Recovery Strategy for the mountain holly fern (*Polystichum scopulinum*) in British Columbia, Québec, and Newfoundland and Labrador

Prepared by the Mountain Holly Fern Advisory Committee

BRITISH COLUMBIA
The Best Place on Earth

Ministry of Environment

May 2009

About the British Columbia Recovery Strategy Series

This series presents the recovery strategies that are prepared as advice to the Province of British Columbia on the general strategic approach required to recover species at risk. The Province prepares recovery strategies to meet its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada – British Columbia Agreement on Species at Risk*.

What is recovery?

Species at risk 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 a species' persistence in the wild.

What is a recovery strategy?

A recovery strategy represents the best available scientific knowledge on what is required to achieve recovery of a species or ecosystem. A recovery strategy outlines what is and what is not known about a species or ecosystem; it also identifies threats to the species or ecosystem, and what should be done to mitigate those threats. Recovery strategies set recovery goals and objectives, and recommend approaches to recover the species or ecosystem.

Recovery strategies are usually prepared by a recovery team with members from agencies responsible for the management of the species or ecosystem, experts from other agencies, universities, conservation groups, aboriginal groups, and stakeholder groups as appropriate.

What's next?

In most cases, one or more action plan(s) will be developed to define and guide implementation of the recovery strategy. Action plans include more detailed information about what needs to be done to meet the objectives of the recovery strategy. However, the recovery strategy provides valuable information on threats to the species and their recovery needs that may be used by individuals, communities, land users, and conservationists interested in species at risk recovery.

For more information

To learn more about species at risk recovery in British Columbia, please visit the Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

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Ben Legler

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Additional copies can be downloaded from the B.C. Ministry of Environment Recovery Planning webpage at:

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Disclaimer

This recovery strategy has been prepared by the Mountain Holly Fern Advisory Committee, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The British Columbia Ministry of Environment has received this advice as part of fulfilling its commitments under the *Accord for the Protection of Species at Risk in Canada,* and the *Canada – British Columbia Agreement on Species at Risk.*

This document identifies the recovery strategies that are deemed necessary, based on the best available scientific and traditional information, to recover mountain holly fern populations in Canada. Recovery actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and recovery approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions and all members of the recovery team have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals on the recovery team.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this strategy. The Ministry of Environment encourages all British Columbians to participate in the recovery of mountain holly fern.

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RESPONSIBLE JURISDICTIONS

The British Columbia Ministry of Environment is responsible for producing a recovery strategy for mountain holly fern under the *Accord for the Protection of Species at Risk in Canada*. The government of Québec, the government of Newfoundland and Labrador, and Environment Canada's Canadian Wildlife Service participated in the preparation of this recovery strategy.

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EXECUTIVE SUMMARY

Mountain holly fern (*Polystichum scopulinum*) was designated by COSEWIC as threatened in Canada in May 2005 and is listed on the federal *Species at Risk Act* Schedule 1. Its current known Canadian range consists of five populations found in British Columbia, Québec, and Newfoundland and Labrador. Mountain holly fern is an evergreen, perennial fern with leaflets that are folded inward and twisted horizontally with slanting bases. This fern is a species of montane ultramafic (serpentine) outcrops. In British Columbia, it is found in three populations in the Tulameen River valley. As well, it is found in 2 other provinces: one population in Québec on the Gaspé Peninsula, and a historic population in western Newfoundland and Labrador at North Arm Mountain.

In general, specific local threats apply primarily to the British Columbia populations of mountain holly fern. No specific local threats to the Québec population are known. It is not known whether the Newfoundland and Labrador population is extant, but the historic locality is remote and not at risk from human activities.

No critical habitat, as defined under the federal *Species at Risk Act* is proposed for identification at this time. It is expected that critical habitat will be proposed following consultation and development of stewardship options with affected landowners and organizations, and completion of outstanding work required to identify specific habitat and area requirements for this species.

The recovery goal for mountain holly fern is to **protect and maintain** all known populations in Canada.

The recovery objectives for this species are

1. to secure long-term protection for extant populations and their habitats (areas of occupancy plus appropriate essential habitat);
2. to refine the current distribution of the species in Canada;
3. to address knowledge gaps including: determining population trends, demographic patterns, and life history (survival and reproduction) of extant populations; and
4. to determine whether augmentation of the populations is necessary and, if required, develop and test techniques to establish populations on existing and historic sites.

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Species Assessment Information from COSEWIC

Date of Assessment: May 2005
Common Name (population): Mountain holly fern
Scientific Name: *Polystichum scopulinum*
COSEWIC Status: Threatened
Reason for designation: A fern of very restricted occurrence on serpentine substrates in three widely separated areas of Canada. These very small populations are at risk from stochastic events and, the three in British Columbia, from potential mining activities for precious metals.
Canadian Occurrence: British Columbia, Québec, Newfoundland and Labrador
COSEWIC Status History: Designated Threatened in May 2005. Assessment based on a new status report.

Description of the Species

Mountain holly fern, *Polystichum scopulinum*, is an evergreen, perennial fern (Figure 1). The stems curve upwards and the upright leaves (fronds) are 10–30 cm long (occasionally ≤ 50 cm long). The leaf stalk (petiole) is 0.2–0.33% the length of the leaf and is densely covered in light brown scales that become smaller and sparser towards the leaf. The leaf is several times longer than wide, broadest above the base, and narrowed towards the tip. The leaf is divided into leaflets (pinnae) that are themselves partially divided. The 1–3 cm long leaflets are longer than broad, with nearly parallel sides but narrowing towards the tips. Leaflets are overlapping, folded inward, and twisted horizontally, with slanting bases. Leaflet edges have fine, sharp, forward-pointing teeth that curve inward. Leaflet tips range from being blunt to having a short, abrupt, rigid point. Towards the tip of the leaflet, the teeth are smaller than the tooth at the tip. The underside of the leaf has a sparse covering of small hair-like growths that have stout projections. The growths are much longer than wide, broadest above the base, and narrowed towards the tips. The thin, scale-like coverings (indusia) of the immature spore-producing bodies (sori) are fringed with hairs. The spores are brown. Several technical descriptions of the species are available (including Wagner 1993; Douglas *et al.* 2000).

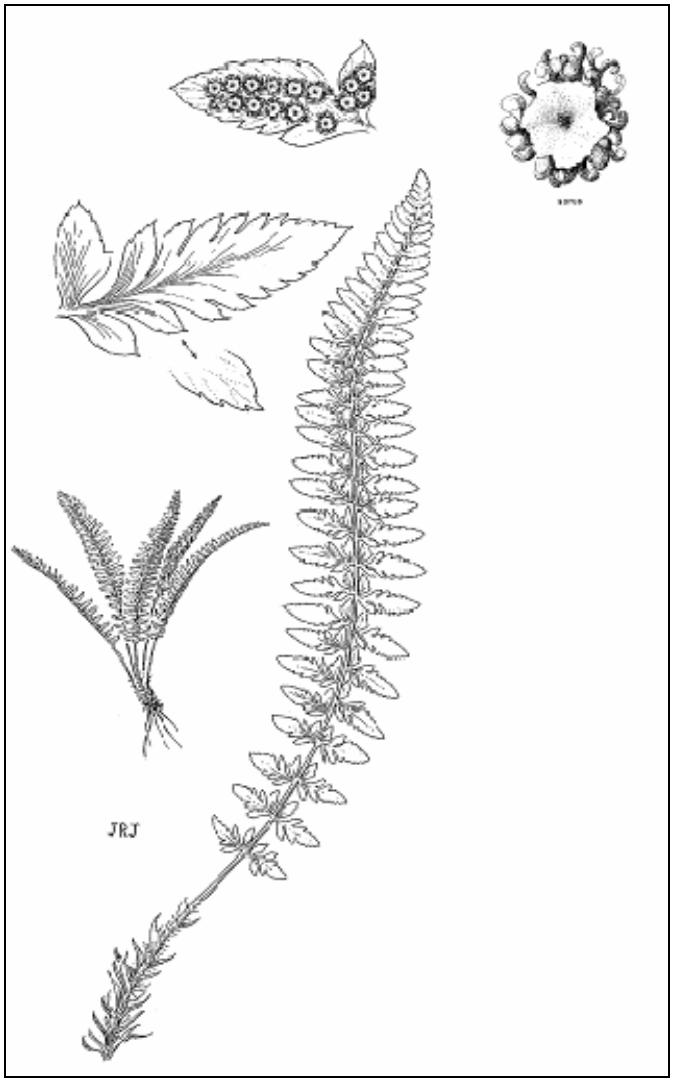

Figure 1. Illustration of mountain holly fern (reproduced with permission from the "Vascular Plants of the Pacific Northwest", University of Washington Press).

