Species at Risk Act
Recovery Strategy Series

Recovery Strategy and Action Plan for the Eastern Waterfan (*Peltigera hydrothyria*) in Canada

Eastern Waterfan

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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].

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

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 and action plans (for species for which recovery has been deemed feasible) for listed Extirpated, Endangered, and Threatened species. They are also required to report on progress within five years after the publication of the final document on the Species at Risk Public Registry.

This document has been prepared to meet the requirements under SARA of both a recovery strategy and an action plan. As such, it provides both the strategic direction for the recovery of the species, including the population and distribution objectives for the species, as well as the more detailed recovery measures to support this strategic direction, outlining what is required to achieve objectives. SARA requires that an action plan also include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation. It is important to note that the setting of population and distribution objectives and the identification of critical habitat are science-based exercises and socio-economic factors were not considered in their development. The socio-economic evaluation only applies to the more detailed recovery measures. The recovery strategy and action plan are considered part of a series of documents that are linked and should be taken into consideration together, along with the COSEWIC status report.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for Eastern Waterfan and has prepared this recovery strategy and action plan, as per sections 37 and 47 of SARA. To the extent possible, it has been prepared in cooperation with the Provinces of Quebec, New Brunswick, and Nova Scotia. It was developed in cooperation and consultation with the Nova Scotia Lands and Forestry Lichens Recovery Team, non-governmental organizations, and other stakeholders as per sections 39(1) and 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 set out in this strategy and will not be achieved by Environment and Climate Change Canada, the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Eastern Waterfan and Canadian society as a whole.

This recovery strategy and action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

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, in either 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 recovery document was prepared by Julie McKnight (Environment and Climate Change Canada, Canadian Wildlife Service (ECCC-CWS) – Atlantic Region). Acknowledgement and thanks are extended to parties that provided invaluable advice, unpublished reports, and personal communications to help inform the development of this document including Individuals, provincial governments, the Nova Scotia Lichens Recovery Team and other stakeholders. Special thanks are extended to Frances Anderson, Robert Cameron, Jean Gagnon, Becky Graham, Tom Neily, Dr. David Richardson and Neil Vinson. Thanks are also extended to Jeffrey Thomas (ECCC-CWS – Atlantic Region) for completing the CH analysis and to Chris Lauzon (ECCC-NCR) for preparing the Canadian occurrence and critical habitat maps. Finally, the contribution made by the Committee on the Status of Endangered Wildlife in Canada in preparing the Status Report on Eastern Waterfan, which served as a basis for this document, is gratefully acknowledged.

Executive Summary

Eastern Waterfan (*Peltigera hydrothyria)* is a dark green or grey (almost black when wet) aquatic cyanolichen[4] with distinctive fan-shaped lobes that is deeply veined on its undersurface. The lichen affixes to rocks (stones, boulders and bedrock) by spongy tufts of fibers at, and below, the water level.

Eastern Waterfan is native and restricted to eastern North America and approximately one-quarter of the population occurs in Canada. The species is known from 39 streams; one in Quebec, 26 in New Brunswick and 12 in Nova Scotia (Atlantic Canada Conservation Centre (ACCDC) unpublished data, Fundy National Park unpublished data). Since the species was assessed by COSEWIC in 2013, new occurrences were documented in Fundy National Park, New Brunswick (ACCDC and Fundy National Park unpublished data 2019) and in Nova Scotia (F. Anderson personal communication 2019).

There are unknowns regarding the feasibility of recovery of Eastern Waterfan as presented in the recovery feasibility summary section. 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.

Eastern Waterfan was assessed by COSEWIC as Threatened in 2013 and listed on Schedule 1 of the *Species at Risk Act* (SARA) in 2018. Eastern Waterfan is not listed in Quebec or New Brunswick. The species is listed as Threatened in Nova Scotia (*Nova Scotia Endangered Species Act* - N.S. Reg. 2017).

This document has been prepared to meet the requirements under SARA of both a recovery strategy and an action plan. As such, it provides both the strategic direction for the recovery of the species as well as the more detailed recovery measures to support this strategic direction, outlining what is required to achieve the objectives.

Factors which directly threaten the survival of individuals include: changes in water quality and quantity associated with human activity (e.g., energy production & mining, logging & wood harvesting resulting in erosion and runoff, roads, dams & water management/use) and changes in the light regime or humidity (e.g., as a result of logging & wood harvesting, droughts, storms & flooding).

The population and distribution objectives for Eastern Waterfan are to maintain a stable (or increasing) population within its range in Canada (2019), including any new sites that may be found in the future.

The broad strategies, general approaches and recovery measures to be taken to support the population and distribution objectives and address threats to Eastern

[4] Lichens are composite organisms composed of a fungus and algae and/or cyanobacterium. Cyanolichens are lichens that contain cyanobacteria (blue-green algae).

Waterfan are presented in the Strategic Direction for Recovery and Measures to be Taken (Section 6.2).

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 partially identified for Eastern Waterfan in this document to the extent possible given the best available information. As more information becomes available, additional critical habitat may be identified.

The direct and societal costs of implementing the recovery measures contained in this document (as part of the action plan content) are expected to be low (between $0 and $5 million) over the short term (five years) and will have limited socio-economic impact and constraints to human land use. Indirect costs are expected to be minimal and resulting benefits relate to the value of biodiversity to Canadians, ecosystem services and conservation of other species.

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 Eastern Waterfan. 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.

Yes. The species is currently found in the United States (Connecticut, Georgia, Maine, Massachusetts, New Hampshire, North Carolina, Pennsylvania, Rhode Island, Tennessee, Vermont and Virginia) and in Canada (Quebec, New Brunswick and Nova Scotia).

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

Unknown. The few documented occurrences despite extensive searches and known needs of the species suggest this lichen occupies a specific and narrow niche. There are no data documenting historical changes to stream habitats in Quebec or Atlantic Canada and without a long-term monitoring plan for habitat or occurrences, it is not possible to assess trends for this species.

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

Unknown. It is unknown whether changes in habitat humidity because of climate change can be avoided or mitigated. It should be possible to avoid or mitigate the human-caused habitat threats (logging & wood harvesting, roads, dams & water management/use, pollution)

Formal and informal partnerships with industry, scientists, municipal governments, federal/provincial governments, Indigenous groups, conservation organizations, landowners, rights- and lease-holders and the public may help achieve the conservation of Eastern Waterfan habitat. Seventy-five percent of the sites with the lichen are conserved under legislation (e.g., Canada National Parks Act, Quebec Natural Heritage Conservation Act, New Brunswick Watershed Protected Area Designation Order, Nova Scotia Special Places Protection Act, Nova Scotia Wilderness Areas Protection Act). Sites occur within the Réserve de biodiversité projetée de la Fôret-Montmorency in Quebec, Fundy National Park in New Brunswick, and in Cape Chignecto Provincial Park, Wentworth Conservation Lands,

Gully Lake Wilderness Area, Alder Grounds Wilderness Area and Aspy Fault Wilderness Area in Nova Scotia.

In Quebec, the "Règlement sur l'aménagement durable des forêts du domaine de l'État' under the "Loi sur l'aménagement durable du territoire forestier" detail riparian harvesting restrictions and these areas are also subject to the "Loi sur la qualité de l'environnement with its Politique de protection des rives, du littoral et des plaines inondables". The rivière Noire population is also included in the réserve de biodiversité projetée de la Forêt-Montmorency, protected under the Loi sur la conservation du patrimoine naturel. Under this Act, a Conservation plan was prepared that enumerates activities permitted or not permitted within that protected area. In Nova Scotia, At-risk Lichens Special Management Practices (SMPs) provide a 200m protected zone (from forest harvest, mineral exploration and new road construction) for the lichen on Crown land (Nova Scotia Lands and Forestry 2018) and the Wildlife Habitat and Watercourses Protection Regulations provides for riparian buffers of 20 m on forested private land (Nova Scotia 2002). A permit must be obtained in New Brunswick for alterations of riparian zones within 30 m of a wetland or banks of a watercourse (New Brunswick 2019) and to a lesser extent, within 75 m of a watercourse in a designated protected watershed (New Brunswick no date). It is unclear if riparian zone restrictions in Quebec, New Brunswick and Nova Scotia are adequate to protect Eastern Waterfan from negative changes in water quality.

It is also unclear whether the effects of climate change can be mitigated for this species. Warmer summers may lead to increased evapotranspiration and drought and Eastern Waterfan may not be able to tolerate desiccation. Changes in water quantity (either significantly increased or decreased) could negatively affect the survival of this lichen as increased rain events during winter storms may remove Eastern Waterfan from its substrate and decreased water flow may cause the lichen to be exposed and become dry beyond what it can tolerate (COSEWIC 2013).

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

Yes. Although studies have not been conducted to confirm whether Eastern Waterfan is able to reproduce by fragmentation, fragmentation is a common method of vegetative reproduction in lichens (Krishnamurthy and Upreti 2001). If split lobes are able to attach after being swept downstream, a new colony may form. It may be possible to augment the population by transplanting fragmented lobes. Success in transplanting aquatic lichens by moving colonised rocks to suitable locations has been demonstrated (Lesher et al. 2003).

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2013

Common Name (population): Eastern Waterfan

Scientific Name: *Peltigera hydrothyria*

COSEWIC Status: Threatened

Reason for Designation: This rare lichen is endemic to Eastern North America. In Canada, it is known only from New Brunswick, Nova Scotia and Quebec. It grows at or below water level in cool, clear, partially shaded streams. It is threatened in the short term by disturbance from activities which cause stream siltation, alteration of microclimate and declines in water quality. In the longer term, changes in weather patterns that alter water levels and flow in its preferred habitat are another threat.

Canadian Occurrence: Quebec, New Brunswick, Nova Scotia

COSEWIC Status History: Designated Threatened in November 2013.

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

2. Species Status Information

Eastern Waterfan (*Peltigera hydrothyria)* was assessed by COSEWIC as Threatened in 2013 and listed on Schedule 1 of the *Species at Risk Act* (SARA) in 2018. Eastern Waterfan is native and restricted to eastern North America and approximately one-quarter of the population occurs in Canada (COSEWIC 2013). The species is listed as Threatened in Nova Scotia (*Nova Scotia Endangered Species Act* - N.S. Reg. 2017). Global, national and sub-national ranks are in Table 1.

Table 1. Conservation status ranks for Eastern Waterfan (NatureServe 2019, CESCC 2016)

Global (G) Rank[a]	**National (N) Rank[a]**	**Subnational (S) Rank[a]**
G- Rank	**N-Rank**	**S-Rank**
GNR	Canada N2	Quebec (S1), New Brunswick (S1), Nova Scotia (S1)
	USA NNR	North Carolina (SNR), Pennsylvania (SNR), Virginia (SNR)

[a] Conservation Status Rank: 1– critically imperiled; 2– imperiled; 3– vulnerable to extirpation or extinction; 4– apparently secure; 5– secure; X – presumed extirpated; H – historical/possibly extirpated; NR – status not ranked; U – unrankable

3. Species Information

3.1 Species Description

Eastern Waterfan is a dark green or grey (almost black when wet) aquatic cyanolichen[5] with distinctive fan-shaped lobes that is deeply veined on its undersurface. The lichen is affixed to rocks (stones, boulders and bedrock) by spongy tufts of fibers and grows at and below water level. Its orange or red-brown fruiting bodies occur on the margin of the lichen. Small pieces of lichen may break off and may become established downstream; providing a means for dispersal. The lichen can also reproduce via the discharge of fungal spores but to successfully resynthesize, the spore must meet a suitable cyanobacterium.

3.2 Species Population and Distribution

Eastern Waterfan is native and restricted to eastern North America. The majority of observations of Eastern Waterfan in the United States come from the Appalachian Mountains in Connecticut, Georgia, Maine, Massachusetts, New Hampshire, North Carolina, Pennsylvania, Rhode Island, Tennessee, Vermont and Virginia (Dennis et al. 1981; Gary Perlmutter personal communication 2011 and Don Flenniken personal communication 2011 *in* COSEWIC 2013).

In Canada, Eastern Waterfan is known from Quebec, New Brunswick and Nova Scotia. The earliest known records of Eastern Waterfan in eastern Canada are from 1978 and these early occurrences were revisited in 2011 to prepare the species' status report (COSEWIC 2013).

The species is known from one stream in Quebec within the Réserve de biodiversité projetée de la Forêt-Montmorency. Eastern Waterfan is now known from 26 streams in New Brunswick and 12 streams in Nova Scotia (Atlantic Canada Conservation Data Centre (ACCDC) unpublished data, Fundy National Park unpublished data, F. Anderson personal communication). Since the status report was published, additional occurrences were discovered in Fundy National Park, New Brunswick bringing the total for Fundy National Park to at least 1,005 colonies, representing nearly half of the Canadian population. Additional occurrences were also reported for Nova Scotia. A minimum of 2,083 colonies are currently known from Canada (2019) (see Appendix B for details).

The available data are not sufficient to assess fluctuations or trends but there is an inferred continuing decline in the number of mature individuals (because of threats to its habitat) (COSEWIC 2013).

