Species at Risk Act
Recovery Strategy Series

Recovery Strategy for Haller's Apple Moss (*Bartramia halleriana*) in Canada

Haller's Apple Moss



October 2010

Parks Canada Parcs Canada

Canada

About the *Species at Risk Act* Recovery Strategy Series

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

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

What is recovery?

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

What is a recovery strategy?

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

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

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

What's next?

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

The series

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

To learn more

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

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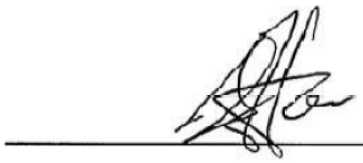
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RECOMMENDATION AND APPROVAL STATEMENT

Recovery Strategy for Haller's Apple Moss (*Bartramia halleriana*) in Canada

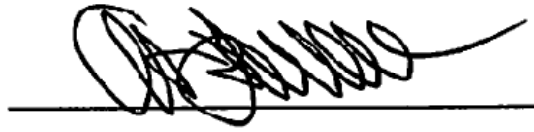
Approved by:



Greg Fenton
Field Unit Superintendent, Jasper National Park
Parks Canada Agency

Date: 5 October 2010

Approved by:



Alan Latourelle
Chief Executive Officer, Parks Canada

Date: 13 October 2010

DECLARATION

Under the *Accord for the Protection of Species at Risk* (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada. The *Species at Risk Act* (S.C. 2002, c.29) (SARA) requires that federal competent ministers prepare recovery strategies for listed Extirpated, Endangered and Threatened species.

The Minister of the Environment presents this document as the recovery strategy for the Haller's Apple Moss as required under SARA. It has been prepared in cooperation with the jurisdictions responsible for the species, as described in the Preface. The Minister invites other jurisdictions and organizations that may be involved in recovering the species to use this recovery strategy as advice to guide their actions.

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

This recovery strategy will be the basis for one or more action plans that will provide further details regarding measures to be taken to support protection and recovery of the species. Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the actions identified in this strategy. In the spirit of the *Accord for the Protection of Species at Risk*, all Canadians are invited to join in supporting and implementing this strategy for the benefit of the species and of Canadian society as a whole. The Minister of the Environment will report on progress within five years.

AUTHORS

Peter L. Achuff	Scientist Emeritus, Parks Canada Agency (Waterton Park, AB)
Rene Belland	Associate Director, Devonian Botanic Garden, University of Alberta (Edmonton, AB)
Brenda Shepherd	Park Ecologist, Parks Canada Agency (Jasper National Park, AB)
Ross Vennesland	Species at Risk Recovery Specialist, Parks Canada Agency (Western and Northern Service Centre, Vancouver, BC)
Diane Casimir	Species at Risk Coordinator, Parks Canada Agency (Western and Northern Service Centre, Calgary, AB)

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Patrick Nantel (Parks Canada, National Office)
Dave Prescott (Alberta Sustainable Resource Development)
Kent Prior (Parks Canada, National Office)
Celine Racette (Parks Canada, National Office)
Lucy Reiss (Environment Canada)
Lindsay Rodger (Parks Canada, National Office)
Pippa Shepherd (Parks Canada, Western & Northern Canada Service Centre)
Geoff Skinner (Jasper National Park)
Patrick Yarnell (Parks Canada, Western & Northern Canada Service Centre)
Scott Chiu (Parks Canada Agency, Western & Northern Service Centre)
Alan Westhaver (Jasper National Park)
Doug Wilson (BC Ministry of Environment)
Richard Pither (Parks Canada, National Office)

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

In accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals* (2004), a strategic environmental assessment (SEA) is conducted on all *Species at Risk Act* recovery strategies. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond their intended benefits. Environmental effects, including impacts to non-target species and the environment, were considered during recovery planning. The SEA is incorporated directly into the strategy and also summarized below.

Haller's Apple Moss is not known to perform any critical ecological keystone function and nothing is known of any symbiotic relationships or dependencies with other species. Activities to meet recovery objectives are unlikely to result in any important negative environmental effects on other species (Section 3.1.1), as activities are limited to research, data collection, management, restoration and stewardship (Section 2.2). The greatest potential for environmental

effects comes from fieldwork activities; however these effects are avoidable or can be fully mitigated with known technology, proper field procedures and monitoring for effect.

RESIDENCE

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

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

PREFACE

This Recovery Strategy addresses the recovery of Haller's Apple Moss (*Bartramia halleriana*). In Canada, this species occurs on federal (national park) lands in Alberta and provincial (provincial park and Crown) and privately-owned lands in British Columbia.

The Parks Canada Agency led the preparation of this recovery strategy working with the Haller's Apple Moss Recovery Team and in cooperation with the provinces of Alberta and British Columbia, and Environment Canada, Canadian Wildlife Service – Pacific & Yukon Region.

EXECUTIVE SUMMARY

Haller's Apple Moss (*Bartramia halleriana*) is currently listed as Threatened under the *Species at Risk Act* and, in North America, is currently known only from 10 Canadian populations in western Jasper National Park and adjacent east-central British Columbia. Total population size is about 835 individuals. This moss generally occurs on low elevation (600-1600 m), mesic (moderately moist), non-calcareous cliffs, bedrock outcrops or talus (large loose rock debris at the base of a cliff), under dense forest cover. The habitat is frequently characterised by a moist, cool microclimate, influenced by seepage, nearby streams or water pools, or cold air movement through talus. The moss occurs on small ledges and in crevices in the rock.

The main threats to this species are tree removal, rock removal, trampling/dislodgement, small population size and pollution. Since Haller's Apple Moss occurs as small populations (most are fewer than 100 individuals) occupying a small area (typically a few square metres), the populations are highly vulnerable to threats. Impacts need not be very large to affect a large proportion of the population and its habitat. One population has been confirmed as extirpated. Four populations are known currently to be subject to active threats but information on threats and trends is limited.

The population and distribution objective for Haller's Apple Moss is to maintain or increase population sizes at all 10 existing locations to ensure that all populations remain viable over the long term and, where feasible, reintroduce the species to extirpated locations with suitable or capable habitat. Consistent with this objective, critical habitat is identified for two locations in Jasper National Park and eight locations in the province of British Columbia on provincial park, Crown and privately-owned lands.

One or more Action Plans for Haller's Apple Moss will be completed by June 2015.

RECOVERY FEASIBILITY SUMMARY

The recovery of Haller's Apple Moss in Canada is considered feasible based on the criteria outlined by the Government of Canada (2009):

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.**
   Although current available information is limited, ten of 11 previously known populations have been recently confirmed with plants that are capable of reproduction and improving the population.

2) **Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.**
   Although there is limited knowledge of habitat requirements for the species, it is believed that sufficient Haller's Apple Moss habitat is available in Jasper National Park and neighbouring British Columbia lands.

3) **The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.**
   Threats can be effectively avoided or mitigated through: (1) the use of management and stewardship actions to protect and improve habitat; (2) research and monitoring to support conservation and management decisions within the context of adaptive management; (3) public outreach and awareness programs; and (4) cooperative approaches to industrial and other anthropogenic development consistent with species' conservation needs.

4) **Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.**
   All necessary recovery actions (outlined in point 3) exist and have been demonstrated to be effective in other recovery programs for species at risk.

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1. BACKGROUND

1.1 COSEWIC Species Assessment Information

Date of Assessment: November 2001

Common Name: Haller's Apple Moss

Scientific Name: *Bartramia halleriana*

COSEWIC Status: Threatened

Reason for designation: A globally widespread species known in North America from only four sites in Canada*, three of which have been verified recently with the fourth being a historic collection lacking precise locality information.

Canadian Occurrence: Alberta, British Columbia

COSEWIC Status History: Designated as Threatened by COSEWIC in November 2001. Assessment based on a new status report.

*Seven additional locations were discovered after this assessment was completed and these are detailed in Table 2.

1.2 Species Status Information

A Threatened plant species in Canada, Haller's Apple Moss is known from 11 locations in western Jasper National Park, Alberta and adjacent eastern British Columbia. The Canadian population represents a very small proportion of the global abundance of this species.

Conservation Status Ranks (NatureServe 2009)

Region	Rank	Status
Global:	G4*	Apparently Secure
National (Continental USA):	Not rated	Absent
National (Canada):	Inferred N1	Critically imperilled
Sub-national (British Columbia):	S2	Imperilled
Sub-national (Alberta):	S1	Critically imperilled

*Globally, Haller's Apple Moss occurs in Europe, Asia, southern South America, Australia, New Zealand, and Hawaii (also see Population and Distribution Context – section 2.1.1).

1.3 Description of the Species and its Needs

1.3.1 Species Description

Haller's Apple Moss is a small to medium-sized moss, 4-14 cm tall, light green to yellowish or brownish green, growing in tufts. The leaves are linear, 5-7 mm long from a more-or-less sheathing base. The stem is covered with fuzzy tomentum (hairs) below. The capsule is on a curved, short (1.5-4 mm long) stalk, immersed among the leaves, more-or-less globose when young and ribbed when dry. A discrete clump or tuft of moss consisting of many shoots is regarded as one individual plant that has arisen from a single spore (Hallingback et al. 1998, Belland 2001).

1.3.2 Species Needs

The habitats occupied by seven of the Haller's Apple Moss populations in Canada are primarily in the Interior Cedar-Hemlock biogeoclimatic zone (Ketcheson et al. 1991) of east-central British Columbia. Four populations occur in the Sub-Boreal Spruce biogeoclimatic zone (Meidinger et al. 1991) adjacent to the Interior Cedar-Hemlock zone in eastern British Columbia and in similar habitats in Alberta. The sites are generally low elevation (600-1600 m), north-facing, mesic, non-calcareous cliffs, bedrock outcrops or talus, under dense forest cover. The microclimate is frequently moist and cool, influenced by seepage, by a stream or water pools, or by cold air movement through talus. The moss occurs on small ledges and in crevices on the rock faces.

Typical overstory trees include western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), subalpine fir (*Abies lasiocarpa*) and spruce (*Picea* spp.). Devil's-club (*Oplopanax horridus*) is often present in these sites, as is another apple moss *Bartramia pomiformis*.

The following are thought to be biologically limiting factors for Haller's Apple Moss, based on current scientific knowledge and expert opinion:

Narrow Environmental Tolerance: Haller's Apple Moss appears to have a narrow environmental tolerance, given its very limited geographic and microhabitat distribution. It is absent in many sites of suitable habitat and its distribution appears limited by one or more of the following: physical habitat factors (e.g. humidity, rock chemistry), competition from other species, limited dispersal capacity, or an interaction of these factors (Achuff et al. 2009, Achuff et al. 2008, Achuff et al. 2006) . Since 2002, over 400 sites with suitable habitat have been searched using 70 person-days of effort (Achuff et al. 2009).

Preliminary relative humidity and temperature data collected at three populations over two growing seasons (2008, 2009) indicates that the microhabitats that Haller's Apple Moss occupies have a higher mean relative humidity and lower mean temperature compared to nearby microhabitats at the same sites (Haller's Apple Moss Recovery Team, unpublished data). These data support the observation across sites that individuals favour northerly aspects with higher canopy cover.