Populations and Distribution

Globally, mountain holly fern is restricted to North America (Figure 2). The species ranges from southwestern British Columbia (B.C.), sporadically south in the western United States (U.S.) to Colorado, Arizona, and California. Disjunct populations also occur in eastern Québec and western insular Newfoundland and Labrador (Wagner 1993; COSEWIC 2005).

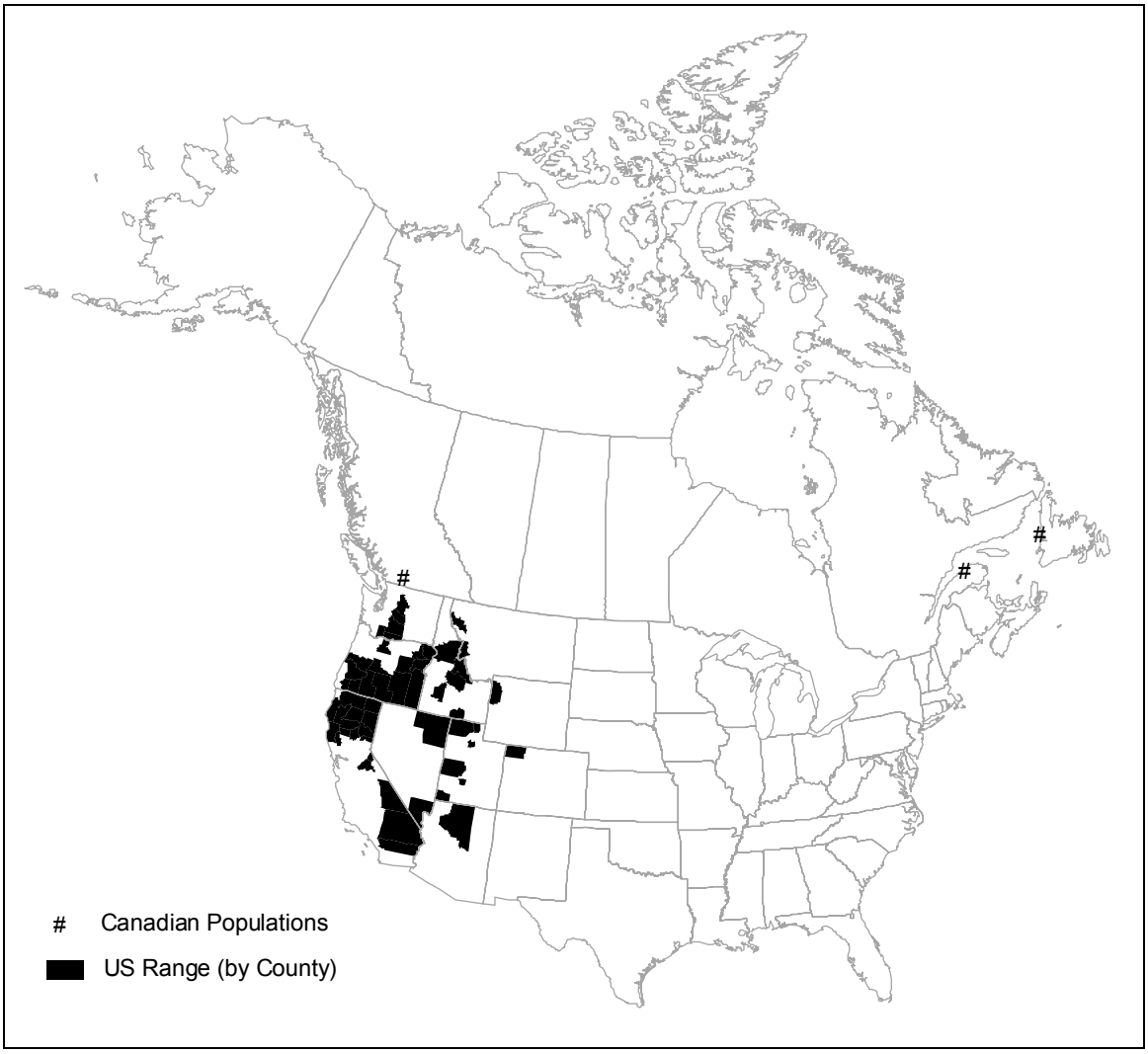

Figure 2. Map of global distribution of mountain holly fern (based on data from COSEWIC 2005; Graham and Ackerfield 2007; Montana Natural Heritage Program 2007; USDA 2007).

In Canada, mountain holly fern occurs in B.C., Québec, and Newfoundland and Labrador (Figures 3 and 4). The B.C. populations are at the northern extent of their range in North America. Table 1 summarizes the details of the Canadian populations.

Table 1. Canadian populations of mountain holly fern (from COSEWIC 2005; USDA 2007).

Population	Location	Land tenure	Year last observed & status	Number of plants	Area of occupancy	Proximity to other populations
Olivine Mountain	Near Tulameen, BC	B.C. Crown land	1996 Extant	4	200 m^2	2.5 km from Britton Ck. population; 230 km from nearest known population in the U.S. (WA)
Britton Creek	Near Tulameen, BC	B.C. Crown land	2002 Extant	400[a]	1 ha	1.1 km from Grasshopper Mtn. population; 230 km from nearest population in the U.S. (WA)
Grasshopper Mountain (2 subpopulations)	Near Tulameen, BC	B.C. Crown land	1996 Extant	5 + 30[b]	200 m^2 + 500 m^2	1.1 km from Britton Ck. population; 230 km from nearest population in the U.S. (WA)
Mont Albert	Southerly slopes of the Vallée du Diable, eastern flank of Mont Albert, Gaspé Peninsula, QC	Québec Crown land in Gaspésie National Park	2004 Extant	215	8 ha	550 km from historic NL population; 3200 km from closest population in the U.S. (CO)
North Arm Mountain, Bay of Islands	Western Newfoundland and Labrador, NL	NL Crown land	1950 Unknown	?	?	550 km from QC population; 3800 km from closest population in the U.S. (CO)

[a] Population stable since 1995.
[b] B.C. Conservation Data Centre records the size of this subpopulation as 30 plants (B.C. CDC 2007), while COSEWIC (2005) states that the subpopulation consists of three plants.