[5] Lichens are composite organisms comprised of a fungus and algae and/or cyanobacterium. Cyanolichens are lichens that contain cyanobacteria (blue-green algae).

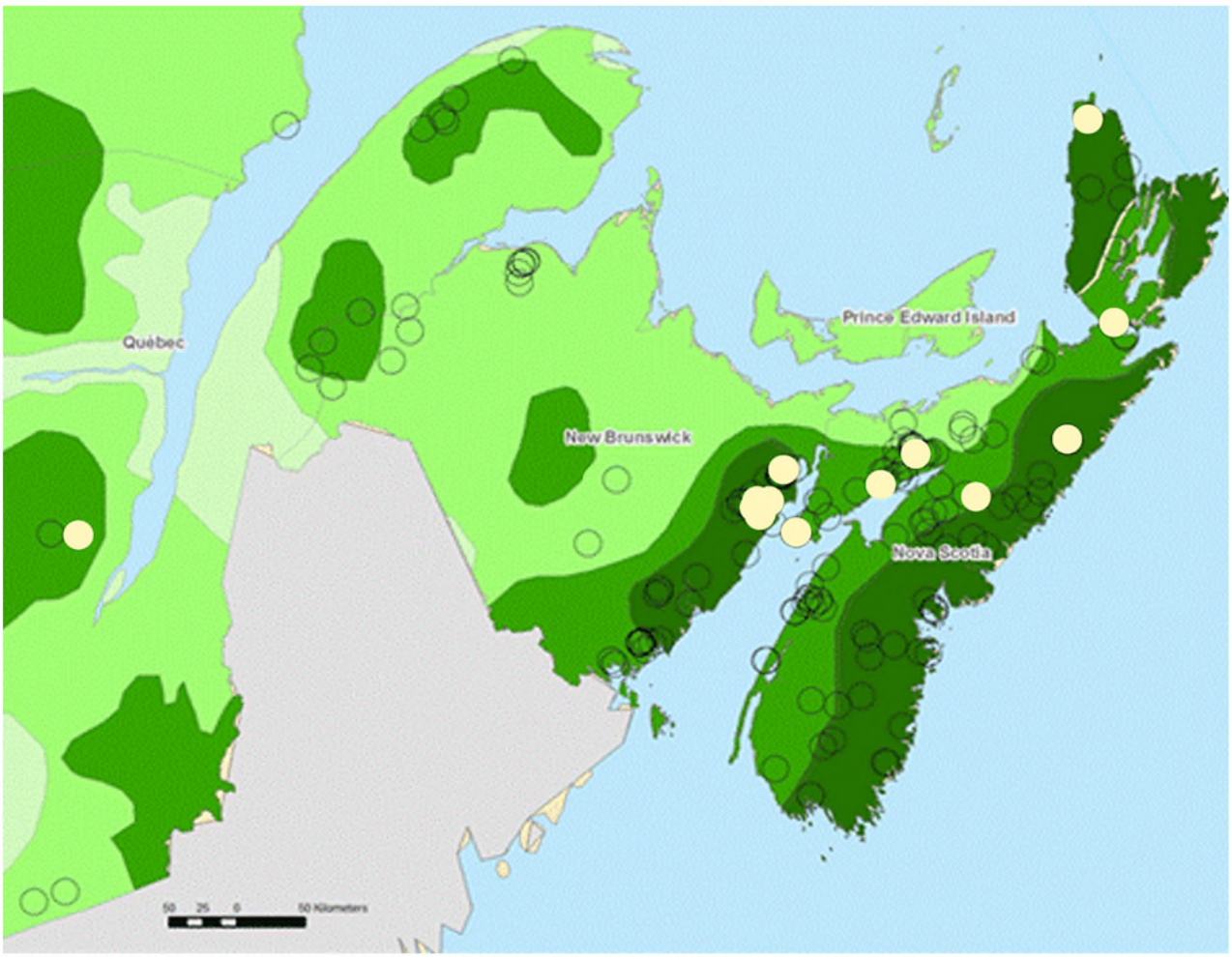

Figure 1. The distribution of Eastern Waterfan in Canada. The yellow circles indicate extant occurrences and the open circles show unsuccessful searches. Occurrences are strongly correlated with high moisture index (dark green shading) (modified from COSEWIC 2013).

3.3 Needs of the Eastern Waterfan

All cyanolichens require water to photosynthesize (Lange et al. 1986). Water is usually available for this lichen as it grows at or below the water surface of rivers and streams.

Known or inferred Eastern Waterfan needs (COSEWIC 2013) include:

- clear streams;
- perhumid climate[6]: this lichen requires year-round wetness;
- waterfalls, exposed boulders and/or sinuous conditions: these create protective eddies and calm backwaters;
- cool water temperatures: studies on closely related Western Waterfan (*P. gowardii*) indicate an intolerance of temperatures above 18°C;
- little or no green filamentous algae;
- silt-free water: clear streams are required for the lichen to photosynthesize and to colonize suitable unoccupied habitat;
- mineral-enriched streams with typical summer seasonal pH between 6.0 and 7.0;
- nitrate levels <5mM[7]: studies on closely related Western Waterfan indicate a narrow tolerance of nitrate levels. Levels at or above 5mM nitrate led to a decline in both weight and photosynthesis; and
- shade: riparian shade reduces peak summer temperatures within streams.

4. Threats

Direct threats to Eastern Waterfan and its habitat are assessed in Table 2. The threat assessment for the species 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) (Salafsky et al. 2008). Limiting factors are not considered during this assessment process. For the purposes of threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

[6] a year-round wet climate where precipitation outweighs evaporation and plant transpiration.
[7] mM = a measure of solution concentration.

4.1 Threat Assessment

Table 2. Threat calculator assessment.

#	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
3	Energy Production & Mining	Medium	Restricted	Serious	Moderate	-
3.1	Oil & Gas Drilling	Medium	Restricted	Serious	Moderate	Fracking, impoundments for fracking effluent; exploration for natural gas
3.2	Mining & Quarrying	Low	Small	Serious	Moderate	Gold mining in Nova Scotia
3.3	Renewable Energy	Low	Restricted	Moderate	Moderate	50 Wind turbines slated for construction in Cobequids
4	Transportation & Service Corridors	Low	Small	Moderate	Moderate	-
4.1	Roads & Railroads	Low	Small	Moderate	Moderate	Additional transportation related to mining and gas production
5	Biological Resource Use	High	Large	Extreme	High	-
5.3	Logging & Wood Harvesting	High	Large	Extreme	High	Logging and biomass harvesting in Cobequids (Gerrish valley, Eatonville and Folly Lake), Guysborough and Daniels Brook NB.
6	Human Intrusions & Disturbance	Low	Restricted	Moderate	Moderate	-
6.1	Recreational Activities	Low	Restricted	Moderate	Moderate	Siltation in streams as a result of off-road vehicle use
7	Natural System Modifications	Medium	Restricted	Serious	Moderate	-
7.2	Dams & Water Management /Use	Medium	Restricted	Serious	Moderate	If fracking exploration successful, large amounts of water required in processing, which may affect water table and construction of water impoundments may be needed

#	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
9	Pollution	Low	Large	Slight	Moderate	-
9.5	Air-borne Pollutants	Low	Large (31-70%)	Slight	Moderate – Insignificant / Negligible	Continuing acid rain may exceed the buffering capacity of the watershed, so the stream pH may drop and negatively affect the lichen. The Port Hawkesbury site may also be affected because of commissioning of the new biomass plant and restarting of the paper mill.
11	Climate change & severe weather	High	Pervasive (71-100%)	Serious	Moderate	-
11.2	Droughts	High	Pervasive (71-100%)	Serious	Moderate	Summer warming trends as a result of climate change
11.4	Storms & Flooding	High	Pervasive (71-100%)	Serious	Moderate	Increased storm events and winter rain leading to scouring of the stream bed and rocks, resulting in removal of the lichen

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

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

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

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

4.2 Description of Threats

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.

3. Energy Production & Mining, 4 Transportation & Service Corridors and 5 Biological Resource Use

COSEWIC 2013 determined the most serious potential threats to Eastern Waterfan were changes in water quality and quantity. Direct threats to the species are associated with industrial activity, road building and/or or wood harvesting adjacent to occupied streams. The species requires clear, cool and silt-free water to thrive and colonize new habitats (COSEWIC 2013). Removing shade trees along occupied streams exposes the stream and the lichen to increased solar radiation, increased air temperatures, reduced humidity, increased siltation due to erosion and run off and may reduce water levels due to the drying effects of sun and wind (COSEWIC 2013). Repeated siltation events likely coat lichen surfaces and cover up suitable but presently unoccupied habitat and intensive wood harvesting can increase nitrate content in nearby streams (Goudie 2006, Tremblay et al. 2009). Road construction (including all phases of bridge construction and installation of culverts) can alter water flow and, along with increased vehicular traffic on roads due to industrial activities (e.g., mining, wind farms, logging and wood harvesting), can increase the risk of siltation events (COSEWIC 2013) as well as the amount of fine sediment in a waterway. It is unclear whether current riparian buffers in Quebec, New Brunswick and Nova Scotia are adequate to mitigate these negative effects (COSEWIC 2013).

6. Human Intrusions & Disturbance

Off-road vehicles can damage vegetation and cause soil erosion and may also alter streamflow regimes, water quality and remove the lichen and/or its suitable substrate (stones, boulders) (COSEWIC 2013, Arp and Simmons 2012).

7. Natural System Modifications

Concerns regarding water quality are often cited as top concerns during public consultation regarding hydraulic fracturing (i.e., fracking, hydro-fracking) (Wheeler 2014). Extraction requires large volumes of water. This water is usually withdrawn from lakes and rivers but sometimes from deep-water wells, which could affect watershed hydrology (COSEWIC 2013). Operational practices may negatively affect water quality (e.g., through accidental spills, inadequate chemical and wastewater handling, storage and/or treatment) (Wheeler 2014).

Hydraulic fracturing processes may also produce air-borne particulate matter emissions (including chemical contaminants), carbon monoxide and oxides of nitrogen. (Wheeler 2014, Colborn et al. 2011) which could negatively affect Eastern Waterfan.

Hydraulic fracturing is not permitted in Quebec or New Brunswick and Nova Scotia imposed a moratorium on all types of hydraulic fracturing (COSEWIC 2013). Both

New Brunswick and Nova Scotia have a number of exploration agreements with companies to explore for onshore natural gas resources. In Nova Scotia, mineral and gas exploration leases could affect two Eastern Waterfan occurrences (one in the Cobequid Mountains and another near Cape Chignecto) (COSEWIC 2013).

9. Pollution

Cyanolichens (and especially young cyanolichens) are extremely sensitive to pollution and acid precipitation (COSEWIC 2013, Cameron & Richardson 2006, Richardson & Cameron 2004). Transboundary air pollution may continue to alter water quality in Atlantic Canada and it is unclear how much buffering capacity remains in the various occupied streams (COSEWIC 2013).

Cyanolichens like Eastern Waterfan may benefit from pollution prevention campaigns and industrial technologies that reduce emissions. However, despite such initiatives, many areas in southern New Brunswick and Nova Scotia are presently exposed to acid rain because of transboundary air pollution (COSEWIC 2010, Environment and Climate Change Canada 2016, CCME 2004, 2011) and due to local point sources of air pollution. Continued exposure to acid rain and other acidifying sources (e.g., logging & wood harvesting) may eventually lead to water that is too acidic to support the survival and recovery of Eastern Waterfan (COSEWIC 2013).

11. Climate Change and Severe Weather

Increases in mean annual temperatures are occurring now and are and expected to continue to occur in Atlantic Canada with summer temperatures showing the greatest increase. Summer temperatures are predicted to increase in Atlantic Canada by 2 to 4 °C by 2050, which may lead to dryer inland conditions. Precipitation is predicted to continue to increase (with more summer rain falling during extreme events (Bonsal et al. 2019)) but more precipitation may not necessarily mean more water in rivers and streams. With warmer dryer summers, increases in rainfall may not offset increased evaporation and a decline in streamflow may occur in Atlantic Canada (especially in snow-fed watersheds) (Cohen et al. 2019, Vasseur & Catto 2008).

5. Population and Distribution Objectives

The population and distribution objectives for Eastern Waterfan are to maintain a stable (or increasing) population within its range in Canada (i.e., extent of occurrence 2019), including any new sites that may be found in the future.

Meeting these objectives may involve conserving suitable habitat to allow for colonization and restoring any suitable habitat (upstream or downstream) that is lost or degraded because of human activity, to the extent possible.

Eastern Waterfan is intrinsically rare in Canada and naturally precarious due to its small range and specific and narrow habitat niche. Because of this, the approaches and measures outlined in this document may not result in de-listing of the species. The best

long-term scenario would be to ensure survival, persistence and independence of the species in its natural habitat at levels sufficient to support resilience to perturbation by random events (demographic or environmental)[8]. Specifically, this would involve addressing vulnerability to human-caused threats and mitigating or restoring any loss of suitable habitat to the extent possible to maintain redundancy in the population.

