PROPOSED

Species at Risk Act
Recovery Strategy Series
Adopted under Section 44 of SARA

Recovery Strategy for the Tall Bugbane (*Actaea elata*) in Canada

Tall Bugbane

2016

Government of Canada
Gouvernement du Canada
Canada

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

Cover illustration: ©Thomas N. Kaye

Également disponible en français sous le titre
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[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

RECOVERY STRATEGY FOR THE TALL BUGBANE (*Actaea elata*) IN CANADA

2016

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.

In the spirit of cooperation of the Accord, the Government of British Columbia has given permission to the Government of Canada to adopt the *Recovery Plan for the Tall Bugbane (*Actaea elata *var.* elata*) in British Columbia* (Part 2) under Section 44 of the *Species at Risk Act* (SARA). Environment Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the Tall Bugbane in Canada consists of two parts:

Part 1 – Federal Addition to the *Recovery Plan for the Tall Bugbane (*Actaea elata *var.* elata*) in British Columbia*, prepared by Environment Canada.

Part 2 – *Recovery Plan for the Tall Bugbane (*Actaea elata *var.* elata*) in British Columbia* prepared by the Tall Bugbane Recovery Team for the British Columbia Ministry of Environment.

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Part 1 - Federal Addition to the *Recovery Plan for the Tall Bugbane (*Actaea elata *var.* elata*) in British Columbia*, prepared by Environment Canada

Preface

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

The Minister of the Environment is the competent minister under SARA for the Tall Bugbane and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Province of British Columbia as per section 39(1) of SARA. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Province of British Columbia provided the attached recovery plan for the Tall Bugbane (Part 2) as science advice to the jurisdictions responsible for managing the species in British Columbia. It was prepared in cooperation with Environment Canada.

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

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

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When the recovery strategy identifies critical habitat, there may be future regulatory implications, depending on where the critical habitat is identified. SARA requires that critical habitat identified within federal protected areas be described in the *Canada Gazette*, after which prohibitions against its destruction will apply. For critical habitat located on federal lands outside of federal protected areas, the Minister of the Environment must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies. For critical habitat located on non-federal lands, if the Minister of the Environment forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of

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

Parliament, and not effectively protected by the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to extend the prohibition against destruction of critical habitat to that portion. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Additions and Modifications to the Adopted Document

The following sections have been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Recovery Plan for the Tall Bugbane (*Actaea elata *var.* elata*) in British Columbia* (Part 2 of this document, referred to henceforth as "the provincial recovery plan") and provide updated or additional information.

Environment Canada is adopting the British Columbia Recovery Plan (Part 2) with the exception of section 7.1: Description of the Species' Survival and Recovery Habitat, Appendix 2: Survival habitat polygons for Tall Bugbane, and Appendix 3: Best management practices for Tall Bugbane. In place of section 7.1, Environment Canada has developed a section on critical habitat.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery plan referring to protection of survival/recovery habitat may not directly correspond to federal requirements. Recovery measures dealing with the protection of habitat are adopted; however, whether these measures will result in protection of critical habitat under SARA will be assessed following publication of the federal recovery strategy.

1. Critical Habitat

Section 41 (1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. A primary consideration in the identification of critical habitat is the amount, quality, and locations of habitat needed to achieve the population and distribution objectives.

The 2015 provincial recovery plan for Tall Bugbane includes a written and geospatial description of survival and recovery habitat. Environment Canada accepts the description of survival and recovery habitat provided in the provincial recovery plan, as the basis for critical habitat identification in the federal recovery strategy, with modification (as follows) to address specific requirements of SARA. More precise boundaries may be mapped, and additional critical habitat may be added in the future if additional information supports the inclusion of areas beyond those currently identified.

Critical habitat for the Tall Bugbane can only be partially identified at this time. Critical habitat cannot yet be identified for six populations owing to a high level of location uncertainty and/or unknown status: Chilliwack River (Population #8), Mount Cheam (Population #9), Cheam Peak (Population #10), Sumas Mountain (Population #11), Liumchen Mountain (Population #12), and Tamihi Trail (Population #13). Additional, broader-scale connective habitat between Tall Bugbane populations is also required, to allow for population dispersal, dynamics, and response to changing habitat conditions in the presence of climate change and/or local threats. When the relevant knowledge gaps relating to these factors are addressed, critical habitat should be identified to maintain

broad-scale connectivity. A schedule of studies (Section 1.2) outlines the activities required to identify additional critical habitat necessary to support the population and distribution objectives for the species. The identification of critical habitat will be updated when the information becomes available, either in a revised recovery strategy or action plan(s).