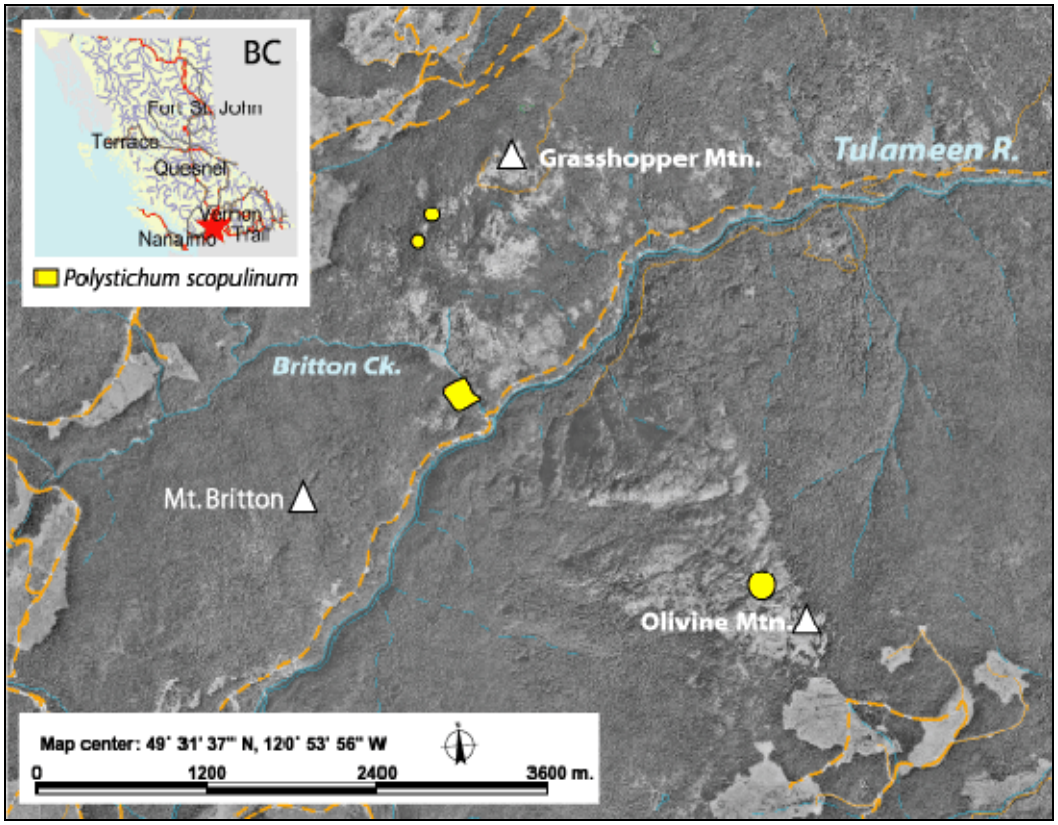

Figure 3. Map of mountain holly fern distribution in British Columbia (adapted from B.C. CDC 2007).

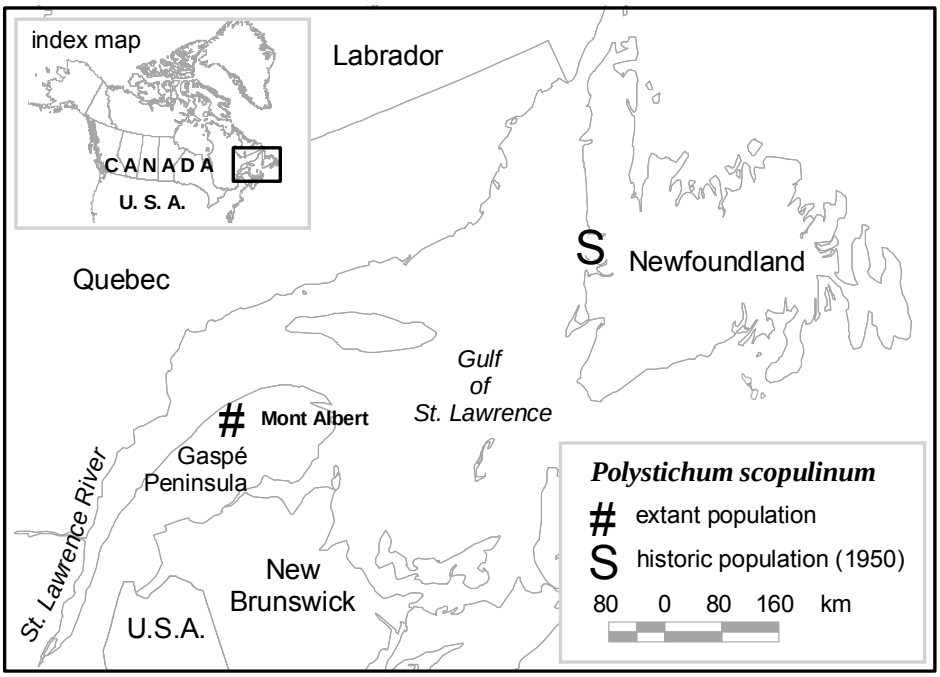

Figure 4. Map of mountain holly fern distribution in Eastern Canada (Wagner and Rouleau 1984; COSEWIC 2005).

Globally, mountain holly fern has a Secure (G5) Conservation Status Rank, meaning that it is common, widespread, and abundant (NatureServe 2007). In the U.S., the species' conservation status rank has not been assessed. In Canada, the species is considered Critically Imperiled (N1) (NatureServe 2007) and Threatened (COSEWIC 2005). The conservation status of the species at the state and provincial levels is summarized in Table 2. Mountain holy fern is a priority 2 species under goal 3 of the B.C. Conservation Framework (see <http://www.env.gov.bc.ca/conservationframework/> for details)

Table 2. Conservation status of mountain holly fern at the subnational level (from NatureServe 2007).

Country	Province or state	NatureServe rank code	NatureServe rank
Canada	British Columbia	S1	Critically Imperiled
	Québec	S1	Critically Imperiled
	Newfoundland and Labrador	SH	Possibly Extirpated (Historical)
U.S.	Arizona	S2	Imperiled
	California	SNR	Unranked
	Colorado	S1	Critically Imperiled
	Idaho	SNR	Unranked
	Montana	S1	Critically Imperiled
	Nevada	SNR	Unranked
	Oregon	SNR	Unranked
	Utah	S2	Imperiled
	Washington	SNR	Unranked
	Wyoming	SH	Possibly Extirpated (Historical)

If the mountain holly fern populations in Canada are lost, the potential for populations to re-establish from spores dispersed from other populations is relatively low. While fern spores can disperse across remarkable distances (Wagner and Rouleau 1984; Barrington 1993), many fern species appear to have difficulty in establishing and recruiting new individuals (Wild *et al.* 2006). While mountain holly fern spores can disperse across thousands of kilometers, the species apparently has low success in colonizing new sites based on the number of apparently suitable montane ultramafic sites (see "Habitat and biological needs" section for description) that are not occupied by the species (Figure 5).