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Actions Already Completed or Currently Underway

Measures targeting Eastern Waterfan and/or its habitat are currently underway or completed in Quebec, New Brunswick and Nova Scotia.

Targeted surveys in Fundy National Park (New Brunswick) and non-targeted surveys elsewhere in New Brunswick and Nova Scotia have resulted in new/ additional discoveries of Eastern Waterfan and have thus improved our understanding of the species' range.

Approximately 95% of Eastern Waterfan colonies are in areas managed for conservation (e.g., provincial parks, designated Wilderness Areas, conservation land owned by the Nature Conservancy of Canada, La réserve de biodiversité projetée de la Forêt-Montmorency in Quebec, Fundy National Park in New Brunswick). Nova Scotia released a set of Special Management Practices for "At-Risk Lichens" (At-risk Lichens SMPs) in May 2018 (Nova Scotia Lands and Forestry 2018) and Eastern Waterfan is included. These At-risk Lichens SMPs only apply to provincial Crown land. The lichen is provided a 200m "protected zone" around its substratum to be managed for minimal disturbance (e.g., no active clearing, removal or disturbance of trees, soil or wetlands, no mineral exploration drill sites within the "zone" and no new roads or trails).

There are recovery documents for cyanolichens in Atlantic Canada and some of the accomplished or proposed measures with respect to these lichens (e.g. gathering data on airborne pollutants in New Brunswick and Nova Scotia) are pertinent to the management of Eastern Waterfan (e.g., Environment and Climate Change Canada 2018a, Environment and Climate Change Canada 2018b, Environment Canada 2011, Environment Canada 2010).

[8] Demographic events that could destabilize small populations (e.g., genetic effects, breeding structure changes). Environmental events influencing changes in vitality, fertility, abundance, and distribution.

6.2 Strategic Direction for Recovery and Measures to be Taken

Table 3. Recovery Planning Table and Implementation Schedule

Broad Strategy and Approach[a]	Recovery Measure[a]	Priority[b]	Threat, Limitation, or Concern Addressed	Timeline
2. Species Management				
2.2 Species Re-introduction & Translocation	If individuals are threatened by immitigable anthropogenic circumstances, facilitate translocation of species to new suitable areas.	Medium	all threats in Table 2	2026
3. Awareness Raising				
3.1 Outreach and Communications	Raise awareness of Eastern Waterfan (e.g., species needs, sites, direct threats) with relevant government agencies, landowners and managers, forestry and mining industry, recreational users.	High	all threats in Table 2	2021-2024
5. Livelihood, Economic & Moral Incentives				
5.2 Better Products & Management Practices	Change behaviours by developing and promoting better management practices for cyanolichens and provide training and/or technical assistance to land managers so practices are adopted.	Medium	all threats in Table 2 except 9. Pollution and 11. Climate Change & Severe Weather	2026
6. Conservation Designation & Planning				
6.1 Protected Area Designation &/or Acquisition	Establish or demarcate Government protected areas, private conservation areas or other types of conservation areas for the species and its habitat.	Medium	all threats in Table 2	as needed
6.2 Easements & Resource Rights	Promote conservation easements with landowners.	Medium	all threats in Table 2	as needed

Broad Strategy and Approach[a]	Recovery Measure[a]	Priority[b]	Threat, Limitation, or Concern Addressed	Timeline
6.4 Conservation Planning	Plan for conserving and managing Eastern Waterfan at occupied sites (e.g., develop a monitoring plan and protocols, include the species in pre-harvest plans and forest planning exercises).	High	all threats in Table 2	2022
7. Legal & Policy Frameworks				
7.1 Laws, Regulations & Codes	Create, amend, or influence laws, regulations and codes regarding the release of air-borne pollutants and water-borne pollutants such that environmental levels do not exceed what cyanolichens can tolerate.	High	9. Pollution, 11. Climate Change and Severe Weather	ongoing
7.2 Policies & Guidelines	Assess existing management practices for at-risk lichens and amend if standards are determined insufficient to ensure survival of Eastern Waterfan.	High	all threats in Table 2 except 9. Pollution and 11. Climate Change & Severe weather	2021-2024
8. Research & Monitoring				
8.1 Basic Research & Status Monitoring	Conduct research on Eastern Waterfan (to address knowledge gaps): • develop a species-specific suitable habitat model and monitor the population (e.g., distribution, threats and their distribution and cumulative effects), • investigate macrohabitat and microhabitat needs and • anticipate climate change impacts • confirm if species is able to reproduce by fragmentation, • assess survival of waterfan if transplanted to new sites (e.g., watersheds with active liming programs to neutralize water pH) and • determine most likely dispersal vectors for the lichen	High	knowledge gaps	2021-2026

Broad Strategy and Approach[a]	Recovery Measure[a]	Priority[b]	Threat, Limitation, or Concern Addressed	Timeline
8.2 Evaluation, Effectiveness Measures and Learning	Collect information about conservation work (e.g., collate data collected by lichen experts, store data with ACCDC).	Medium	knowledge gaps	ongoing
9. Education & Training				
9.2 Training & Individual Capacity Development	Provide conservation capacity development through • hands-on coaching & technical assistance and • workshops & professional development training courses	Low	all threats in Table 2 except 9. Pollution and 11. Climate Change & Severe weather	2026

[a] Refer to the CMP Conservation Actions Classification v 2.0 for more details on Broad Strategies and Approaches: https://docs.google.com/spreadsheets/d/1i25GTaEA80HwMvsTiYkdOoXRPWiVPZ5l6KioWx9g2zM/edit#gid=1144804238

[b] "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.

6.2.1 Monitoring

There is currently no published monitoring protocol for Eastern Waterfan but developing a monitoring plan and protocols are recovery measures set out in the recovery planning table (Table 3).

Each time a brook is visited, the following attributes should be recorded using a standardized method:

- substrate(s),
- water depth,
- stream characteristics (e.g., width, temporal streamflow patterns)
- location of lichen in the stream,
- depth lichen is submerged,
- water pH and temperature,
- turbidity,
- canopy cover,
- associated species (bryophytes, lichens, vascular species), and
- threats to the species and its habitat (refer to Table 2).

6.3 Narrative to Support the Recovery Planning Table

2. Species Management: 2.2 Species Re-introduction & Translocation
Determining if Eastern Waterfan can successfully reproduce by fragmentation is an important research measure. It may be possible to augment the population by transplanting fragmented lobes or, if downstream occurrences may be lost, by moving colonised rocks to suitable locations (Lesher et al. 2003 successfully demonstrated this is possibly for aquatic lichens). Developing and implementing a successful protocol for transplanting this lichen may prove to be necessary to meet the species' population and distribution objectives.

3. Awareness Raising: 3.1 Outreach and communications
Efforts to communicate with landowners, resource users, Indigenous communities, developers, land managers and other stakeholders to promote species stewardship and private land conservation are an important part of conserving habitat. Landowners and land users where Eastern Waterfan occurs (and in areas nearby) will be informed about this rare lichen, its threats and provided with knowledge of stewardship actions to conserve the species (e.g., through fact sheets).

5. Livelihood, Economic & Moral Incentives: 5.2 Better Products & Management Practices
Beneficial management practices (BMPs) to help landowners and land managers act as stewards of the environment should be developed for this aquatic lichen.

6. Conservation Designation & Planning: 6.1 Protected Area Designation &/or Acquisition, 6.2 Easements & Resource Rights and 6.4 Conservation Planning
Protected Areas, as well as private lands conserved through private land conservation mechanisms, have a role to play in the conservation of lichens and should be pursued where feasible. The experience and knowledge of stakeholders will be important in making management decisions on private and public lands.

A monitoring plan and protocol for occupied sites where there is evidence of a direct threat must be developed and implemented. The final monitoring plan should detail the collection of ecological indices for extant occurrences.

7. Legal & Policy Frameworks: Laws, Regulations & Codes and Policies & Guidelines
In Nova Scotia, At-risk Lichens Special Management Practices (SMPs) provide a 200m protected zone (from forest harvest, mineral exploration and new road construction) for the lichen on Crown land (Nova Scotia Lands and Forestry 2018). These At-risk Lichens SMPs require expert-conducted surveys for all areas with a high potential for species at risk lichens. Eastern Waterfan is the only aquatic lichen covered by the at-risk Lichen SMPs and given how different this lichen is from epiphytic lichens, it may not be adequately addressed by this SMP.

The Canadian government supports third-party forest certification as a tool to promote modern sustainable forest management (Canadian Council of Forest Ministers 2019cam). Nova Scotia is Crown land (Nova Scotia Department of Natural Resources 2013) can only be leased for forestry by third-party forest-certified industrial partners (J. Weldon-Genge personal communication). Certification standards vary but include but some precautionary measures to identify and conserve species at risk and their habitats and may help conserve this lichen.

Eastern Waterfan would benefit from reductions in air pollutants and acid rain but 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 Quebec Climate Change Action Plan, the New Brunswick Climate Change Action Plan, the Nova Scotia Energy Strategy and the Nova Scotia Climate Change Action Plan.

8. Research & Monitoring: 8.1 Basic Research & Status Monitoring and 8.2 Evaluation, Effectiveness Measures and Learning
Permanent monitoring plots should be set up for occupied streams to monitor persistence of the lichen. Microclimate and macroclimate measurements (e.g., humidity, forest composition, forest age structure, temporal streamflow patterns and indicator species) could be undertaken before and after buffer establishment to assess the impact of edge effects and nearby human activity.

9. Education & Training: 9.2 Training & Individual Capacity Development
Eastern waterfan can be hard to locate in the dark and shady streams where it occurs. Stakeholders (especially forest sector) and other relevant individuals (e.g., landowners, land managers) should be provided with information and tips to identify the lichen in the field.

A significant knowledge gap in directing recovery measures for Eastern Waterfan and in assessing its conservation status is the extent to which the population is stable or declining. There are no active monitoring programs in streams containing Eastern Waterfan in Eastern Canada (COSEWIC 2013).

Data should be collated, stored, made available for landscape and resource planning purposes and be updated as new information becomes available. Finally, previously un-surveyed potential habitat within the species range should be prioritised for inventory, as past surveys have not necessarily surveyed all occupied streams to their source (F. Anderson, personal communication 2019).

7. Critical Habitat

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 for Eastern Waterfan is based on habitat occupancy and habitat suitability and is partially identified in this document, to the extent possible, based on the best available information. Additional critical habitat may be added in the future if new information supports the inclusion of areas beyond what is currently identified (e.g., additional areas vital for dispersal).

A schedule of studies (Table 5) has been developed to provide the information necessary to complete the identification of critical habitat that will be sufficient to meet the population and distribution objectives. The identification of critical habitat will be updated when new information becomes available, either in a revised recovery strategy or action plan(s).

7.1 Identification of the Species' Critical Habitat

Critical habitat for Eastern Waterfan is identified as all areas with suitable habitat within the yellow polygons in Figures 2-14 (see Appendix C). Suitable habitat relates to areas possessing a specific set of biophysical attributes required for Eastern Waterfan's life processes as summarized in Table 4.

Areas within the polygons that clearly do not contain the biophysical attributes (e.g., existing road and/or trail bridges) are not identified as critical habitat under SARA.

Table 4. The area and associated biophysical attributes necessary for Eastern Waterfan.

Life Stage	Life Process[a]	Area or Type of Site[b]	Biophysical Attributes[c]
All	• Reproduction (fungal spore discharge and resynthesis with suitable cyanobacterium), • Growth, • Nutrition (photosynthesis), and • Dispersal (reproduction by fragmentation)	• Clear streams in regions with perhumid climate[d] • Riparian habitat	• cool, mineral-enriched, water (generally<18°C); • waterfalls, exposed boulders/rocks and/or sinuous stream configurations that create protective eddies and calm backwaters; • stones, boulders and bedrock substrata; • typical seasonal summer pH 6.0-7.0; • sediment/silt-free substrate; • low Nitrate levels (generally <5mM); and • shade provided by trees, large boulders and intact native riparian vegetation

[a] Life Process: The life-cycle process of the listed species taking place in critical habitat. This function informs the rationale for its protection. The identification of critical habitat must describe how the functions support a life process necessary for the survival or recovery of species at risk.

[b] Area or type of site - The area or type of site where the listed species naturally occurs or depends on in order to carry out its life processes.

[c] Biophysical attributes: measureable properties or characteristics of the area or type of site. In essence, biophysical attributes provide the greatest level of information about the area or type of site required to support the life process requirements of the species.

[d] A year-round wet climate where precipitation outweighs evaporation and plant transpiration.