Competition: *Bartramia pomiformis* a closely related species, occurs at all Haller's Apple Moss sites, as well other seemingly suitable sites not occupied by Haller's Apple Moss, and may compete with Haller's Apple Moss.

Dispersal: Sexual reproduction in Haller's Apple Moss is by spores, with male and female reproductive structures on the same plant; spore production has been observed in all populations but the dispersal biology of this species is unknown. Unoccupied seemingly suitable habitat suggests the species may be dispersal-limited.

1.4 Threat Identification

The following factors are believed to be threatening the recovery of Haller's Apple Moss in Canada. The impact of the threats were assessed by population, using the IUCN (International Union for the Conservation of Nature) scoring of threats, to identify the most prominent threat (identified in bold) for each population. For a detailed description of the threat classification system see Master et al. (2009). Stochastic events are listed as a threat, but are not classified because they result from the inherent small population sizes and areas of occupancy and are not the result of an anthropogenic impact.

Table 1. Threat classification table.

Population	Site-specific Threats	Scope[1]	Severity[2]	Timing[3]	Impact[4]
Fitzwilliam Spur	**Tree removal** Deposition of harmful substances	Pervasive Large	Moderate Slight	High High	Medium Low
Fraser Bridge	**Tree removal** Climbing/walking on plants Stochastic events	Large Restricted	Moderate Slight	Moderate Moderate	Medium Low
Holmes River 1	**Tree removal** Hydroelectric Power Development[6] Trampling/Dislodgement Deposition of harmful substances Rock removal/Soil disturbance Stochastic events	Large Small Small Large Restricted	Moderate Moderate Slight Unknown Serious	Moderate Low Low High Low	Medium Low Low Unknown Medium
Holmes River 2	**Tree removal** **Hydroelectric Power Development**[5] Trampling/Dislodgement Stochastic events	Large Large Small	Moderate Moderate Serious	Moderate Moderate Moderate	Medium Medium Low
Hugh Allan 1	**Tree removal** Deposition of harmful substances Stochastic events	Pervasive Restricted	Moderate Unknown	Low Low	Medium Unknown
Hugh Allan 2	**Tree removal** Trampling/Dislodgement Deposition of harmful substances Stochastic events	Pervasive Restricted Restricted	Moderate Low Unknown	Low Low Low	Medium Low Unknown
Jasper Meadow Creek	**Tree removal (fire)** Deposition of harmful substances Stochastic events	Restricted Restricted	Serious Unknown	Low High	Medium Unknown
Jasper West Gate	Deposition of harmful substances **Tree removal (fire)** Trampling/Dislodgement Stochastic events	Restricted Restricted Restricted	Unknown Serious Slight	High Low High	Unknown Medium Low
Ptarmigan Creek	**Tree removal** Deposition of harmful substances Stochastic events	Large Large	Moderate Unknown	High High	Medium Unknown
Wood River	Tree removal **Hydroelectric Power Development**[5] Trampling/Dislodgement Stochastic events	Small Large Restricted	Moderate Moderate Low	Low Moderate Low	Low Medium Low

1. **Scope** – Percentage of total population or occurrences affected (Pervasive = 71-100%, Large = 31-70%, Restricted = 11-30%, Small = 1-10%)

[2] **Severity** – Within the scope, percentage by which the threat is likely to destroy or eliminate the occurrences, or reduce the population (Extreme = 71-100%, Serious = 31-70%, Moderate = 11-30%, Slight = 1-10%)

[3] **Timing** – High = continuing, Moderate = only in the future (could happen in the short term [less than 10 years or three 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)

[4] **Impact** - based on Severity and Scope rating (e.g., Large Scope and Serious Severity = High Impact; Restricted Scope and Moderate Severity = Low Impact)

[5] **Hydroelectric Development:** The severity of this threat depends on the quantity of water removed or diverted from critical habitat.

Tree removal

The shaded, mesic habitat of Haller's Apple Moss is affected by removal of tree and shrub cover by cutting or fire, either immediately above or adjacent to populations. Adverse effects of canopy removal, which raises air temperature and light intensity, and decreases relative humidity, are inferred from: (1) studies that have shown the effects of forest edge on moss diversity and species health (Baldwyn & Bradfield 2005, Hylander 2005, Hylander et al.2002, Stewart & Mallick 2006) and (2) the lack of species occurrences in habitats that are less shaded or mesic (Achuff et al. 2009, Achuff et al. 2008, Achuff et al. 2006) indicating the species is desiccation intolerant (Stark et al. 2007, Johnson and Kokila 1970, R. Belland, personal communication) and (3) evidence of desiccation following tree removal at the Fitzwilliam Spur site (see Industrial Land Use section below). Tree removal could occur from a number of different activities, specifically the following:

Forest Harvesting: Six of the populations (Wood River, Ptarmigan Creek, Hugh Allan 1 & 2, Holmes River 1 & 2) are in areas where forest harvesting occurs. While the local sites occupied by Haller's Apple Moss have not been harvested (e.g. the two Hugh Allan populations are in uncut forest strips along small creeks within a larger harvested area), there is concern that other activities related to current forest harvesting (road construction/widening or channelisation of stream beds), could result in tree removal. Five of these six populations are adjacent to active roads. At Wood River, a forestry haul road is within 1 km of the population, and flagging tape indicates that a cutblock has been surveyed within 100m of the population (R. Belland, Haller's Apple Moss Recovery Team, personal observation, June 2008).

Road Maintenance: Tree removal at both Jasper locations, and Avola could occur as part of road widening or maintenance. The roadside Avola population has not been relocated during four surveys following the initial observation in 1995 (Achuff et al. 2009, Achuff et al. 2008, Achuff et al. 2006). Also, the Jasper West Gate population could be affected by maintenance activities on the adjacent trail and adjacent railway and access road. The Ptarmigan Creek population occurs adjacent to a road and its population size is very small at only 2 individuals. Tree removal has already occurred in the right-of-way within 10 meters of this population (Achuff et al. 2009). Additional roadside populations potentially affected include: Fraser Bridge, Hugh Allan 1 & 2, and Holmes River 1.

Residential Development: The Fraser Bridge population is located on private land. Two of the three private land parcels have had some residential development. A restrictive covenant on the properties protects against clearing or developing of any sort on any land within a minimum of 30 horizontal meters from the natural boundary of the Fraser River except for the removal of dead or dangerous trees. All of the Haller's Apple Moss plants are within 30m of the river;

however tree removal related to building is a potential threat to critical habitat in areas further than 30 m than the Fraser River (described in section 2.3.2).

Industrial Land Use: Tree removal occurred in 2007 at the Fitzwilliam Spur population during pipeline twinning. After this was discovered, a mesh screen was constructed in 2008 to reduce direct sunlight on the Haller's Apple Moss plants and maintain moisture on the site (Achuff et al. 2009). The site was re-contoured, and small trees and forbs were replanted in 2009. Relative humidity and temperature are being monitored at this site and two control populations to determine the effectiveness of reclamation within and adjacent to the population. Monitoring of the condition of the plants at Fitzwilliam Spur suggests 2 of 7 individuals are dying with a colour change from green to brown following tree removal, indicating desiccation (Stark et al. 2007 and Johnson and Kokila 1970, Haller's Apple Moss Recovery Team, unpublished data). Facility construction for hydroelectric development may result in tree removal that affects critical habitat (refer to section 1.4, Microclimate).

Wildfire: Additionally, tree removal in areas adjacent to Haller's Apple Moss populations has the potential to increase fire threats. Tree removal and associated vegetation changes may affect fuel loading and other fire behaviour factors, resulting in more intense fires that are able to burn areas that were previously infrequently affected. The Jasper West Gate population is adjacent to a railway which increases the risk of fire, most commonly through sparking during rail-grinding and brake-related train issues. Activities on the railway have caused 18 fires during the last twenty years in Jasper National Park (Parks Canada 2009). If Haller's Apple Moss habitats are burned by high intensity fires, the impacts are expected to be severe.

Hydrological Changes

Given that the microclimate of occupied sites is frequently moist and cool, and can be influenced by seepage, streams, water pools, or by cold air movement through talus, changes to the hydrology or humidity of sites will negatively affect Haller's Apple Moss as inferred from Stark et al. (2007), Deltoro et al. (1998), Silvola (1991) and Johnson and Kokila (1970). This threat could occur due to anthropogenic factors (e.g. water diversion for hydroelectric development), or natural factors (e.g. climate change or change in land surface characteristics).

Three populations (Holmes River 1 and 2 and Wood River) are in areas where hydroelectric development is in the planning stage (Government of British Columbia 2009). A hydroelectric project at Holmes River 1 and 2 has received conditional approval from the British Columbia government. A transmission line proposed for Holmes River 1 can be relocated to avoid critical habitat. The project proposes to divert over 90% of the flow of the creek at Holmes River 2, which forms a waterfall and creates high humidity within the canyon area where the population grows. Relative humidity and temperature sensors have been installed at Holmes River 2 to gather baseline data to better understand how these two measures vary with distances from the creek. A hydroelectric development is also in the planning stage for Wood River and it proposes to divert water around a section of the river where that population occurs (Government of British Columbia). New roads, transmission lines and penstock right-of-ways also are proposed for this location.

Rock removal/Soil Disturbance

Removal of non-calcareous talus, rock outcrops or cliffs on which Haller's Apple Moss grows would have a severe effect, resulting in the death of the plants and degradation of suitable habitat. This is currently of greatest concern for the Avola site (extirpated) and Holmes River 1 populations. The talus slope occupied by the Avola population is adjacent to an area designated as a "talus mine" by BC Ministry of Transportation. Neither the extent of the talus mine nor plans for its use are currently known. A rock outcrop about three km away from the Holmes River 1 population is being quarried for building rock (Achuff et al. 2006). No Haller's Apple Moss has been observed at the quarry site. If quarrying operations were expanded to include the outcrops that contain Haller's Apple Moss, the effects would be severe. It is not known if the rock at the Holmes River 1 site is of commercial quality.

Rock removal and soil disturbance may also occur for road and bridge maintenance and may affect populations directly adjacent to roads/bridges: Fraser Bridge, Ptarmigan Creek, Hugh Allan 1 & 2, and Holmes River 1.

Trampling/Dislodgement

Trampling or dislodgement of Haller's Apple Moss plants due to climbing or walking would have a severe effect. None of the populations is currently known to be affected by climbing or walking, although the Jasper West Gate population is adjacent to a public trail and some scrambling does occur on the adjacent cliffs. Residential development and use of the privately owned Fraser Bridge site will likely increase walking in this area. It is notable that this population has persisted with private landownership since it was first identified in 1955, however the parcel was subdivided in 2002 and sold to three owners. Since that time, cabins have been developed on two of three riverside lots. Trampling may also occur from trapping activities. A search of existing tenures at Haller's Apple Moss populations indicates the following populations are in areas with trapline interests: Holmes River 1, Holmes River 2, Hugh Allan 1, Hugh Allan 2, Ptarmigan Creek and Wood River. There is evidence of trapping only at Hugh Allan 2 and Wood River sites.

Trampling or dislodgement could also affect other plants in Haller's Apple Moss habitat, causing habitat degradation by altering the microclimate created by these other plants.