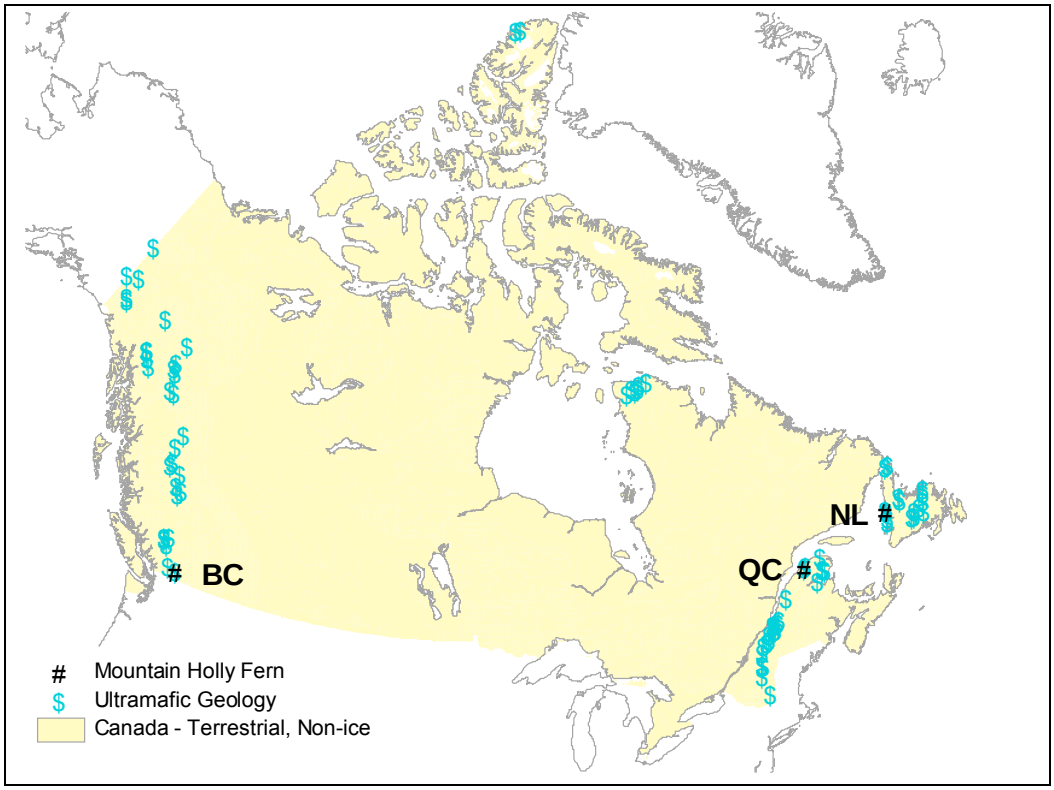

Figure 5. Map of mountain holly fern distribution in Canada in relation to ultramafic geology (based on data from Wheeler *et al.* 1996; COSEWIC 2005). Note: not all occurrences of ultramafic geology provide suitable habitat for mountain holly fern — the species colonizes dry, montane slopes only.

Although the global population size of mountain holly fern is unknown, it is likely that the estimated population size of less than 1000 plants in Canada (COSEWIC 2005) represents far less than 1% of the global population.

Little is known about the rate of change in geographical distribution and populations of mountain holly fern in Canada. All populations are known to be extant except for the Newfoundland and Labrador one, the status of which is unknown since it was originally discovered in 1950. The collection location is vague and the area is very remote (boat access), therefore is it possible that the population has persisted to the present without being re-discovered (COSEWIC 2005; C. Hanel, pers. comm., 2007). British Columbia and Québec populations are assumed to be stable.

Needs of the Mountain Holly Fern

Habitat and biological needs

Mountain holly fern is a species of montane ultramafic (serpentine) outcrops (Wagner 1993). Ultramafic rocks are granular, and consist almost entirely of ferromagnesian minerals (Longwell *et al.* 1969). Habitats associated with ultramafic outcrops have several distinct characteristics that influence vegetation:

- ultramafic rocks are highly erodible (Brooks 1987);

- available water in the soil is generally reduced by adsorption to montmorillonite clays (Brooks 1987);
- ultramafic slopes can also have excess moisture in the form of seepage, as is commonly observed in Newfoundland and Labrador (C. Hanel, pers. comm., 2007);
- soils are poor in nitrogen and phosphorus nutrients, and the calcium: magnesium ratio is low (Kruckeberg 1984; Brooks 1987); and
- soils may be toxic to most plants due to the presence of heavy metals such as chromium and nickel (Brooks 1987).

In B.C., mountain holly fern occurs along the ultramafic band (olivine clinopyroxenite) between Olivine Mountain and Grasshopper Mountain in the Tulameen River valley. The mountain holly fern populations occur at elevations from 979 to 1768 m. The vegetation of the sites is characteristically depauperate (in contrast to the dense surrounding forest), with dominant species including lodgepole pine (*Pinus contorta*), whitebark pine (*Pinus albicaulis*), Indian's-dream (*Aspidotis densa*), Kruckeberg's holly fern (*Polystichum kruckebergii*), common juniper (*Juniperus communis*), lance-leaved stonecrop (*Sedum lanceolatum*), Rocky Mountain butterweed (*Senecio streptanthifolius*), and kinnikinnick (*Arctostaphylos uva-ursi*).

In Québec, mountain holly fern occurs in a south-facing montane setting above the treeline (800–900 m). The fern grows in cracks in the ultramafic bedrock (serpentinite, dunite, and pyroxenite) and at the bases of large rocks. The depauperate vegetation is dominated by black spruce (*Picea mariana*), dwarf birch (*Betula nana*), Labrador tea (*Ledum groenlandicum*), lingonberry (*Vaccinium vitis-idaea*), and shrubby cinquefoil (*Dasiphora floribunda*). Associated plants include local serpentine endemics such as serpentine stitchwort (*Minuartia marcescens*), green-scaled willow (*Salix chlorolepis*), and Mount Albert goldenrod (*Solidago simplex* ssp. *simplex* var. *chlorolepis*), as well as eastern disjuncts such as Aleutian maidenhair (*Adiantum aleuticum*) and Indian's dream (*Aspidotis densa*) (COSEWIC 2005; MDDEP 2006).

The original locality description for the Newfoundland and Labrador occurrence was given as "southerly slopes of dry serpentine ridge" (Wagner and Rouleau 1984).

The gametophytic stage of mountain holly fern has not been observed in Canada, and its habitat requirements are unknown.

Ecological role

The ecological role of mountain holly fern is unknown, but it is assumed to be minor given its small population sizes (Table 1). The ultramafic habitat of the species may allow the species to survive in a situation where competition from other vegetation is low.

Limiting factors

Several biological factors limit the recovery potential of mountain holly fern in Canada.

Potentially sterile populations
Given their dramatically disjunct locations, the Québec and Newfoundland and Labrador populations of mountain holly fern can be assumed to have arisen from spore dispersal. In Washington State, however, primary sterile diploid hybrids of the species have been found (as opposed to the normal fertile tetraploid form) (Wagner and Rouleau 1984). Sterile hybrids are incapable of dispersing or reproducing by spores and depend totally on vegetative reproduction. Given the proximity of the B.C. populations to the Washington State ones, it is possible that some or all of the B.C. populations consist of sterile diploid hybrids.

Ecological requirements of gametophytic stage
If Canadian populations of mountain holly fern do reproduce by spore then, like other ferns, the colonization and persistence of the species may be limited by the ecological requirements of the gametophytic stage, including the need for specific moisture regimes and substratum chemistry (Given 1993; Wild *et al.* 2006). This factor has been used to explain the frequently observed "empty niche" phenomenon in fern species, where apparently suitable habitat is not occupied (Wild and Gagnon 2005). In B.C., George Douglas speculated that mountain holly fern reproduction occurs primarily through vegetative means, given that he failed to find gametophytes in the field (COSEWIC 2005). However, the failure to find gametophytes for fern species is not uncommon (Farrar 1976).

Poor competitors
Ferns tend to be poor competitors with other plant species and this could also limit the colonization and persistence of mountain holly fern (Given 1993).

Habitat specificity and limited habitat extent
Because montane ultramafic habitats are relatively rare in Canada, there is relatively little potential habitat for mountain holly fern to colonize. The habitat of the species is also inherently highly fragmented (controlled by geological outcroppings). The species may also have additional unknown habitat requirements at the edges of its range that further limit its potential habitat.

Small population sizes
The small population sizes of the species in Canada (see Table 1) place the populations at risk for extirpation due to demographic stochasticity.

Threats

In general, specific local threats apply primarily to the B.C. populations of mountain holly fern. No specific local threats to the Québec population, which occurs in the Gaspésie National Park, are known (F. Coursol, pers. comm., 2007). It is not known whether the Newfoundland and Labrador population is extant; however, the assumed historical locality is very remote and not currently at risk from human activities (C. Hanel, pers. comm., 2007).