7.1.1 Information and methods used to identify critical habitat

Eastern Waterfan location data were received from the Atlantic Conservation Data Centre for New Brunswick and Nova Scotia. The Quebec coordinates were accessed from the Consortium of North American Lichen Herbaria (Consortium of North American Lichen Herbaria 2019). Fundy National Park provided additional records collected in fall 2019 not yet incorporated in the Atlantic Conservation Data Centre database and a species expert provided location data from additional sites in Nova Scotia. Only recent records (2006-2019) with error ≤ 50 m were included in the data set used to create the yellow polygons in Figures 2-14 (see Appendix C). A radius of 1,000 m was drawn around each record and the flow was determined for all rivers/streams within the radius. Only river/stream sections within the 1,000 m radius were included in the yellow polygons. Stream sections within the 1,000 m radius were removed where no records occur on the downstream section. All lakes/waterbodies were removed (as they do not

provide biophysical attributes) and all river/stream segments downstream of lakes/waterbodies were removed where no records occur on the downstream section. A 50 m riparian zone extending landward of banks of the river/stream was drawn on all segments of the river remaining after the methods above were implemented. This intact riparian zone is necessary to maintain suitable biophysical attributes required for the lichen's survival (table 4), especially to maintain water temperature regimes, for removal of significant portions of nitrogen and because it is simple and easy to implement.

7.2 Schedule of Studies to Identify Critical Habitat

Table 5. Schedule of Studies to Identify Critical Habitat.

Description of Activity	Rationale	Timeline
If studies confirm Eastern Waterfan is able to reproduce by fragmentation, determine distance the lichen is able to disperse downstream and colonize suitable habitat.	allows for dispersal to suitable new habitat.	2021-2026

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction 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. Activities described in Table 6 include those likely to cause destruction of critical habitat for the species; however, destructive activities are not limited to those listed.

Table 6. Examples of Activities Likely to Result in the Destruction of Critical Habitat of Eastern Waterfan in Canada.

Description of Activity	Description of Effect	Details of Effect
Development or land conversion (e.g., energy production and mining, transportation and service corridors (culverts and road crossings), biological resource use (logging and wood harvesting))	• Natural hydrology regimes and water quality may be altered (e.g., flow regimes, water temperatures, pH, sediment, nutrient loads) such that aquatic habitat becomes unsuitable due to changes in streamflow and/or temperature and/or pH changes and/or siltation.	Related IUCN-CMP Threats 3.1 Oil & gas drilling, 3.2 Mining & quarrying, 3.3 Renewable energy, 4.1 Roads & railroads and 5.3 Logging & wood harvesting. This activity may likely result in the destruction of critical habitat if it occurred within the bounds of critical habitat or near (upstream of) critical habitat. This activity could cause destruction all times of the year.
Use of off-road vehicles in streams	• Habitat and/or the function of a site may be physically destroyed or altered. • Water quality, hydrology and flow may be altered (e.g., through increased siltation) such that aquatic habitat becomes unsuitable due to sediment.	Related IUCN-CMP Threat 6.1 Recreational activities (off-road vehicles). This activity may likely result in the destruction of critical habitat if it occurred within the bounds of critical habitat or near (upstream of) critical habitat. This activity could cause destruction all times of the year.

Release of water-borne pollutants	• Water quality may be altered such that aquatic habitat becomes unsuitable due to toxicity.	Related IUCN-CMP Threats 9.1 Household Sewage & Urban Waste Water, 9.2 Industrial & Military Effluents and 9.3 Agricultural & Forestry Effluents This activity may likely result in the destruction of critical habitat if it occurred within the bounds of critical habitat or near (upstream of) critical habitat. This activity could cause destruction all times of the year.
Dams and water management/use	• Natural hydrology regimes and water quality may be altered (e.g., flow regimes, water temperatures, pH, sediment, nutrient loads) such that aquatic habitat becomes unsuitable due to temperature and/or pH changes and/or siltation and/or changes in streamflow and in the natural seasonal regime of streamflow and water level fluctuations.	Related IUCN-CMP Threat 7.2 Dams & water management /use. This activity may likely result in the destruction of critical habitat if it occurred within the bounds of critical habitat or near (upstream of) critical habitat. This activity could cause destruction all times of the year.

7.4 Proposed Measures to Protect Critical Habitat

The information below outlines the measures proposed to be taken to protect critical habitat for Eastern Waterfan.

7.4.1 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[9] are published in the Canada Gazette Part 1 (Gazette Statement). This critical habitat will then be protected under subsection 58(1) of SARA. Gazette statements are available on the Species at Risk Public Registry. A gazette statement is required for Fundy National Park to complete the description of federal properties with critical habitat.

If it is determined critical habitat for Eastern Waterfan also occurs on federal lands that are not federally protected areas, under the provisions of subsection 58(5) of SARA, the competent minister shall, after consulting with every other competent minister, make an order for any portion of critical habitat that is not legally protected by provisions in or measures under SARA or any other Act of Parliament. If the minister does not make the order, the minister shall include in the Registry a statement setting out how the critical habitat or portions of it are legally protected. ECCC will continue to work with relevant federal departments to ensure that critical habitat on other federal lands is protected.

7.4.2 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 Quebec, New Brunswick, and Nova Scotia 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.

[9] 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.

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.

8. Evaluation of Socio-economic Costs and 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.

8.1 Policy Baseline

The provinces of Quebec, New Brunswick and Nova Scotia have access to many legislative, regulatory and management tools for the conservation and stewardship of Eastern Waterfan and its critical habitat. For example,

in Quebec:

- *Natural Heritage Conservation Act* (including the amendments made by the *Act respecting the conservation of wetlands and bodies of water*): may protect species at risk critical habitat through the creation of protected areas (e.g., biodiversity reserves, ecological reserves, nature reserves on private lands, natural environments/ “natural settings”).

- *Environment Quality Act* (including the amendments made by the *Act respecting the conservation of wetlands and bodies of water*): provides a sustainable framework for various projects and species at risk must be considered in project assessments. Applications are assessed to prevent, minimize and mitigate adverse impacts on the environment and habitats of species at risk. Projects may be rejected based on their potential effects on the environment. The *Act respecting the conservation of wetlands and bodies of water* includes provisions to improve the conservation of wetlands and bodies of water, with the objective of no net loss.
- *Act respecting land use planning and development* (including certain provisions of the *Municipal Powers Act* and the *Act respecting the preservation of agricultural land and agricultural activities* (APALAA)): governs land use planning and takes into account the protection of natural environments in the development and organization of the Province.
- *Sustainable Forest Development Act* (including the sustainable forest development strategy and integrated forest planning): maintains or improves the long-term health of forest ecosystem on public lands and some provisions apply to private lands. This Act may be used to designate biological refuges and exceptional forest ecosystem in which logging and wood harvesting activities may be prohibited.
- *Act respecting threatened or vulnerable species* and *Act respecting the conservation and development of wildlife*: under these Acts, specific habitat protection measures can be taken for species at risk.

in New Brunswick:

- *Species at Risk Act*: may protect species at risk critical habitat by regulation or order at the discretion of the Minister. At present, this lichen is not listed on the New Brunswick Species at Risk Public Registry. To date, neither a regulation nor an order have been made/issued.
- *Protected Natural Areas Act*: includes provisions that may conserve species at risk critical habitat in Protected Natural Areas should the species at risk not receive habitat protection under the provincial *Species at Risk Act*.
- *Parks Act*: includes prohibitions against activities likely to result in the destruction of critical habitat in provincial parks.
- *Conservation Easement Act*: may include prohibitions against activities likely to result in the destruction of critical habitat. However, the scope of this Act is limited and there is a lack of clarity regarding offences and penalties.
- *Crown Lands and Forests Act*: provides for the management of forest harvesting, which may result in positive impacts for species at risk critical habitat. A forest management agreement and an operating plan are required as is a license to operate on Crown lands. The license holder must manage the Crown Land as directed by the license. This Act does not contain mandatary provisions to prevent the destruction of critical habitat.

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.
- *Conservation Easements Act*: may include prohibitions against activities likely to result in the destruction of critical habitat. However, the scope of this Act is limited and there is a lack of clarity regarding offences and penalties.
- *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.
- *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.
- *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.
- *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.
- *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.
- *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.
- At-Risk Lichen SMPs: this policy requires surveys for the presence of at risk lichens on all provincial Crown lands where forest resource development/harvesting, mineral resource exploration/development and any activities authorized under the *Crown Lands Act* may disturb lichen habitat are proposed in areas with high likelihood of finding at-risk lichens. Should an at-risk lichen be found, its habitat is conserved as directed in the SMP.

8.2 Socio-economic Profile and Baseline

The forestry industry is primarily affected by the protection of lichen species and their critical habitat. Increasingly, the mining industry may be affected by the protection of lichen species and their critical habitat. Stakeholders include the Government of

Canada, the governments of Quebec, New Brunswick and Nova Scotia, 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.

8.3 Socio-economic Costs of Implementing this Action Plan

Implementation of the recovery measures identified in Table 3 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., harvesting, mineral resource exploration/development) compared to measures already in place (see ongoing measures in Table 3).

SMPs are already in place on crown lands in Nova Scotia for Eastern Waterfan, which places restrictions on forestry and mining activities near the species.

For Eastern Waterfan, 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 occupies a limited geographic area in Quebec, New Brunswick, and Nova Scotia. Costs at the regional or provincial scale are expected to be minimal.

8.4 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).

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).

By focusing on increasing protection measures, as well as improved 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.

8.5 Distributional Impacts

Although Eastern Waterfan occurs on private properties, landowners are not expected to bear the brunt of the responsibility for the species' recovery. Non-governmental organizations are active in Quebec, New Brunswick and Nova Scotia where the species occurs, and an approach of this action plan is to foster cooperative relationships with landowners and others to conserve 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.

9. Measuring Progress

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

- No observed, estimated, inferred, or suspected reduction in the total number of colonies of Eastern Waterfan in Canada from 2019 levels.
- No significant observed or inferred decline in the species' range (extent of occurrence) from 2019.

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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*[10]. 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[11] (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 Eastern Waterfan. 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. At a regional level, any progress in reducing air-borne pollutants will benefit not only cyanolichens, but most (if not all) of the flora and fauna of the Atlantic forest region as well.

[10] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[11] www.fsds-sfdd.ca/index.html#/en/goals/

Appendix B: Population information for Eastern Waterfan in Canada.

Pr	Figure # (Appendix C)	Critical Habitat Site Name	Land Tenure	Critical Habitat Polygon Centroid - Latitude	Critical Habitat Polygon Centroid - Longitude	Latest survey	Estimated # colonies
QC	3	rivière Noire, Municipalité régionale de Comté de la Côte-de-Beaupré (Territoire non-organise Lac-Jacques Cartier)	Non-federal	47.32774	-71.10057	Aug-2012	12
NB	5	East Branch Point Wolfe River tributary	Federal Protected Area (Fundy National Park)/ Non-federal	45.61641	-65.11798	Aug-2019	1005
NB	5	East Branch Point Wolfe River tributary	Federal Protected Area (Fundy National Park)/ Non-federal	45.60444	-65.11377	Aug-2019	
NB	5	Black Brook/Bennett Brook tributary	Federal Protected Area (Fundy National Park)	45.60378	-65.08766	Aug-2019	
NB	5	Bennett Lake tributary	Federal Protected Area (Fundy National Park)	45.64101	-65.08431	Jul-Sep-2019	
NB	5	Caribou Lake Brook	Federal Protected Area (Fundy National Park)	45.61548	-65.07513	Jul-2019	
NB	5	Rossiter Brook	Federal Protected Area (Fundy National Park)	45.54585	-65.07075	Jul-Sep-2019	
NB	5	Matthews Brook/Brandy Brook/Chambers Brook	Federal Protected Area (Fundy National Park)	45.58867	-65.06627	Jul-Sep-2019	
NB	5	Second Mile Brook	Federal Protected Area (Fundy National Park)	45.55197	-65.05302	Jul-Sep-2019	
NB	5	Sweeney Brook/Foster Brook	Federal Protected Area (Fundy National Park)	45.58100	-65.02258	Jul-Sep-2019	
NB	5	Second Vault Brook	Federal Protected Area (Fundy National Park)/ Non-federal	45.62287	-64.99981	Jul-2019	
NB	5	Ash Brook	Federal Protected Area (Fundy National Park)	45.66358	-64.99463	Jul-Sep-2019	
NB	5	Third Vault Brook/Macaloney Brook	Federal Protected Area (Fundy National Park)	45.64257	-64.98758	Jul-2019	

Pr	Figure # (Appendix C)	Critical Habitat Site Name	Land Tenure	Critical Habitat Polygon Centroid - Latitude	Critical Habitat Polygon Centroid - Longitude	Latest survey	Estimated # colonies
NB	5	Kinnie Brook	Federal Protected Area (Fundy National Park)	45.61068	-64.98037	Jul-Sep-2019	
NB	5	Forty Five River tributary	Federal Protected Area (Fundy National Park)	45.65679	-64.97049	Jul-Sep-2019	
NB	5	Dickson Brook/Dickson Brook tributary	Federal Protected Area (Fundy National Park)	45.59082	-64.96813	Jul-2013	
NB	5	Long Reach Brook	Federal Protected Area (Fundy National Park)/ Non-federal	45.66956	-64.94696	Jul-Sep-2019	
NB	5	Lake Brook tributary	Federal Protected Area (Fundy National Park)/ Non-federal	45.64331	-64.94331	Jul-Sep-2019	
NB	6	Hamilton Creek tributary	Non-federal	45.80596	-64.63912	Oct-2011	2
NB	6	Daniels Brook	Non-federal	45.78928	-64.63890	Sep-2011	77
NS	7	Eatonville Brook	Non-federal	45.40889	-64.88804	Jul-2011	200
NS	8	Beaver Brook tributary	Non-federal	45.44804	-63.98801	2012	100+
NS	9	Carter Lake Brook/Carter Lake Brook tributary	Non-federal	45.52674	-63.56384	May-Jul-2011	150+
NS	9	Harty Brook	Non-federal	45.57631	-63.56287	Jul-2018	n.d.
NS	10	St. Andrews River	Non-federal	45.12375	-63.17015	Jul-2015	n.d.
NS	11	Salmon River tributary	Non-federal	45.54363	-63.09254	Jul-2016	n.d.
NS	11	West Branch River John/West Branch River John tributary	Non-federal	45.55957	-63.01108	Jul-2016	n.d.
NS	12	West River Lake tributary	Non-federal	45.12405	-62.26267	Dec-2011	500+
NS	13	Embrees Brook tributary	Non-federal	45.63751	-61.35411	Sep-2011	12
NS	14	Grays Hollow Brook	Non-federal	46.89759	-60.55431	Aug-2012	23

Appendix C: Maps and locations of critical habitat.