1.1 Identification of the Species' Critical Habitat

Geospatial location of areas containing critical habitat

Tall Bugbane is found in moist, old-growth and mature forests, in the Cultus Lake–Chilliwack River drainage of southwest British Columbia. Critical habitat is identified for seven extant populations; these are linked with the population numbers provided in the provincial recovery plan:

- North Vedder Mountain (Population #1)
- South Vedder Mountain (Population #2)
- Upper Tamihi (Population #3)
- Chipmunk Creek (Population #4)
- Elk Mountain (Population #5)
- Mount Thom (Population #6)
- Opsee (Population #7)

The area containing critical habitat for Tall Bugbane is based on three additive components: (1) the area occupied by individual plants or patches of plants, including the associated potential location error from Global Positioning System (GPS) units (ranging from 5 m to 25 m uncertainty distance); (2) a 50 m (i.e., critical function zone distance[3]) to encompass immediately adjacent areas; and (3) an additional 200 m distance to support the broader-scale ecosystem processes occurring in mature, mixed coniferous forests that are integral to the production and maintenance of suitable microhabitat conditions for Tall Bugbane, and to retain some degree of connective habitat between sub-populations of plants.

Biophysical attributes of critical habitat

Tall Bugbane is found in moist, old-growth and mature forests composed of mixed Douglas-fir (*Pseudotsuga menziesii*) or Western Red Cedar (*Thuja plicata*) – Western Hemlock (*Tsuga heterophylla*), with some amount of Bigleaf Maple (*Acer macrophyllum*) representation. Tall Bugbane is a rhizomatous species that grows in canopy gaps (patches of high understory light) within the mature- to old-growth forests where it is found. Tall Bugbane prefers moist habitats, typically occurring near shaded

[3] Critical function zone distance has been defined as the threshold habitat fragment size required for maintaining constituent microhabitat properties for a species (e.g., critical light, moisture, humidity levels necessary for survival). Existing research provides a logical basis for applying a minimum critical function zone distance of 50 m for all rare plant species occurrences (see: http://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&n=6A845288-1#_Toc285808423).

watercourses (creeks/streams/rivers), moist slopes, or seepage areas with stable hydrological conditions provided by subsurface moisture. As the species occurs in canopy gaps, which is a natural and relatively transient habitat type within mature- and old-growth forests, it is important to recognize that microhabitat suitability, and correspondingly the species' local population and distribution, may shift in space and time within the broader-scale forest ecosystem. Therefore, maintaining the integrity of the broader contextual forest ecosystem (i.e., allowing for the perpetuation of natural canopy gap dynamics, moisture and humidity) is important to the survival and recovery of the species.

The areas containing critical habitat for Tall Bugbane (totalling 1304.7 ha) are presented in Figures 1-5. The critical function zone, and broader ecosystem context areas as described above comprise the biophysical attributes of critical habitat for this species, and therefore the shaded yellow polygons (units) shown on the map represent a close approximation of actual critical habitat. Within these polygons, unsuitable habitat such as elevations above 1600 m[4], and existing anthropogenic features (e.g., building surfaces, running surfaces of paved roads and railways) do not possess the biophysical attributes required by Tall Bugbane and they are not identified as critical habitat.
The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that highlights the general geographic area containing critical habitat, for land use planning and/or environmental assessment purposes.

[4] Tall Bugbane has generally been reported from low to mid-elevations 30–950 m, but may occur as high as 1600 m.

