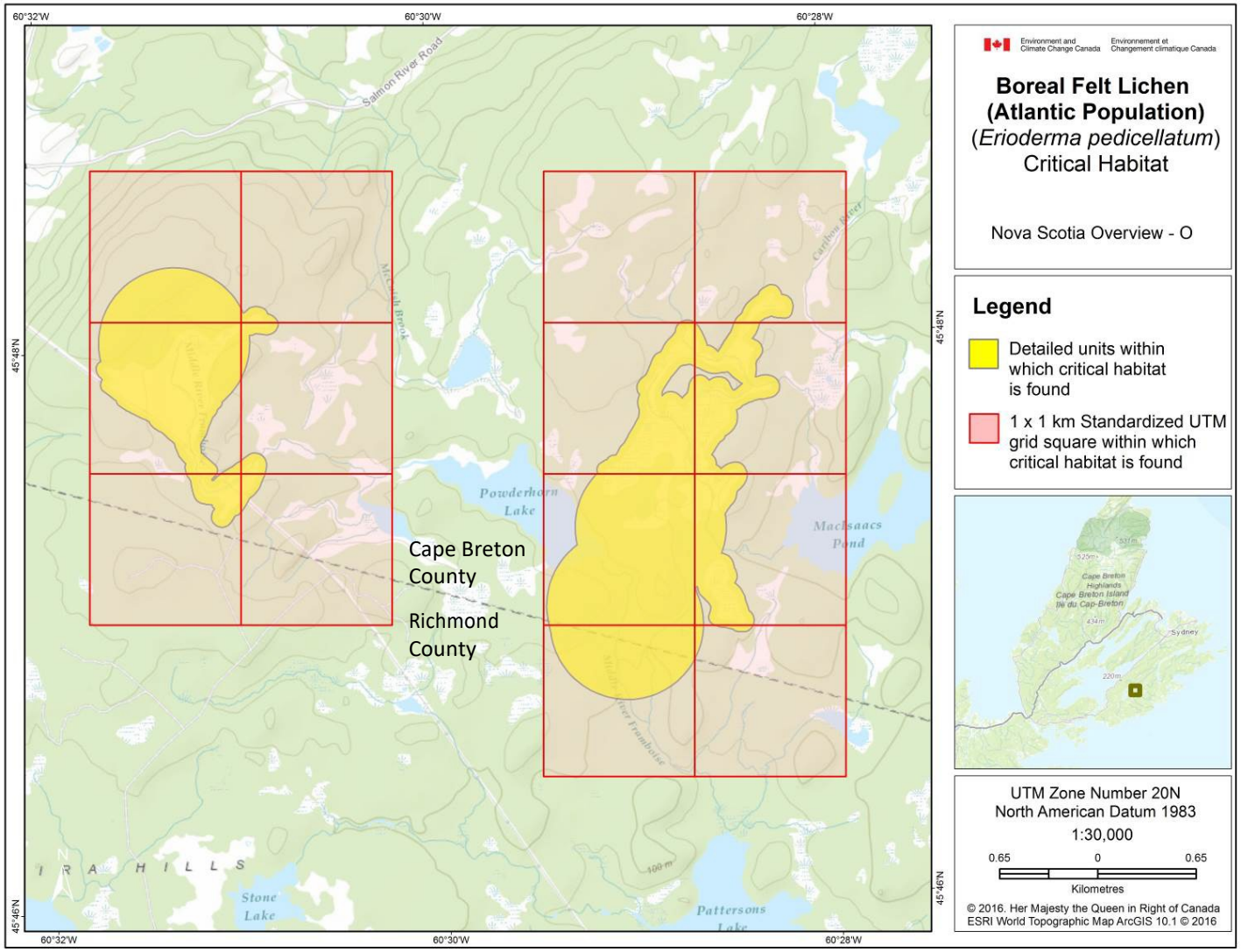

Figure 18. Critical habitat for Boreal Felt Lichen in Richmond County and Cape Breton County (see Nova Scotia overview map area O) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

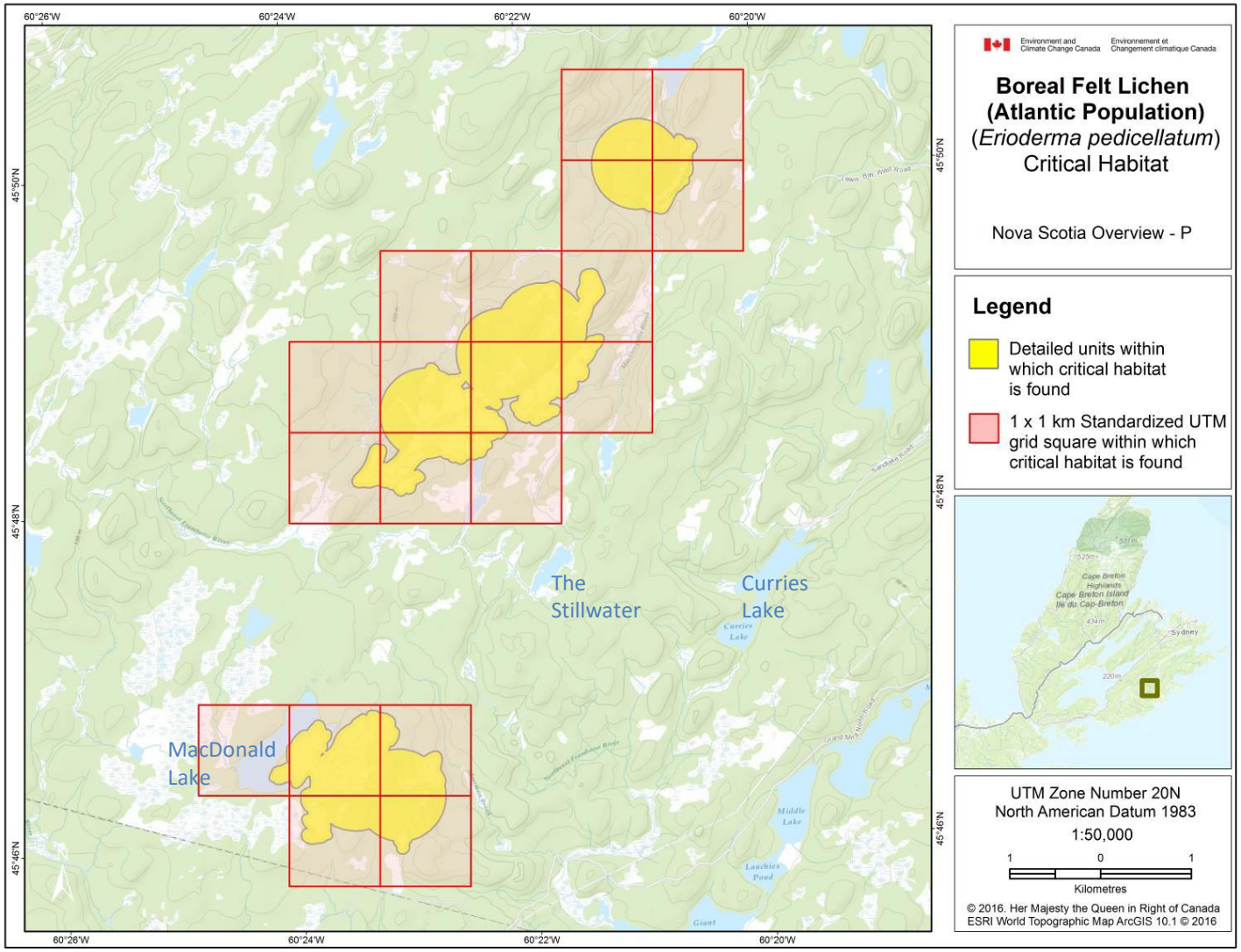

Figure 19. Critical habitat for Boreal Felt Lichen in Cape Breton County (see Nova Scotia overview map area P) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

7.2 Schedule of Studies to Identify Critical Habitat

Table 4. Schedule of Studies to Identify Critical Habitat

Description of Activity	Rationale	Timeline
Assess the relationship between wetland size and recharge area required to maintain wetland functionality. Assess the relationship between critical function zone and persistence of the lichen.	To ensure the long-term viability of extant sites, it is necessary to determine if the current zone surrounding the phorophyte and the wetland is sufficient to maintain presence of the lichen, protect wetland function, and mitigate effects of fragmentation.	2023

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Destruction of critical habitat is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. When critical habitat is identified in a recovery strategy, examples of activities that are likely to result in its destruction will be provided. Activities likely to result in destruction of critical habitat include, but are not limited to those set out in Table 5.

Table 5. Activities likely to result in the destruction of critical habitat.

Description of activity	Description of effect in relation to function loss	Details of effect
Activities that result in the removal of phorophytes, such as tree blazing, clear cutting, logging and tree harvesting	Phorophytes are essential for growth, survival and reproduction of the lichen, or may alter the suitability of the tree as a host for the lichen.	These activities are likely to result in destruction of critical habitat, regardless of what time of year they occur.
Activities that result in the loss of trees within critical habitat such as clear cutting, logging, tree harvesting, road construction, and cottage development in adjacent areas	The loss of trees in critical habitat may reduce the availability of potential host trees and may indirectly lead to a decrease in bark pH in the remaining softwoods (Richardson and Cameron 2004). Such removal may also decrease humidity and increase wind-speeds (and associated wind-throw damage) within critical habitat. Activities that result in the loss or removal of trees within critical habitat are particularly likely to destroy critical habitat (i.e., removal of trees within 100 m of a phorophyte, removal of any potential habitat identified in the field within 500 m of a phorophyte that is suitable for colonization, or removal of a > 150,000 m^2 block from within the 100-500 m critical function zone around a phorophyte).	It may be possible that additional blocks could be removed from the 100-500 m critical function zone around a phorophyte once the previously cut block becomes fully stocked with regenerating trees at least 3 m in height. This will be assessed on a case by case basis by species experts. Additional guidance regarding the management of these activities will be developed once the schedule of studies for Boreal Felt Lichen is complete.
Activities that alter the hydrology of the site and wetland such as road construction, infilling, clear cutting, tree harvesting, and cottage development.	These activities are likely to alter the hydrology of the wetland adjacent to, or hosting the lichen, resulting in temperature and moisture conditions not suitable for growth and colonisation by the lichen.	These activities are likely to result in destruction of critical habitat, regardless of what time of year they occur.

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

- Extant sites remain throughout the known extent of occurrence for the lichen.
- No adult thalli are lost due to human-induced habitat deterioration or loss.

This recovery strategy and supporting action plan(s) will be subject to an adaptive management approach, whereby new information will be integrated on an ongoing basis.

9. Statement on Action Plans

One or more action plans will be completed within three years of the final version of this recovery strategy being posted on the Species at Risk Public Registry.

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Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[6]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[7] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

This recovery strategy will clearly benefit the environment by promoting the recovery of Boreal Felt Lichen. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects.

The effects on other species were also considered. Boreal Felt Lichen is one of a suite of rare cyanolichens, many of which occur in similar habitats within the humid Atlantic forest region of Nova Scotia. Because these species share similar habitat requirements, actions directed towards better understanding ecosystem-level associations and securing habitat for Boreal Felt Lichen will almost certainly result in the protection of populations of other rare cyanolichens. At a regional level, any progress in reducing air-borne pollutants will benefit not only Boreal Felt Lichen, but most (if not all) of the flora and fauna of the Atlantic forest region as well.

[6] www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[7] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1

Appendix B: Knowledge Gaps to Recovery

- Identify life cycle of the species and critical life stages
- Genetic diversity (Newfoundland and Labrador vs. Nova Scotia)
- Dispersal distance: distance and mechanisms
- Track resilience of the lichen
- Identify microclimate requirements and specific effects of pollution and acid deposition
- Identify microclimate requirements and effects of adjacent tree harvesting
- Identify mortality factors and determine their population effect
- Effects of gastropod herbivory

Appendix C: Provincial Definitions of a Wetland

As defined under the *Environment Act* (Nova Scotia) a wetland is a marsh, swamp, fen or bog that either periodically or permanently has a water table at, near or above the land's surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation (*Sphagnum* species and Cinnamon Fern) and biological activities adapted to wet conditions.

Wetlands are identified and delineated based on three diagnostic environmental characteristics: hydrophytic vegetation, hydric soil, and wetland hydrology (U.S. Army Corps of Engineers 2012). Nova Scotia Environment provides wetland professionals with resources and references to identify and delineate wetland boundaries at: http://www.novascotia.ca/nse/wetland/delineating.wetland.boundaries.asp

Appendix C:

Environment and Climate Change Canada. 2018b. Action Plan for the Boreal Felt Lichen (*Erioderma pedicellatum*) (Atlantic population) and Vole Ears Lichen (*Erioderma mollissimum*) in Canada [Proposed]. Species at Risk Series. Environment and Climate Change Canada, Ottawa. v + 41 pp.

PROPOSED

Species at Risk Act
Action Plan Series

Action Plan for the Boreal Felt Lichen (*Erioderma pedicellatum*) (Atlantic population) and Vole Ears Lichen (*Erioderma molissimum*), in Canada

Boreal Felt Lichen (Atlantic population) and Vole Ears Lichen

2018

Government of Canada
Gouvernement du Canada

Canada

Recommended citation:

Environment and Climate Change Canada. 2018. Action Plan for the Boreal Felt Lichen (*Erioderma pedicellatum*) (Atlantic population) and Vole Ears Lichen (*Erioderma mollissimum*) in Canada [Proposed]. *Species at Risk Act* Action Plan Series. Environment and Climate Change Canada, Ottawa. v + 41 pp.

For copies of the action plan, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, recovery strategies, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Boreal Felt Lichen (Atlantic population) and Vole Ears Lichen on Balsam Fir, eastern shore, Nova Scotia. Photo by Mersey Tobeatic Research Institute (MTRI), used with permission.

Également disponible en français sous le titre
« Plan d'action pour l'érioderme boréal (*Erioderma pedicellatum*) (population de l'Atlantique) et l'érioderme mou (*Erioderma mollissimum*) au Canada [Proposition] »

ISBN
Catalogue no.

[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of action plans for species listed as Extirpated, Endangered, and Threatened for which recovery has been deemed feasible. They are also required to report on progress within five years after the publication of the final document on the SAR Public Registry.

Under SARA, one or more action plan(s) provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The plan outlines what needs to be done to achieve the population and distribution objectives (previously referred to as recovery goals and objectives) identified in the recovery strategy, including the measures to be taken to address the threats and monitor the recovery of the species, as well as the proposed measures to protect critical habitat that has been identified for the species. The action plan also includes an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation. The action plan is considered one in a series of documents that are linked and should be taken into consideration together. Those being the COSEWIC status report, the recovery strategy, and one or more action plans.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Boreal Felt Lichen (Atlantic population) (hereafter Boreal Felt Lichen) and Vole Ears Lichen and has prepared this action plan to implement the recovery strategies, as per section 47 of SARA. To the extent possible, it has been prepared in cooperation with the Provinces of New Brunswick, Nova Scotia, and Newfoundland and Labrador, the Nova Scotia Lichen Recovery Team, environmental non-government organizations, Indigenous groups, industry stakeholders, and private landowners, as per section 48(1) of SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this action plan and will not be achieved by Environment and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this action plan for the benefit of the Boreal Felt Lichen and Vole Ears Lichen and Canadian society as a whole.

Implementation of this action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

Acknowledgments

This action plan was prepared by Brad Toms (Mersey Tobeatic Research Institute), Julie McKnight (Environment and Climate Change Canada – Canadian Wildlife Service), and Rob Cameron (Nova Scotia – Environment) with extensive input from Mark Elderkin (Nova Scotia Department of Natural Resources). Maureen Toner (New Brunswick Department of Natural Resources), Claudia Hanel (Newfoundland and Labrador Department of Environment and Conservation) and André Arsenault (Natural Resources Canada – Canadian Forest Service) provided comments on this action plan. The efforts and contributions of the Nova Scotia Cyanolichen Recovery Team and the Newfoundland and Labrador Department of Natural Resources Lichen Working Group are gratefully acknowledged. Appreciation is also extended to Matt Mahoney (Environment and Climate Change Canada – Canadian Wildlife Service) for developing the critical habitat maps.

Executive Summary

This action plan compliments the amended recovery strategy for Boreal Felt Lichen (*Erioderma pedicellatum)* (Environment and Climate Change Canada 2018), and the recovery strategy for the Vole Ears Lichen (*Erioderma mollissimum*) (Environment Canada 2014). It addresses the population and distribution objectives established in the amended Boreal Felt Lichen recovery strategy and the Vole Ears recovery strategy. Recovery measures are identified, in relation to the broad strategies set out in the recovery strategies for Boreal Felt Lichen and Vole Ears Lichen.

The amended recovery strategy for Boreal Felt Lichen contains the identification of critical habitat for that species.

This action plan identifies new critical habitat for Vole Ears Lichen in Nova Scotia taking into account new population information. 1000 hectares of critical habitat were identified in the recovery strategy and an additional 1420 hectares of critical habitat in Nova Scotia are identified in this action plan. Critical habitat is now identified at a total of 2420 hectares along the Atlantic Coast of Nova Scotia. Critical habitat for Vole Ears Lichen in Newfoundland and Labrador is identified in the recovery strategy for the species at 106 hectares on the Avalon Peninsula (Figures 23-25).

Proposed measures to protect critical habitat are presented in section 1.4. The recovery measures included in this plan build on the recommended approaches outlined in the amended recovery strategy for the Boreal Felt Lichen and the recovery strategy for the Vole Ears Lichen. An implementation schedule is included and prioritizes each recovery measure and delineates timelines.