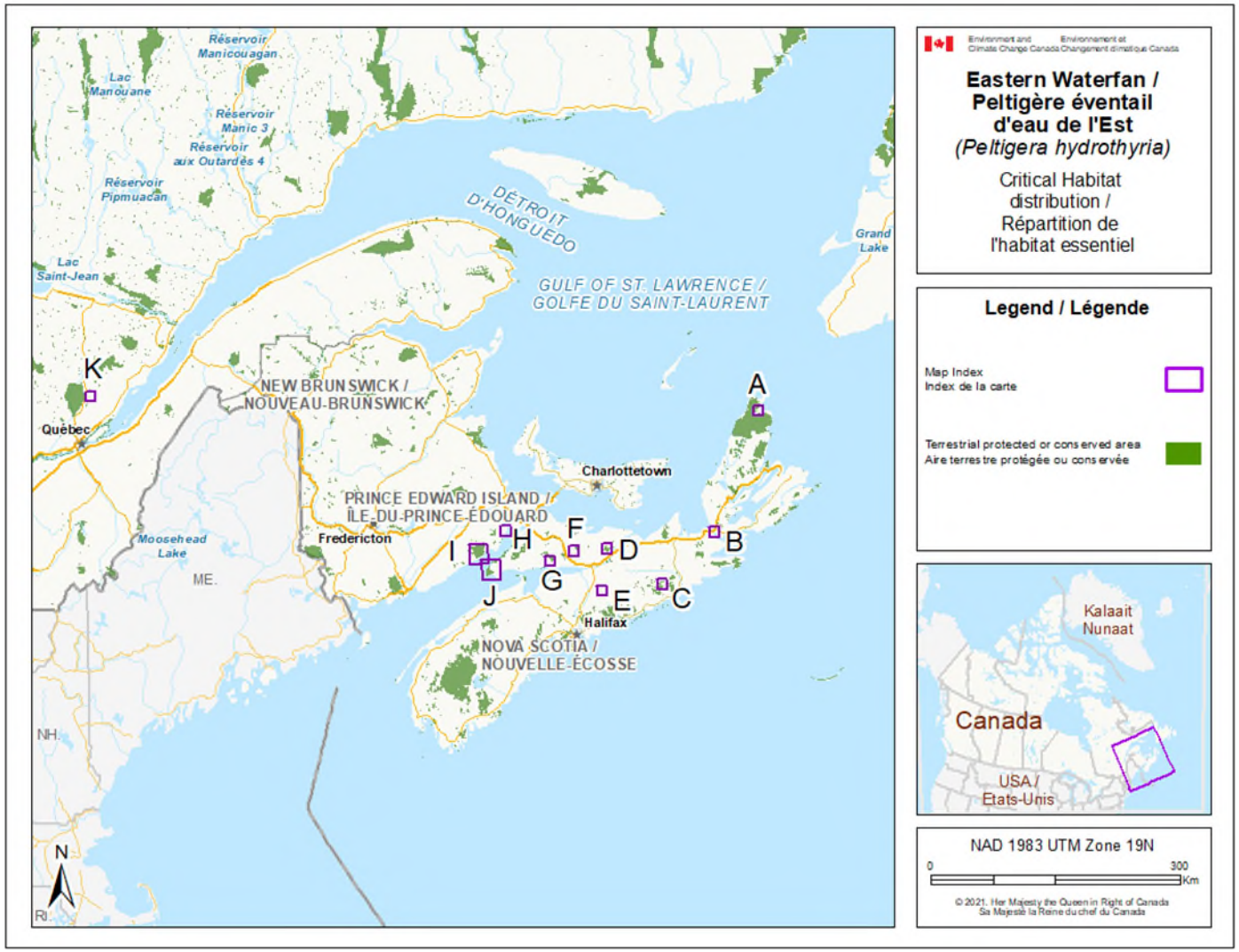

Figure 2. Overview map for Eastern Waterfan in Canada.

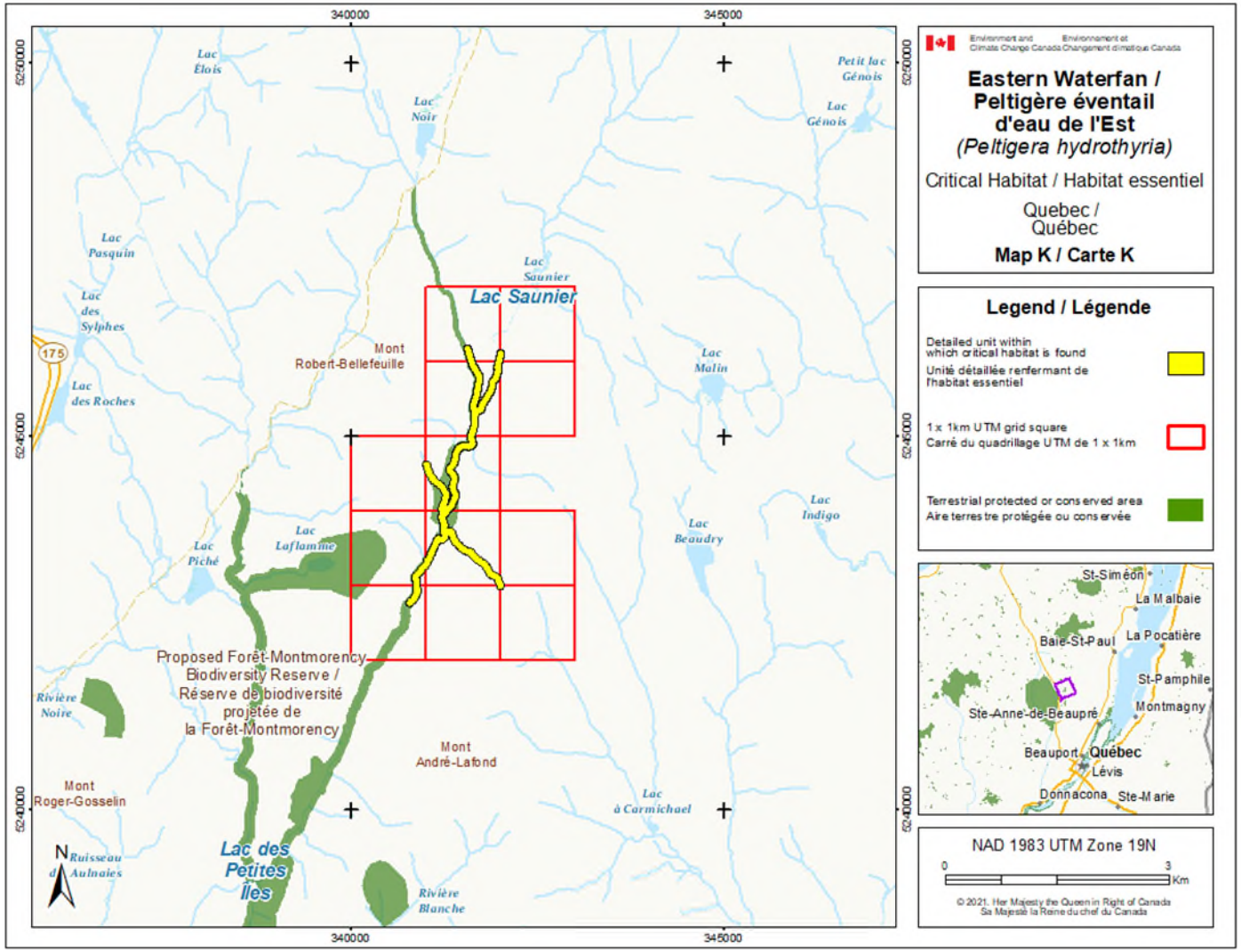

Figure 3. Critical habitat for Eastern Waterfan in Quebec is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

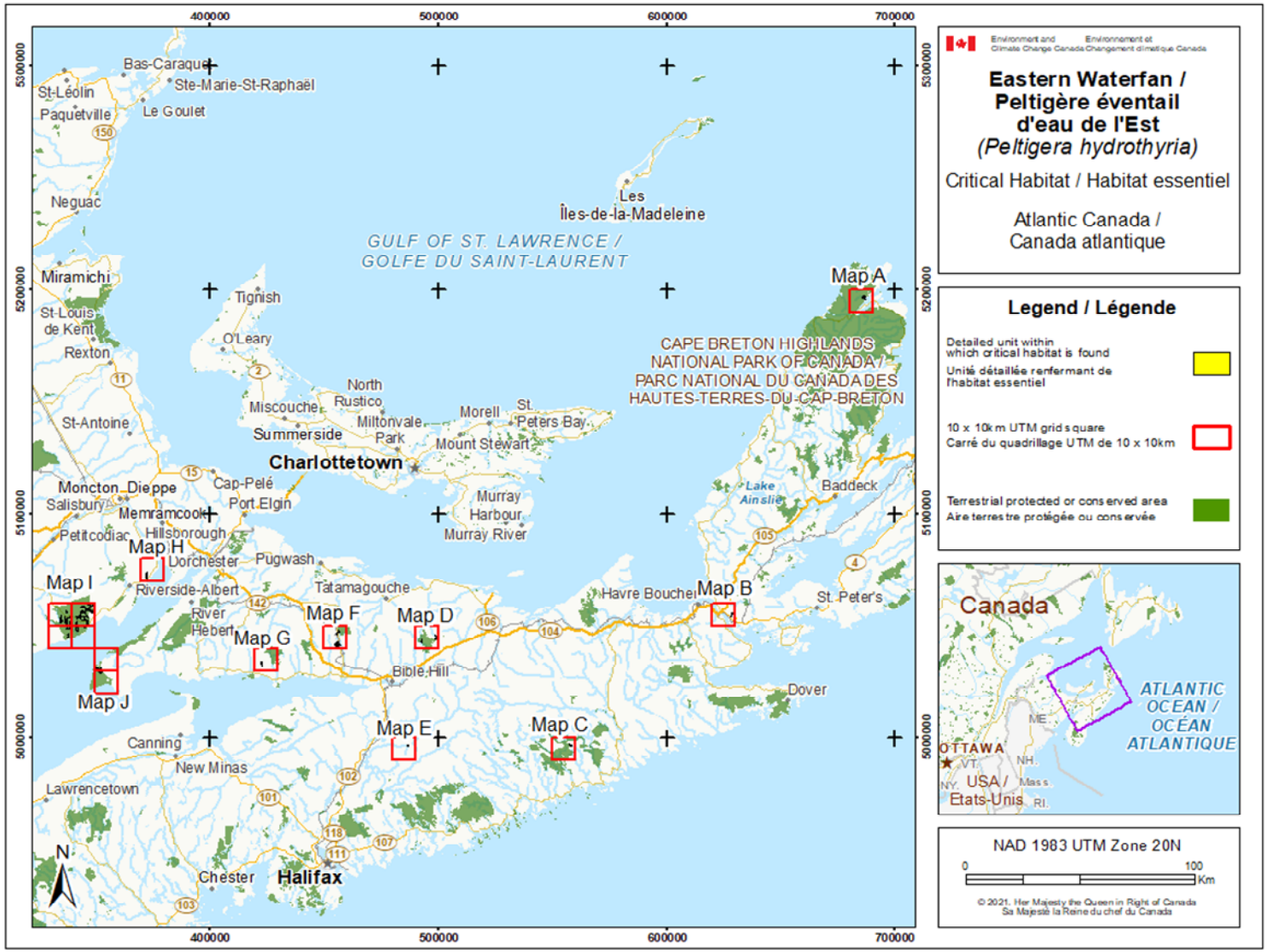

Figure 4. Index map for Eastern Waterfan in New Brunswick and Nova Scotia.