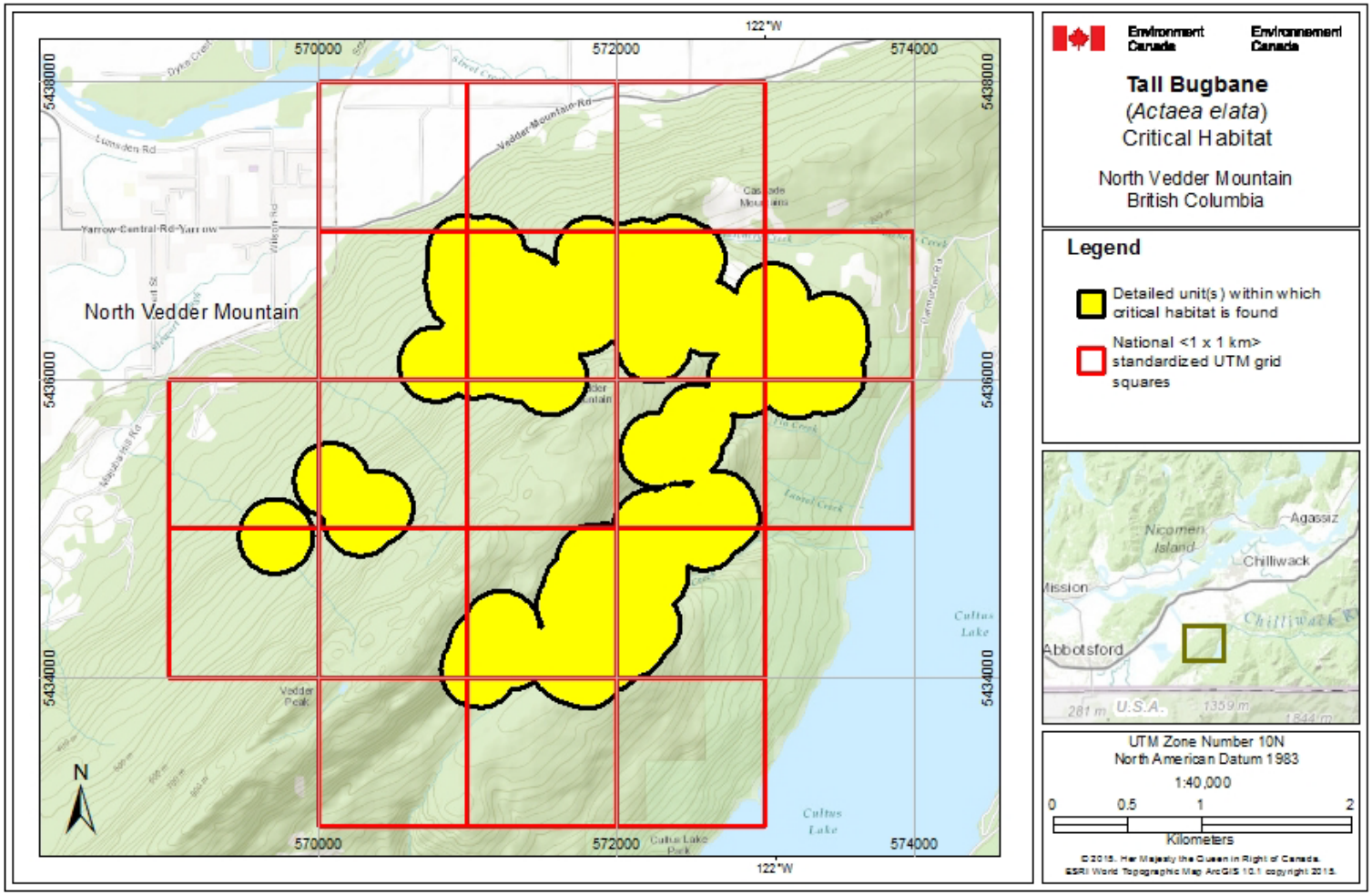

Figure 1. Critical habitat for Tall Bugbane in Canada is represented by the yellow shaded polygons (units) where the criteria and methodology set out in Section 1.1 are met. The detailed polygons show the area within which critical habitat is found at North Vedder Mountain (Population #1; 577.2 ha). The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found in Canada. Areas outside of the shaded yellow polygons do not contain critical habitat.