Threat classification

Potential threats to the survival of mountain holly fern populations in B.C. include mining, road construction, slope failure, and severe fire. Current threats to the species within in B.C. include mountain pine beetle (*Dendroctonus ponderosae*) control and mineral exploration. Potential threats in all three provinces include climate change and botanical collecting (summarized in Table 3).

Table 3. Threat classification table for mountain holly fern.

1 Mineral exploration		**Threat attributes**		
Threat category	Habitat loss or degradation, accidental mortality	**Extent**	Widespread in B.C.	
			Local	**Range-wide**
General threat	Mineral exploration	**Occurrence**	B.C.: anticipated QC: not anticipated NL: not anticipated	Unknown
		Frequency	Unknown	Unknown
Specific threat	Destruction, removal, or burial of plants and alteration of habitat	**Causal certainty**	High	High
		Severity	High	High
Stress	Increased mortality, reduction in population size, population extinction	**Level of concern**	Medium	
2 Mining		**Threat attributes**		
Threat category	Habitat loss or degradation, accidental mortality	**Extent**	Widespread in B.C.	
			Local	**Range-wide**
General threat	Mining	**Occurrence**	B.C.: anticipated QC: not anticipated NL: not anticipated	Unknown
		Frequency	Unknown	Unknown
Specific threat	Destruction, removal, or burial of plants and alteration of habitat	**Causal certainty**	Low	Low
		Severity	Low	Low
Stress	Increased mortality, reduction in population size, population extinction	**Level of concern**	Low	
3 Mountain pine beetle control		**Threat attributes**		
Threat category	Habitat loss or degradation, accidental mortality	**Extent**	Localized	
			Local	**Range-wide**
General threat	Harvesting of *Pinus* trees to control the spread of the mountain pine beetle	**Occurrence**	B.C.: current QC: not anticipated NL: not anticipated	-
		Frequency	One-time	-
Specific threat	Destruction or burial of plants and alteration of habitat	**Causal certainty**	Low	-
		Severity	High	-

Stress	Increased mortality, reduction in population size, population extinction	**Level of concern**	Medium	
4	**Road construction**	**Threat attributes**		
Threat category	Habitat loss or degradation, accidental mortality	**Extent**	Widespread in B.C.	
			Local	**Range-wide**
General threat	Road construction	**Occurrence**	B.C.: anticipated QC: not anticipated NL: not anticipated	Unknown
		Frequency	One-time	One-time
Specific threat	Destruction, removal, or burial of plants and alteration of habitat	**Causal certainty**	High	High
		Severity	High	High
Stress	Increased mortality; reduction in population size; population extinction	**Level of concern**	Medium	
5	**Climate change**	**Threat attributes**		
Threat category	Climate and natural disasters	**Extent**	Widespread	
			Local	**Range-wide**
General threat	Climate change	**Occurrence**	-	Current
		Frequency	-	Seasonal
Specific threat	Potential for increased frequency and length of drought periods	**Causal certainty**	-	Low
		Severity	-	Unknown
Stress	Poor reproductive success, increased mortality, reduction in population size, population extinction	**Level of concern**	Low	
6	**Slope failure**	**Threat attributes**		
Threat category	Climate and natural disasters	**Extent**	Widespread	
			Local	**Range-wide**
General threat	Slope failure	**Occurrence**	-	Anticipated
		Frequency	-	Recurrent
Specific threat	Destruction, burial, and uprooting of plants	**Causal certainty**	-	Low
		Severity	-	High
Stress	Increased mortality, reduction in population size, population extinction	**Level of concern**	Low	
7	**Severe fire**	**Threat attributes**		
Threat category	Climate and natural disasters	**Extent**	Widespread	
			Local	**Range-wide**

General threat	Severe fire	**Occurrence**	B.C.: anticipated QC: not anticipated NL: not anticipated	Anticipated
		Frequency	-	Recurrent
Specific threat	Destruction of plants	**Causal certainty**	-	Low
		Severity	-	High
Stress	Poor reproductive success, increased mortality, reduction in population size, population extinction	**Level of concern**	Low	
8 Botanical collecting		**Threat attributes**		
Threat category	Disturbance or persecution	**Extent**	Widespread	
			Local	**Range-wide**
General threat	Discriminate killing	**Occurrence**	-	Anticipated
		Frequency	-	Unknown
Specific threat	Collection of botanical specimens	**Causal certainty**	-	Medium
		Severity	Moderate in Canada	Low
Stress	Reduction in population size, population extinction	**Level of concern**	Low	

B.C. = British Columbia; NL = Newfoundland and Labrador; QC = Québec.

Description of the threats

Mining

Mining was identified as the primary potential threat to mountain holly fern in B.C. (COSEWIC 2005). Bright Star Ventures, a mining exploration company (now delisted), no longer seems to be active in the area as was the case when the status report was written (COSEWIC 2005). Despite decades of intensive exploration activities in the area, most prospects fail to get developed. Mining is not considered to be a threat for Québec or Newfoundland and Labrador populations.

Mineral exploration

Mineral exploration in the Tulameen area currently represents a greater threat to B.C. mountain holly fern populations than mining. Figure 6 illustrates the locations of current and past mining activities near mountain holly fern populations. Mining and mineral exploration are not considered threats for Québec or Newfoundland and Labrador populations.

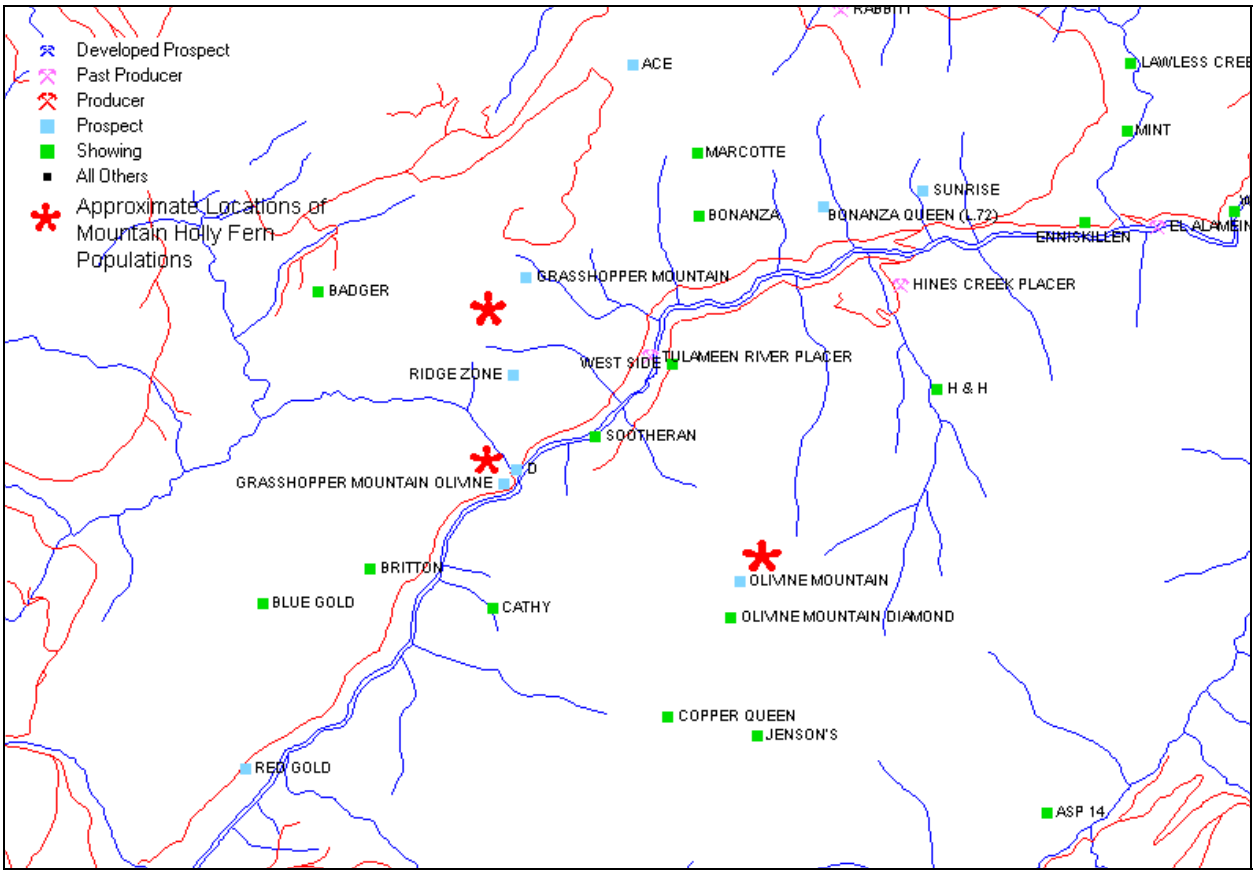

Figure 6. Mining activity locations near mountain holly fern populations in B.C. Source: B.C. MEMPR (2007).