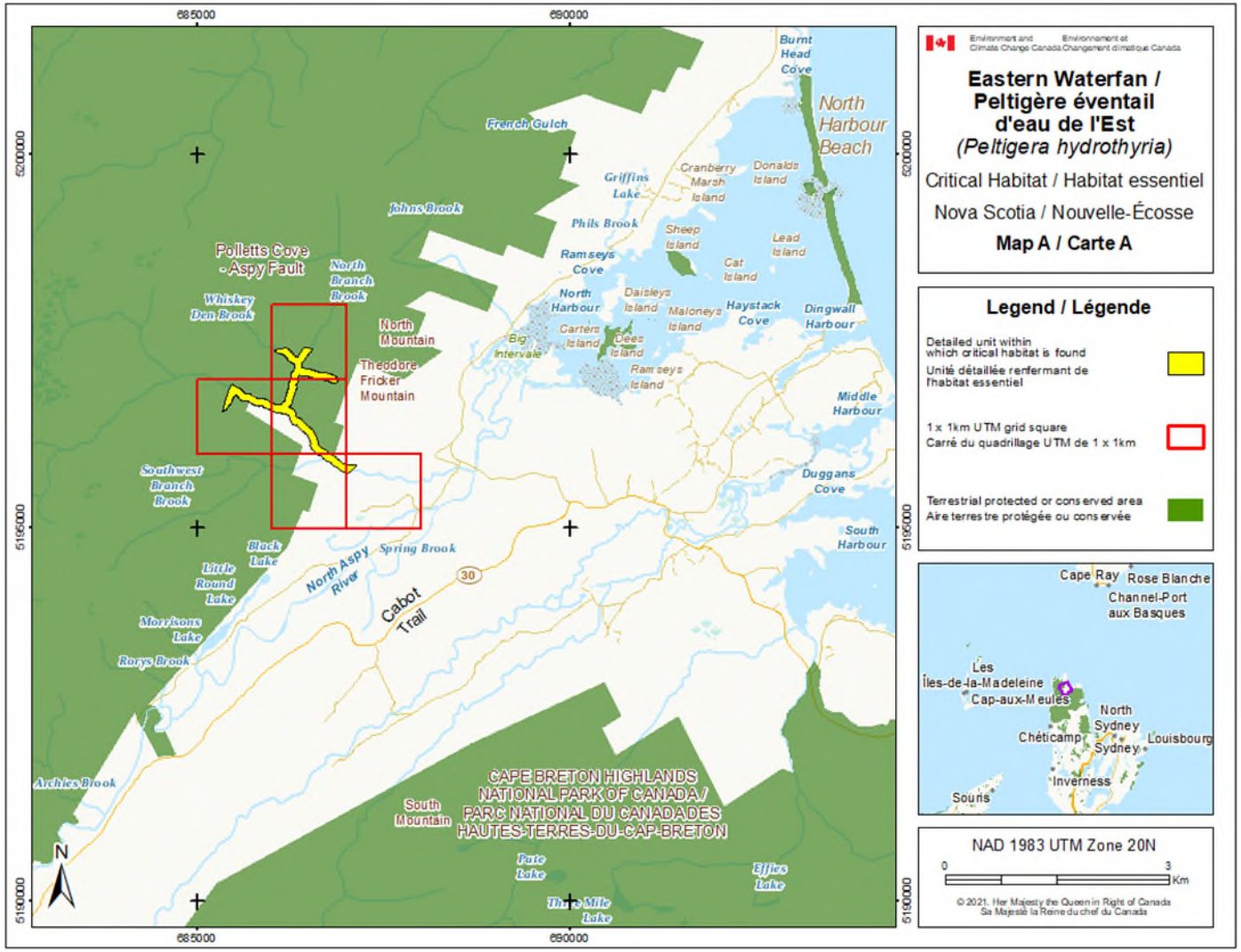

Figure 5. Critical habitat for Eastern Waterfan in Victoria County, Nova Scotia is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

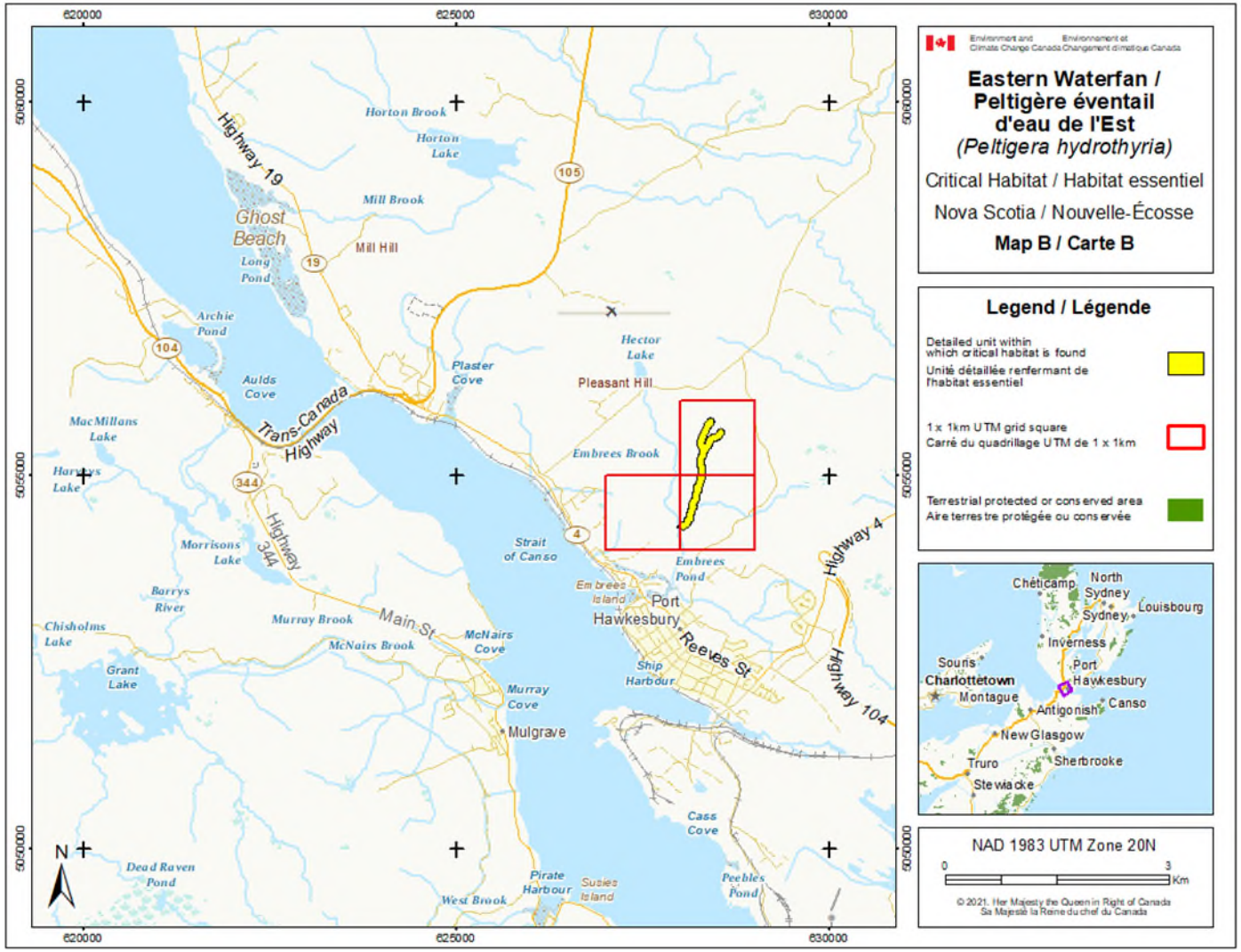

Figure 6. Critical habitat for Eastern Waterfan in Inverness County, Nova Scotia is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

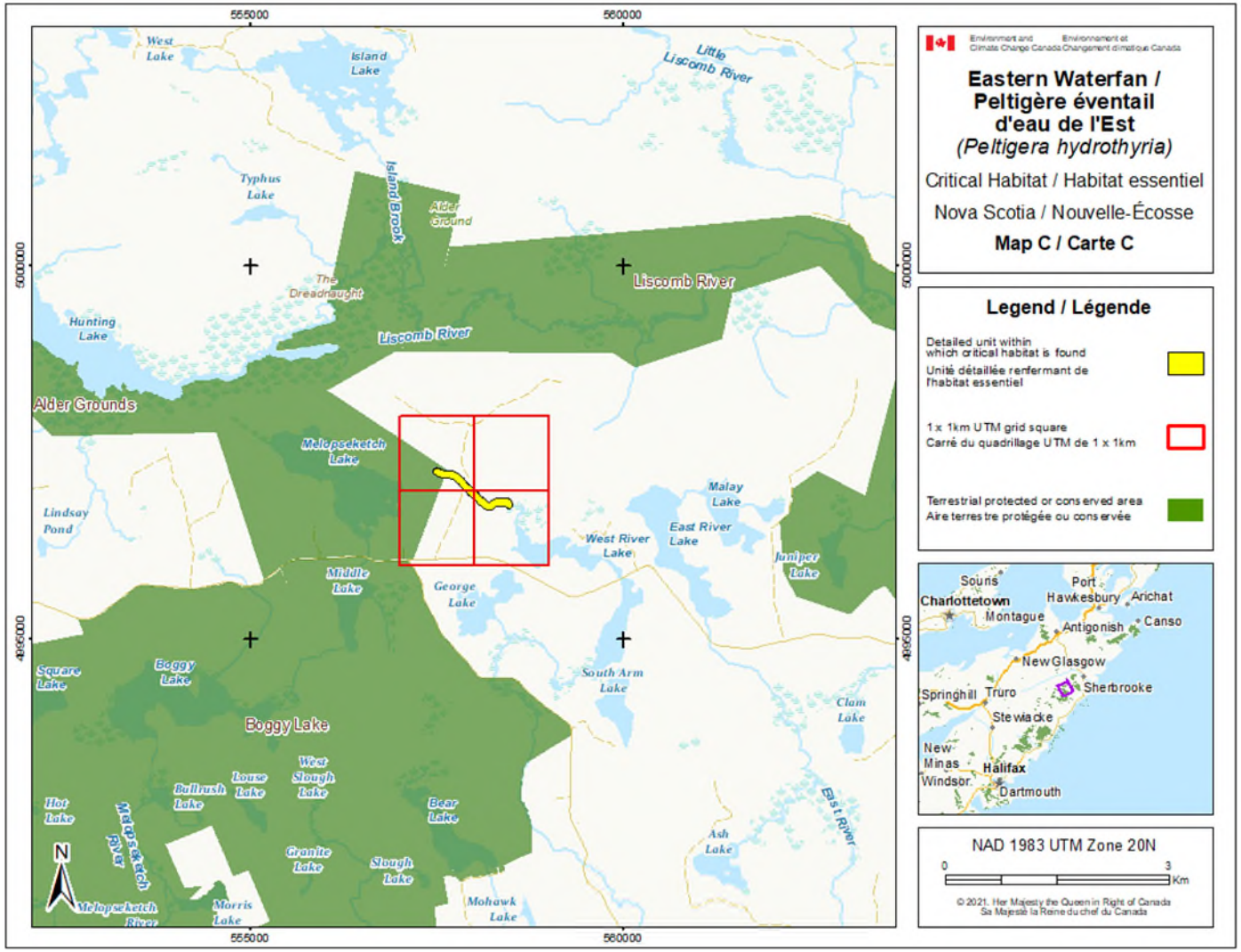

Figure 7. Critical habitat for Eastern Waterfan in Guysborough County, Nova Scotia is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