Proposed recovery measures in this action plan will have limited socio-economic impact and constraints to human land use. Indirect costs are expected to be minimal and the benefits relate to the value of biodiversity to Canadians, positive impacts cultural values, and conservation of other species.

Table of Contents

1. Recovery Actions

1.1 Context and Scope of the Action Plan

Boreal Felt Lichen (*Erioderma pedicilatum*) is an epiphytic cyanolichen. It is restricted to cool, moist, oceanic regions, occurring at elevations less than 200 m above sea level within 25 km of the Atlantic coast only in mature to over mature Balsam Fir (*Abies balsamea*) forests within or adjacent to wetlands where sphagnum species cover the ground. There are two designated populations in Canada: the Boreal population in Newfoundland and the Atlantic population in New Brunswick and Nova Scotia. This action plan covers the Atlantic population. The Boreal Felt Lichen (Atlantic population) (hereafter Boreal Felt Lichen) was listed under the *Species at Risk Act* (*SARA*) as Endangered in 2005. It is believed to be extirpated from New Brunswick (Cameron et al. 2009).

The Vole Ears Lichen (*Erioderma mollissimum*) is also an epiphytic cyanolichen. It requires cool humid coastal conifer forests in and adjacent to wetlands dominated by Balsam Fir and/or Red Maple (*Acer rubrum*) and/or Yellow Birch (*Betula alleghaniensis*) where sphagnum species cover the ground. Vole Ears Lichen was listed under the *Species at Risk Act* as Endangered in 2012.

The recovery strategy for the Boreal Felt Lichen in Canada was posted on the Species at Risk Registry in 2007 (Environment Canada 2007) and was amended in 2018 (Environment and Climate Change Canada 2018). The recovery strategy for Vole Ears Lichen was posted on the Species at Risk Registry in 2014 (Environment Canada 2014). This action plan should be considered along with the Multi-species Action Plan for Kejimkujik National Park and National Historic Site of Canada (Parks Canada Agency 2017).

The population and distribution objectives established by both recovery strategies are to ensure the species' extent of occurrence (i.e., known range) and the health of the populations are not impacted by anthropogenic habitat deterioration or loss (i.e., through biological resource use (of the species' host tree), transportation and service corridors, or residential and commercial development).

All broad strategies and general approaches to meet objectives detailed in the amended recovery strategy for Boreal Felt Lichen and the recovery strategy for Vole Ears Lichen are addressed in this document.

Surveys undertaken from 2005 to present have increased the number of known sites of Boreal Felt Lichen, however, loss of the lichen from sites continues to occur and the estimated 10 year decline is 34% (COSEWIC 2014). Many new sites of Vole Ears Lichen have been found since 2012 due to recent survey efforts but declines continue, particularly in Nova Scotia, where at least 80% of sites documented in the 1980's no longer contain the lichen. It is important to maintain intact biophysical attributes at sites that have apparently lost their lichens recently because they may still contain the necessary building blocks for colonization and juveniles are difficult to inventory until they reach a certain size.

Critical habitat is partially identified in the amended recovery strategy for Boreal Felt Lichen and the recovery strategy for Vole Ears Lichen. No new critical habitat is identified for Boreal Felt Lichen in this document. New critical habitat is identified for Vole Ears Lichen in this action plan (refer to section 1.3) in addition to the 29 sites in two populations in Nova Scotia and the five sites in one population in Newfoundland and Labrador identified in the recovery strategy.

This action plan should be considered along with the amended recovery strategy for the Boreal Felt Lichen and the recovery strategy for the Vole Ears Lichen. The recovery strategies provide more details on the strategic direction for recovery of the species, critical habitat information, and background information on the species and their threats.

1.2 Measures to be Taken and Implementation Schedule

The recovery measures outlined below are arranged according to the broad strategies identified in the amended recovery strategy for Boreal Felt Lichen and the recovery strategy for Vole Ears Lichen.

Table 1: Implementation schedule

#	Recovery Measures	Priority[a]	Threats or objectives addressed	Timeline
Broad Strategy: Law and policy				
Approach: Engage in existing pollution reduction programs for local and transboundary pollution and greenhouse gasses				
1	Collaborate with government departments to continue implementing the Nova Scotia Energy Strategy and the Nova Scotia Climate Change Action Plan.	H	Air-borne pollutants	ongoing
2	Collaborate to incorporate Boreal Felt Lichen and Vole Ears Lichen in air pollution reduction programs and general air quality education materials.	M	Air-borne pollutants	ongoing
Approach: Review and revise Beneficial Management Practices (BMPs)/ Special Management Practices (SMPs) for the species and their habitat, where necessary				
3	Ensure Vole Ears Lichen in maintained on Crown Land in Nova Scotia (NS) through implementation of 'Special Management Practices'.	H	Logging & wood harvesting	2019
4	Identify existing or planned land uses that could negatively impact Boreal Felt Lichen or Vole Ears Lichen sites. Implement relevant recovery measures to address threats.	H	Logging & wood harvesting, Roads & railroads, and Housing & urban areas	2018 (NS) as identified (NL)
Approach: In NL: Support existing relevant programs by the provincial Department of Natural Resources				
5	Quantify extent of the regeneration problem and encourage multi-stakeholder collaboration.	M	Invasive non-native/alien species/diseases and problematic native species	ongoing

#	Recovery Measures	Priority[a]	Threats or objectives addressed	Timeline
	Approach: Engage forest certification systems to implement private standards and codes governing private sector practice that are beneficial for the species			
6	Evaluate efficacy of private sector certifications in the conservation of cyanolichens at risk. Determine gaps in current certifications and work with certifiers to fill gaps.	L	Logging & wood harvesting and Roads & railroads	2018
	Approach: Monitor and enforce compliance with relevant laws, policies, and regulations, and voluntary standards and codes			
7	During surveys and inventory work, identify any potential infractions and engage enforcement branches when necessary.	H	Logging & wood harvesting, Roads & railroads, and Housing & urban areas	ongoing
Broad Strategy: Education and awareness, stewardship, and partnerships				
	Approach: Foster cooperative relationships with landowners, foresters, industry, and volunteers to maintain critical habitat			
8	Develop stewardship agreements with landowners where possible.	H	Logging & wood harvesting, Roads & railroads, and Housing & urban areas	2019
9	Inform interested landowners regarding formal habitat conservation options.	H	Logging & wood harvesting, Roads & railroads, and Housing & urban areas	2019
10	Contact stakeholders regarding the significance and requirements of Boreal Felt Lichen and Vole Ears Lichen and share BMPs (NL) and SMPs (NS) to conserve the species.	H	Logging & wood harvesting, Roads & railroads, and Housing & urban areas	as new stakeholders are identified

#	Recovery Measures	Priority[a]	Threats or objectives addressed	Timeline
	Approach: Promote volunteer participation in surveys and monitoring			
11	Provide identification workshops for interested individuals and organizations.	M	All	completed in 2008, 2009; thereafter as needed
	Approach: Promote ecosystem conservation through forest certification, if deemed effective for recovery of the species			
12	Investigate extent of forest certification in Eastern Canada and promote the use of third-party certified sustainable forest management certification standards where appropriate.	L	Logging & wood harvesting and Roads & railroads	2020
	Approach: Promote compliance with Federal, Provincial, and Municipal Acts and Policies as well as BMPs/SMPs that protect the species and their habitat			
13	Evaluate existing education materials, revise and reprint as needed.	M	All	completed 2008
14	Publish a website for the dissemination of information on the biology and conservation of Boreal Felt Lichen, Vole Ears Lichen, and other rare cyanolichens.	M	All	Boreal Felt Lichen: completed 2007; revise as needed Vole Ears Lichen: 2017
	Approach: Promote the species as an indicator of healthy coastal rain forests			
15	Develop an outreach plan for engaging Forest managers and private woodlot owners on “lichens at risk” .	M	Logging & wood harvesting and Roads & railroads	2021
Broad Strategy: Habitat and species protection and management				
	Approach: Conserve habitat for the species			
16	Engage private landowners of priority sites to conserve lichens.	H	Logging & wood harvesting, Roads & railroads, and Housing & urban areas	2021
	Approach: Prevent gastropods from ascending phorophytes			
17	Research collars, tapes, and traps to ensure that cyanolichens are not negatively impacted by their use and implement where feasible.	L	Invasive non-native/alien species/diseases and problematic native species	2018

#	Recovery Measures	Priority[a]	Threats or objectives addressed	Timeline
	Approach: Develop a protocol for transplanting cyanolichens if phorophyte is lost			
18	Refine methodology developed for transplanting Boreal Felt Lichen, Boreal population (2014) and implement protocol at sites where the lichen will be lost due to immitigable anthropogenic circumstances.	L	All	if deemed necessary
Broad Strategy: Monitoring and Research				
	Approach: Implement inventory and monitoring protocol(s)			
19	Inventory new sites identified by the habitat suitability model.	H	Monitoring	ongoing
20	Track site size and vigour (e.g., condition, health, presence of disease or herbivory) of individuals.	H	Monitoring	ongoing
21	Track threats (e.g., Logging and wood harvesting, roads, gastropod grazing).	H	Monitoring	ongoing
22	Track habitat conditions (e.g., forest composition, forest age structure, presence of indicator species).	H	Monitoring	ongoing
	Approach: Research (refer to Appendix B in respective recovery strategies)			
23	Collaborate with researchers working with the cyanolichens to address the following knowledge gaps relevant to the survival and recovery of the species: their life cycle, growth rates, habitat dynamics, genetic diversity, minimum viable population size, sensitivity to specific pollutants and acid deposition, sensitivity to specific forestry practices.	L-M	Knowledge gaps	2021
24	Consult the National Pollutant Release Inventory to identify point sources of important pollutants and assess whether location and survival of lichens are affected.	L-M	Air-borne pollutants	2018

[a] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the population and distribution objectives for the species. Medium priority measures may have a less immediate or less direct influence on reaching the population and distribution objectives, but are still important for the recovery of the population. Low priority recovery measures will likely have an indirect or gradual influence on reaching the population and distribution objectives, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.

1.2.1 Monitoring

While there is currently no published monitoring protocol for Boreal Felt Lichen or Vole Ears Lichen, monitoring measures for Boreal Felt Lichen are in place and will be applied for Vole Ears Lichen as new sites are found and extant sites are revisited. Each time a site is visited, the following criteria/measures will be recorded:

- maturity of the lichen (i.e., adult or juvenile);
- the width and height of the lichen;
- a rating of the lichen's health;
- percentage of the thallus area grazed; and
- a score for necrosis (percentage of thallus area discolored by death of the fungus).

Monitoring studies of Boreal Felt Lichen (consisting of a visual assessment of any major changes – e.g., death of trees, cutting) have been conducted and involve collecting habitat parameters using a standardized method. This methodology will be adopted for Vole Ears Lichen as new sites are found and extant sites are revisited.

1.3 Critical Habitat

The critical habitat deemed necessary to meet the population and distribution objectives was partially identified for Boreal Felt Lichen in the amended recovery strategy. The amended recovery strategy contains the methodology for identifying critical habitat and outlines a schedule of studies required to complete the identification of critical habitat. Additional critical habitat for Boreal Felt Lichen is not identified in this action plan.

Critical habitat was also partially identified for Vole Ears Lichen in its recovery strategy. The recovery strategy contains the methodology for identifying critical habitat and outlines a schedule of studies required to complete the identification of critical habitat. Critical habitat for Vole Ears Lichen in Newfoundland and Labrador is identified in the recovery strategy for the species (106 hectares) and is located on the Avalon Peninsula (Figures 23-25). Critical habitat for Vole Ears Lichen in Nova Scotia is identified in the recovery strategy for the species (1000 hectares) in two populations. An additional 1420 hectares, in two populations along the Atlantic Coast of Nova Scotia, are identified in this action plan based on recent survey work, using the same approach described in the recovery strategy.

1.3.1 Identification of Vole Ears Lichen critical habitat

Critical habitat description

Critical habitat for Vole Ears Lichen is presented in Figures 1-25. Critical habitat for Vole Ears Lichen in Canada occurs within the shaded yellow and blue polygons (units where the critical habitat criteria and methodology described section 7.1 of the recovery strategy are met). The UTM grid overlay shown in the figures is a standardized national grid system that indicates the general geographic area containing critical habitat.

More detailed information on the location of critical habitat to support protection of the species and its habitat may be requested, on a need-to-know basis, by contacting Environment and Climate Change Canada's Recovery Planning section at: ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

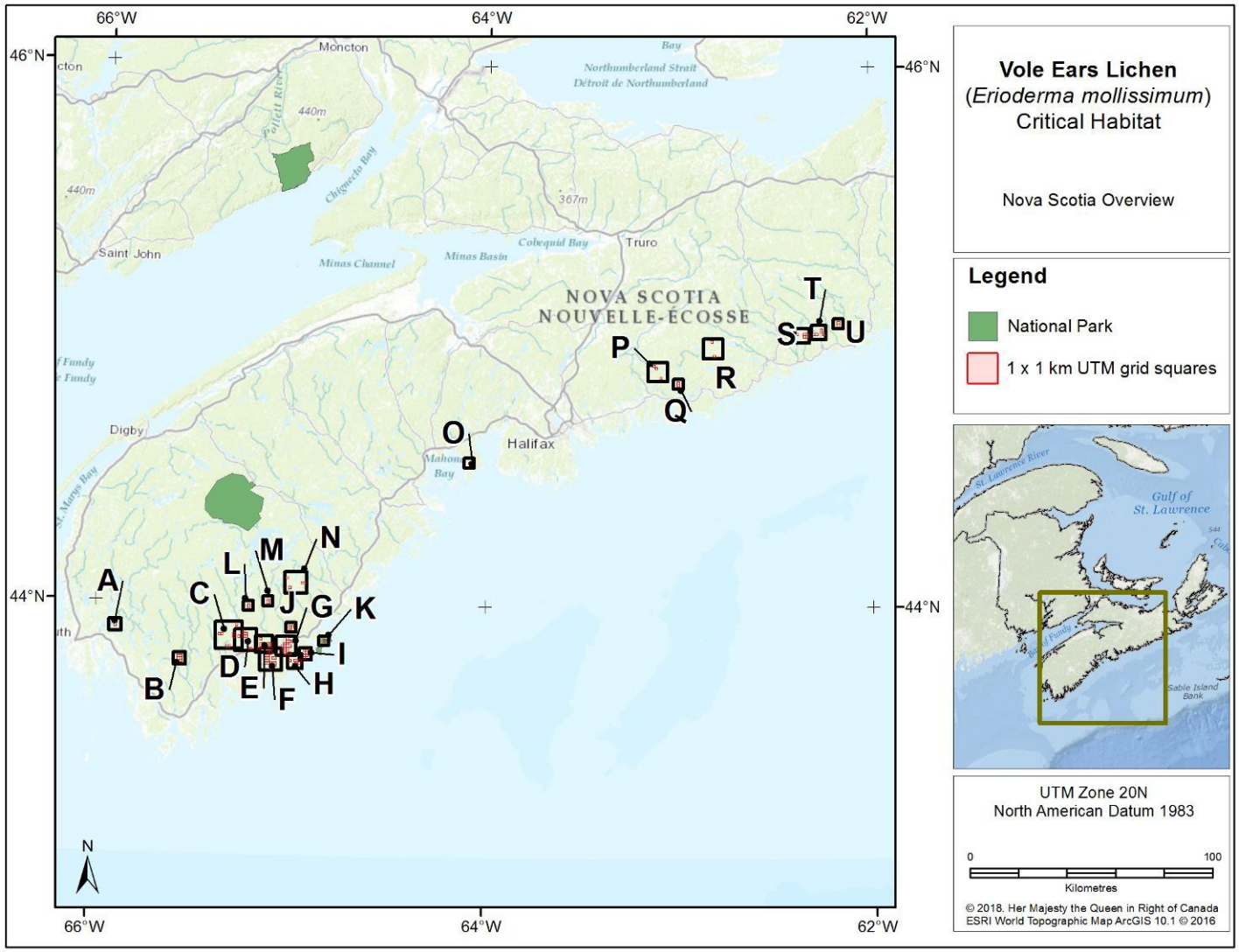

Figure 1. Overview map of critical habitat for Vole Ears Lichen in Nova Scotia. Refer to Figures 2-22 for detailed representations of critical habitat.