Mountain pine beetle control

The Merritt Timber Supply Area in B.C. is experiencing an exponential increase in mountain pine beetle attack and the B.C. Ministry of Forests and Range is currently taking "an aggressive pro-active approach to identifying and managing the destructive forest pests" (Senger 2006). As part of their strategy, they set a forest licensee salvage/sanitation harvest target of 212,524 m^3 in the Tulameen Landscape Unit (where the B.C. mountain holly fern populations occur) in 2006–2007 (Senger 2006). However, the 3 known populations of mountain holly fern occupy less than 2 ha of the Tulameen Landscape Unit and it is unknown how much of this harvest could overlap with mountain holly fern populations.

Salvage logging activities of this nature could result in habitat destruction by disturbing rocks and soil. Plants could also be destroyed by heavy machinery and buried under disturbed rocks and soil. Mountain pine beetle control is not a threat for Québec or Newfoundland and Labrador populations.

Road construction

Road construction is a potential threat near mountain holly fern populations in B.C. The construction of mining exploration roads is not subject to the same degree of regulation as that of

forestry roads, and they may cause more habitat destruction. Road construction is not a threat for Québec or Newfoundland and Labrador populations.

Climate change
The potential impacts of climate change on mountain holly fern populations are difficult to assess. Although altered climate regimes may be favourable for populations by creating conditions more similar to those in the centre of the species' range, there is a risk of more extreme climatic conditions, which could potentially reduce the viability of populations (e.g., more severe droughts). Climate change is a potential threat to the species throughout its range.

Slope failure
Severe slope failures (due to the colluvial nature of the soil) could eradicate some populations. It is not known which populations are most at risk due to this potential threat but it applies to populations throughout Canada.

Severe fire
Severe fires could eradicate the B.C. mountain holly fern populations. The populations occur within areas where stand-replacing fires are expected to occur every 4–50 years or every 100 years (Natural Disturbance Types 3 and 4) (Senger 2006).

The Québec population is less at risk because it occurs above the tree line (COSEWIC 2005). The Newfoundland and Labrador population, if extant, is unlikely to be at risk due to severe fire because of the climate in which it occurs (C. Hanel, pers. comm., 2007).

Botanical collecting
Given the small population sizes of mountain holly fern in Canada (Table 1), indiscriminate botanical collecting in extant populations could have significant impacts on population sizes. This potential threat is a minor one for all of the Canadian populations due to their locations, which are either remote, or at least removed from human pathways.

Actions Already Completed or Underway

A preliminary conservation plan has been drafted for the Québec population (MDDEP 2006). Searching for the historic Newfoundland and Labrador population was conducted in 2000 (seven people searched for one day). No specific recovery actions have been completed or are underway in B.C.

Knowledge Gaps

Recovery efforts for mountain holly fern in Canada are limited by several knowledge gaps, discussed below.

Distribution of species in Canada
The potential for finding additional populations in B.C. is relatively high. Known populations occur at montane ultramafic sites. Ultramafic sites have attracted a lot of botanical interest, but mountain holly fern populations are likely easily overlooked, particularly when the species co-

occurs with other *Polystichum* species such as the more common Kruckeberg's holly fern (*Polystichum kruckebergii*) which is found in the area. Also, some ultramafic sites occur in remote mountainous areas that have presumably received less search effort.

Additional survey effort is needed to determine whether the historic Newfoundland and Labrador population is extant. Relatively little survey effort has been devoted to the area due to its remote location (boat access only) (C. Hanel, pers. comm., 2007). The Newfoundland and Labrador specimen of mountain holly fern was also originally misidentified as Braun's hollyfern (*Polystichum braunii)* until 1978 (Wagner and Rouleau 1984).

The likelihood of finding additional populations in Québec is relatively low, given the intensive search effort that has been devoted to ultramafic sites (G. Hall, F. Coursol, pers. comm. via M. Wild 2007).

Gametophyte ecology
The importance of the gametophyte stage in the reproduction of mountain holly fern in Canada is unknown, as are the habitat requirements of the gametophyte, if applicable (gametophytes have not been observed in Canada). Information about gametophyte ecology would influence recovery actions and could be used to refine a definition of critical habitat.

Vegetative reproduction
The importance of vegetative reproduction in population persistence, growth, and dispersal is unknown. If vegetative reproduction is the primary mode of reproduction as suggested by COSEWIC (2005), recovery actions and the estimation of population viabilities will be influenced.

Genetics of Canadian populations
Investigations are needed to determine whether Canadian populations consist of the normal fertile tetraploid form or of the sterile diploid form of mountain holly fern (Wagner and Rouleau 1984). This information would influence recovery actions and estimates of population viability.

RECOVERY

Recovery Feasibility

The recovery of mountain holly fern in Canada is **feasible**, based on the following criteria:

- Mature sporophytes capable of vegetative reproduction (and possibly sexual reproduction) are currently available to improve the population growth rate and population abundance.
- Sufficient suitable habitat is available to support the species (according to the known habitat requirements).
- Significant threats to the species or its habitat can be avoided or mitigated through recovery actions.
- The necessary recovery techniques exist — most have been demonstrated to be effective.

Recovery Goal

The recovery goal for mountain holly fern is to **protect and maintain** all known[1] populations in Canada.

Rationale for the Recovery Goal

The recovery goal is based on ensuring the survival of the species in Canada. Distribution within Canada was historically, and is currently, very restricted. While the populations face some threats, the recovery potential of mountain holly fern is primarily limited by the biological factors discussed in the "Limiting factors" section.

Recovery Objectives

The recovery goal for mountain holly fern is supported by the following objectives (which should be achieved by 2014):

1. to secure long-term protection for extant populations and their habitats (areas of occupancy plus appropriate essential habitat);
2. to refine the current distribution of the species in Canada;
3. to address knowledge gaps including: determining population trends, demographic patterns, and life history (survival and reproduction) of extant populations; and
4. to determine whether augmentation of the populations is necessary and, if required, develop and test techniques to establish populations on existing and historic sites.

[1] "All known populations" will include the Newfoundland and Labrador population if it is re-located.

Approaches Recommended to Meet Recovery Objectives

Recovery planning table

Recovery planning for mountain holly fern is summarized in Table 4.

Table 4. Recovery planning table for mountain holly fern.