Deposition of Harmful Substances

Deposition of harmful substances – road dust, de-icing agents, herbicides - may adversely affect a number of Haller's Apple Moss populations that occur near roads (Myers-Smith 1991, Viskari et al. 1997, Walker and Everett 1987). There is no information on what concentrations of these substances would be harmful to Haller's Apple Moss or how much is currently being deposited on various populations. Dust stirred up by vehicle traffic on a gravel road may affect the populations at Fraser Bridge, Ptarmigan Creek, Hugh Allan 1 & 2, and Holmes River 1, either by directly affecting Haller's Apple Moss or by effects on other plants in its habitat that provide shade. De-icing agents (e.g. "road salt" – sodium chloride) may be transported either as dry dust or in ploughed snow deposited on the population. Road traffic and dust at Holmes River 1 are

likely to increase with hydroelectric development planned for this area (Province of British Columbia). Populations potentially affected by de-icing agents include Jasper West Gate, Jasper Meadow Creek, and Avola, while the Hugh Allan and Ptarmigan populations are on less frequently used, seasonal roads. Drift of herbicide applied to control non-native plants could also affect Haller's Apple Moss populations. This is most likely a threat to populations that are adjacent to active roads, which includes all populations except Wood River, Fitzwilliam Spur and Holmes River 2. It is not known currently which populations have non-native plant management activities occurring adjacent to them.

Stochastic Events: Small Population Size

Haller's Apple Moss occurs naturally as small populations (most are fewer than 100 individuals) occupying a small area (typically a few square metres) and populations are highly vulnerable to random events. Impacts need not be very large in scale to affect a large proportion of the population and its habitat. Small population size and small area of occupancy are known to be associated with greater risks of extirpation (Primack 1998).

2. RECOVERY

2.1 Populations and Distribution

2.1.1 Population and Distribution Context

Globally, Haller's Apple Moss occurs in Europe, Asia, southern South America, Australia, New Zealand, New Guinea and Hawaii, though it is considered uncommon or rare in many areas (JNCC 2010, Werner 2008, NMNI 2006-07, Preston 2006, Kucera and Vana 2003, Hoe 1979). In North America, this species occurs only in Canada in western Jasper National Park, Alberta and adjacent eastern British Columbia (Figure 1). When assessed by COSEWIC in 2001, only three extant populations, totalling fewer than 250 individual individuals, were known in Canada. At that time, an additional historic population had not been observed for more 100 years.

Field surveys were conducted in 2004, 2005, 2007, 2008 and 2009 guided by an environmental profile model (Achuff et al. 2006, Achuff et al. 2008, Achuff et al. 2009). The model attributes were: 1) elevation <1600 m; 2) BC Interior Cedar Hemlock (ICH) biogeoclimatic subzone - ICHmk, mm, mw, vk, wk; and Sub-Boreal Spruce dh and mm (and Alberta equivalents) that were adjacent to the ICH polygons 3) coniferous closed forest; 4) non-calcareous bedrock; 5) northerly aspects (NW to ENE). These criteria were applied through GIS analysis to a triangular area of about 26,500 sq km extending roughly from north of McBride, BC south to Clearwater, BC and east to Lake Louise, AB. This analysis produced map polygons, within which 400 potential sites were field surveyed. During the surveys, Haller's Apple Moss was distinguished from similar species using morphological measurements. Surveys relocated the Fraser Bridge, Wood River, and Jasper West Gate populations, but not the Avola population. They also located seven new populations within the same general area of western Jasper National Park and adjacent eastern British Columbia.

The 10 extant populations of Haller's Apple Moss that have been observed recently, comprise an estimated total population of about 835 individuals (Table 2). Population numbers are based on complete counts of all individual plants observed at a site. The population at Avola is considered extirpated. Haller's Apple Moss populations were delineated using habitat and distance criteria (NatureServe 2004). Genetic testing of the voucher (sample) specimen originally collected from Avola confirmed it as Haller's Apple Moss. The recent increase in the number of populations and individuals observed since the production of the COSEWIC status report is due to increased survey effort and not to an on-going increase in the species' range or individual population sizes. It is likely that the number of populations known will increase if inventories of more remote areas with suitable habitat are completed.

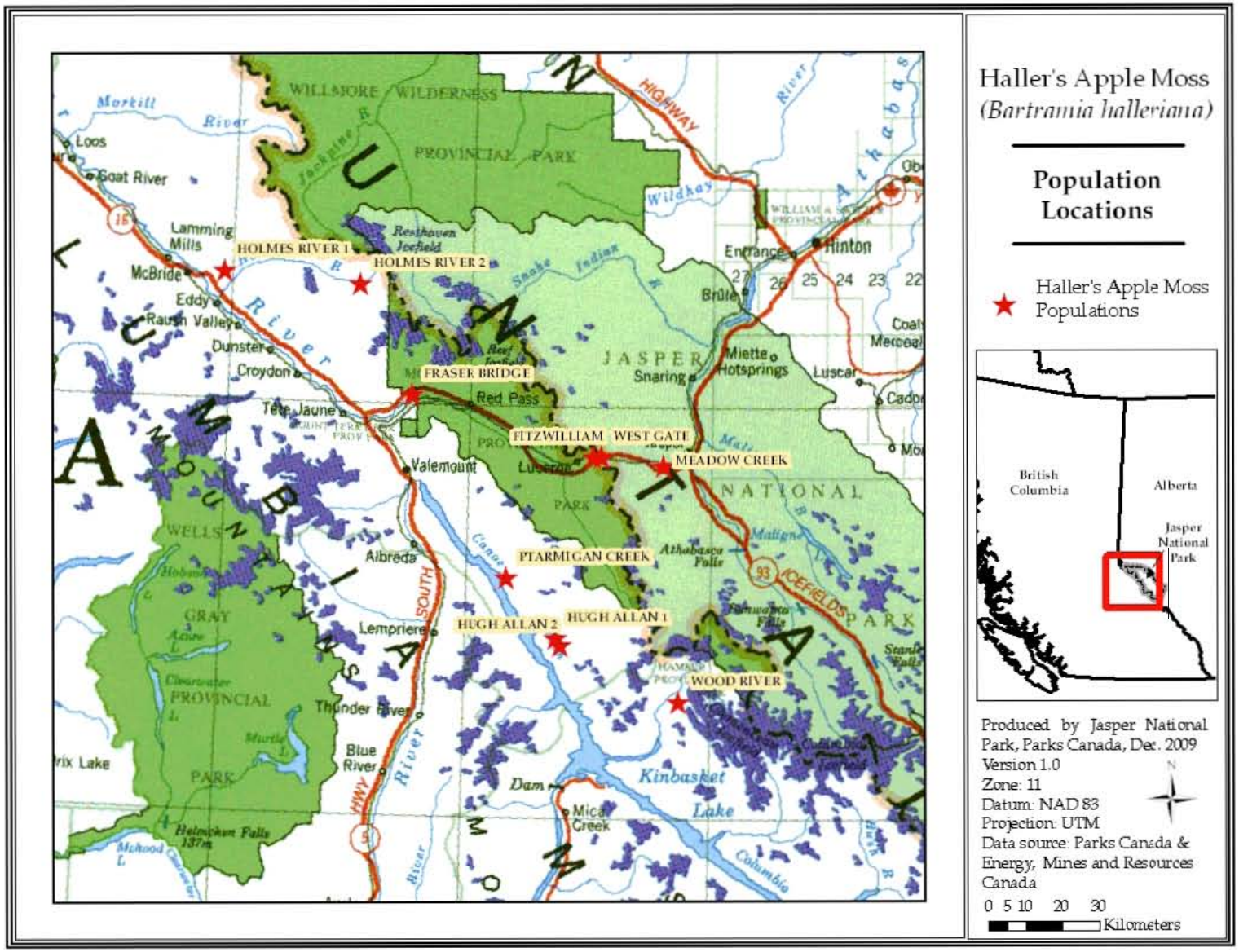


Figure 1. Locations of Haller's Apple Moss populations in Canada. The dark blue areas are glaciers and green are protected areas.

Table 2. Currently known populations of Haller's Apple Moss. See 1.3.1 for definition of an individual.

Population	First observation	Last observation	Approx. # individuals	Ownership
Wood River	1826	2009	235	BC Crown land
Fraser Bridge	1955	2008	120	Private land
Jasper West Gate	1980	2009	260	Jasper National Park
Avola	1995	1995	0	BC Crown land
Jasper Meadow Ck	2004	2009	5	Jasper National Park
Fitzwilliam Spur	2004	2009	7	Mt Robson Provincial Park
Ptarmigan Ck	2004	2008	2	BC Crown land
Hugh Allan 1	2005	2008	11	BC Crown land
Hugh Allan 2	2005	2008	100	BC Crown land
Holmes River 1	2005	2009	28	BC Crown land
Holmes River 2	2005	2009	39	BC Crown land

2.1.2 Population and Distribution Objectives

The population and distribution objective for Haller's Apple Moss is to maintain or increase population sizes at all 10 existing locations to ensure that all populations remain viable over the long term and, where feasible, reintroduce the species to extirpated locations with suitable or capable habitat.

Rationale:
Haller's Apple Moss in Canada is naturally rare, occurring as small, isolated populations within a restricted geographic area, in light of extensive survey effort. Additional populations may be discovered but there is little potential to reassess the species as Special Concern or Not-at-Risk given its small population size and limited distribution, as currently known.

2.2 Broad Strategies and Approaches to Recovery

Many activities have been initiated and link to the strategies and approaches in Table 3. They include the following:

- Field inventory, population size estimates and site condition monitoring,
- Preliminary monitoring of microclimate and plant health at impacted and control populations,
- Communication with private landowners,
- Project proposal reviews for hydroelectric power development through a British Columbia environment assessment process,
- Communication with land use project managers to provide advice about Haller's Apple Moss to avoid or mitigate impacts from hydroelectric power development and industrial land use,
- Public outreach and management planning in Jasper National Park.

Table 3. Recovery planning table.

Priority	Threat(s) addressed	Broad strategies to address threat(s)	Recommended approaches (listed in priority order by strategy)
Urgent	Tree removal Microclimate Rock removal Trampling Pollution	Management, coordination, stewardship, monitoring	1. Legally protect extant populations on national park lands through regulatory controls and enforcement; 2. Secure effective protection of extant populations on private , provincial park and provincial crown lands through voluntary instruments (such as covenants), leases, legally binding agreements and/or regulatory controls; 3. Provide detailed site and species information to, and collaborate with, Environmental Assessment practitioners to reduce or mitigate the effects of industrial, infrastructure and roadway development; 4. Using an adaptive management approach, monitor development projects and populations to achieve effective mitigation and restoration; 5. Work to restore impacted habitats adjacent to extant populations (see 1.4 and 2.3.1 for context for forest restoration surrounding populations) 6. Develop education and outreach initiatives to increase understanding of threats and foster voluntary stewardship
Necessary	Small population	Inventory, communication and outreach, monitoring, research	1. Conduct further field surveys for new Haller's Apple Moss populations; 2. Monitor Haller's Apple Moss populations including population dynamics, plant condition, and habitat conditions; 3. Develop minimum viable population estimate. 4. Develop outreach (e.g fact sheets) and training (e.g. industry and landowners) to gather information from volunteers and other stakeholders.
Beneficial	Tree removal Microclimate Rock removal Trampling Pollution Small population	Research	1. Develop & implement research plan to gain information on 1) biological characteristics (e.g. physiological tolerances, competitive relationships with other species, reproductive/dispersal biology) and 2) habitat characteristics to guide threat assessment, inventory and management of populations and habitat.
Beneficial	Small population	Reintroduction, population augmentation	1. Determine feasibility of reintroduction or population augmentation; 2. Restore habitat at extirpated locations and reintroduce plants; 3. Monitor the effectiveness of reintroduction or augmentation.