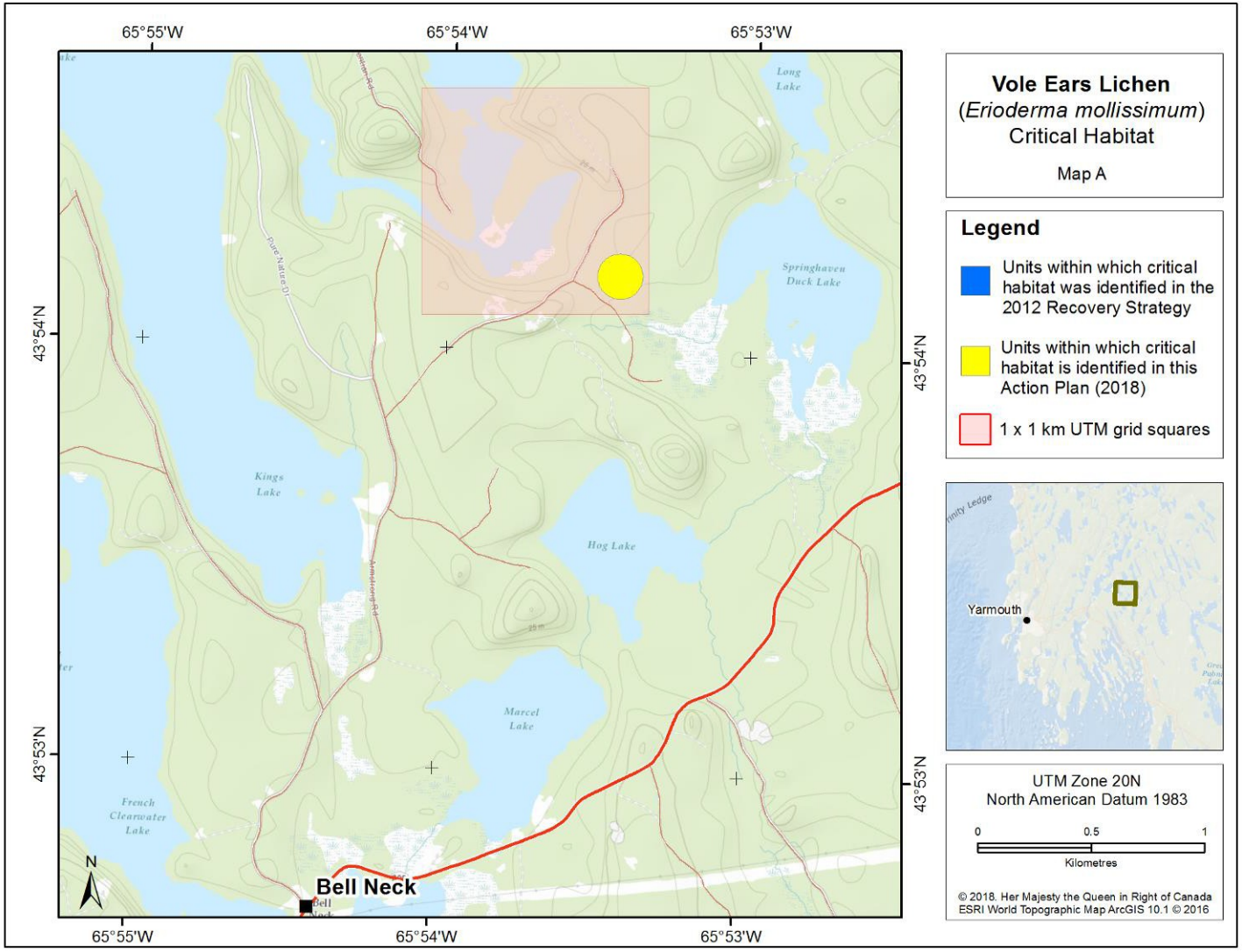

Figure 2. Critical habitat for Vole Ears Lichen in Yarmouth County (see Nova Scotia overview map area A) is represented by the yellow shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

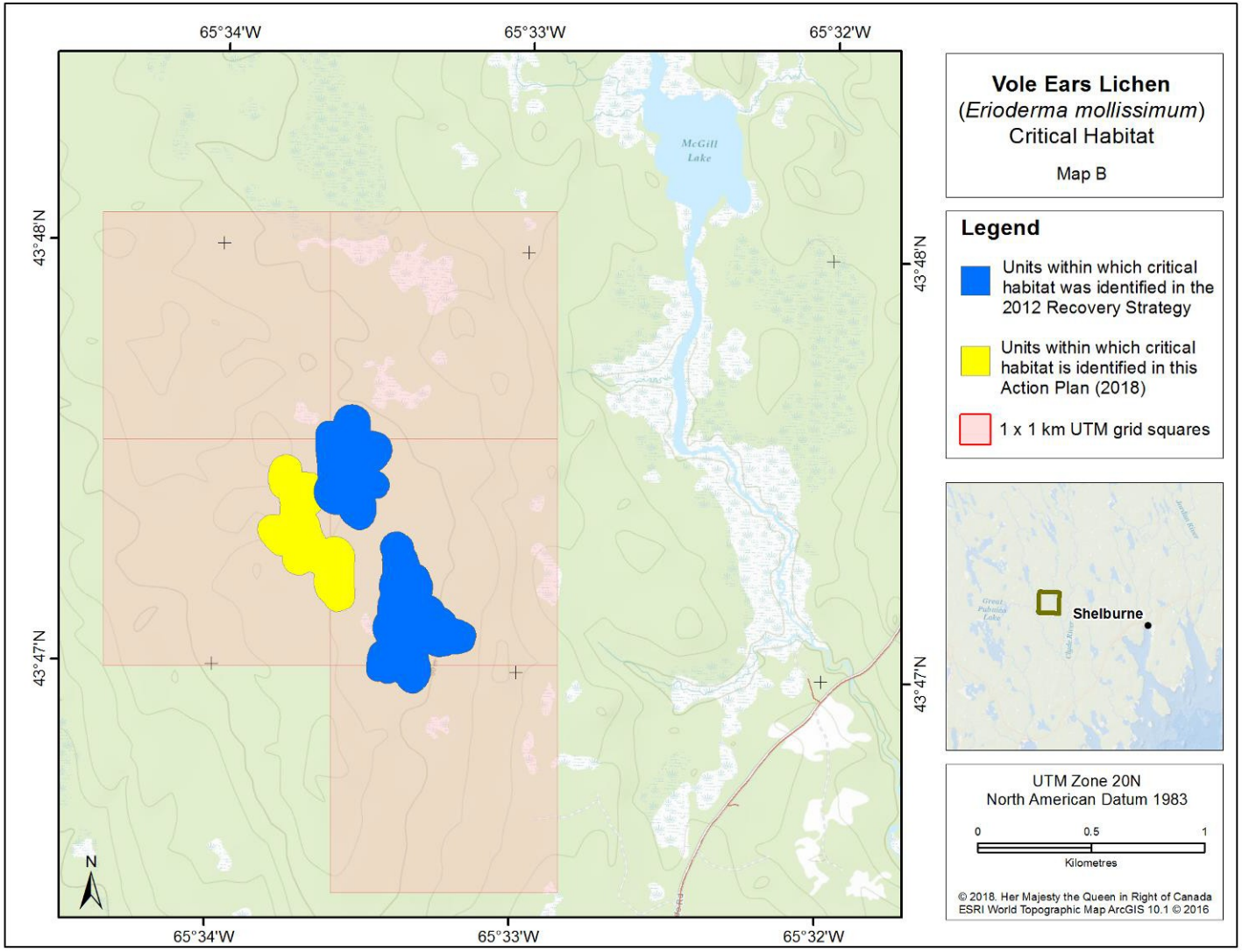

Figure 3. Critical habitat for Vole Ears Lichen in Shelburne County (see Nova Scotia overview map area B) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

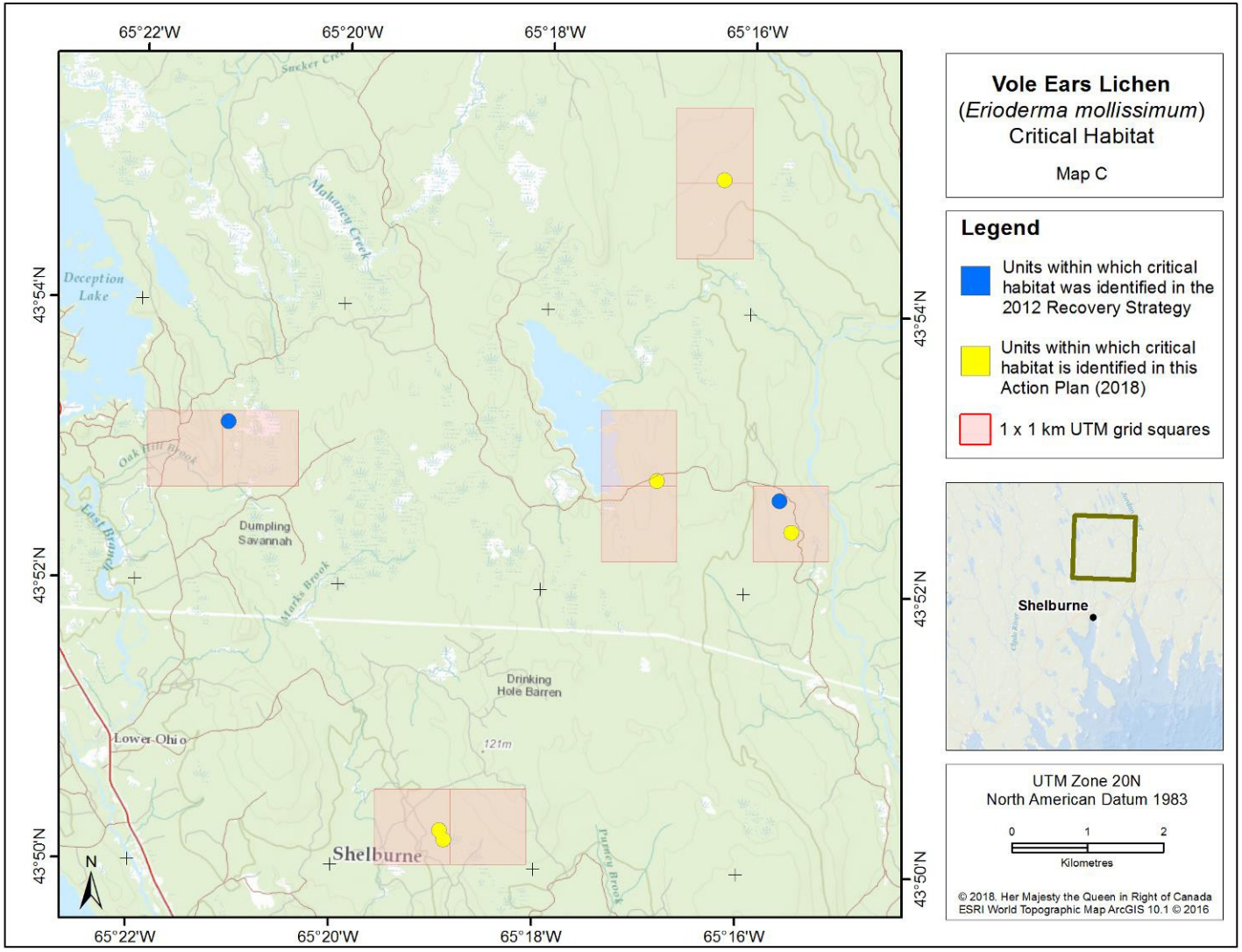

Figure 4. Critical habitat for Vole Ears Lichen in Shelburne County (see Nova Scotia overview map area C) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

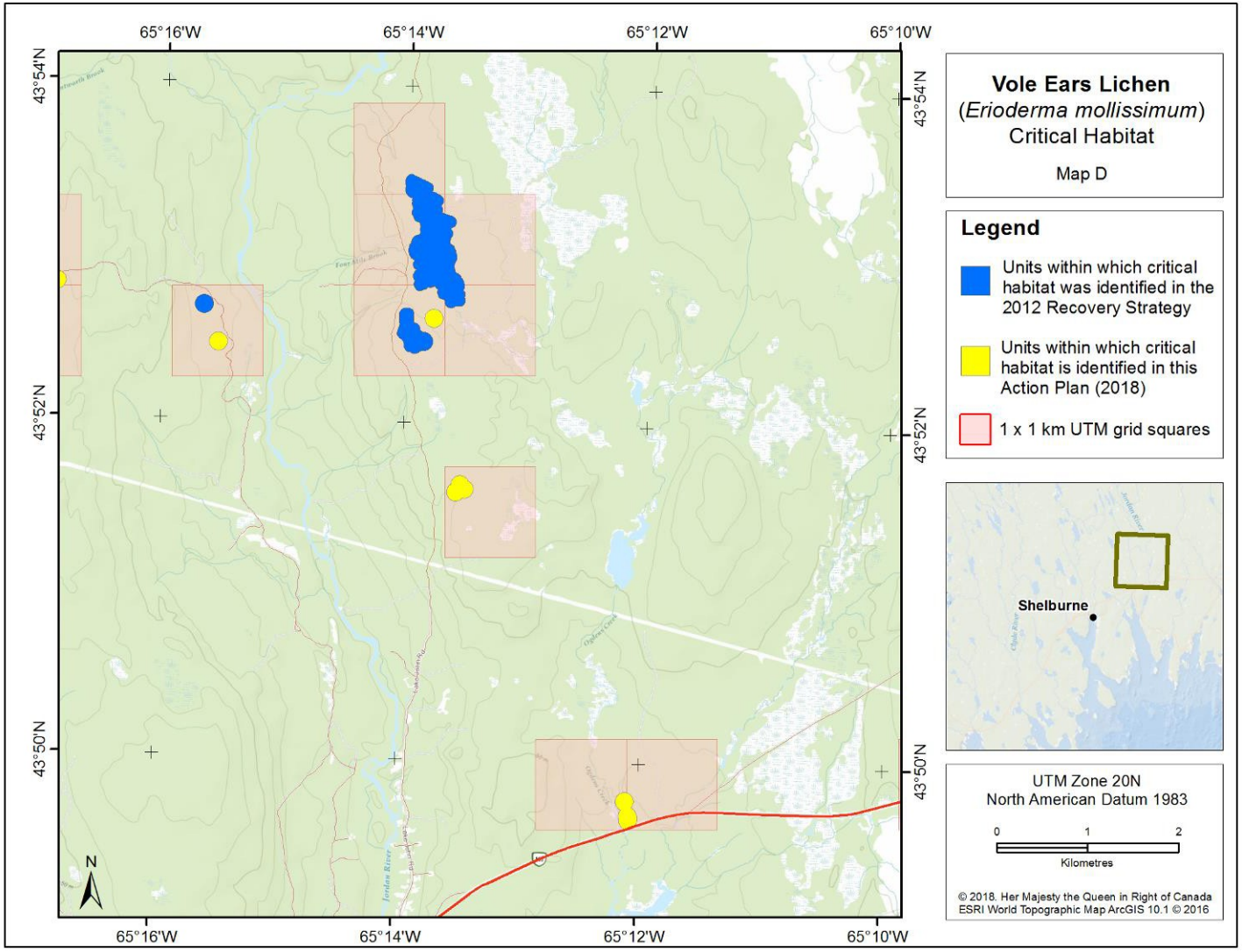

Figure 5. Critical habitat for Vole Ears Lichen in Shelburne County (see Nova Scotia overview map area D) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

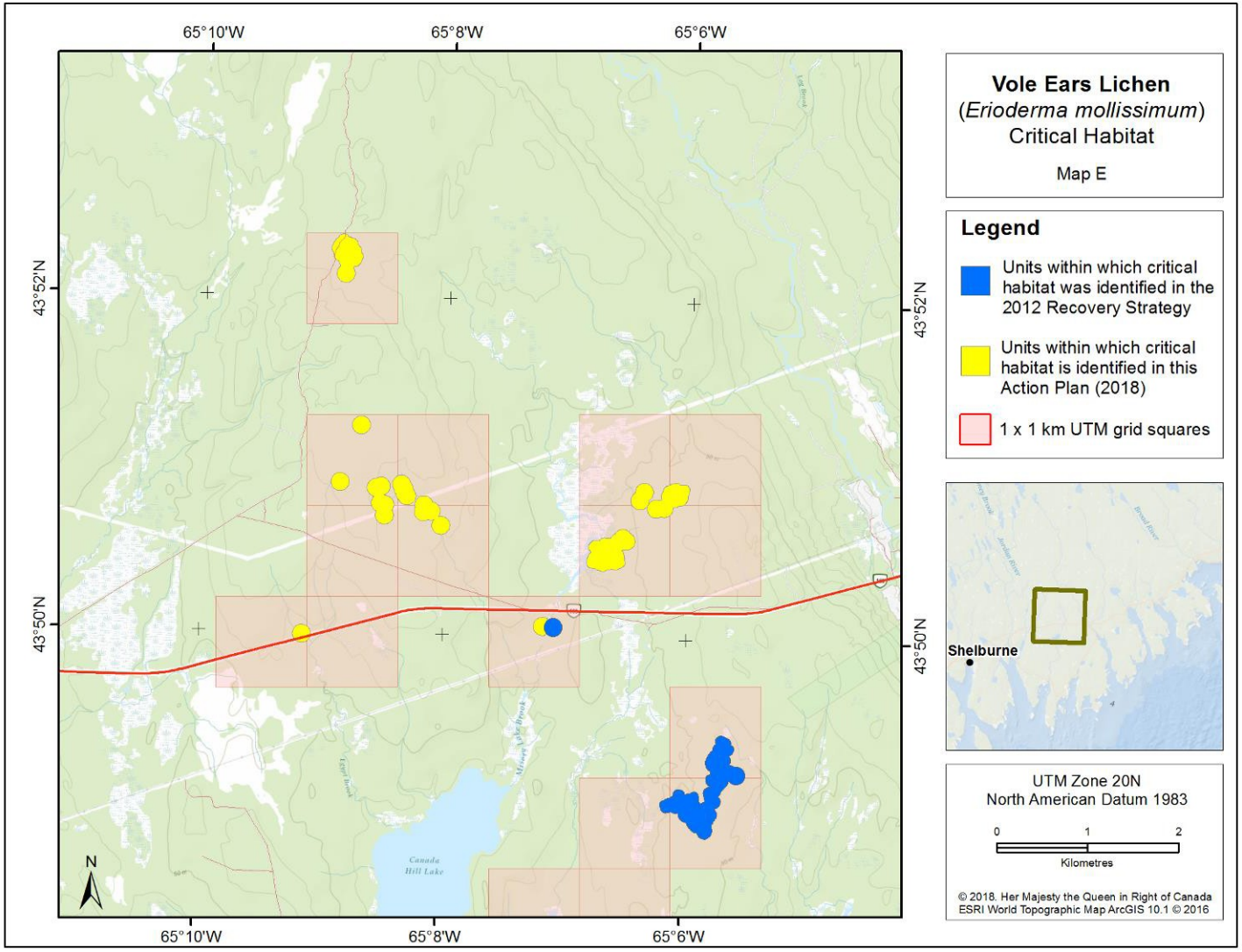

Figure 6. Critical habitat for Vole Ears Lichen in Shelburne County (see Nova Scotia overview map area E) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