Priority	Threat or concern addressed	Broad strategy to address threat	Recommended approaches to meet recovery objectives
Objective 1: to secure long-term protection for extant populations and their habitats (areas of occupancy plus appropriate essential habitat)			
High	Mining and mineral exploration, mountain pine beetle control, road construction, slope failure, severe fire	Protection (habitat, species), management (habitat, species), stewardship, research, enforcement, coordination, communication and outreach	• designate the Crown land on which B.C. populations grow for the conservation of natural resources under Section 17 of the B.C. Land Act to make land users aware of the location of the species • list the mountain holly fern as a species at risk under the B.C. Forest and Range Practices Act and establish wildlife habitat areas • determine the amount of habitat required to adequately protect the populations (including those that occur in unstable, sloping habitats) • communicate with and facilitate the development of an appropriate road construction plan with B.C. Ministry of Forests and Range and Ministry of Energy, Mines and Petroleum Resources • assist the B.C. Ministry of Forests and Range in developing a site management plan for the area • develop management plans in B.C. that include guidelines on: o mitigating the effects of mountain pine beetle control on mountain holly fern populations, and o managing the risk of severe fires extirpating populations.
Low	Botanical collecting	Communication and outreach	• education of botanical collectors regarding the need to protect the species and its habitat
Objective 2: to refine the current distribution of the species in Canada			
Medium	Knowledge gaps	Inventory, communication and outreach	• NL: conduct additional field surveys for the species in its presumed historic locality • B.C.: identify potential habitats in the southern part of the province using detailed geological mapping and aerial photography; conduct field surveys in potential habitats • B.C.: communicate with Ministry of Energy, Mines and Petroleum Resources in regard to the locations of the fern with respect to mining and mineral exploration • B.C.: communicate with the Ministry of Forests and Range in regard to the locations of the fern with respect to Mountain Pine Beetle control and road construction • QC: conduct surveys on south-facing slopes that have not yet been surveyed • provide field botanists with descriptions of mountain holly fern and its habitat
Objective 3: to address knowledge gaps including: determining population trends, demographic patterns, and life			

history (survival and reproduction) of extant populations			
Medium	Knowledge Gaps	Research, inventory, and monitoring	• develop a research program to estimate the viability of extant populations • conduct studies to estimate critical population viability parameters including: o population sizes and structures (and trends) o demographic parameters (including survival and fecundity of gametophytes, surveys for gametophytes in all extant populations, the importance of the various modes of dispersal, etc.) o genetic parameters (determine whether populations consist of sterile diploid hybrids or fertile tetraploids)
Objective 4: to determine whether augmentation of the populations is necessary and, if required, develop and test techniques to establish populations on existing and historic sites			
Low	Climate change (and to support the recovery goal in general)	Research, propagation	• assess the appropriateness of reintroduction • delineate potential habitat if determined appropriate • conduct greenhouse studies to investigate the potential of propagating plants from field-collected spores, from the spore bank, and from vegetative propagules • conduct field studies to investigate methods of transplanting propagated plants for potential population augmentation

B.C. = British Columbia; NL = Newfoundland and Labrador; QC = Québec.

Description of the recovery planning table

The first high priority of recovery planning is to protect the populations and habitats of mountain holly fern in Canada. This objective addresses the majority of the threats to the species and prevents the extirpation of populations due to anthropogenic causes in the short term. Most of the recovery approaches focus on the B.C. populations. Although B.C. populations occur on provincial Crown land, they are not covered by any stewardship initiatives nor are they specifically protected.

The first medium priority objective is to refine the distribution of the species in Canada. The finding of additional populations of mountain holly fern (or finding the historic Newfoundland and Labrador population) could influence the status of the species and the future refinement of recovery objectives. Although ultramafic habitats in Canada have been the focus of considerable botanical survey effort, mountain holly fern can be confused with other *Polystichum* species in the field where they co-occur. In B.C., mountain holly fern can easily be mistaken for the more common and blue-listed, Kruckeberg's holly fern *Polystichum kruckebergii*. In Newfoundland and Labrador, the single mountain holly fern specimen from 1950 was originally mistaken for *Polystichum braunii* and the specimen was not correctly identified for 28 years (Wagner and Rouleau 1984). Targeted field surveys for the species may therefore reveal additional occurrences. Québec is a lower priority for inventory given that considerable search effort has been undertaken in ultramafic habitats, and no other *Polystichum* species occur in ultramafic habitats there (G. Hall and F. Coursol, pers. comm. via M. Wild, 2007).

The second medium priority objective is estimating the viability of extant populations. This objective addresses many of the knowledge gaps related to the recovery of mountain holly fern.

Once the biology and demography of the species is better understood, more specific recovery objectives can be formulated towards meeting the recovery goal for the species in Canada.

Finally, a low priority objective entails determining whether augmentation of the populations is necessary, and if required, develop and test techniques to establish populations on existing and historic sites. Given (1993) recommends that off-site garden collections and germplasm banks be maintained for fern species as a back-up to *in situ* conservation through the protection of natural habitats. These techniques will be necessary if population objectives are eventually refined to include population augmentation based on additional information about population viability.

Performance Measures

The following performance measures will evaluate the success of the recovery strategy in meeting its objectives:

- population monitoring indicates that the numbers of plants at the known existing sites are stable or increasing by 2014;
- suitable habitat in B.C. for new populations, and in Newfoundland and Labrador for the historic population has been surveyed and documented by 2014;
- demographic patterns and life history (survival and reproduction) of extant populations has been investigated by 2014;
- review of population demographics and life history information has determined whether the populations should be augmented in any of the three jurisdictions by 2014; and
- the known mountain holly fern sites in B.C. are recognized by managers in the B.C. Ministry of Forests and Range and included in their forests and range management plans for fire protection and mountain pine beetle control by 2014.

Critical Habitat

Identification of the species' critical habitat

Critical habitat as legally defined under the federal *Species at Risk Act* will not be proposed until data gaps are addressed and consultation is complete. Relatively little is known about the specific habitat needs of the species or its distribution, and more definitive work must be completed before any specific sites will be formally proposed as critical habitat. It is expected that critical habitat will be proposed following consultation and development of stewardship options with affected landowners and organizations, and completion of outstanding work required to identify specific habitat and area requirements for this species where required.

No critical habitat will be proposed in Newfoundland and Labrador unless the historically known population is confirmed to be extant. If applicable, proposed critical habitat will be addressed through a schedule of studies as part of an action plan for the species.

Recommended schedule of studies to identify critical habitat

Additional information is needed to define the critical habitat of mountain holly fern in B.C. Several studies should be completed within the next 5 years to refine recommendations for critical habitat (Table 5).

Table 5. Schedule of studies.

Description of activity	Outcome/Rationale	Timeline
Using established survey and mapping techniques delineate the boundaries of all occupied habitats for all extant Canadian populations	Mapping of the extant areas of occupancy is needed to define critical habitat	2009–2014
Identify habitat attributes at extant sites	Determine the necessary abiotic and biotic attributes required for critical habitat	2009-2014
Complete survey for extant populations in Newfoundland and Labrador	Areas of occupancy of new populations should be considered for critical habitat	2009–2014
Complete inventory for additional populations in B.C.	Areas of occupancy of new populations should be considered for critical habitat	2009–2014

Existing and Recommended Approaches to Habitat Protection

The Québec population is protected within a provincial park (le Parc national de la Gaspésie), and a conservation plan has been drafted for the species. The B.C. populations occur on provincial Crown land, but the habitat of mountain holly fern is not formally protected. The following approaches to habitat protection in B.C. are recommended:

- identify mountain holly fern as a species at risk under the B.C. *Forest and Range Practices Act* and establish Wildlife Habitat Areas as appropriate;
- *Land Act* designations for the conservation of a natural resource under Section 17 can be sought to make land users aware of the location of mountain holly fern;
- facilitation of the development of an appropriate road construction plan in the areas where mountain holly fern occurs with B.C. Ministry of Forests and Range and Ministry of Energy, Mines and Petroleum Resources;
- communication of the road construction plan to forestry and mining contractors; and
- provide assistance to the B.C. Ministry of Forests and Range in developing site protection and management plans for the known existing mountain holly fern sites.