2.3 Critical Habitat Identification

Critical habitat is defined in section 2(1) of the *Species at Risk Act* (2002) as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species". For Haller's Apple Moss in Canada, critical habitat is identified to the extent possible, based on the best available information up to November 1, 2009.

2.3.1 Information used to identify critical habitat locations and attributes

Critical habitat identification is based on recent field data (2003-2009), including standard vegetation plots, collected at all ten currently extant sites and a previously known site at which the population is extirpated (Achuff et al. 2006, Achuff et al. 2008, Achuff et al. 2009). Attributes of critical habitat for Haller's Apple Moss were determined by identifying common and frequent habitat features in proximity to the populations outlined in Table 2. In addition, critical habitat for Haller's Apple Moss in Canada includes areas adjacent to existing populations that may or may not contain plants, but the destruction of which would lead to loss of plants through a change in habitat attributes as described below.

Numerous scientific studies have focussed on the extent of forest cover required to maintain a cool, moist microclimate around a location. Research indicates that edge effects generally extend 100-150m into the forest (reviewed in Kremsater and Bunnell 1999). Hylander et al. (2005) established that red listed bryophyte species showed the strongest declines in frequency or occurrence in relation to edge. Finally, Stewart and Mallick (2006) found that species requiring similar microclimate conditions as Haller's Apple Moss (moist, cool, high canopy cover) were more sensitive to microclimate changes than other species. These findings suggest that forest cover to a distance of at least 100m surrounding a Haller's Apple Moss population is required to maintain the microclimate conditions needed to support population persistence.

Several populations are persisting at the present time in areas lacking continuous forest cover (e.g. Holmes 1 and 2). However, population sizes and plant condition at these sites before and after these habitat changes, many of which occurred more than 30 years ago, are not known. While established plants may be persisting at these sites, it is also not known whether new plants are being recruited into the population or whether there may be a time lapse in response to habitat conditions. Therefore, we identify forest restoration at disturbed sites as a recovery approach.

2.3.2 Critical Habitat Identification

Within the identified polygon boundaries (shown in the following maps), critical habitat is where the following required habitat attributes are located:

- non-calcareous talus deposits, bedrock outcrops, or cliffs with crevices and ledges,
- closed canopy forest cover and understory vegetation that maintains the cool, moist microclimate at each population,
- seepages (some sites only, noted by population below),
- creeks or rivers (some sites only, noted by population below).

Within the identified polygon boundaries the following areas are excluded from critical habitat: (1) areas where the required habitat attributes are not located and (2) existing infrastructure that will persist on the landscape (e.g. roads, railways, buildings). The former includes several forested locations within polygon boundaries that no longer influence the microclimate where the plants grow as a result of large infrastructure or a combination of infrastructure and natural features that bisects the polygon (noted by population below).

Polygon boundaries were delineated using a geographic information system (GIS) based on location data collected using a hand-held Global Positioning System (GPS) at each site. For nine of the ten populations, a polygon of 100m surrounding known plant locations was identified and these polygons were squared-off to create rectangular, easily measurable and identifiable areas. For the Wood River population, where the moss occurs on both sides of the river, a polygon of 130m was applied to the centre-line of the Wood River for the length of river within which individuals have been found. This approach included habitat within 100m of all individuals known along this stretch of river (i.e., some individuals occur 30m from the river's edge). We varied our mapping approach because in this case only, squaring off the polygon included a large amount of habitat beyond 100m from the individual plants because this population is located in a large area along a sinuous river. All coordinates refer to the North American Datum 1983 (Nad83).

Jasper West Gate population:

Critical habitat for the West Gate population is located in two subpopulations about 22 km west of the town of Jasper, north of Highway 16 and straddling the Alberta-British Columbia (Jasper National Park-Mt Robson Provincial Park) border. The Portal Lake sub-population consists of 60 individuals located on rocks and cliffs, adjacent to a day-use area (Achuff et al. 2009). The Cairn 5S sub-population consists of 200 individuals located along cliffs and ledges shaded by dense forest. The area containing critical habitat is 29 hectares in total and is identified in Figure 2. In addition to the critical habitat attributes identified for all populations above, within this polygon critical habitat includes seepages in the cliffs in both subpopulation polygons. A specific area excluded from critical habitat is the small forested area south of Highway 16. This is in addition to areas that meet the exclusion criteria noted within this section above.

Jasper Meadow Creek population

Critical habitat for the Jasper Meadow Creek population is located in Jasper National Park about 14 km west of the town of Jasper, south of Highway 16, on the lower portion of cliffs adjacent to the highway. The population consists of 5 individuals (Achuff et al. 2009). The area containing critical habitat is 4 hectares and is identified in Figure 3. In addition to the critical habitat attributes identified for all populations above, within this polygon critical habitat includes seepages in the cliffs. A specific area excluded from critical habitat is the small forested strip north of Highway 16. This is in addition to areas that meet the exclusion criteria noted within this section above.

Fitzwilliam Spur population:

Critical habitat for the Fitzwilliam Spur population is located in Mount Robson Provincial Park in British Columbia, about 2 km west of the Alberta-British Columbia boundary, south of Highway 16, at the base of a small cliff and adjacent to a pipeline right-of-way. The existing population consists of 7 individuals (Achuff et al. 2009). A portion of this critical habitat is in the early stages of forest restoration following pipeline construction (see Section 1.4, Industrial Land Use). The area containing critical habitat is 4 hectares and is identified in Figure 4. A specific area excluded from critical habitat is the small vegetated strip north of Highway 16. This is in addition to areas that meet the exclusion criteria noted within this section above.

Fraser Bridge population:

Critical habitat for the Fraser Bridge population is located on three private land holdings (under residential development on the south side of the river) downstream of Mount Robson Provincial Park on steep cliffs and ledges above the Fraser River. The existing population consists of 120 individuals also located on the south side of the river (Achuff et al. 2005). The area containing critical habitat is 10 hectares and is identified in Figure 5. In addition to the critical habitat attributes identified for all populations above, within this polygon critical habitat includes the Fraser River and its hydrological characteristics (e.g. flow volume, flow rate and turbulence), including seepages in the cliff. Although no plants grow on the north side of the river, this forested area is considered critical habitat, because it maintains the cool, moist microclimate within the river canyon.

Holmes River 1 population:

Critical habitat for the Homes River 1 population is located on British Columbia Crown land, east of the town of McBride, about 9 km north of Highway 16 on a small cliff adjacent to the Holmes River Forestry Road. The existing population consists of approximately 28 individuals (Achuff et al. 2005). The area containing critical habitat is 4 hectares and is identified in Figure 6. In addition to the critical habitat attributes identified for all populations above, within this polygon critical habitat includes the Holmes River and its hydrological characteristics (e.g. flow volume, flow rate and turbulence) in addition to the seepages in the cliff above the river where the plants grow. A specific area excluded from critical habitat is the small forested area north of the Holmes River and the Holmes River Forestry Road. This is in addition to areas that meet the exclusion criteria noted within this section above.

Holmes River 2 population:

Critical habitat for the Holmes River 2 population is located on British Columbia Crown land, east of the town of McBride, about 49 km north of Highway 16 on the Holmes River Forestry Road, on cliffs adjacent to waterfalls on Kelly Creek. The existing population consists of approximately 39 individuals (Achuff et al. 2009). The area containing critical habitat is 6 hectares and is identified in Figure 7. A portion of this critical habitat is a regenerating forestry cut-block. In addition to the critical habitat attributes identified for all populations above, within

this polygon critical habitat includes Kelly Creek and its hydrological characteristics (e.g. flow volume, flow rate and turbulence).

Hugh Allan 1 population:

Critical habitat for the Hugh Allan 1 population is located on British Columbia Crown land, about 60 km southeast of the town of Valemount on the east side of Kinbasket lake. It is about 2.5 km east on the Hugh Allan Forestry Road from its junction with the East Canoe Forestry Road on a cliff about 350m upslope of Hugh Allan Creek where the road crosses a bridge over a small creek that flows into Hugh Allan Creek. The existing population consists of approximately 11 individuals (Achuff et al. 2009). The area containing critical habitat is 4 hectares and is identified in Figure 8. In addition to the critical habitat attributes identified for all populations above, within this polygon critical habitat includes the small creek adjacent to the population and its hydrological characteristics (e.g. flow volume, flow rate and turbulence).

Hugh Allan 2 population:

Critical habitat for the Hugh Allan 2 population is located on British Columbia Crown land about 63 km south east of the town of Valemount on the east side of Kinbasket lake. It is about 4.4 km east on the Hugh Allan Forestry Road from its junction with the East Canoe Forestry Road on a cliff about 320m upslope of Hugh Allan Creek where the road crosses a bridge over a small creek that flows into Hugh Allan Creek. There is evidence of active trapping along the small creek. The existing population consists of approximately 100 individuals (Achuff et al. 2005). The area containing critical habitat is 4 hectares and is identified in Figure 9. In addition to the critical habitat attributes identified for all populations above, within this polygon critical habitat includes the small creek adjacent to the population and its hydrological characteristics (e.g. flow volume, flow rate and turbulence).

Ptarmigan Creek population:

Critical habitat for the Ptarmigan Creek population is located on British Columbia Crown land 40 km south east of the town of Valemount on the east side of Kinbasket lake. It is adjacent to the East Canoe Forestry Road on a cliff at the base of a slope, south of nearby Ptarmigan Creek. The population was estimated at 25 individuals in 2007, but only two individuals could be relocated in 2008 (Achuff et al. 2009). The area containing critical habitat is 4 hectares and is identified in Figure 10. In addition to the critical habitat attributes identified for all populations above, within this polygon critical habitat includes Ptarmigan Creek and its hydrological characteristics (e.g. flow volume, flow rate and turbulence).

Wood River population:

Critical Habitat for the Wood River population is located on British Columbia Crown land about 100 km south of Valemount and about 20 km west of Hamber Provincial Park on the east side of Kinbasket Lake. The population grows on cliffs that are continuous on both sides above the Wood River between Pacific and Jeffrey Creeks. Habitat upstream of Pacific Creek has not been surveyed to determine whether Haller's Apple Moss is present. The existing individuals are not

regularly spaced but are no greater than 100m apart and suitable habitat is continuous along the river. The population consists of approximately 235 individuals (Achuff et al. 2009). The area containing critical habitat is 63 hectares and is identified in Figure 11. In addition to the critical habitat attributes identified for all populations above, within this polygon critical habitat includes the Wood River and its hydrological characteristics (e.g. flow volume, flow rate and turbulence), small creeks within the polygon that drain into the Wood River and seepages in the cliffs and canyon.