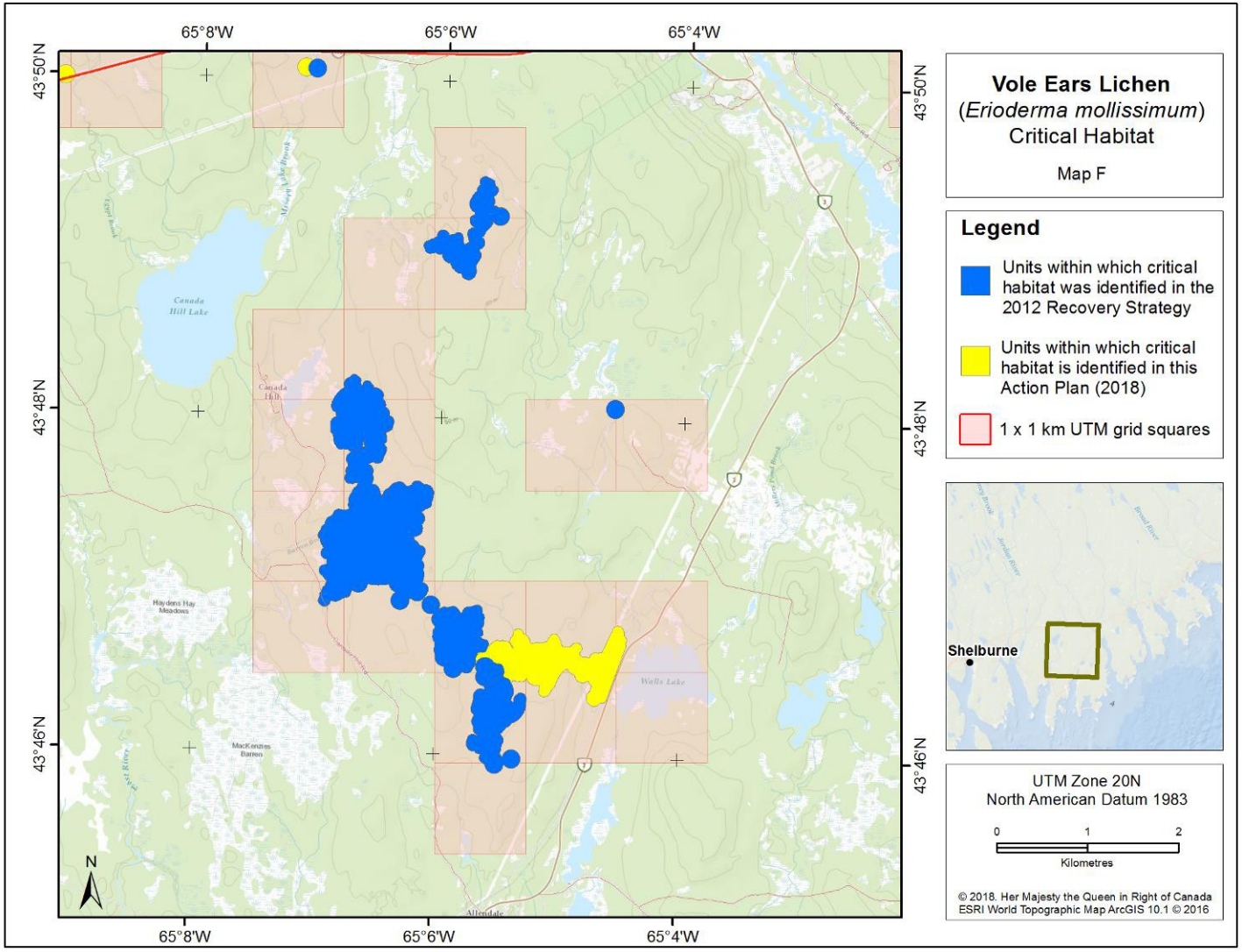

Figure 7. Critical habitat for Vole Ears Lichen in Shelburne County (see Nova Scotia overview map area F) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

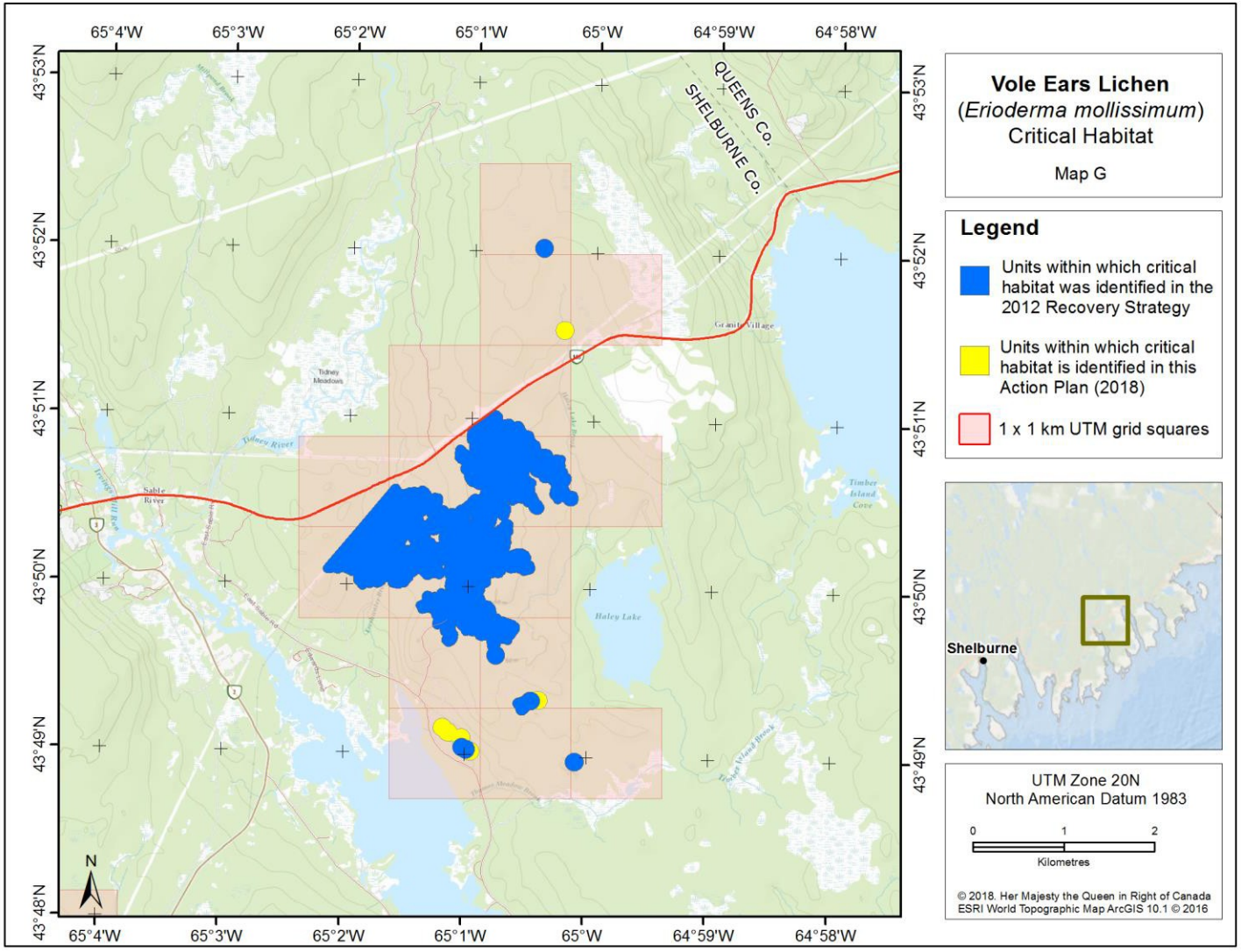

Figure 8. Critical habitat for Vole Ears Lichen in Shelburne County (see Nova Scotia overview map area G) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

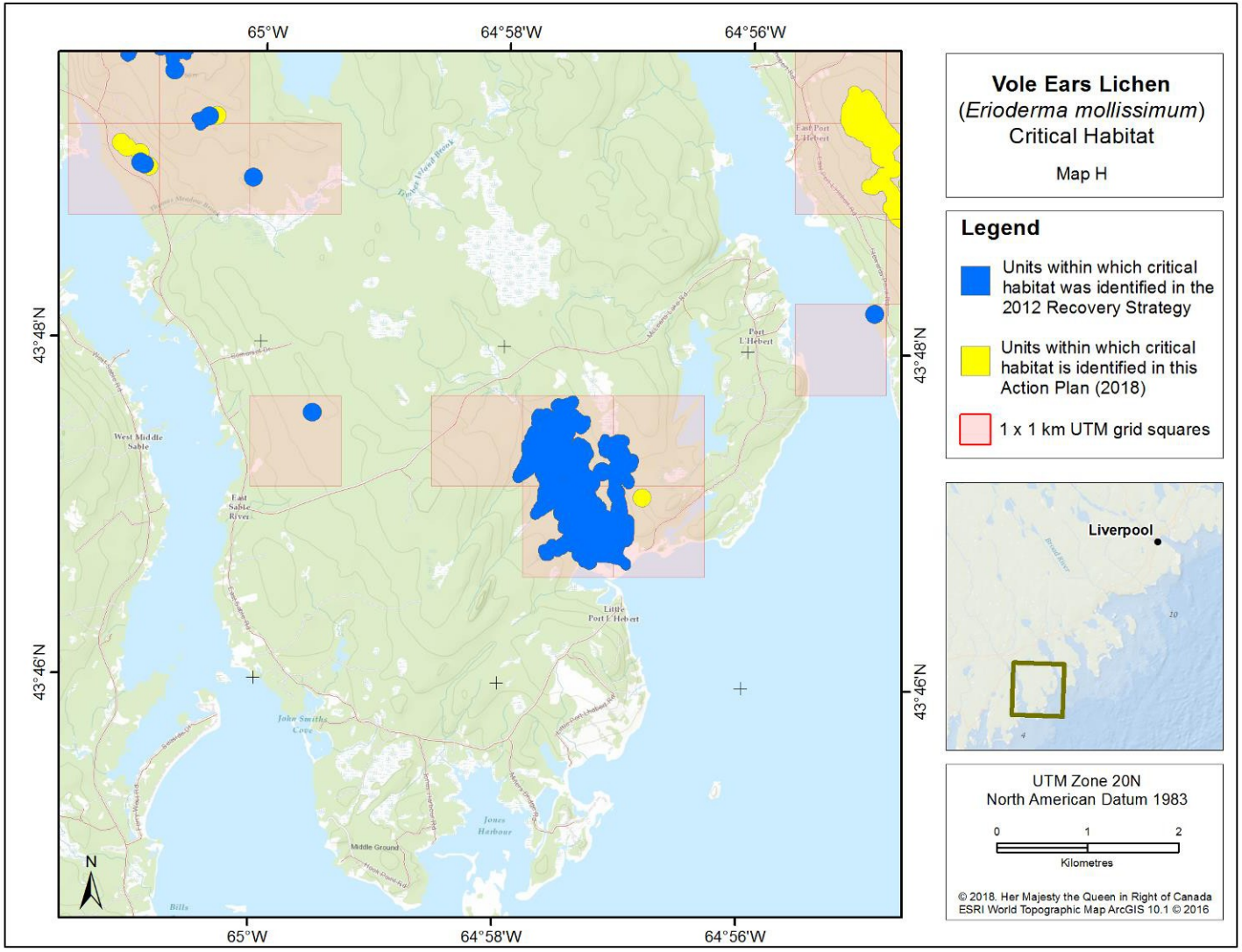

Figure 9. Critical habitat for Vole Ears Lichen in Queens County (see Nova Scotia overview map area H) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

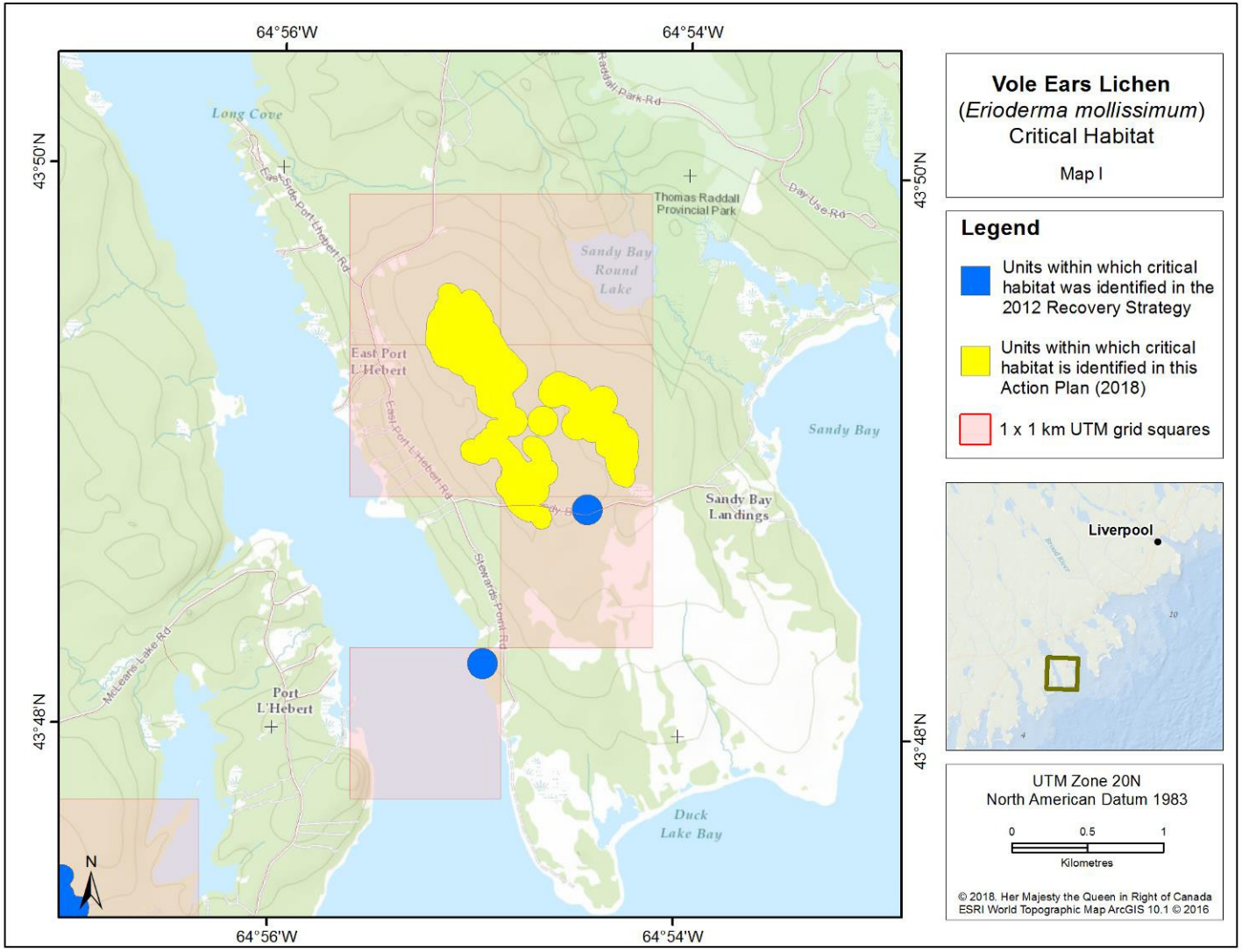

Figure 10. Critical habitat for Vole Ears Lichen in Queens County (see Nova Scotia overview map area I) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