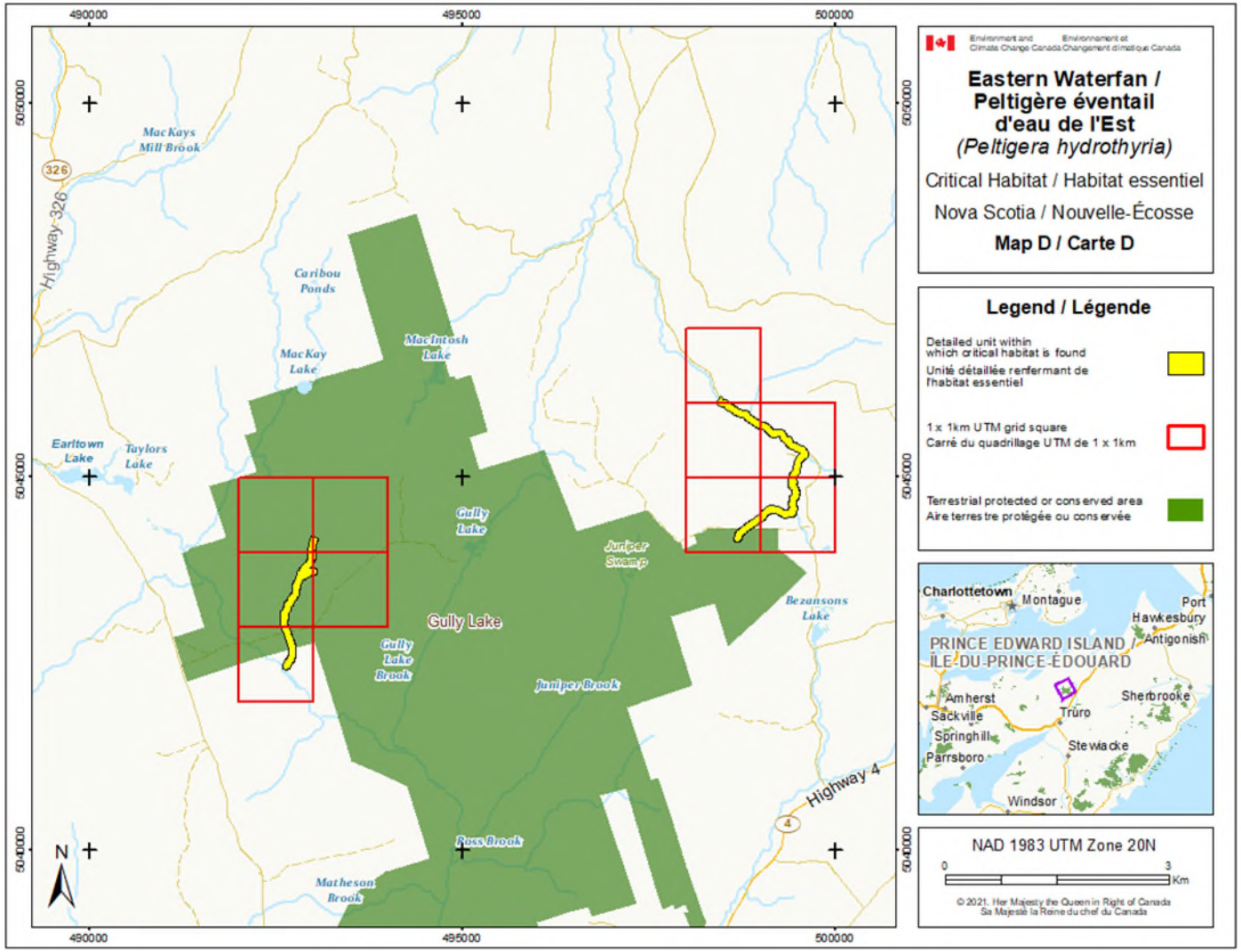

Figure 8. Critical habitat for Eastern Waterfan in Colchester and Pictou Counties, Nova Scotia is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

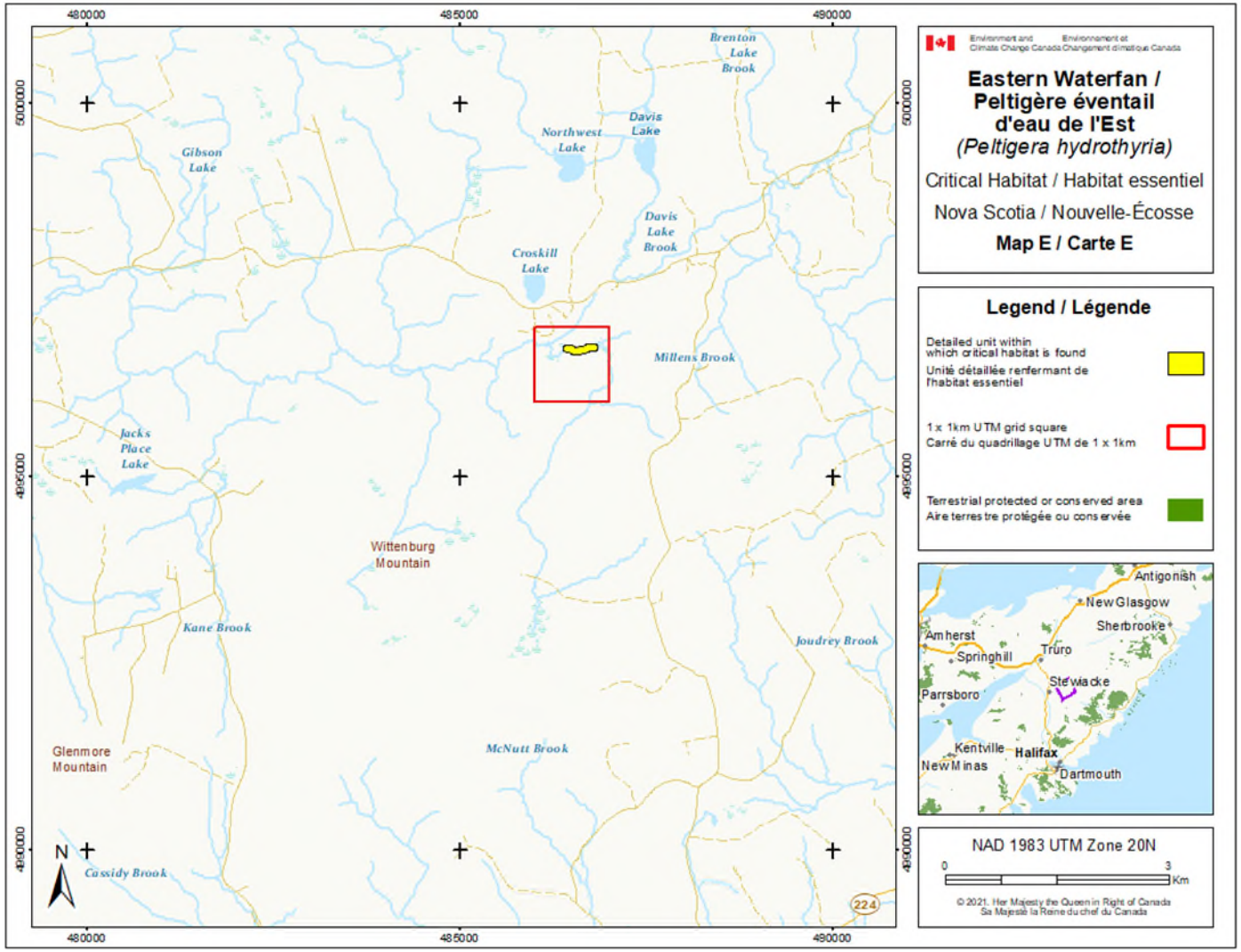

Figure 9. Critical habitat for Eastern Waterfan in Colchester County, Nova Scotia is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

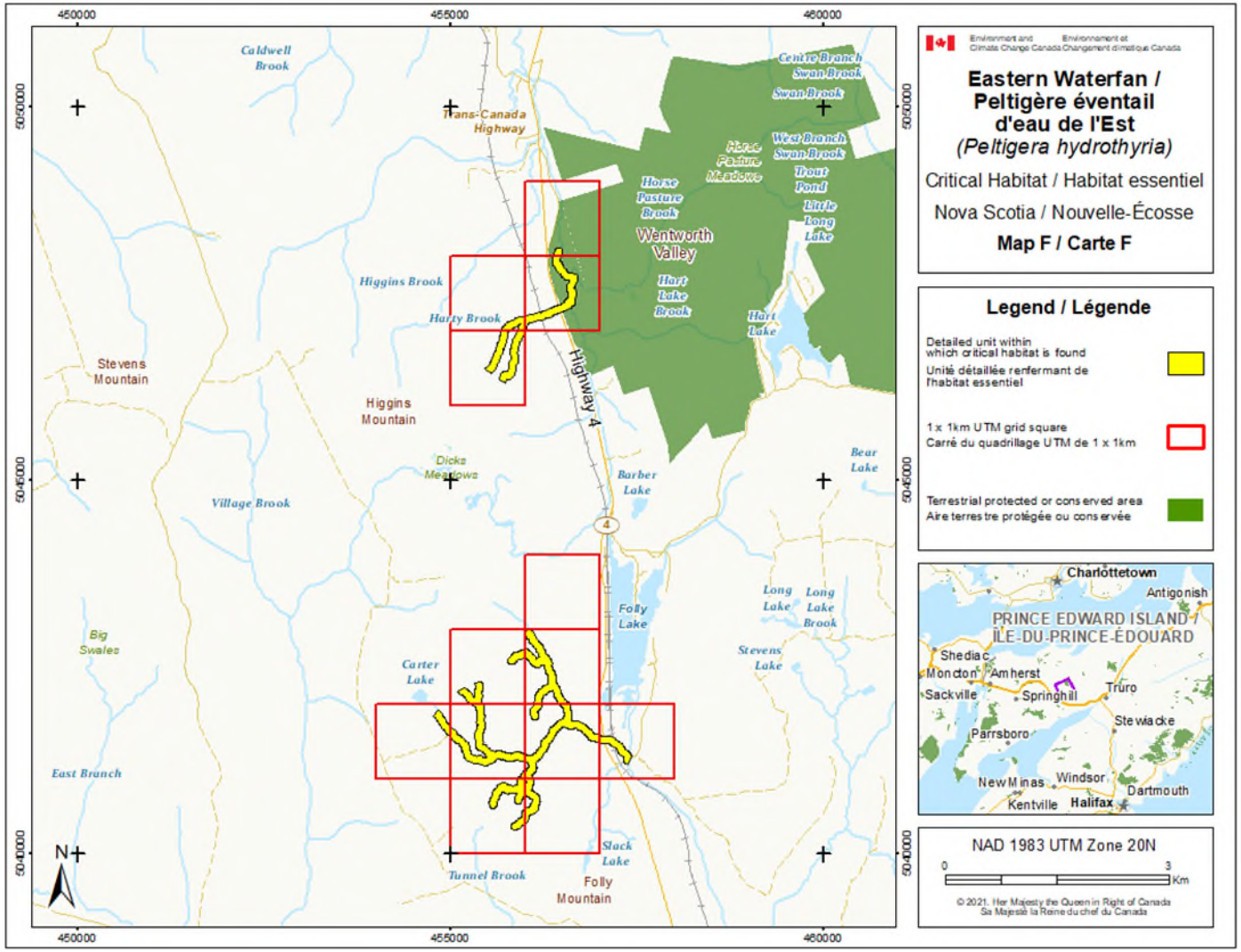

Figure 10. Critical habitat for Eastern Waterfan in Colchester and Cumberland Counties, Nova Scotia is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

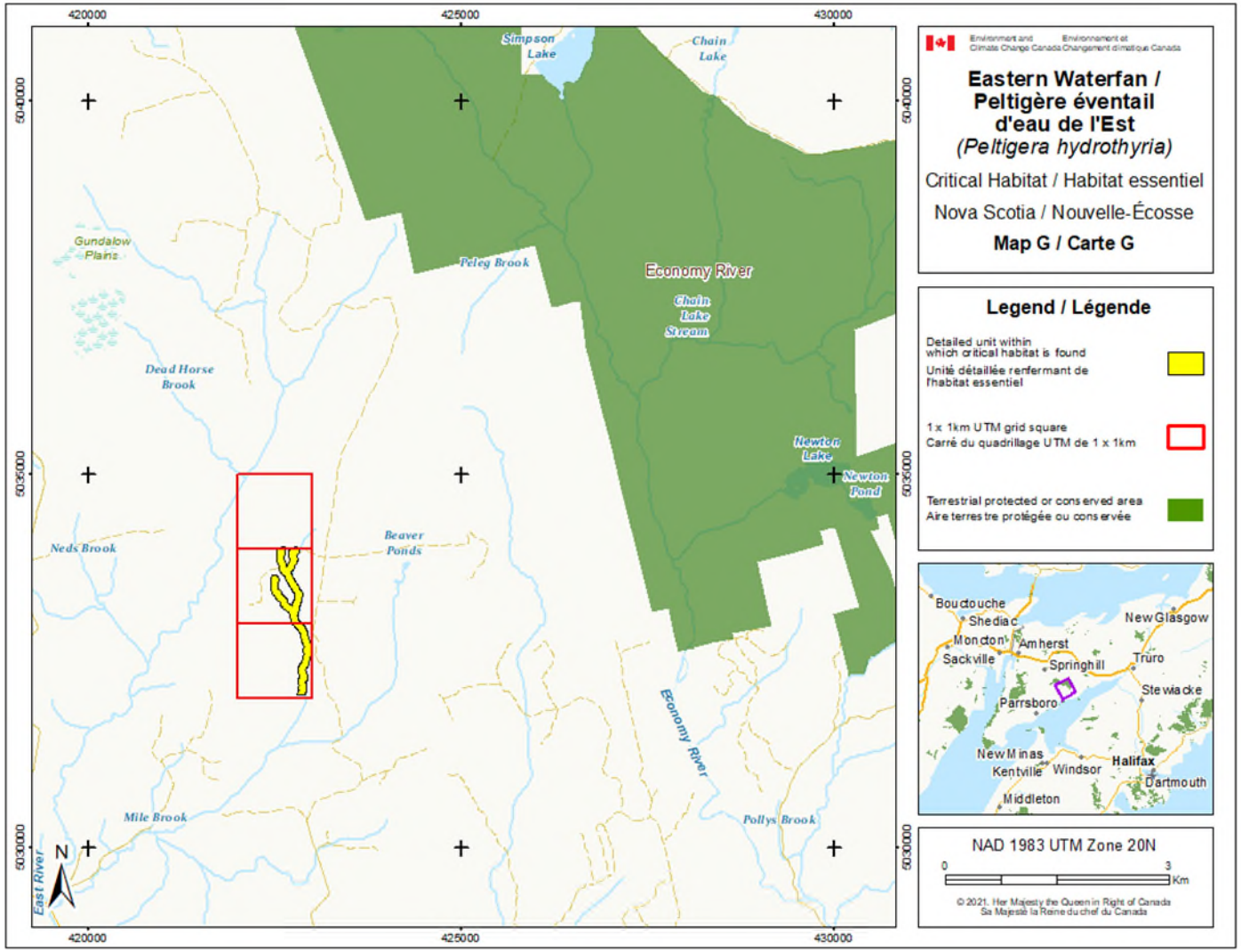

Figure 11. Critical habitat for Eastern Waterfan in Colchester County, Nova Scotia is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