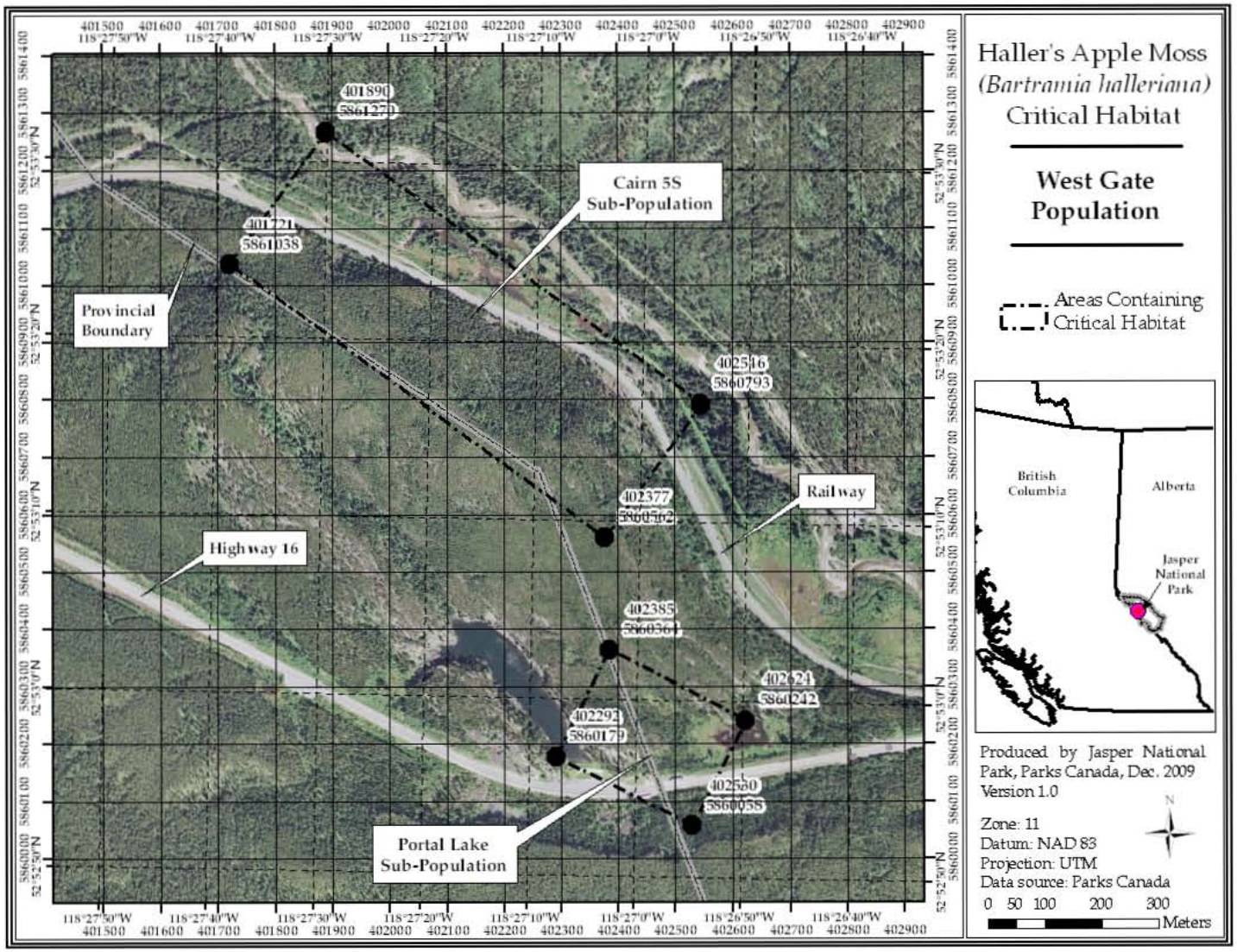


Figure 2. Location of areas containing critical habitat at Jasper West Gate, Jasper National Park, AB and Mount Robson Provincial Park, BC (parcel 689_1). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

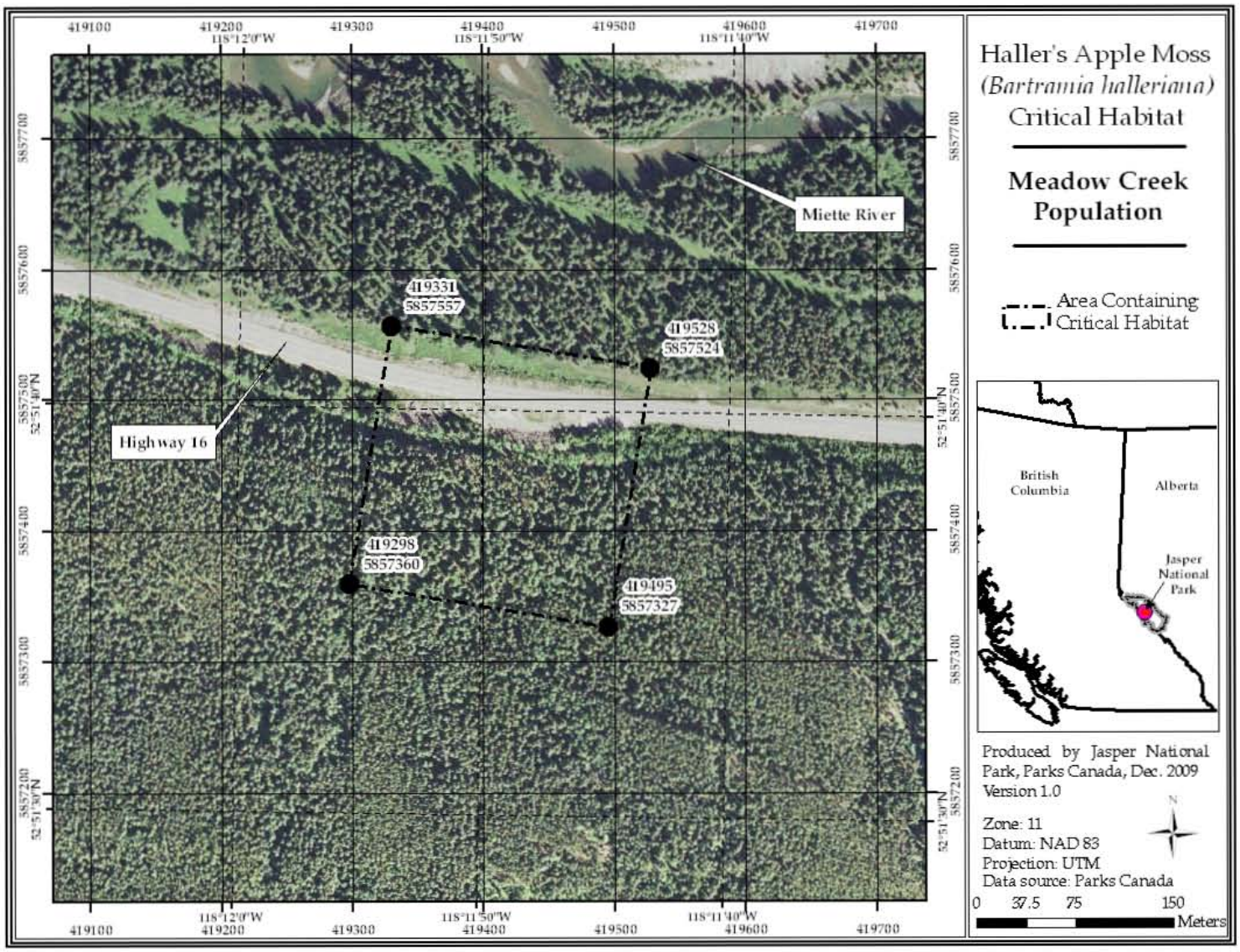


Figure 3. Location of critical habitat at Meadow Creek, Jasper National Park, AB (parcel 689_2). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

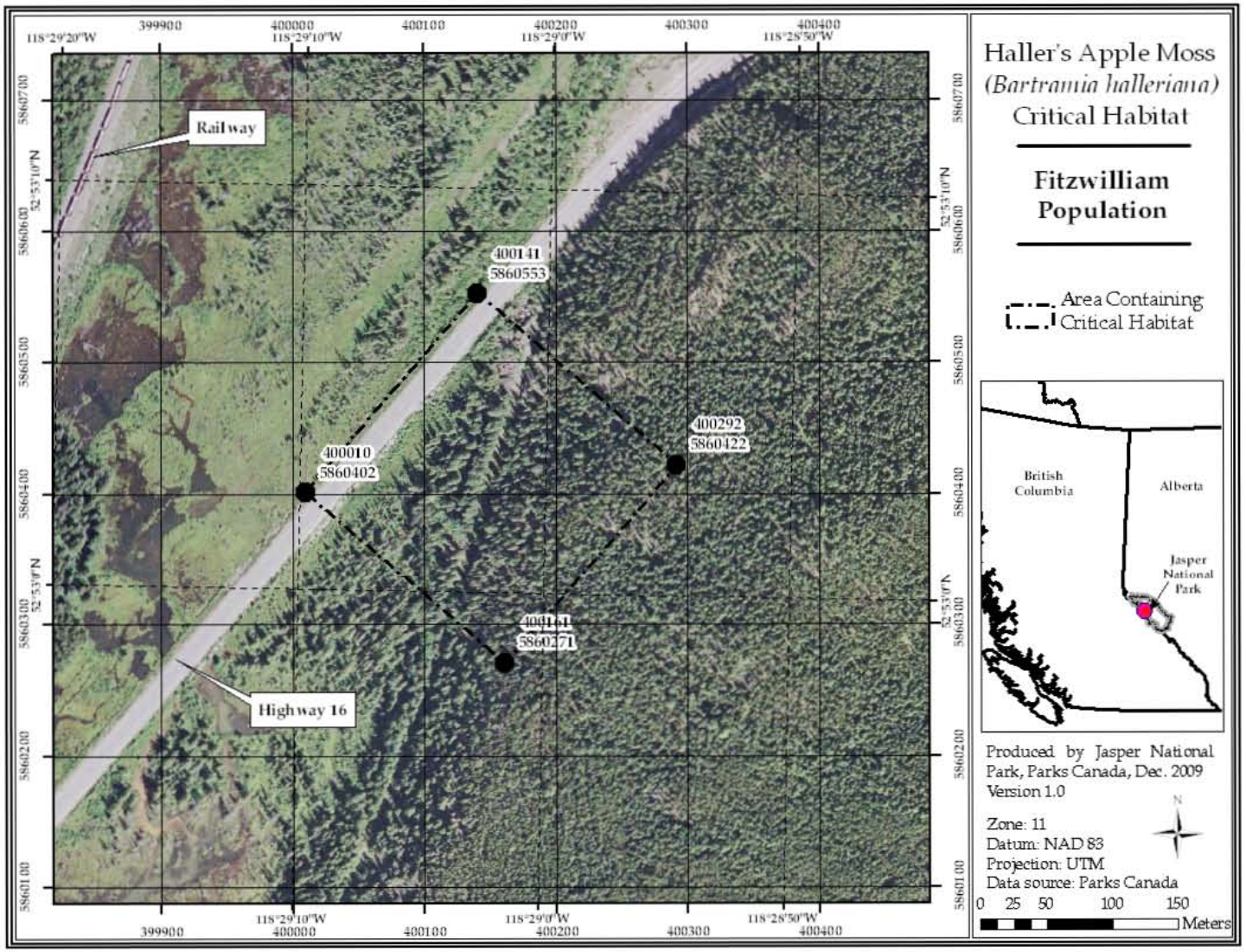


Figure 4. Location of critical habitat at Fitzwilliam Spur, Mount Robson Provincial Park, BC (parcel 689_3). Note that this imagery was taken prior to tree removal for pipeline construction. Trees southeast of Highway 16 to the cutline bisecting critical habitat have been removed. Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