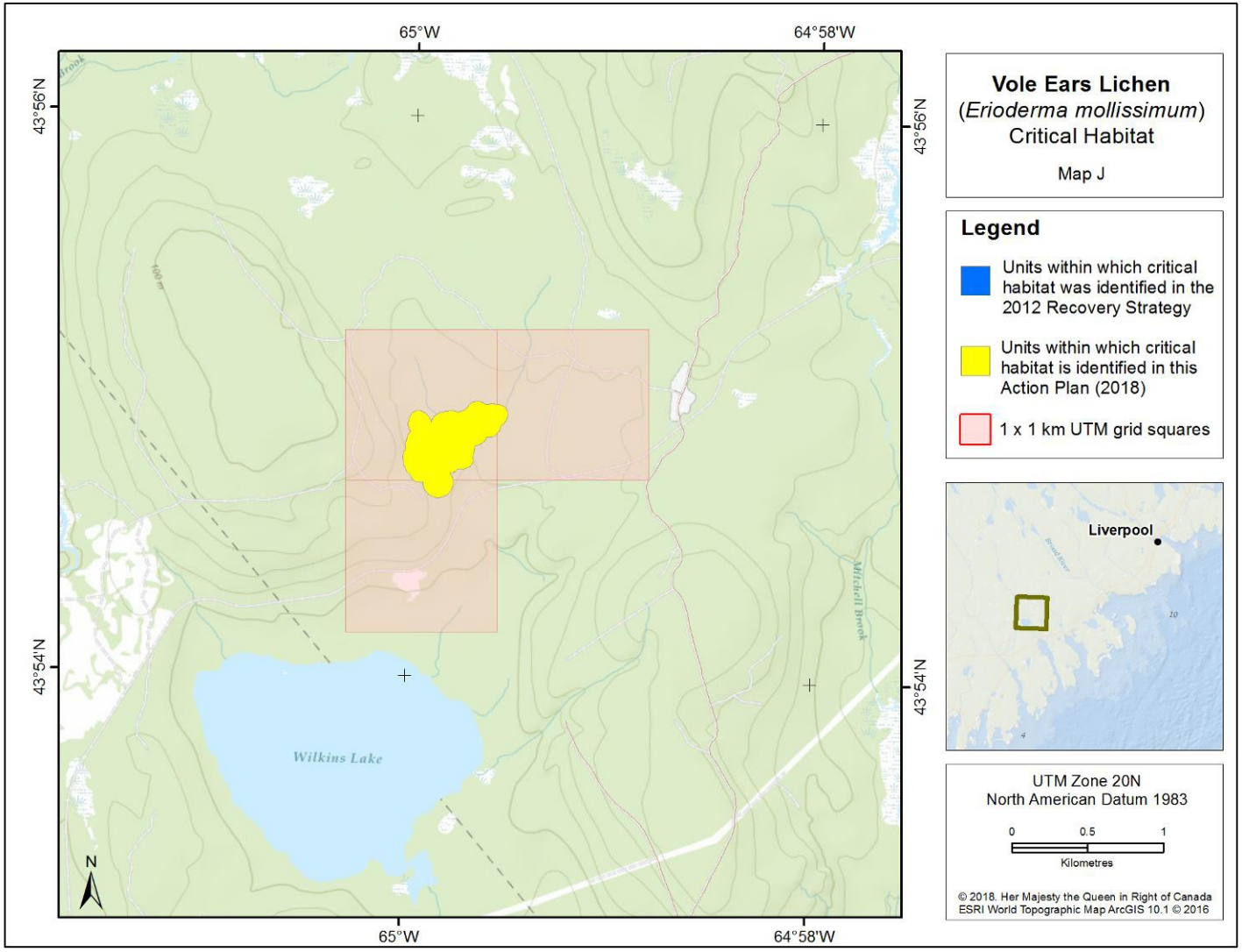

Figure 11. Critical habitat for Vole Ears Lichen in Queens County (see Nova Scotia overview map area J) is represented by the yellow shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

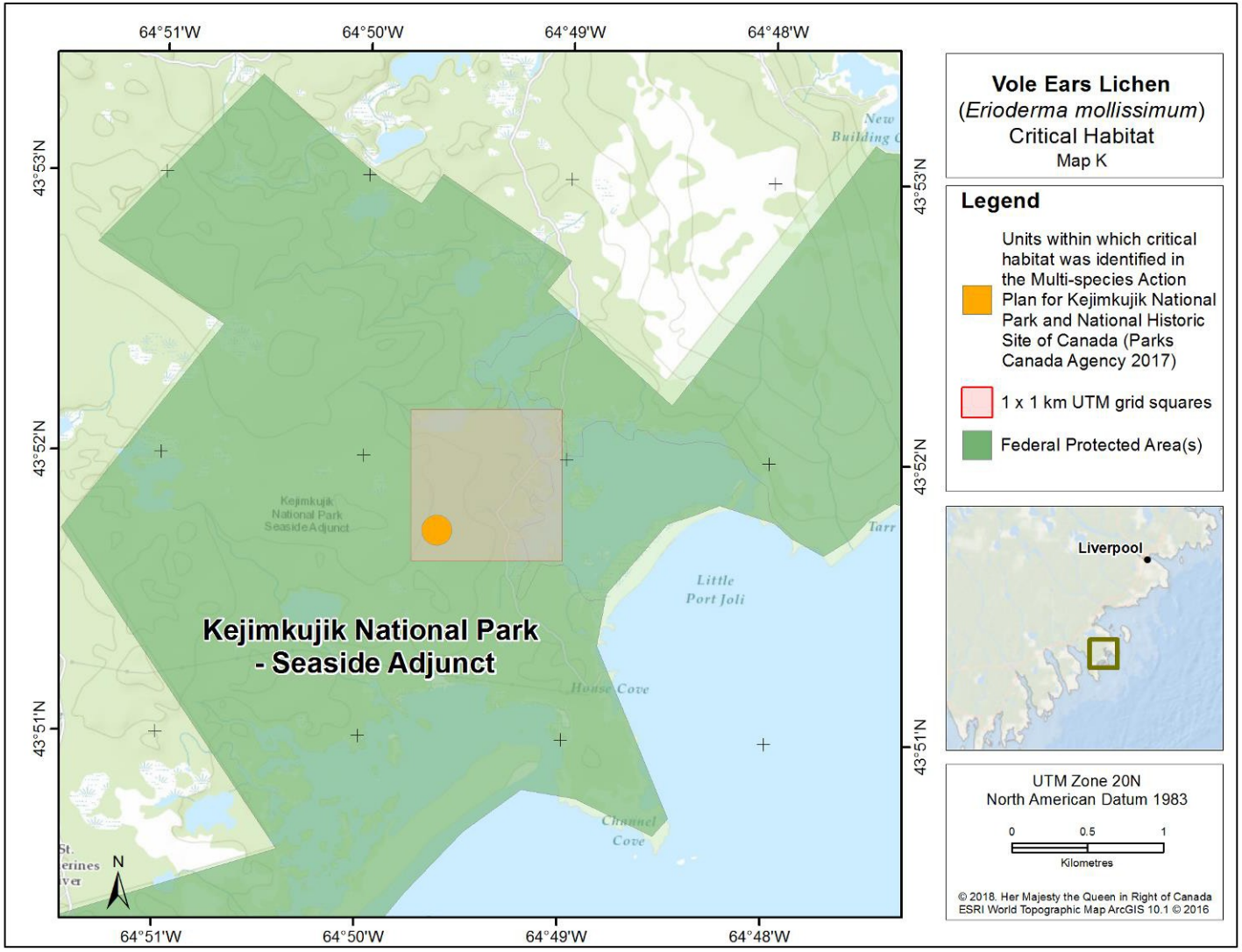

Figure 12. Critical habitat for Vole Ears Lichen in Kejimkujik National Park Seaside, Queens County (see Nova Scotia overview map area K) is represented by the orange shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

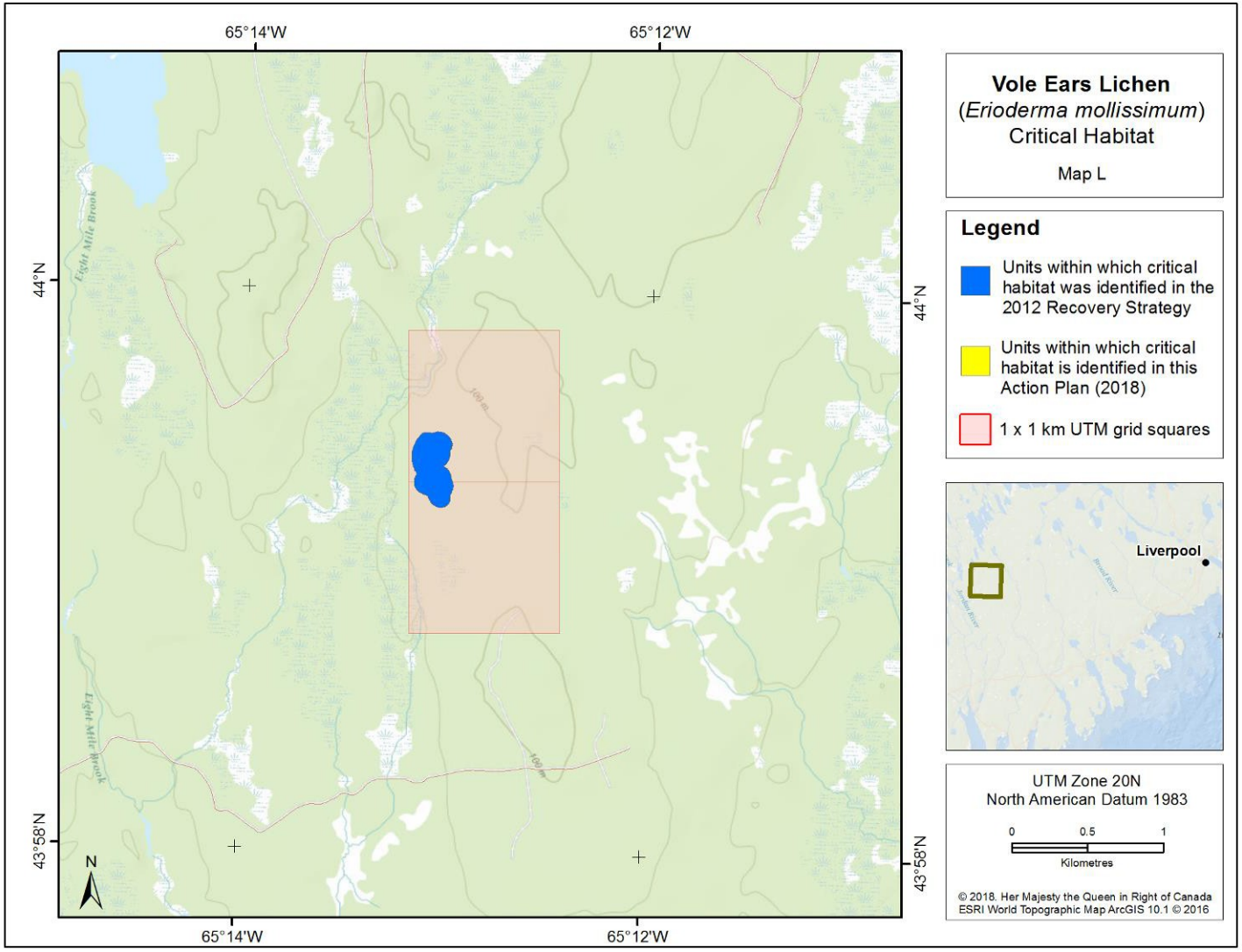

Figure 13. Critical habitat for Vole Ears Lichen in Shelburne County (see Nova Scotia overview map area L) is represented by the blue shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

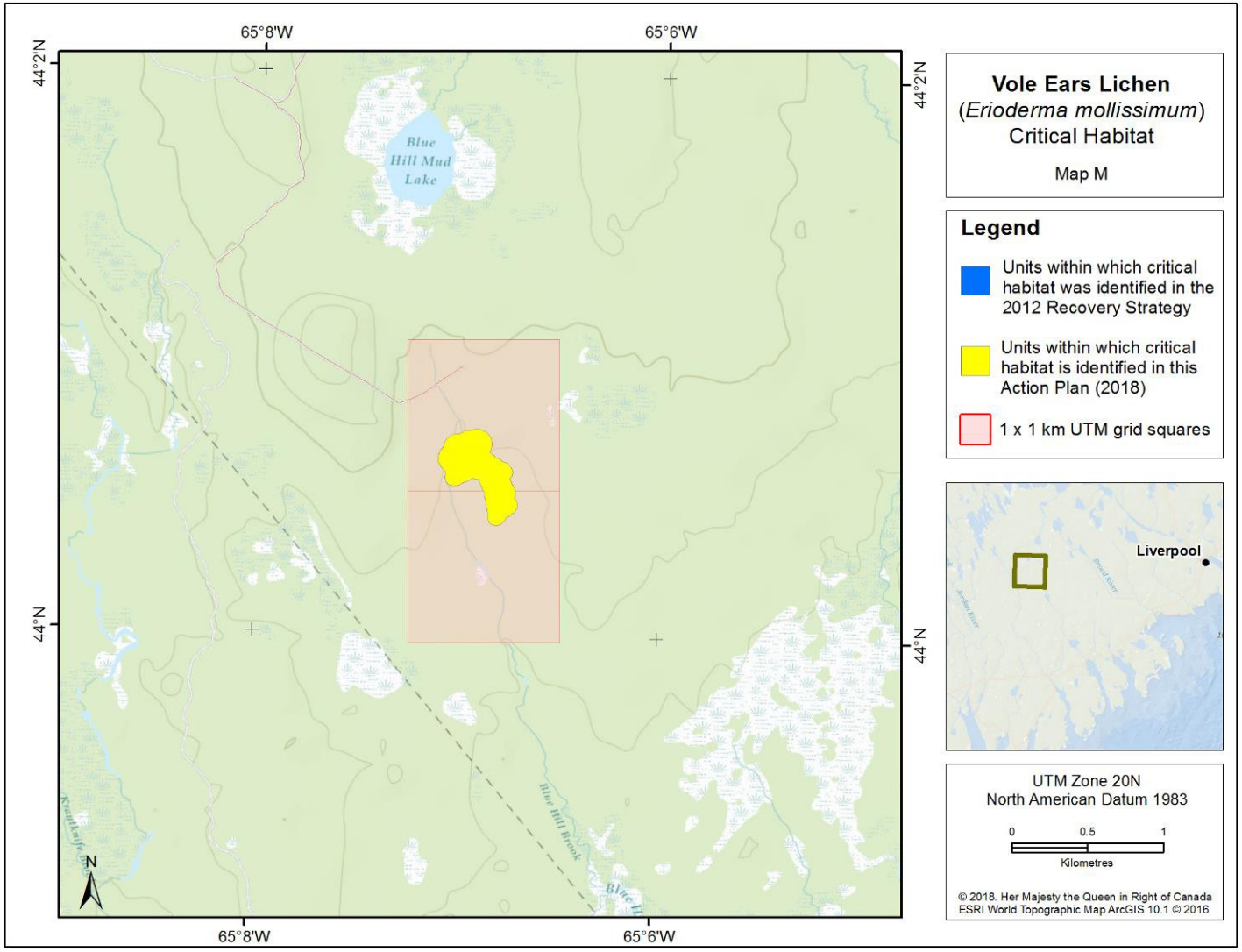

Figure 14. Critical habitat for Vole Ears Lichen in Queens County (see Nova Scotia overview map area M) is represented by the yellow shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

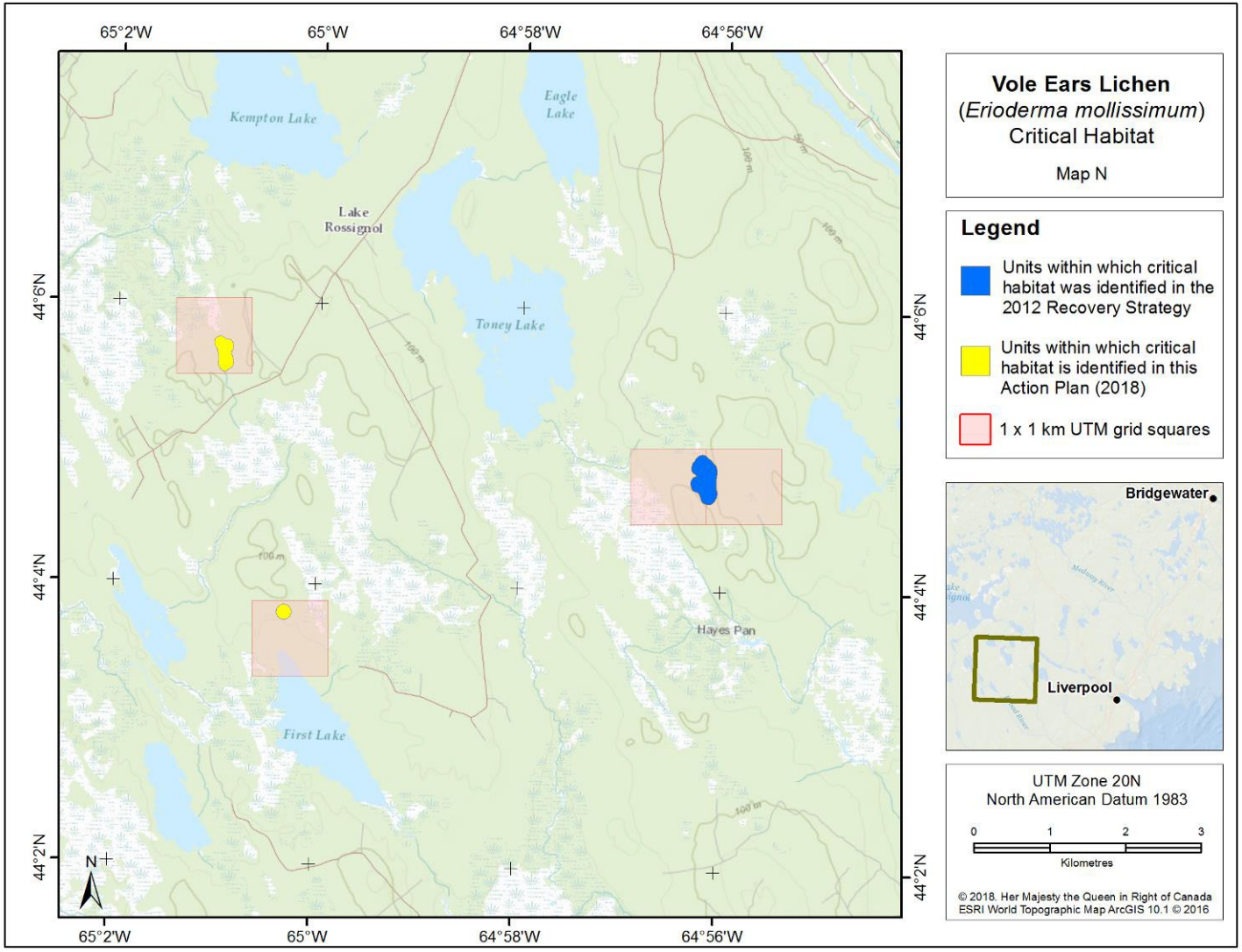

Figure 15. Critical habitat for Vole Ears Lichen in Queens County (see Nova Scotia overview map area N) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