The historical Newfoundland and Labrador population is thought to occur on provincial Crown land (C. Hanel, pers. comm., 2007) with no special habitat protection in place.

Effects on Other Species

In B.C., mountain holly fern occurs in the same habitats with Kruckeberg's holly fern (*Polystichum kruckebergii*). This species is ranked by the B.C. Conservation Data Centre as Red-listed in the province and by NatureServe as critically imperiled (S1) (B.C. CDC 2007; NatureServe 2007), however, it is widespread in the area and also overlaps with the smaller mountain holly fern sites. Mountain holly fern populations also occur in an area where there have been many observations of Mountain Beaver (*Aplodontia rufa*), which is considered vulnerable (Blue-listed) in B.C. and of Special Concern in Canada (B.C. CDC 2007; COSEWIC 2005). The

Mountain Beaver uses wetter habitats than those colonized by mountain holly fern; however, recovery activities for all species are expected to positively impact the associated rare species and ecological communities, by ensuring local habitat protection. Recovery activities in Québec are not expected to have any effects on other species, as habitat protection is already in place. Recovery activities in Newfoundland and Labrador are not expected to have effects on other species.

Socioeconomic Considerations

Recovery activities in B.C. could have negative impacts on mining interests, but the impacts are expected to be low. Recovery activities for the species in Québec and Newfoundland and Labrador are expected to have negligible socioeconomic impacts.

Recommended Approach for Recovery Implementation

Because three jurisdictions are involved, each with different species at risk legislation, regulations, policies, and priorities, it is recommended that each jurisdiction prepare an action plan under its respective program as detailed in Table 6.

Table 6. Recovery implementation approach.

Jurisdiction	Responsible agency	Federal representative	Type of action plan
British Columbia	Province of British Columbia	Environment Canada, Canadian Wildlife Service (Pacific-Yukon)	Single-species
Québec	Province of Québec	Environment Canada, Canadian Wildlife Service (Québec)	Single-species or multi-species
Newfoundland and Labrador	Province of Newfoundland and Labrador	Environment Canada, Canadian Wildlife Service (Atlantic)	Single-species (if applicable)

Statement on Action Plans

Actions plans for the recovery strategy should be completed as follows under the approach outlined in Table 6:

- by 2014 in British Columbia;
- by 2014 in Québec; and
- in Newfoundland and Labrador, if the presence of the species is confirmed, the Government of Newfoundland and Labrador will consider listing the species under the *Newfoundland and Labrador Endangered Species Act*. A listing of Threatened or Endangered will require the development of a recovery plan however the Province can adopt a national plan if one exists. The timeline for the development of an action plan should take about 2 years from the time of legal listing. If the species presence is confirmed, but the species is not listed under Provincial legislation, the Province will consult with the Federal Government regarding the conservation of the species.

REFERENCES

Barrington, D.S. 1993. Ecological and historical factors in fern biogeography. J. Biogeogr. 20(3):275–279.

B.C. Conservation Data Centre (B.C. CDC). 2007. Conservation Data Centre Mapping Service [web application]. Victoria, BC. <http://maps.gov.bc.ca/imf50/imf.jsp?site=cdc> [Accessed Feb. 6, 2007]

B.C. Ministry of Energy, Mines and Petroleum Resources (B.C. MEMPR). 2007. Mineral activity maps. <http://webmap.em.gov.bc.ca/mapplace/minpot/minStats.cfm> [Accessed Feb. 1, 2007]

Brooks, R. 1987. Serpentine and its vegetation. Dioscorides Press, Portland, OR.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2005. COSEWIC assessment and status report on the mountain holly fern *Polystichum scopulinum* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. <www.sararegistry.gc.ca/status/status_e.cfm> [Accessed Feb. 1, 2007]

Douglas, G.W., D. Meidinger, and J. Pojar, eds. 2000. Volume 5. Dicotyledons (Salicaceae through Zygophyllaceae) and Pteridophytes. *In* Illustrated flora of British Columbia. B.C. Min. Environ., Lands and Parks and B.C. Min. For., Victoria, BC.

Farrar, D.R. 1976. Spore retention and release from overwintering fern fronds. Am. Fern J. 66(2):49–52.

Given, D.R. 1993. Changing aspects of endemism and endangerment in Pteridophyta. J. Biogeogr. 20(3):293–302.

Graham, J. and J. Ackerfield. 2007. Information for *Polystichum scopulinum* (mountain hollyfern). PICEA Database. Colorado State University Herbarium <http://wsprod.colostate.edu/cwis440/herbarium/plantinfo.asp?PlantID=3303> [Accessed Feb. 6, 2007]

Kruckeberg, A. 1984. California serpentines: flora, vegetation, geology, soils, and management problems. Univ. California Press, Berkeley, CA.

Longwell, C.R., R.F. Flint, and J.E. Sanders. 1969. Physical geology. John Wiley and Sons, Inc., New York, NY.

Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP). 2006. Plan de conservation préliminaire du polystic des rochers (*Polystichum scopulinum*): espèce menacée au Québec. Avril 2006. Direction du patrimoine écologique et des parcs, Gouvernement du Québec.

Montana Natural Heritage Program. 2007. *Polystichum scopulinum*. Montana plant field guide <http://nhp.nris.state.mt.us/plants/plantguide.asp> [Accessed Feb. 6, 2007]

NatureServe. 2007. NatureServe Explorer: an online encyclopedia of life. Version 6.1. Arlington, VA. <http://www.natureserve.org/explorer> [Accessed Feb. 1, 2007]

Senger, E. 2006. 2006/2007 Merritt TSA Forest Health Strategy. Prepared by Landscope Consulting Corporation for the Cascades Forest District. Lillooet, BC. <http://www.for.gov.bc.ca/dcs/Programs/2006-07%20Merritt%20TSA%20FH%20Strategy_Final%20Mar31-06.pdf> [Accessed Mar. 20, 2007]

U.S. Department of Agriculture (USDA). 2007. The PLANTS Database. National Plant Data Center, Natural Resources Conservation Centre, Baton Rouge, LA. <http://plants.usda.gov> [Accessed Feb. 6, 2007]

Wagner, D.H. 1993. *Polystichum*. *In* Flora of North America Editorial Committee, eds. 1993+. Vol. 2. Pteridophytes and Gymnosperms. Flora of North America North of Mexico. <http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=126461> [Accessed Feb. 3, 2007]

Wagner, Jr., W.H. and E. Rouleau. 1984. A western holly fern, *Polystichum* × *scopulinum*, in Newfoundland. Am. Fern J. 74(2):33–36.

Wheeler, J.O., P.F. Hoffman, K.D. Card, A. Davidson, B.V. Sanford, A.V. Okulitch, and W.R. Roest. 1996. Geological map of Canada. “A” Series Map, 1860A. Digital map. Geological Survey of Canada. <http://geopub.nrcan.gc.ca/moreinfo_e.php?id=208175> [Accessed Feb. 1, 2007]

Wild, M. and D. Gagnon. 2005. Does lack of available suitable habitat explain the patchy distributions of rare calcicole fern species? Ecography 28:191–196.

Wild, M., D. Gagnon, and A. Bouchard. 2006. Why are ferns regularly over-represented on state and provincial rare plant lists? Divers. Distrib. 12:749–755.

Personal Communications

Coursol, Frédéric. 2007. Botanist. QC.

Hanel, Claudia. 2007. Ecosystem Management Ecologist (Botanist), Wildlife Division, Newfoundland and Labrador Department of Environment and Conservation, Corner Brook, NL.

Wild, Matthew. 2007. Species at Risk Biologist, Canadian Wildlife Service - Québec Region, Environment Canada.