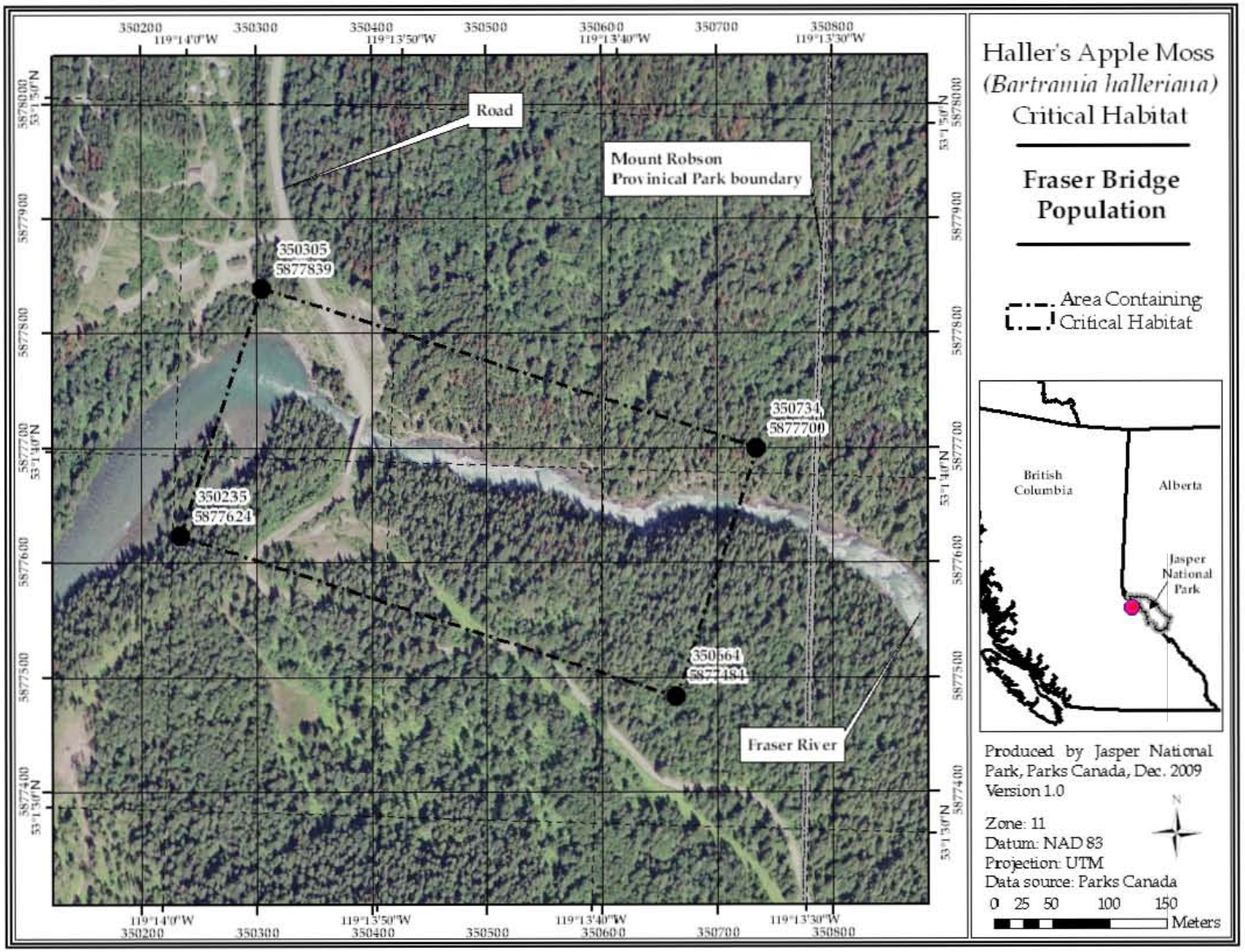


Figure 5. Location of critical habitat at Fraser River Bridge, British Columbia (parcel 689_4). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

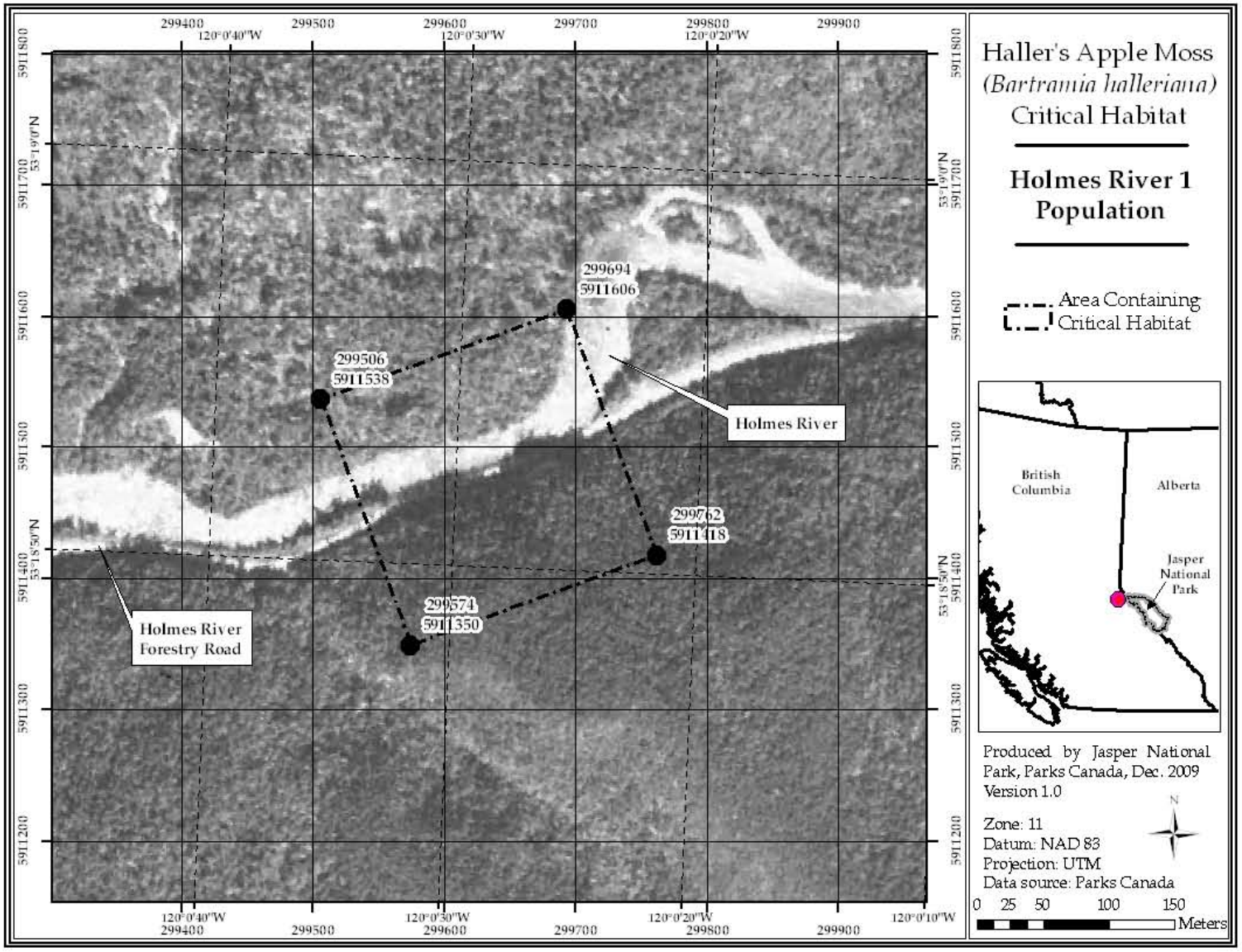


Figure 6. Location of critical habitat at Holmes River 1, British Columbia (parcel 689_5). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

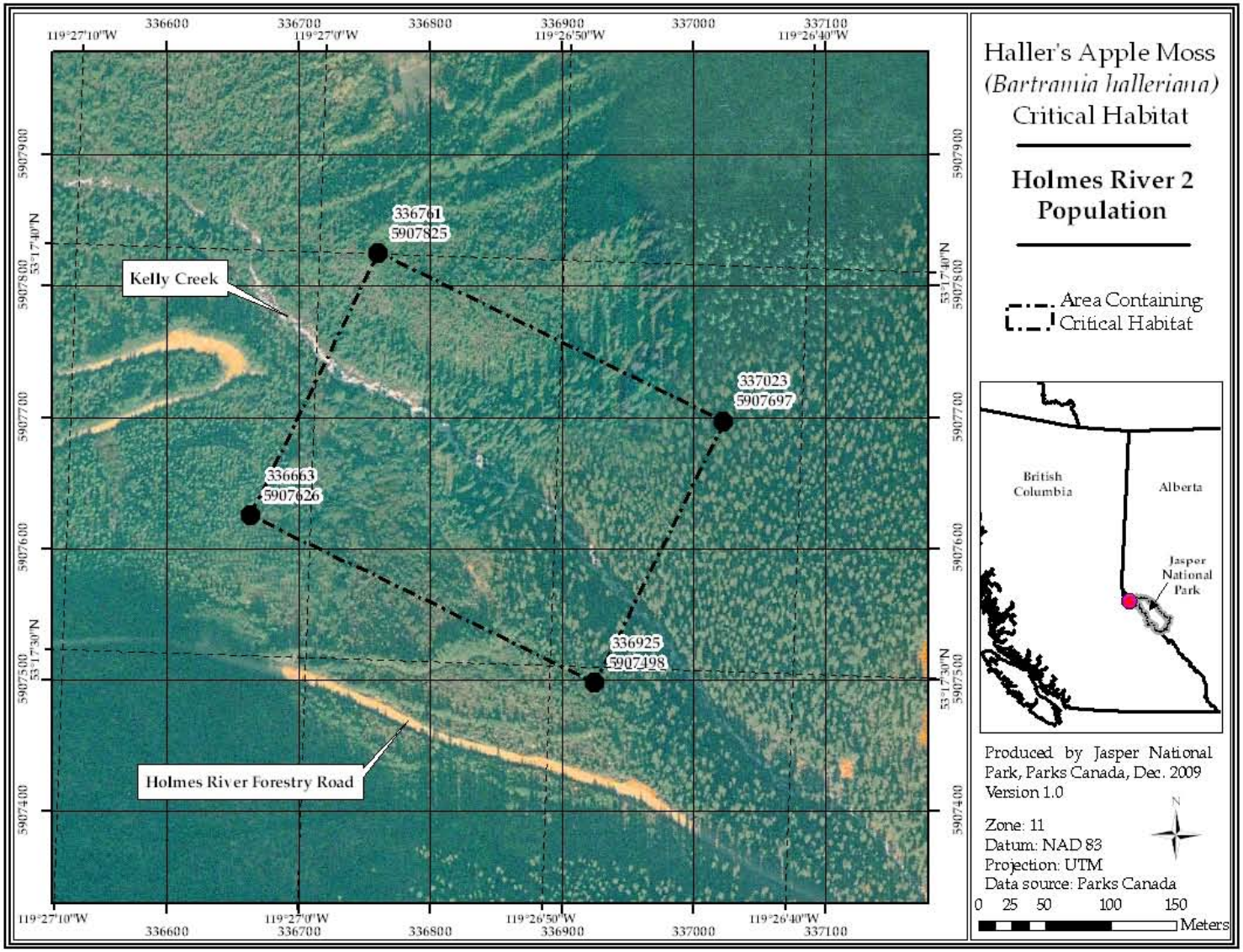


Figure 7. Location of critical habitat at Holmes River 2, British Columbia (parcel 689_6). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