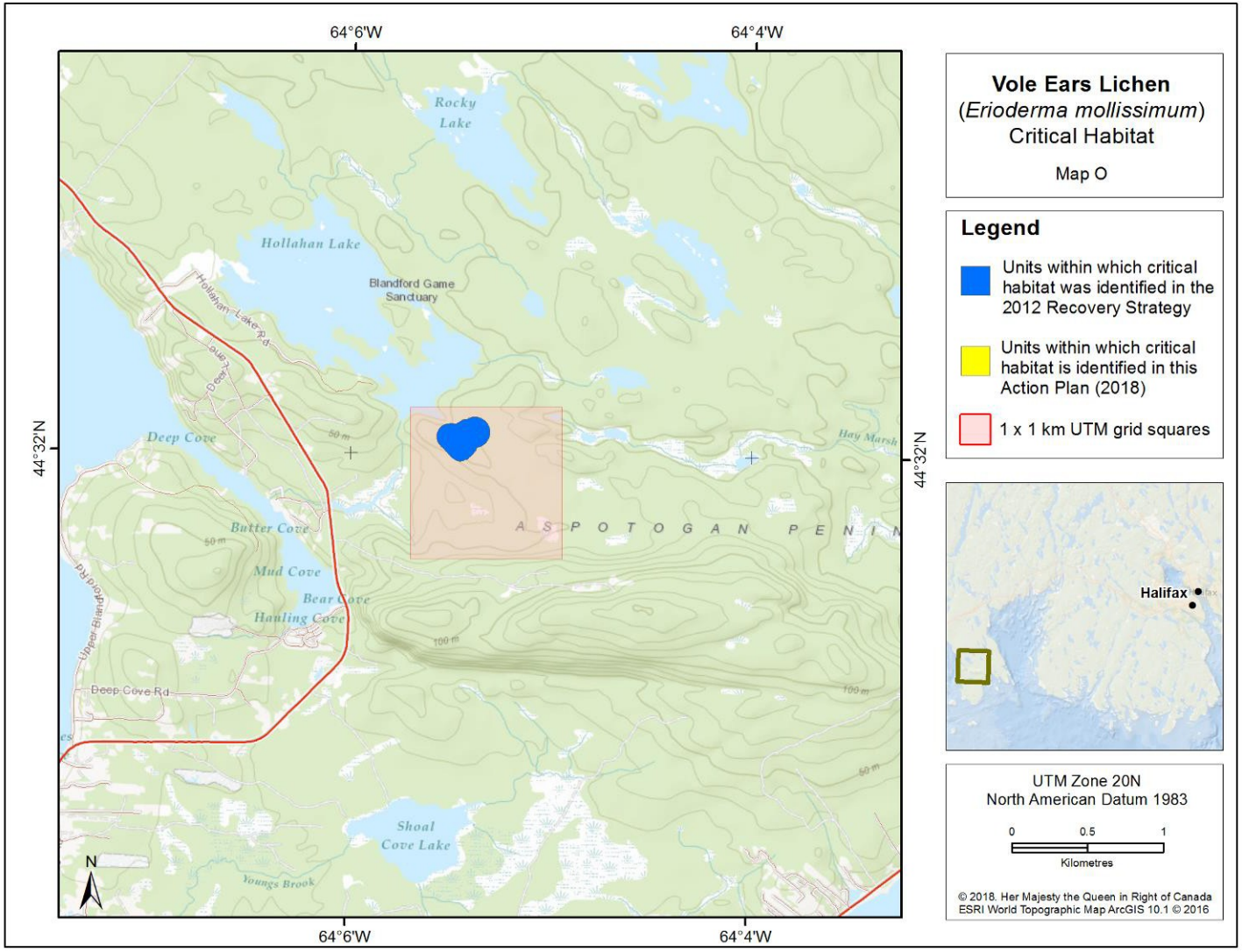

Figure 16. Critical habitat for Vole Ears Lichen in Halifax County (see Nova Scotia overview map area O) is represented by the blue shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

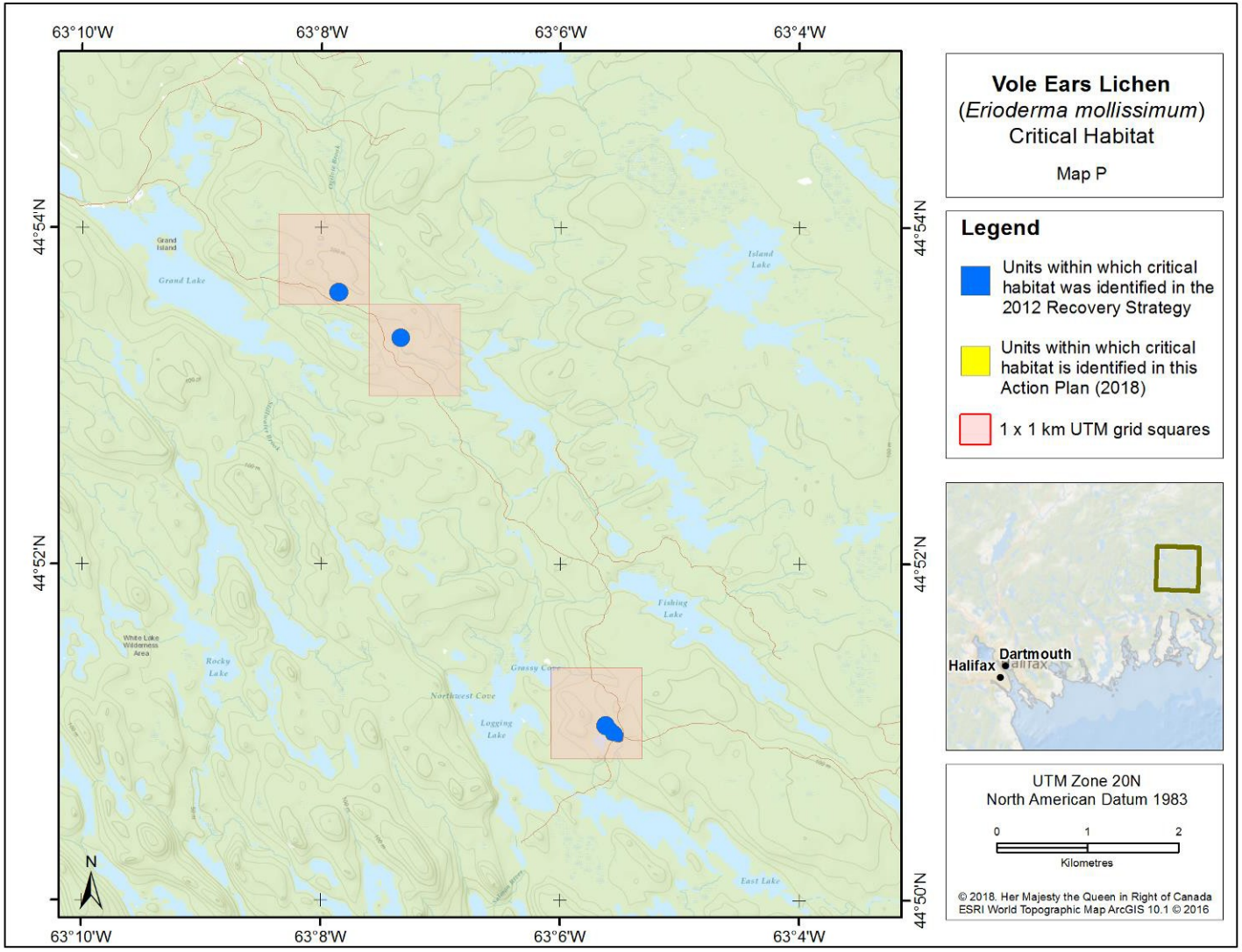

Figure 17. Critical habitat for Vole Ears Lichen in Halifax County (see Nova Scotia overview map area P) is represented by the blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

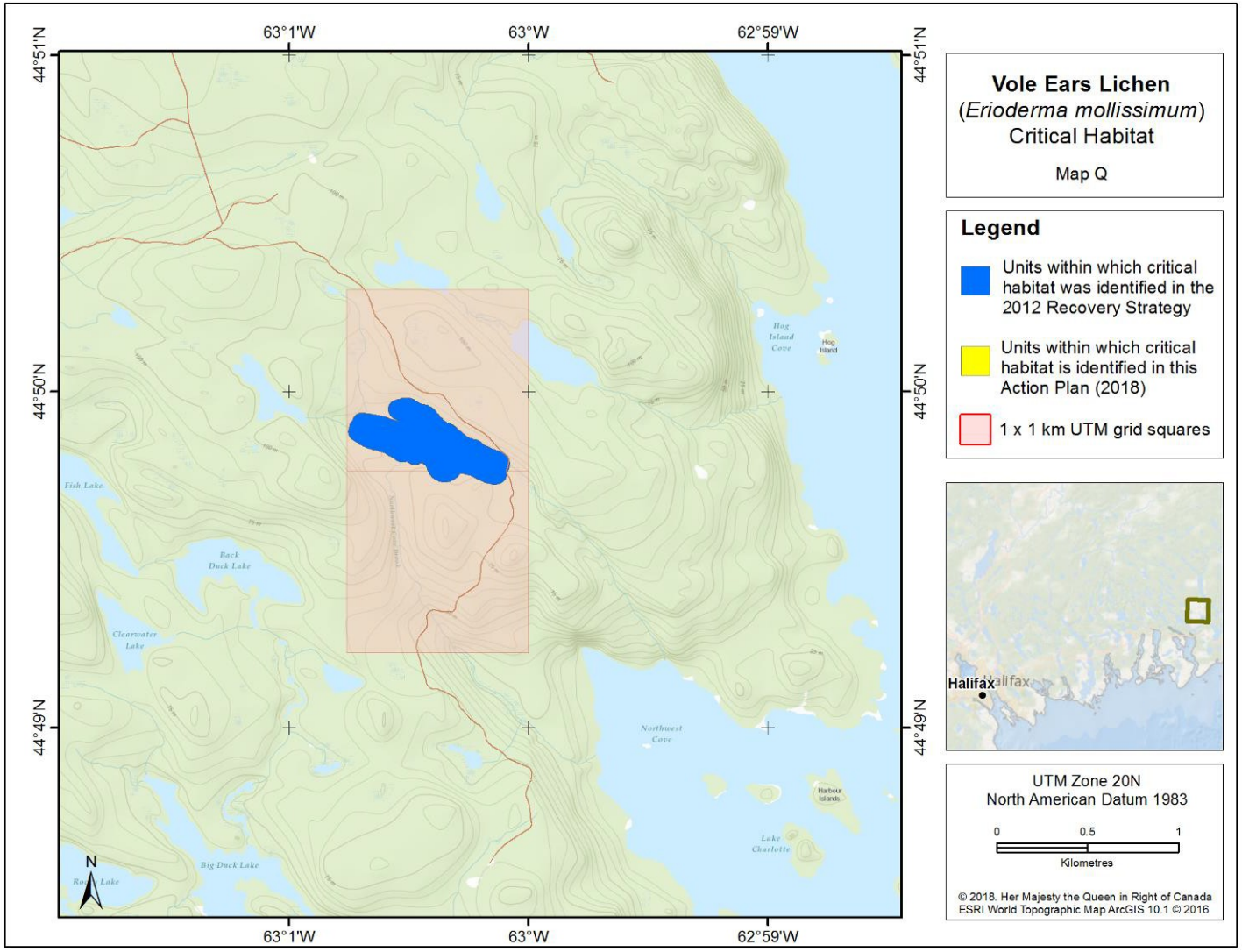

Figure 18. Critical habitat for Vole Ears Lichen in Halifax County (see Nova Scotia overview map area Q) is represented by the blue shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

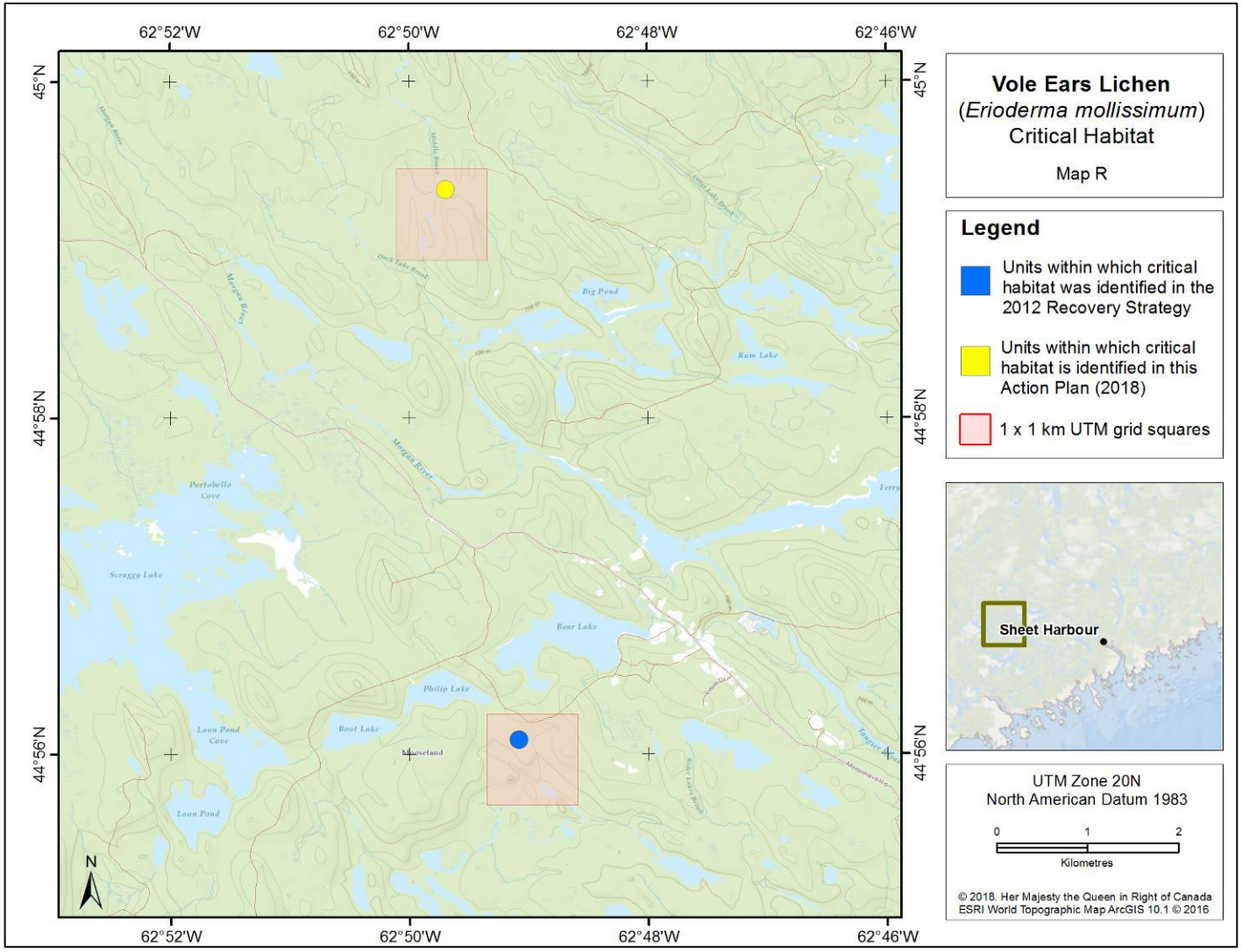

Figure 19. Critical habitat for Vole Ears Lichen in Halifax County (see Nova Scotia overview map area R) is represented by the yellow and blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