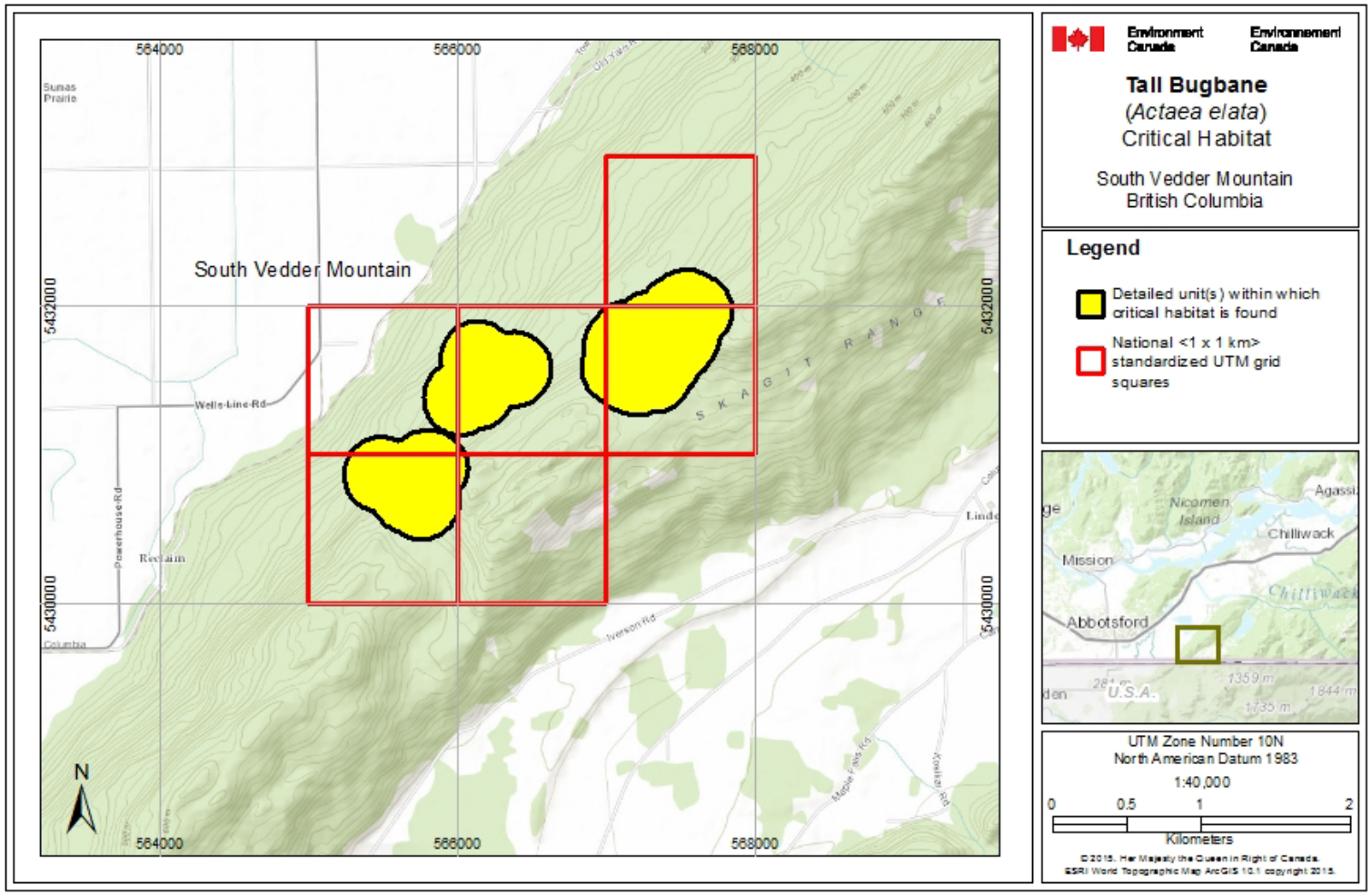

Figure 2. Critical habitat for Tall Bugbane in Canada is represented by the yellow shaded polygons (units) where the criteria and methodology set out in Section 1.1 are met. The detailed polygons show the area within which critical habitat is found at South Vedder Mountain (Population #2; 160.3 ha). The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found in Canada. Areas outside of the shaded yellow polygons do not contain critical habitat.