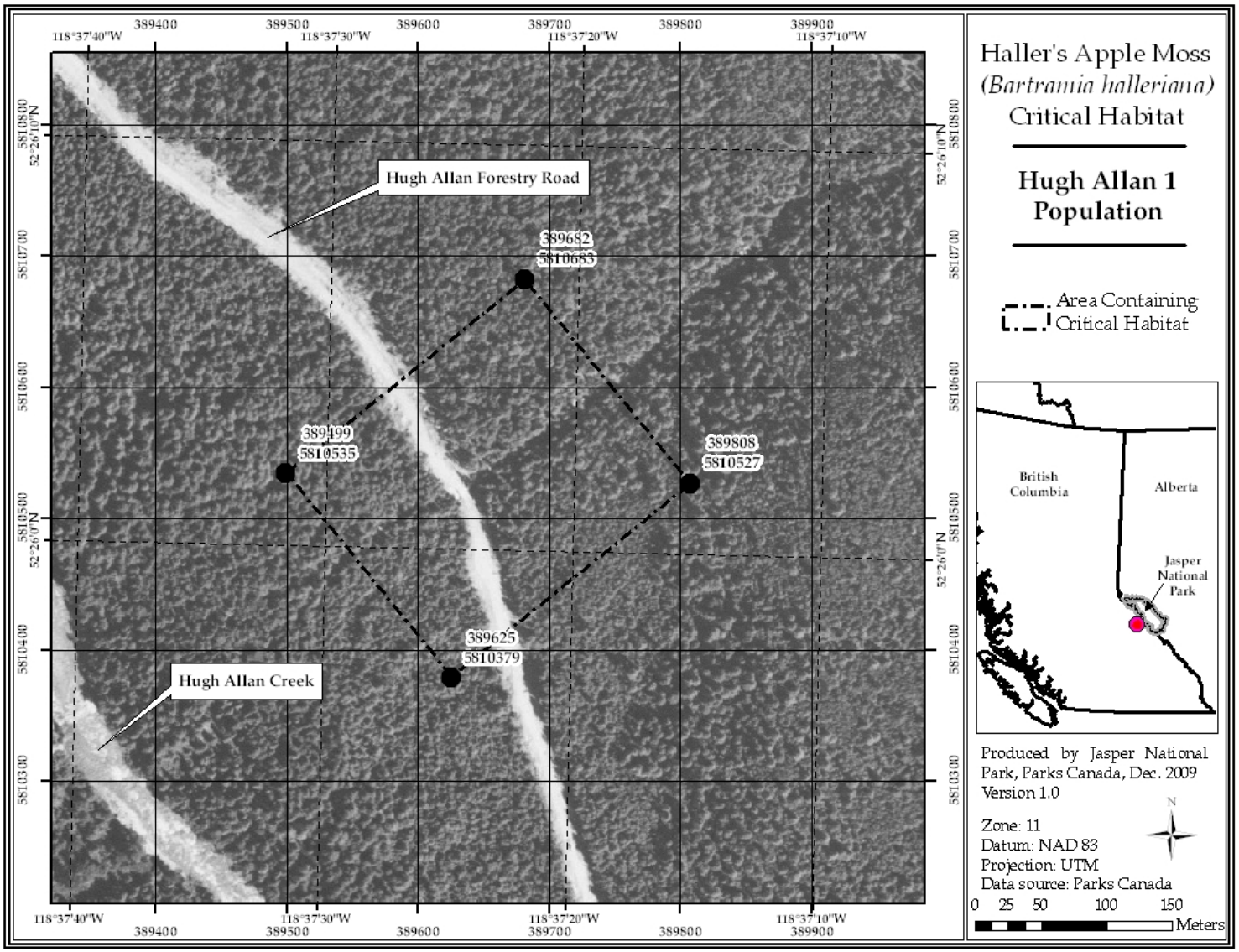


Figure 8. Location of critical habitat at Hugh Allan 1, British Columbia (parcel 689_7). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

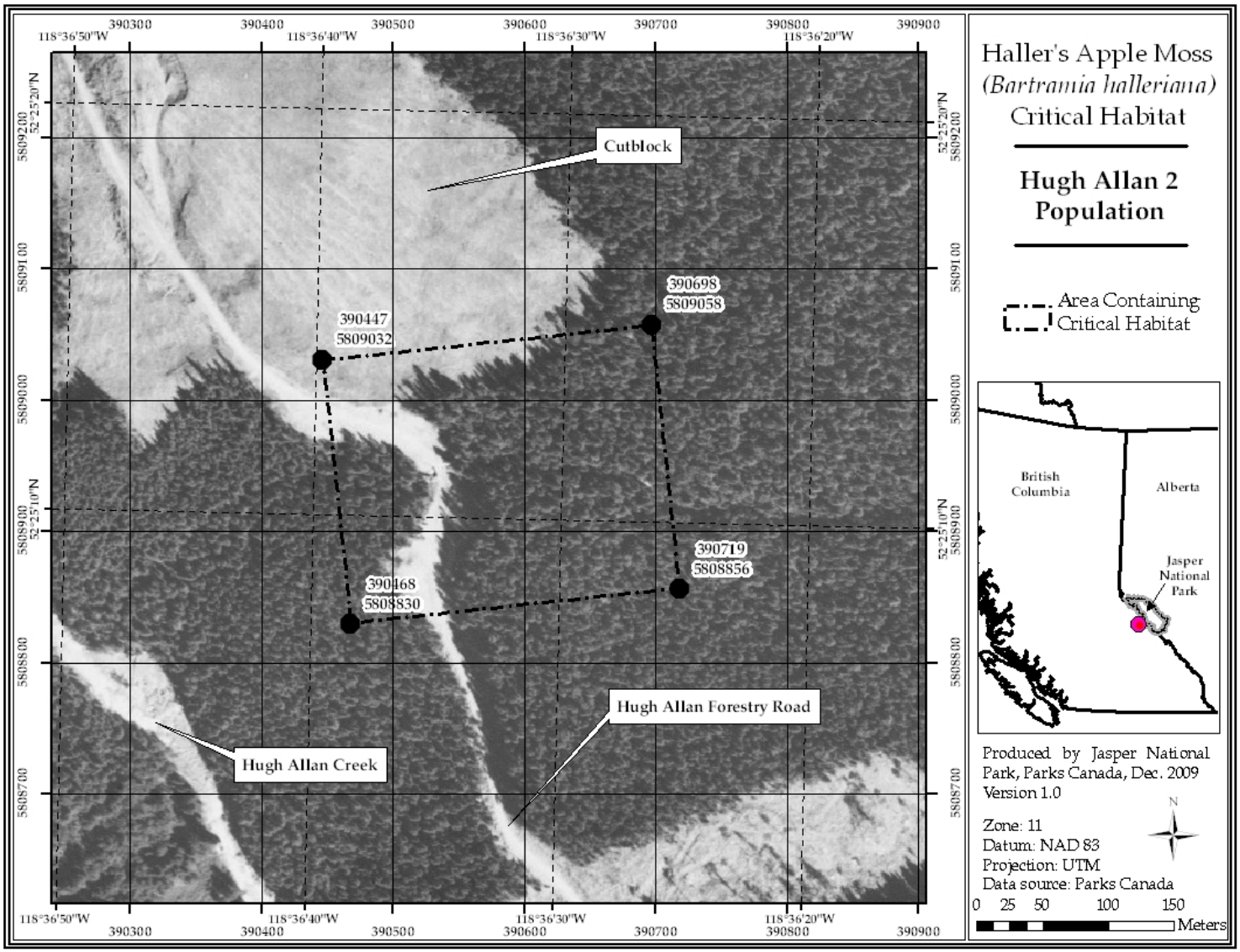


Figure 9. Location of critical habitat at Hugh Allan 2, British Columbia (parcel 689_8). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