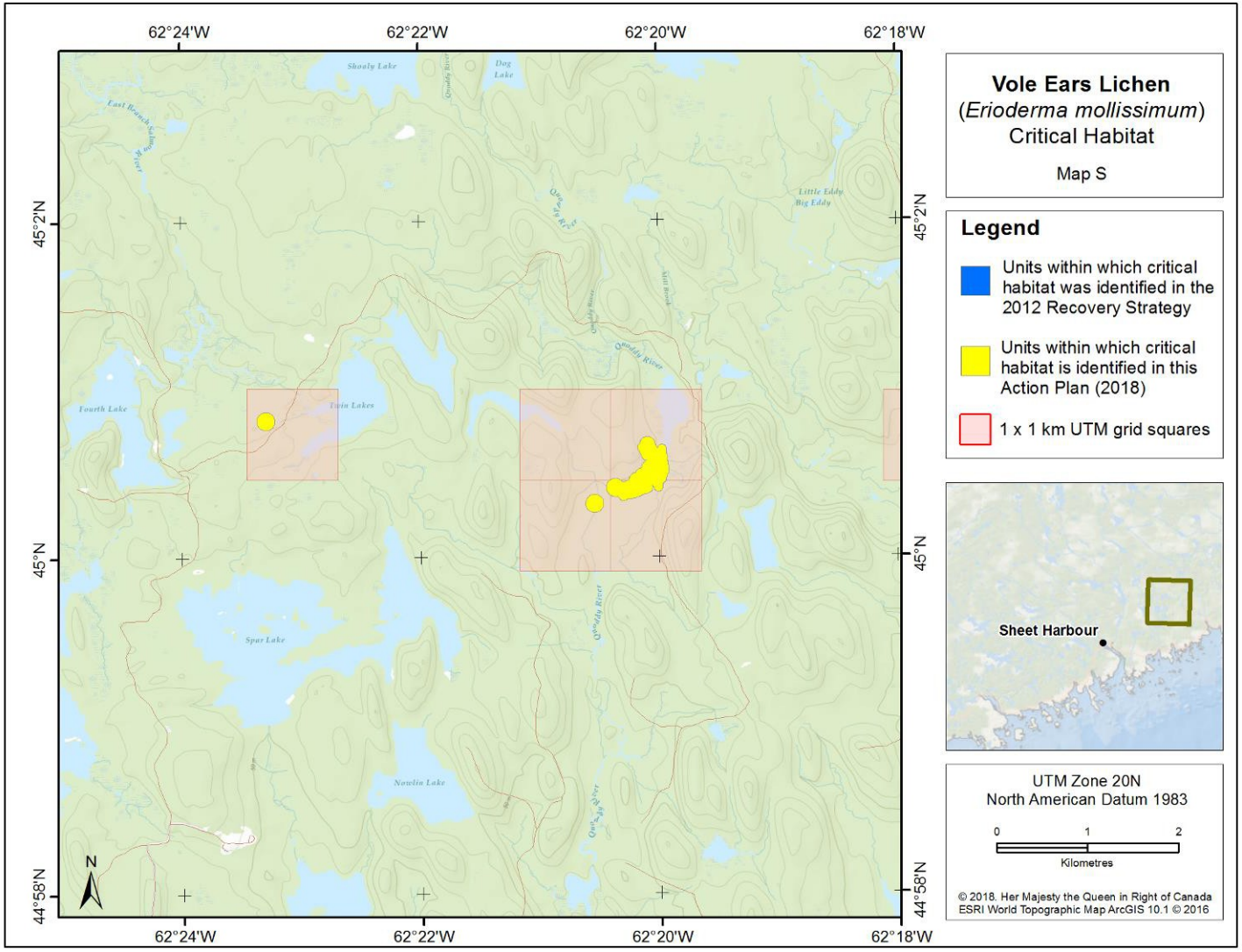

Figure 20. Critical habitat for Vole Ears Lichen in Halifax County (see Nova Scotia overview map area S) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

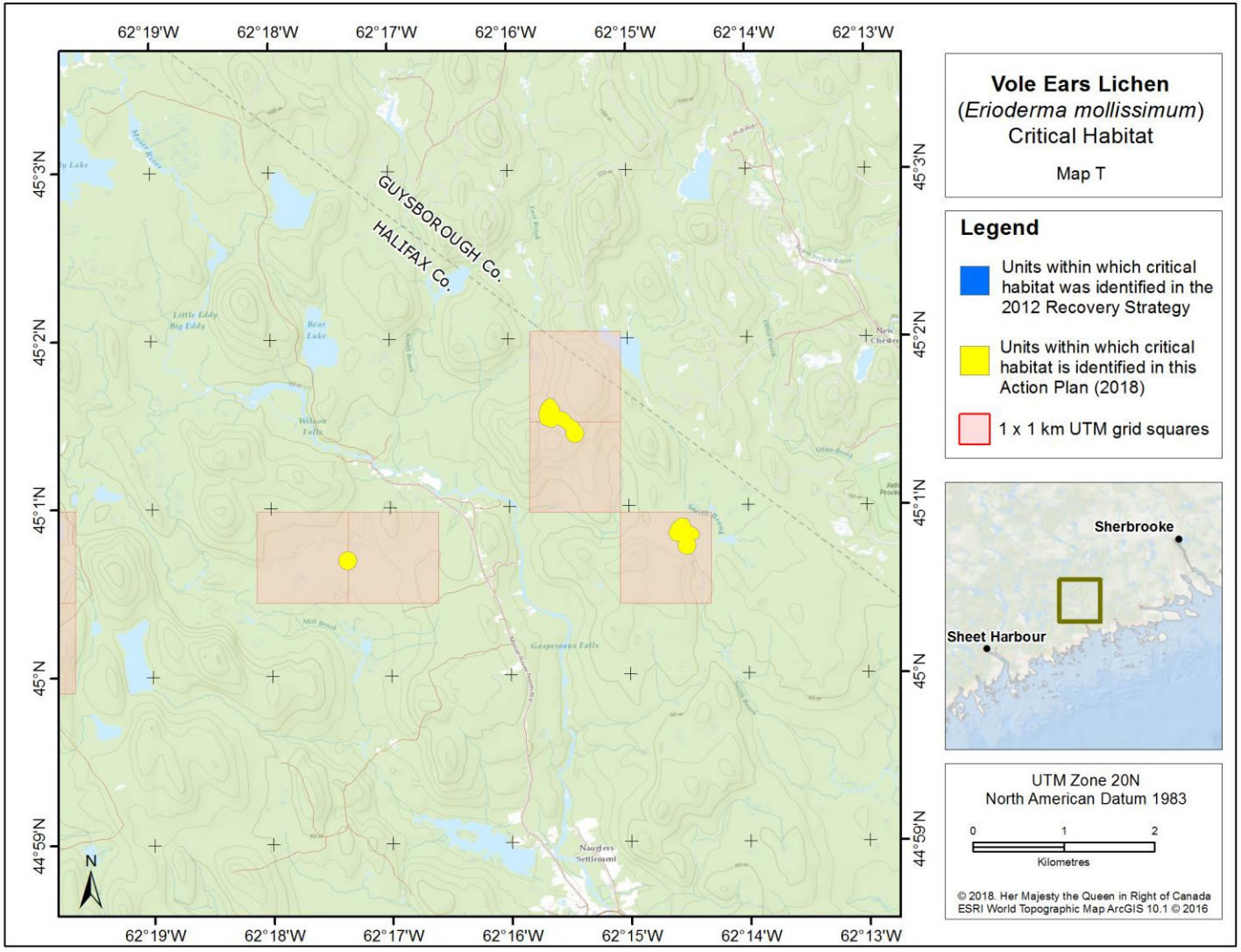

Figure 21. Critical habitat for Vole Ears Lichen in Halifax County (see Nova Scotia overview map area T) is represented by the yellow shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

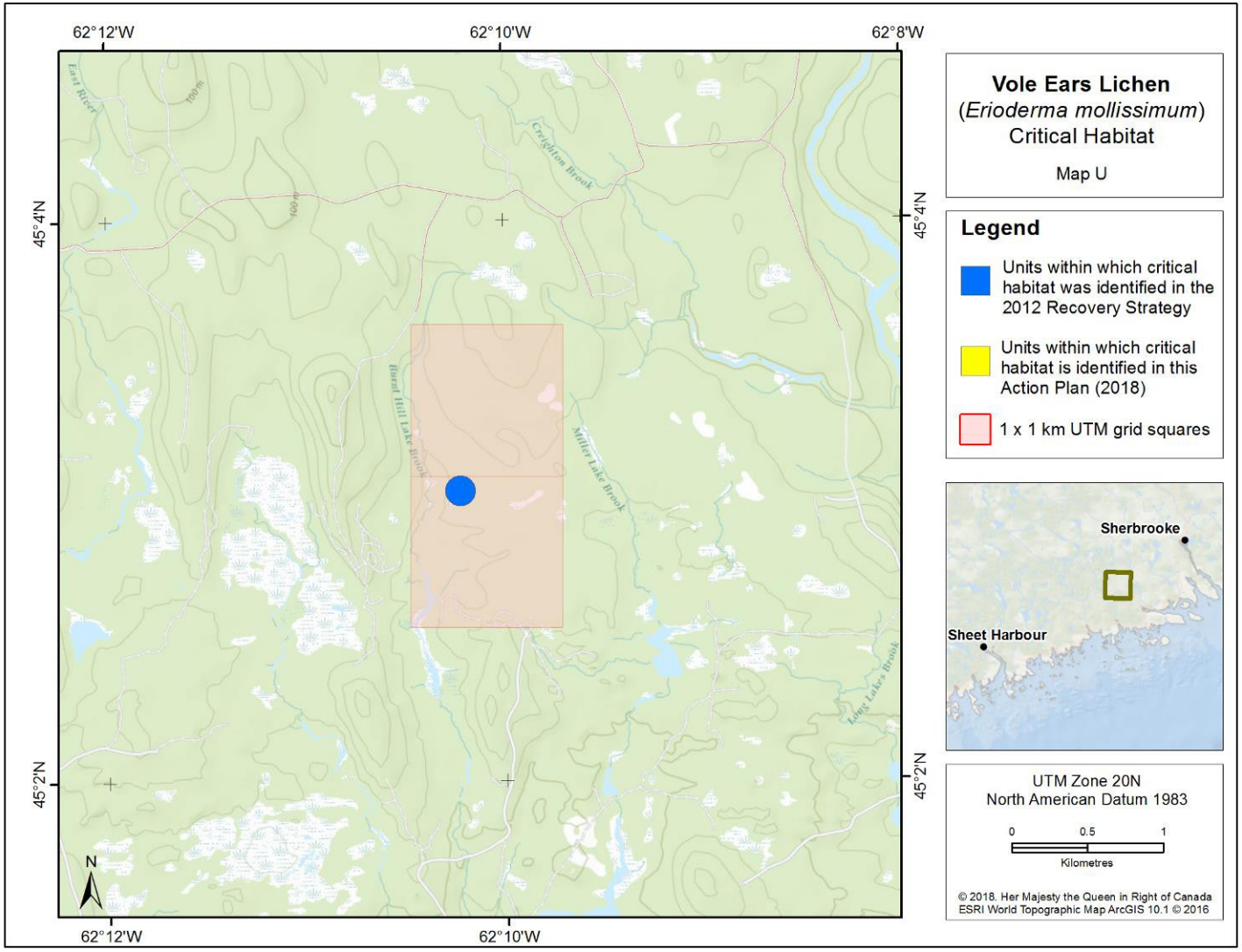

Figure 22. Critical habitat for Vole Ears Lichen in Guysborough County (see Nova Scotia overview map area U) is represented by the blue shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

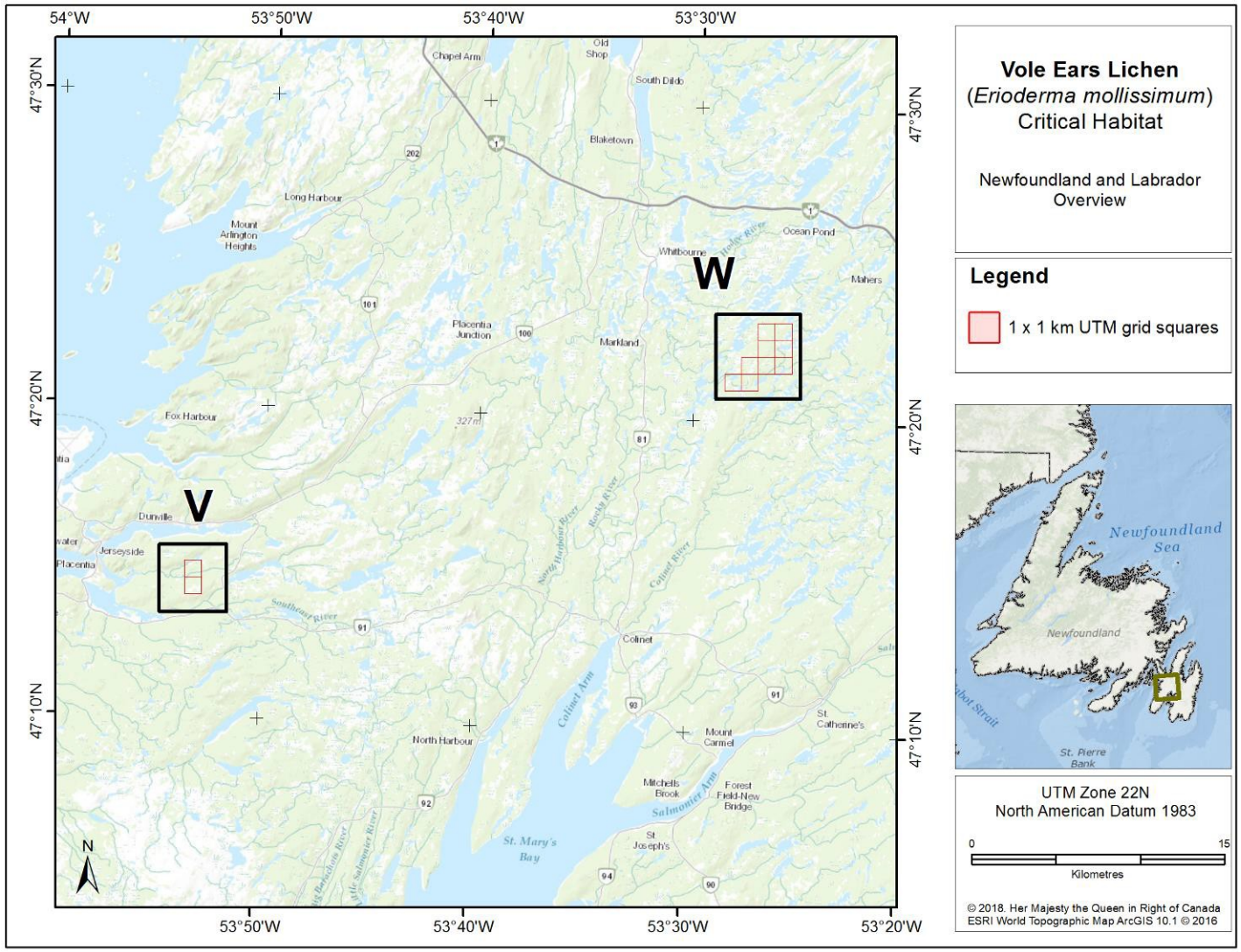

Figure 23. Overview map of critical habitat for Vole Ears Lichen in Newfoundland and Labrador. Refer to Figures 24-25 for detailed representations of critical habitat.

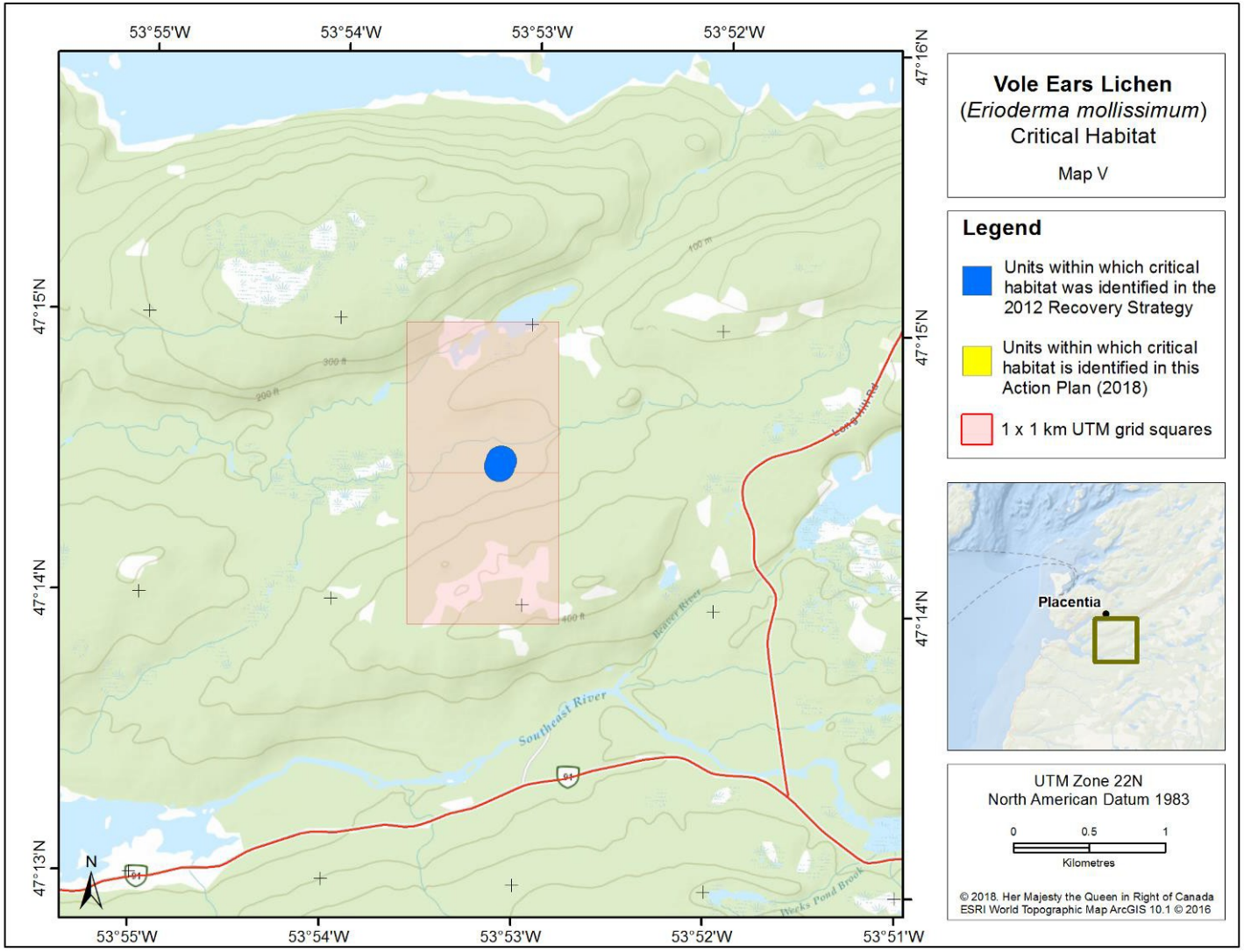

Figure 24. Critical habitat for Vole Ears Lichen on the Avalon Peninsula (see Newfoundland and Labrador overview map area V) is represented by the blue shaded polygon where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