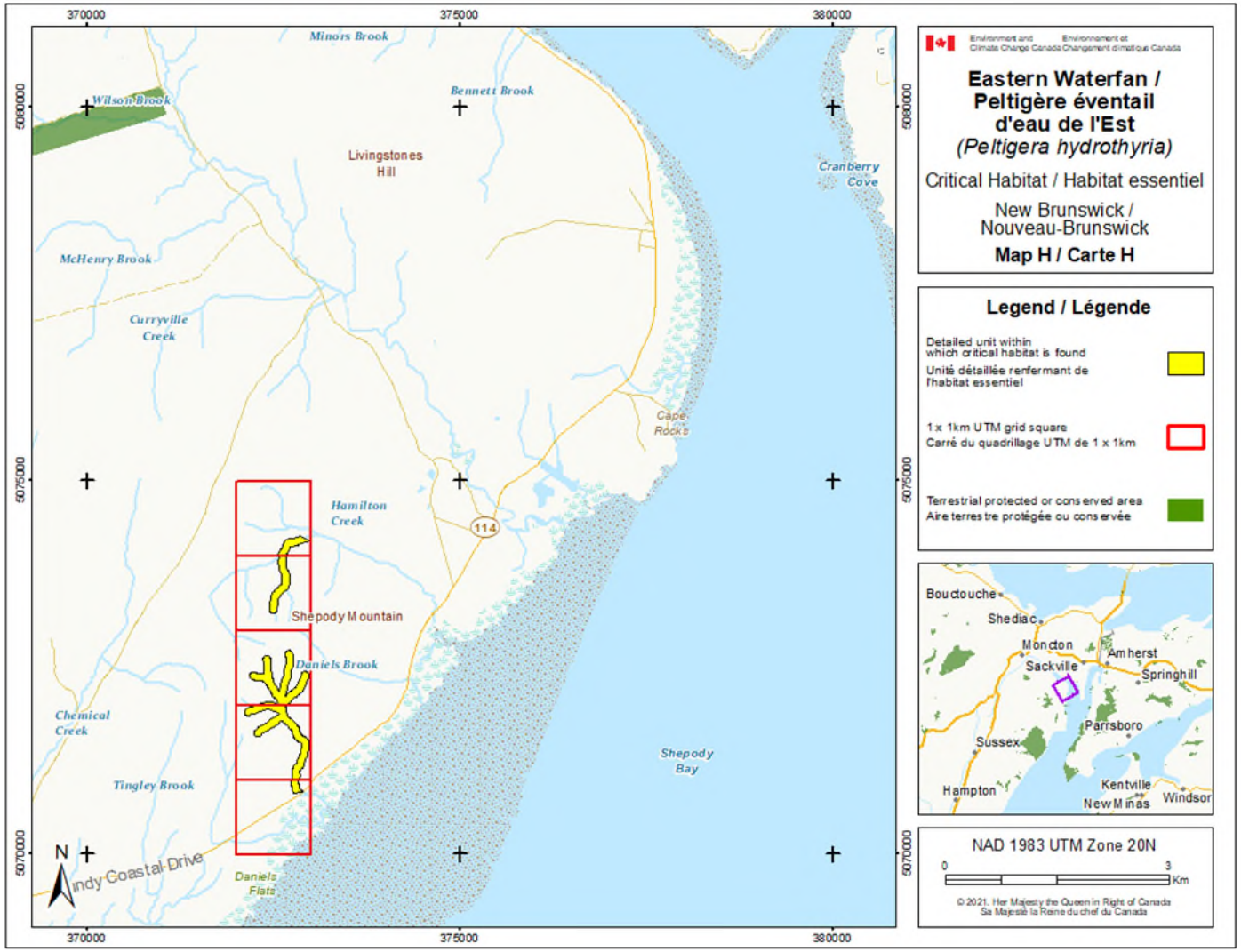

Figure 12. Critical habitat for Eastern Waterfan in Albert County (East), New Bruswick is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

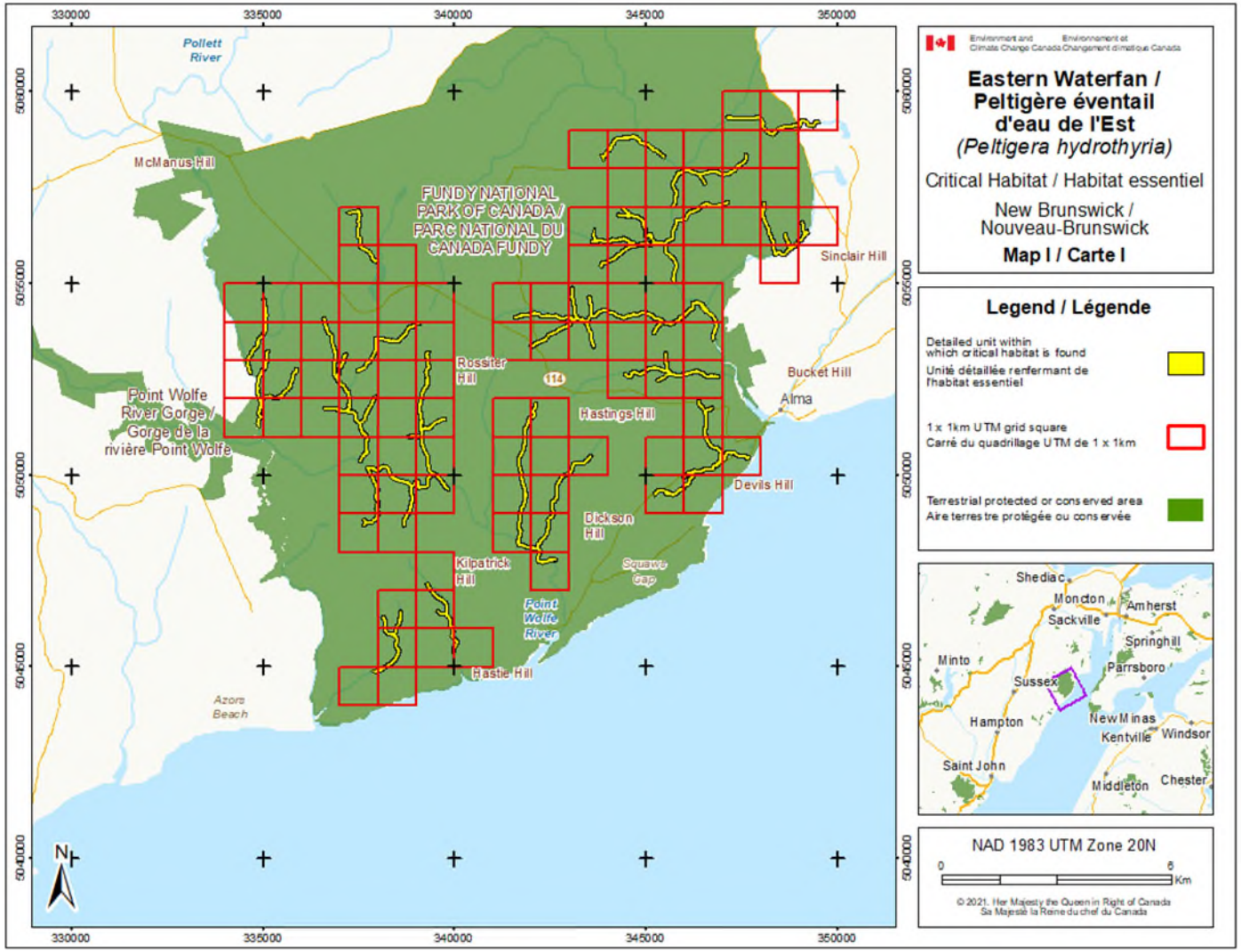

Figure 13. Critical habitat for Eastern Waterfan in Albert County (West), New Brunswick is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.

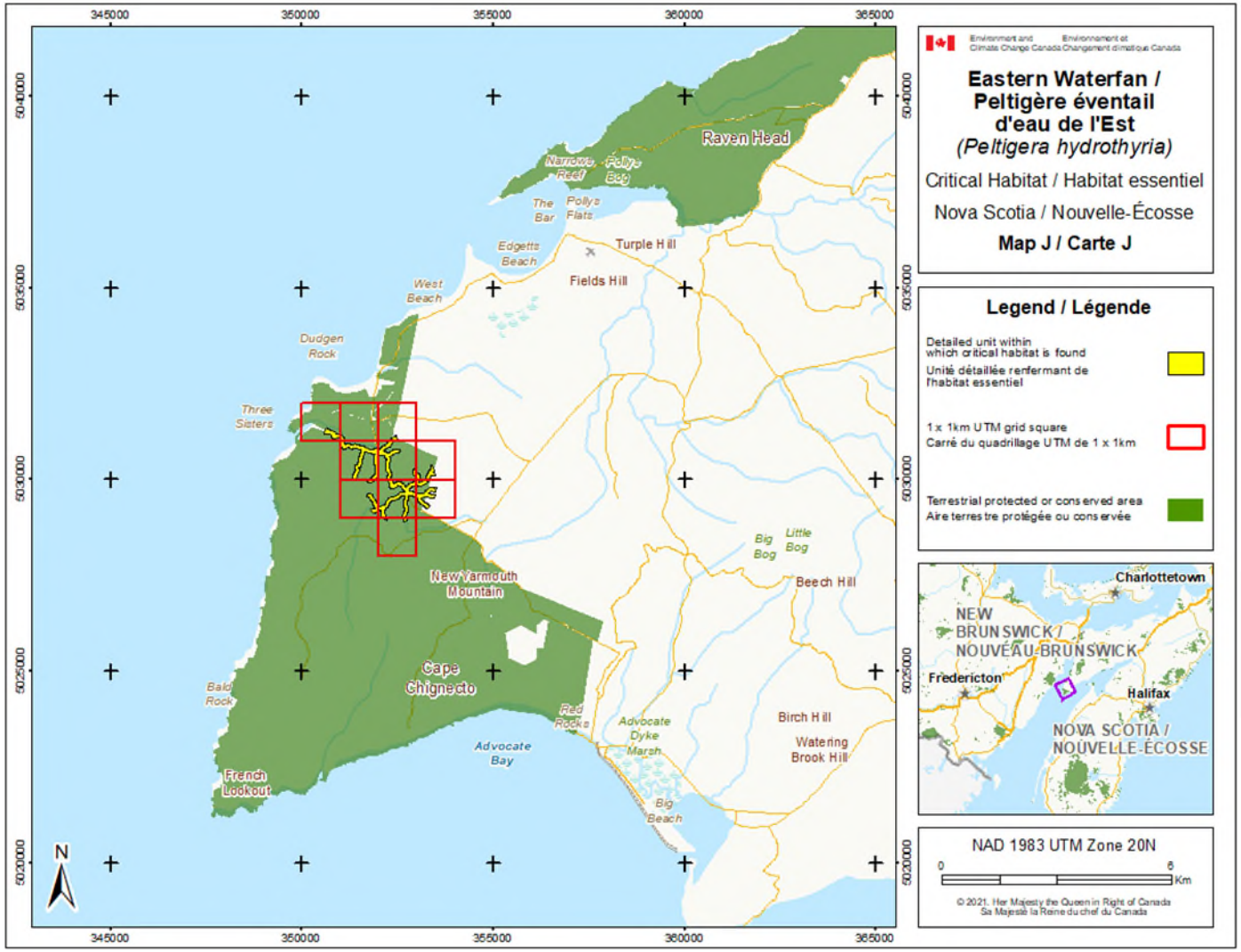

Figure 14. Critical habitat for Eastern Waterfan in Cumberland County, Nova Scotia is represented by the yellow shaded polygons where the habitat occupancy and biophysical attributes criteria and methodology set out in the recovery strategy (section 7) are met. Areas outside of the shaded polygon do not contain critical habitat. The 1 x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside the shaded yellow polygons do not contain critical habitat.