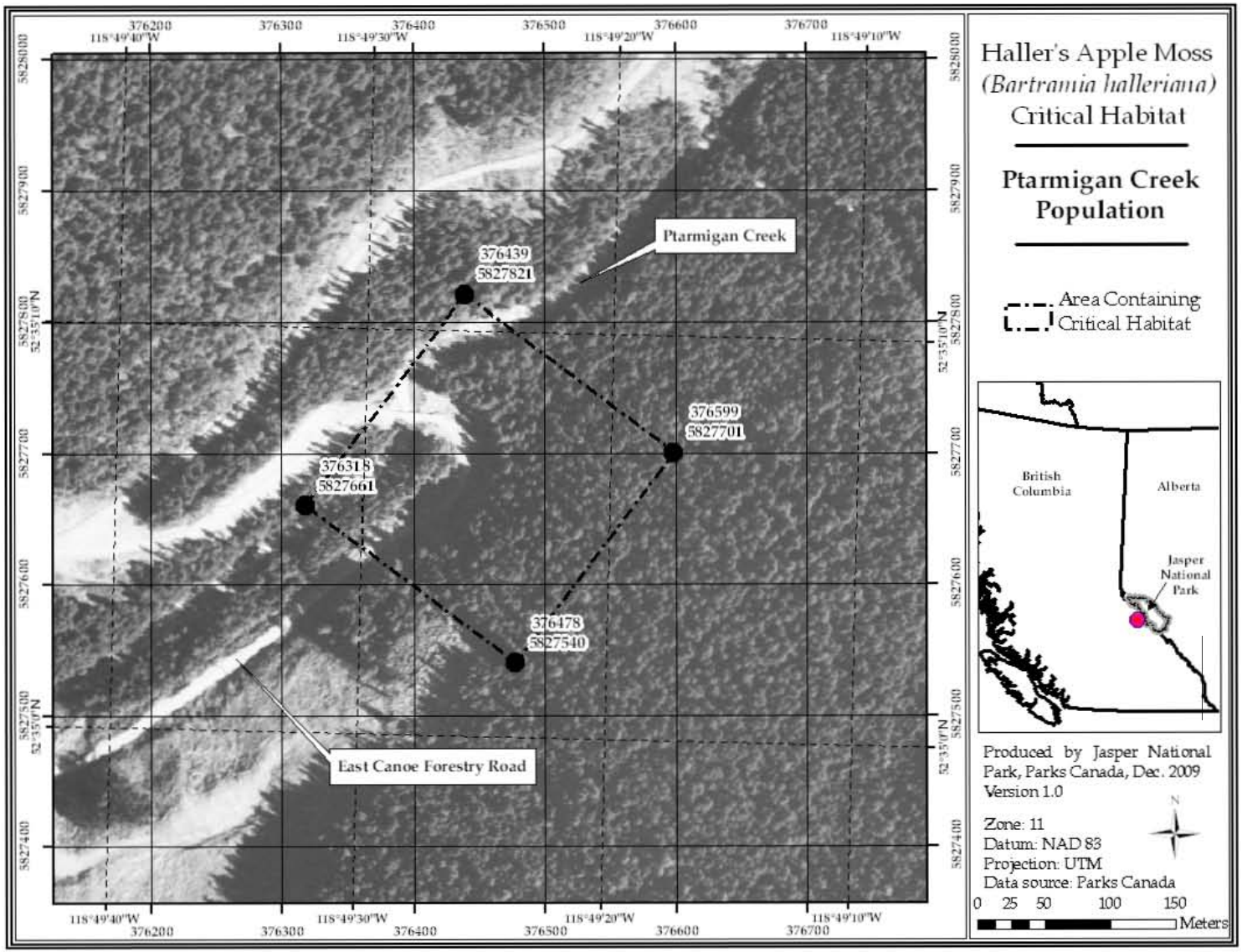


Figure 10. Location of critical habitat at Ptarmigan Creek, British Columbia (parcel 689_9). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

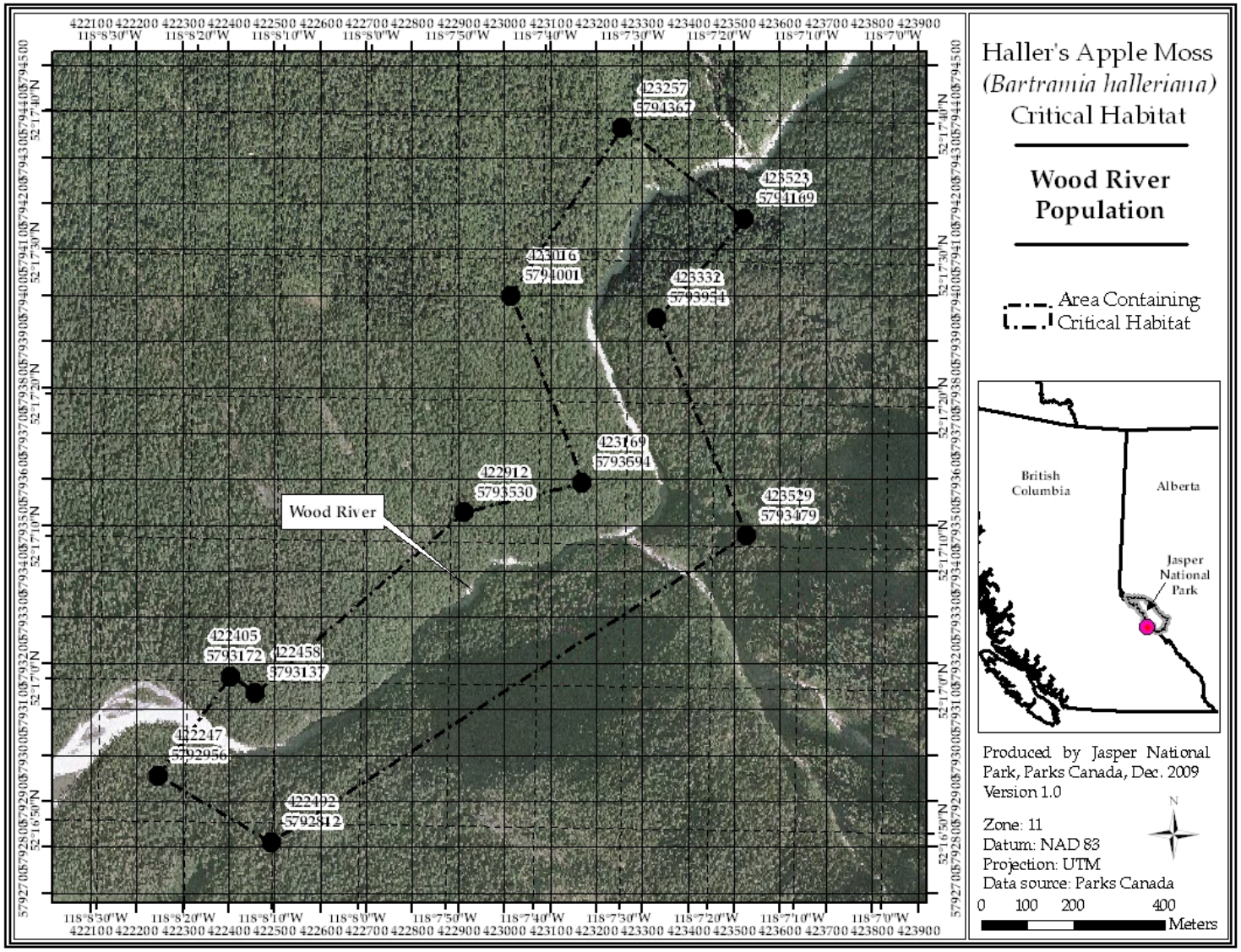


Figure 11. Location of critical habitat at Wood River, British Columbia (parcel 689_10). Refer to the text for a description of critical habitat, required habitat attributes and areas excluded from critical habitat.

2.4 Activities Likely to Result in Destruction of Critical Habitat

Destruction of critical habitat will result if any part of the critical habitat is degraded, either permanently or temporarily, such that it adversely affects the species. Destruction may result from single or multiple activities at one point in time or from the cumulative effects of one or more activities over time.

Activities that maintain required habitat attributes within the critical habitat polygon may not result in destruction of critical habitat. These activities are best identified on a site-by-site basis in consultation with a Haller's Apple Moss expert and those responsible for protection of the species.

Table 4. Examples of activities likely to destroy critical habitat for Haller's Apple Moss, potential effect(s) of the activity and sites where activities are likely to occur.

Examples of activities likely to destroy critical habitat	Potential effect(s) of the activity	Site(s) where each activity is likely to occur (listed within each activity in decreasing likelihood)
• Tree/vegetation removal a. Forest harvesting b. Fire c. Road maintenance d. Industrial land use e. Residential development	• Reduction in mean or maximum relative humidity • Increase in mean or maximum temperature • More extreme relative humidity and temperatures	• Fitzwilliam Spur (a,c) • Fraser Bridge (e) • Holmes River 2 (a, d) • Holmes River 1 (c, d) • Wood River (a, d) • Hugh Allan 1 (a, c) • Hugh Allan 2 (a, c) • Ptarmigan Creek (a, c) • Jasper West Gate (b) • Jasper Meadow Creek (b, c)
• Hydroelectric power development (Off-site (e.g. upstream) activities may affect hydrological characteristics at sites with rivers, streams or seepages).	• Reduction in mean or maximum relative humidity • More extreme relative humidity and temperatures	• Holmes River 2 • Holmes River 1 • Wood River
• Trampling or dislodgement of surrounding vegetation a. Walking/climbing b. Trapping	• Reduction in mean or maximum relative humidity • Increase in mean or maximum temperature • More extreme relative humidity and temperature	• Jasper West Gate (a) • Fraser Bridge (a) • Hugh Allan 2 (b) • Wood River (b)
• Rock and soil disturbance or removal a. Quarry b. Road maintenance c. Bridge maintenance	• Reduction in soil or rock stability	• Holmes River 1 (a, c) • Fraser Bridge (b, c) • Ptarmigan Creek (b, c) • Hugh Allan 1 (b, c) • Hugh Allan 2 (b, c)
• Deposition of harmful substances (affects of road dust, de-icing agents or herbicides on adjacent vegetation).	• Reduction in mean or maximum relative humidity • Increase in mean or maximum temperature • More extreme relative humidity and temperature	• Holmes River 1 • Fraser Bridge • Ptarmigan Creek • Hugh Allan 1 • Hugh Allan 2

2.5 Additional Information Requirements about the Species

The following are information requirements that must be addressed in order to fully implement this recovery strategy:

- Population dynamics and viability analysis
- Physiological tolerance of Haller's Apple Moss
- Competitive relationships of Haller's Apple Moss with *Bartramia pomiformis* and other mosses
- Dispersal biology
- Feasibility of population augmentation or reintroduction

2.6 Habitat Conservation

In Canada, Haller's Apple Moss occurs on national park land (managed by the Parks Canada Agency), provincial park land (managed by British Columbia Ministry of Environment), and both provincial crown land and privately owned lands in British Columbia.

Haller's Apple Moss habitat in Jasper National Park is protected under *Canada's National Parks Act* and, after posting on the Canada Gazette, critical habitat for the species in the park will be protected under Canada's *Species at Risk Act* as well. Haller's Apple Moss habitat in Mount Robson Provincial Park is protected under the *British Columbia Parks Act*. A restrictive covenant provides protection to a portion of the species' critical habitat on private lands at the Fraser Bridge site.

Additional tools for protection of Haller's Apple Moss habitat on provincial crown and privately-owned lands include British Columbia's *Forest and Range Practices Act,* Canada's *Species at Risk Act,* legally binding agreements, voluntary instruments (such as covenants) and stewardship activities (such as those supported by Canada's Habitat Stewardship Program).

2.7 Measuring Progress

Demonstrated progress within five years towards recovering Haller's Apple Moss in Canada includes:

- Number and size of individuals at all 10 locations are maintained or increased,
- All extant populations still occur,
- Adverse impacts are absent or adequately mitigated (e.g. determined via microclimate monitoring),
- Feasibility study and recommended methods for reintroduction and population augmentation completed,
- Completed studies of physiological tolerances, competitive relationships, dispersal biology and demonstrated progress on studies of population dynamics/viability analysis.

2.8 Statement on Action Plans

One or more Action Plans for Haller's Apple Moss will be completed by June 2015.

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3. APPENDIX

3.1.1 Effects on the Environment and Other Species

Recovery approaches outlined in this strategy focus primarily on mitigating effects of land use, restoring habitat adjacent to populations, increasing knowledge of Haller's Apple Moss, protecting the species' natural habitat and the ecological processes that sustain it, and maintaining the existing distribution of the species. No negative effects on the environment and other species are anticipated. Conversely, it is expected that other species occurring in the same environment as Haller's Apple Moss will benefit from this strategy, via increased knowledge gained through inventory, monitoring and research programs, and on-the-ground conservation and recovery initiatives. Other species expected to benefit from this strategy include: *Bartramia pomiformis* which is ranked S2, or vulnerable to extirpation, in Alberta (Kemper 2009). Implementation of recovery actions for Haller's Apple Moss in British Columbia and Jasper National Park in Alberta will be integrated with those for other species at risk in British Columbia or Jasper National Park wherever possible.