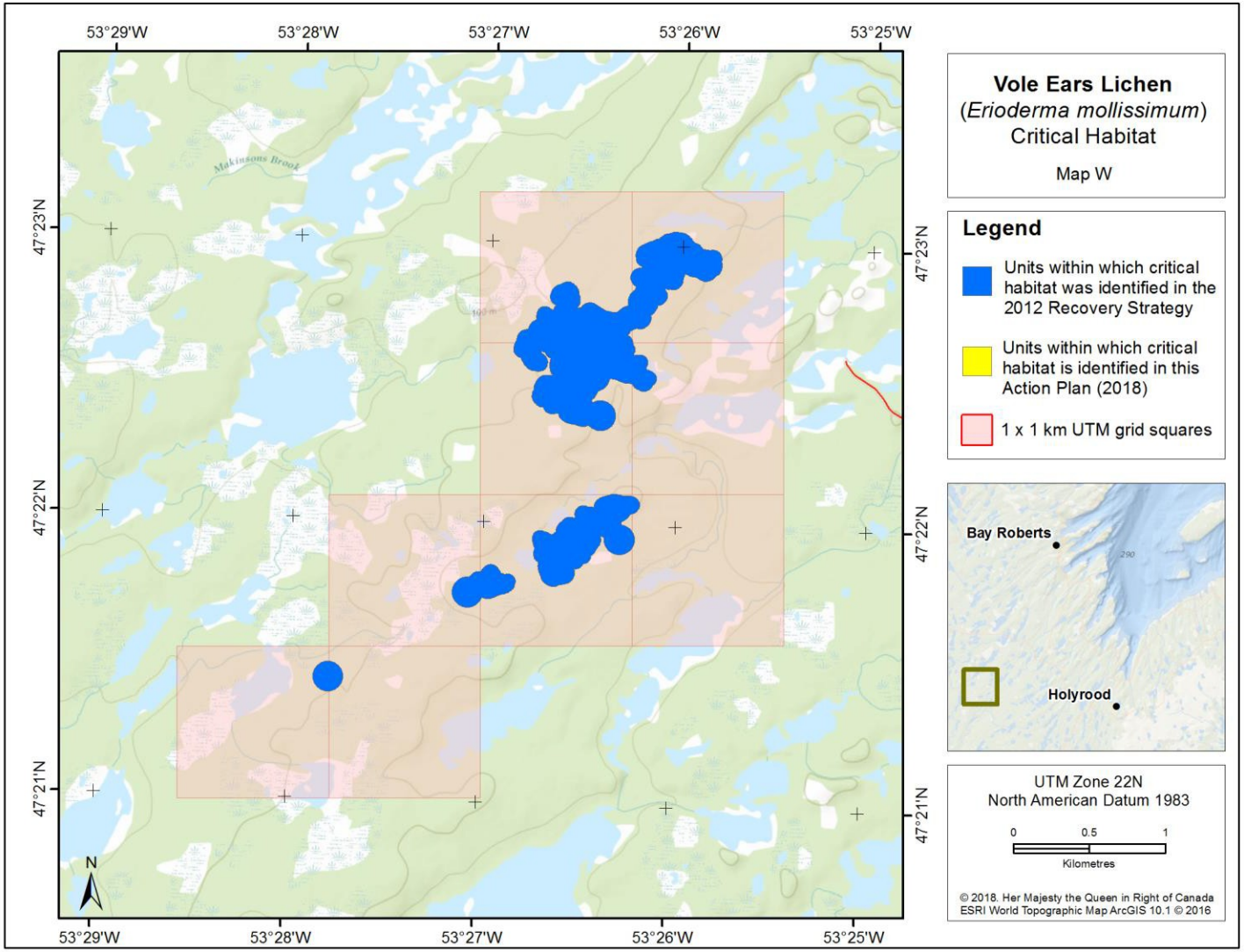

Figure 25. Critical habitat for Vole Ears Lichen on the Avalon Peninsula (see Newfoundland and Labrador overview map area W) is represented by the blue shaded polygons where the criteria and methodology set out in section 7.1 of the recovery strategy are met. The 1 km × 1 km UTM grid overlay shown in this figure is a standardized national grid system that indicates the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

1.3.2 Examples of activities likely to result in destruction of critical habitat

Examples of activities likely to result in destruction of critical habitat for Vole Ears Lichen may be found in section 7.3 of the recovery strategy for the Vole Ears Lichen.

1.4 Proposed Measures to Protect Critical Habitat

The information below outlines the measures proposed to be taken to protect critical habitat for Boreal Felt Lichen and Vole Ears Lichen.

1.4.1 Measures proposed to protect critical habitat on federal lands

As required under SARA, a description of the portions of critical habitat found in federally protected areas[4] are published in the Canada Gazette Part 1. This critical habitat will then be protected under subsection 58(1) of SARA. Gazette statements are available on the Species at Risk Public Registry. In March 2017, a gazette statement associated with the Multi-species Action Plan for Kejimkujik National Park and National Historic Site of Canada (Parks Canada Agency 2017) describing critical habitat for Vole Ears Lichen in Kejimkujik Seaside was posted on the Species at Risk Registry. This critical habitat was protected under s.58(1) of SARA.

1.4.2 Measures proposed to protect critical habitat on non-federal lands

With regard to the portions of critical habitat on non-federal lands, Environment and Climate Change Canada will assess the protection currently in place. This involves first working with the Governments of Nova Scotia and Newfoundland and Labrador to determine which provincial laws and legal instruments are in place to prevent destruction of critical habitat. If there are gaps in the protection of critical habitat, provisions or measures in place under SARA or other federal legislation will be reviewed to determine whether they prevent destruction of critical habitat. The laws and legal agreements in place that protect critical habitat will be monitored for efficacy at least every five years. Conservation measures, including stewardship initiatives, that contribute to preventing critical habitat destruction will also be considered and monitored.

If it is determined that any portions of critical habitat are not protected, and steps are being taken to protect those portions, those steps will be communicated via the Species at Risk Public Registry through the reports referred to in section 63 of SARA.

[4] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

2. Evaluation of Socio-Economic Costs and of Benefits

SARA requires that an action plan include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation (SARA 49(1)(e), 2002). This evaluation addresses only the incremental socio-economic costs of implementing this action plan from a national perspective as well as the social and environmental benefits that would occur if the action plan were implemented in its entirety, recognizing that not all aspects of its implementation are under the jurisdiction of the federal government. It does not address cumulative costs of species recovery in general nor does it attempt a cost-benefit analysis. Its intent is to inform the public and to guide decision making on implementation of the action plan by partners.

The protection and recovery of species at risk can result in both benefits and costs. The Act recognizes that "*wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological and scientific reasons*" (SARA 2002). Self-sustaining and healthy ecosystems with their various elements in place, including species at risk, contribute positively to the livelihoods and the quality of life of all Canadians. A review of the literature confirms that Canadians value the preservation and conservation of species in and of themselves. Actions taken to preserve a species, such as habitat protection and restoration, are also valued. In addition, the more an action contributes to the recovery of a species, the higher the value the public places on such actions (Loomis and White 1996; DFO 2008). Furthermore, the conservation of species at risk is an important component of the Government of Canada's commitment to conserving biological diversity under the *International Convention on Biological Diversity*. The Government of Canada has also made a commitment to protect and recover species at risk through the Accord for the Protection of Species at Risk. The specific costs and benefits associated with this action plan are described below.

2.1 Policy Baseline

The provinces of Nova Scotia and Newfoundland and Labrador have access to many legislative, regulatory, and management tools for the conservation and stewardship of Boreal Felt Lichen and Vole Ears Lichen. For example,

in Nova Scotia:

- *Endangered Species Act:* requires recovery planning which must identify areas of habitat to be considered for designation as core habitat. Once core habitat has been designated the Minister may create regulations controlling, restricting or prohibiting access to or activities in the habitat.

- *Parks Act:* preserves unique, rare, representative, or otherwise significant elements of the natural environment and historic resources of Nova Scotia and prevents the willful destruction of park property (including trees and other natural

resources). In addition, the Minister may take such measures as the Minister deems necessary to protect flora and fauna within a provincial park.

- *Crown Lands Act*: enables the Minister to set aside special areas on Crown lands for habitat protection and requires the Minister to integrate appropriate protective measures in forest-management planning for Crown lands to respect wildlife habitats.

- *Environment Act*: protects the environment including biological diversity, requires many activities to undergo an approval process that may incorporate consideration of habitat, and requires environmental assessments for designated undertakings. The Minister can reject an undertaking or place conditions on an undertaking including conditions to protect habitat.

- *Forests Act*: maintains or enhances wildlife and wildlife habitats, and water quality. The intent and purpose of this Act is to ensure that wildlife, wildlife habitats, and the long term diversity and stability of the forest ecosystems, water supply watersheds, and other significant resources are maintained or enhanced. In addition, under the *Wildlife Habitat and Watercourse Protection Regulations,* buffers are maintained around the associated wetland.

- *Special Places Protection Act*: preserves ecological sites containing rare or endangered species in their natural habitats, enables designation of land as ecological sites. The Minister may develop a management plan for an ecological site and the Minister may issue ecological research permits.

- *Nova Scotia Wetland Conservation Policy*: prevents the net loss of wetlands in Nova Scotia through wetland conservation practices that integrate the need for wetland protection with the need for sustainable economic development.

- *Wilderness Areas Protection Act*: provides for the establishment, management, protection, and use of wilderness areas; maintains and restores the integrity of natural processes and biodiversity; and protects representative examples of natural landscapes and ecosystems.

- *Special Management Practices*: this policy requires surveys for the presence of endangered lichens (specifically for Boreal Felt Lichen) on all provincial Crown lands where forest harvesting and silviculture operations are proposed in areas with suitable habitat biophysical attributes (as determined by the habitat supply model (Cameron et al. 2013)) and enacts forested buffers around phorophytes.

<u>in Newfoundland and Labrador:</u>

- *Endangered Species Act*: prohibits the disturbance or destruction of a designated species' residence, provides further protection for 'critical habitat' and 'recovery' habitat.

- *Environmental Protection Act*: protects the environment through regulation. Prohibits certain activities (refer to regulations) unless the appropriate approvals are in place and requires environmental assessments for certain projects involving endangered species and their habitats.

- *Forestry Act*: requires the proponent to submit a management plan that addresses the impacts to wildlife habitat.

- *Lands Act*: allows for the designation of special management areas to protect wildlife habitat.

- *Water Resources Act*: requires permits for development activities in, and affecting, wetlands.

- *Wilderness and Ecological Reserves Act*: provides the Minister with broad authority to prohibit or control activities within protected areas.

2.2 Socio-economic Profile and Baseline

The forestry industry is primarily affected by the protection of these lichen species and their critical habitat. Stakeholders include the Government of Canada, the governments of Nova Scotia and Newfoundland and Labrador, and private landowners.

Many recovery measures are undertaken with the assistance of federal or provincial species at risk funding programs, in-kind contributions by recovery biologists, or research by universities.

2.3 Socio-economic Costs of Implementing this Action Plan

Implementation of the recovery measures identified in Table 1 may generate direct costs as well as societal costs. These costs are reported in this section only if they result in incremental expenditures or constraints in land uses (including foregoing or modifying current and future activities; e.g., forest harvesting activities) compared to measures already in place (see ongoing measures in Table 1).

A special management practice is already in place on crown lands in Nova Scotia for Boreal Felt Lichen which places restrictions on forestry activities in the vicinity of the species' critical habitat.

For Boreal Felt Lichen and Vole Ears Lichen, the direct and societal costs are expected to be low (i.e., between $0 and $5 million) over the short term (five years). Costs at the regional or provincial scale are expected to be minimal. These anticipated costs include salary, volunteer time, travel, materials, equipment, and other related costs. Indirect costs are those resulting from implementing the action plan, which may have an impact

on various stakeholders. Impacts to stakeholders include foregoing or modifying current and future activities.

Costs would only be incurred locally as the species occupy a limited geographic area in Nova Scotia and Newfoundland and Labrador. Costs at the regional or provincial scale are expected to be minimal.

2.4 Benefits of Implementing this Action Plan

Nearly half (46%) of respondents to the 2012 Canadian Nature Survey (Federal, Provincial, and Territorial Governments of Canada 2014) reported taking some form of direct action to assist in the recovery of species at risk. Care for the environment is consistently ranked as one of Canada's top priorities in public opinion polls (Environment Canada 2009). A recent opinion poll found that three quarters of Canadian respondents feel that preserving natural areas and the variety of native plant and animal life in Canada is important to them (Ipsos Reid Opinion Poll 2011).

Wetlands are designated by international convention (The Ramsar Convention) specifically to foster conservation because they provide a myriad of essential ecosystem services. Among others, wetlands filter sediments and toxins, serve as groundwater recharge areas, supply food and habitat for wildlife and humans, provide products, and provide areas for outdoor recreational activities such as bird watching, fishing, and hunting.

Forest ecosystems provide a number of goods and services such as: provisional goods (e.g., fishing, hunting and gathering forest plants, fresh water), regulating services (e.g., air quality maintenance, climate and atmospheric regulation, water regulation and supply, water purification, pollination, erosion control and sediment retention), cultural services (e.g., recreation and ecotourism, aesthetic cultural heritage) and supporting services (e.g., soil formation, nutrient cycling, habitat refugium, primary production).

Cyanolichens such as the Boreal Felt Lichen and Vole Ears Lichen contribute to forest ecosystem services through nutrient cycling including converting biologically inactive nitrogen gas into forms usable for other plant species. Cameron and Richardson (2006) show that cyanolichens can contribute significant amounts of nitrogen to ecosystems. Cyanolichens give humans the ability to detect fluctuations in local air quality due to the lichen's sensitivity to pollution. This makes cyanolichens valuable indicators of environmental and ecosystem health. Given that Nova Scotia receives air pollution from industrialized areas of the eastern United States and central and eastern Canada, Nova Scotia lichens can provide an early warning system for the ecosystem effects of pollutants (Cameron 2004).

By focusing on increasing protection measures, as well as improved public outreach, education and stewardship, it is expected that the recovery approaches outlined in the action plan will benefit the larger ecological community as well. Achieving the goal of this action plan will have a positive impact for Canadians.

2.5 Distributional Impacts

Although Boreal Felt Lichen and Vole Ears Lichen both occur on private properties, landowners are not expected to bear the brunt of the responsibility for the species' recovery. Non-governmental organizations are active in Nova Scotia and Newfoundland and Labrador where the species occur, and an approach of this action plan is to foster cooperative relationships with landowners and others to maintain critical habitat.

Indirect incremental costs resulting from the impacts of implementing some recovery measures may be absorbed by the forestry industry through increased operating costs.

3. Measuring Progress

The performance indicators presented in the associated recovery strategies provide a way to define and measure progress toward achieving the population and distribution objectives.

Reporting on *implementation* of the action plan (under s. 55 of SARA) will be done by assessing progress towards implementing the broad strategies.

Reporting on the ecological and socio-economic impacts of the action plan (under s. 55 of SARA) will be done by assessing the results of monitoring the recovery of the species and its long term viability, and by assessing the implementation of the action plan.

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Species at Risk Act (SARA) (S.C. 2002, c. 29)
http://laws-lois.justice.gc.ca/eng/acts/s-15.3/FullText.html

Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[5]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[6] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of action plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the action plan itself, but are also summarized below in this statement.

This action plan will clearly benefit the environment by promoting the recovery of the Boreal Felt Lichen and Vole Ears Lichen. The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to relevant sections in the recovery strategies (e.g., effects on other species; and the recommended approaches for recovery).

The effects on other species were also considered. Boreal Felt Lichen and Vole Ears Lichen are part of a suite of rare cyanolichens, all of which occur in similar habitats within the humid Atlantic forest region of Nova Scotia and Newfoundland and Labrador. In fact, the habitat suitability mapping algorithm for Boreal Felt Lichen in Nova Scotia is much more effective at identifying habitats that support one or more of these species (approx. 50% accuracy) than it is at identifying habitat that supports Boreal Felt Lichen (approx. 7% accuracy). Survey work directed towards locating new Boreal Felt Lichen and Vole Ears Lichen sites has produced many new records for members of this larger group of species (Cameron and Neily 2008). Furthermore, since all of these species share similar habitat requirements, actions directed towards better understanding ecosystem-level associations and securing habitat for Boreal Felt Lichen and Vole Ears Lichen will almost certainly result in the protection of populations of other rare cyanolichens, such as *Degelia plumbea* (special concern) Frosted Glass-whiskers (*Sclerophora peronella*) (special concern) and other rare cyanolichens not yet assessed by COSEWIC. At a regional level, any progress in reducing air pollution will benefit not only Boreal Felt Lichen and Vole Ears Lichen, but most (if not all) of the flora and fauna of New Brunswick, Nova Scotia, and Newfoundland and Labrador as well.

[5] www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[6] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1