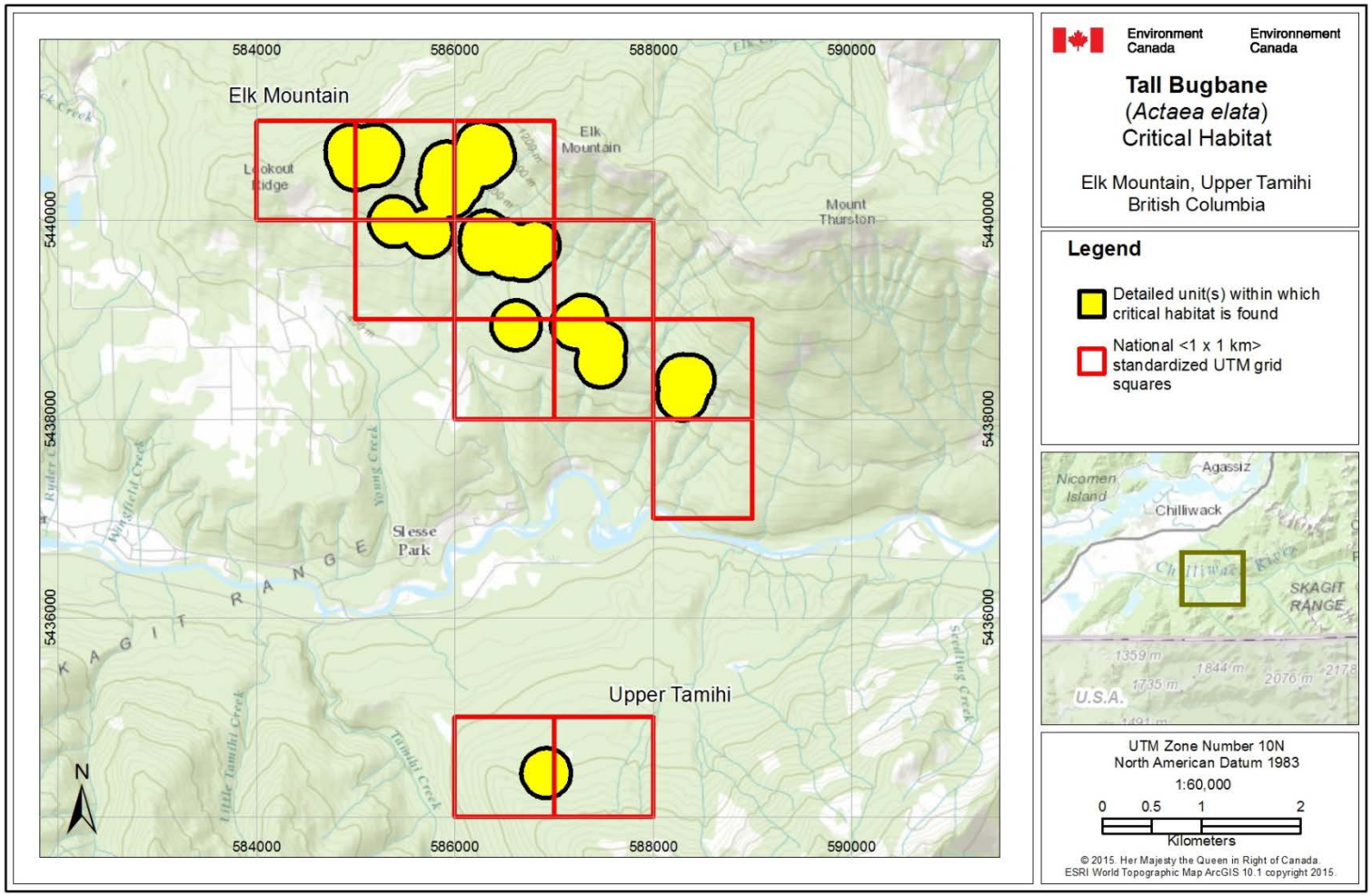

Figure 3. Critical habitat for Tall Bugbane in Canada is represented by the yellow shaded polygons (units) where the criteria and methodology set out in Section 1.1 are met. The detailed polygons show the area within which critical habitat is found at Upper Tamihi (Population #3; 19.6 ha) and Elk Mountain (Population #5; 291.6 ha). The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found in Canada. Areas outside of the shaded yellow polygons do not contain critical habitat.

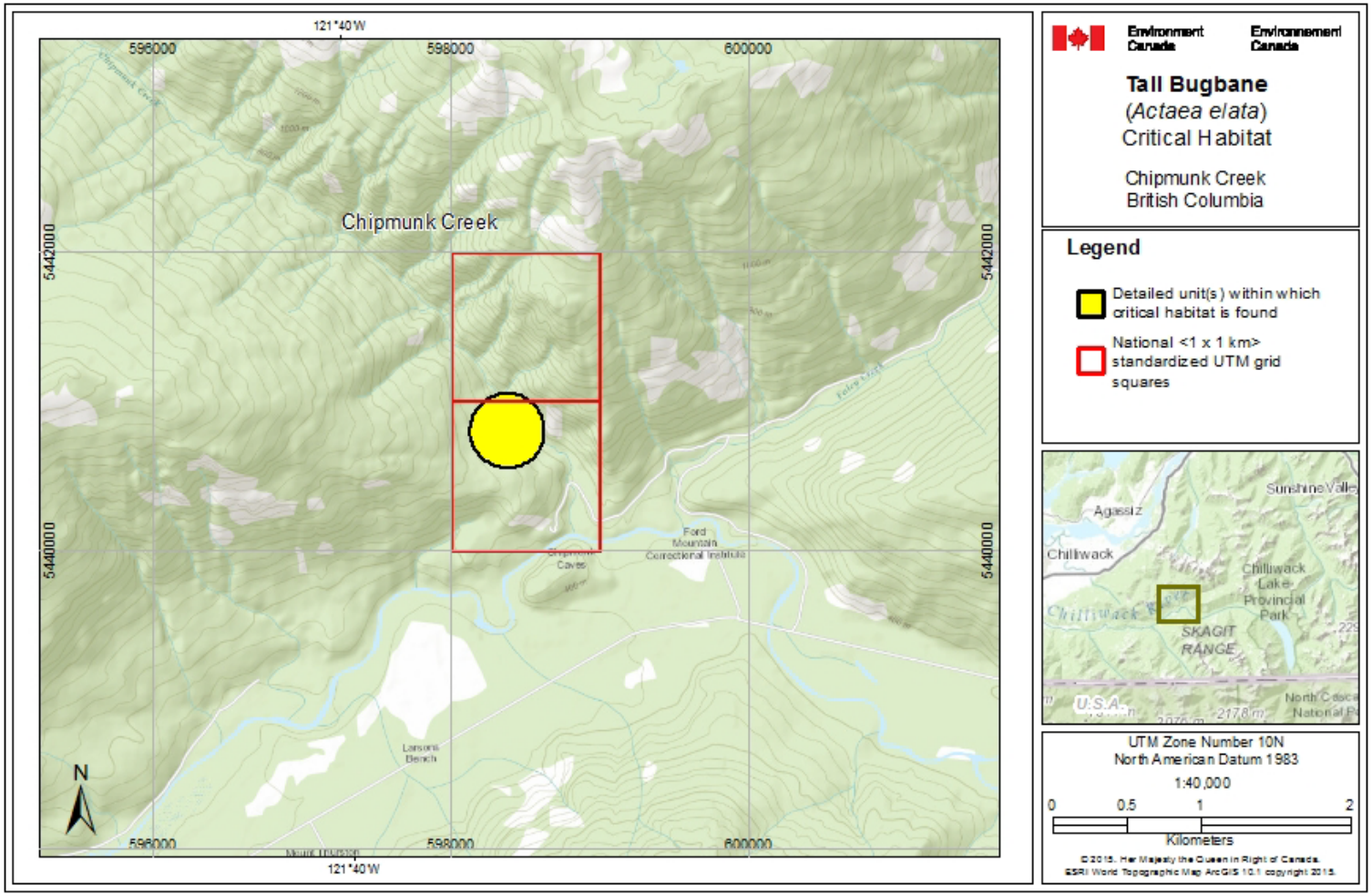

Figure 4. Critical habitat for Tall Bugbane in Canada is represented by the yellow shaded polygons (units) where the criteria and methodology set out in Section 1.1 are met. The detailed polygons show the area within which critical habitat is found at Chipmunk Creek (Population #4; 19.6 ha). The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found in Canada. Areas outside of the shaded yellow polygons do not contain critical habitat.

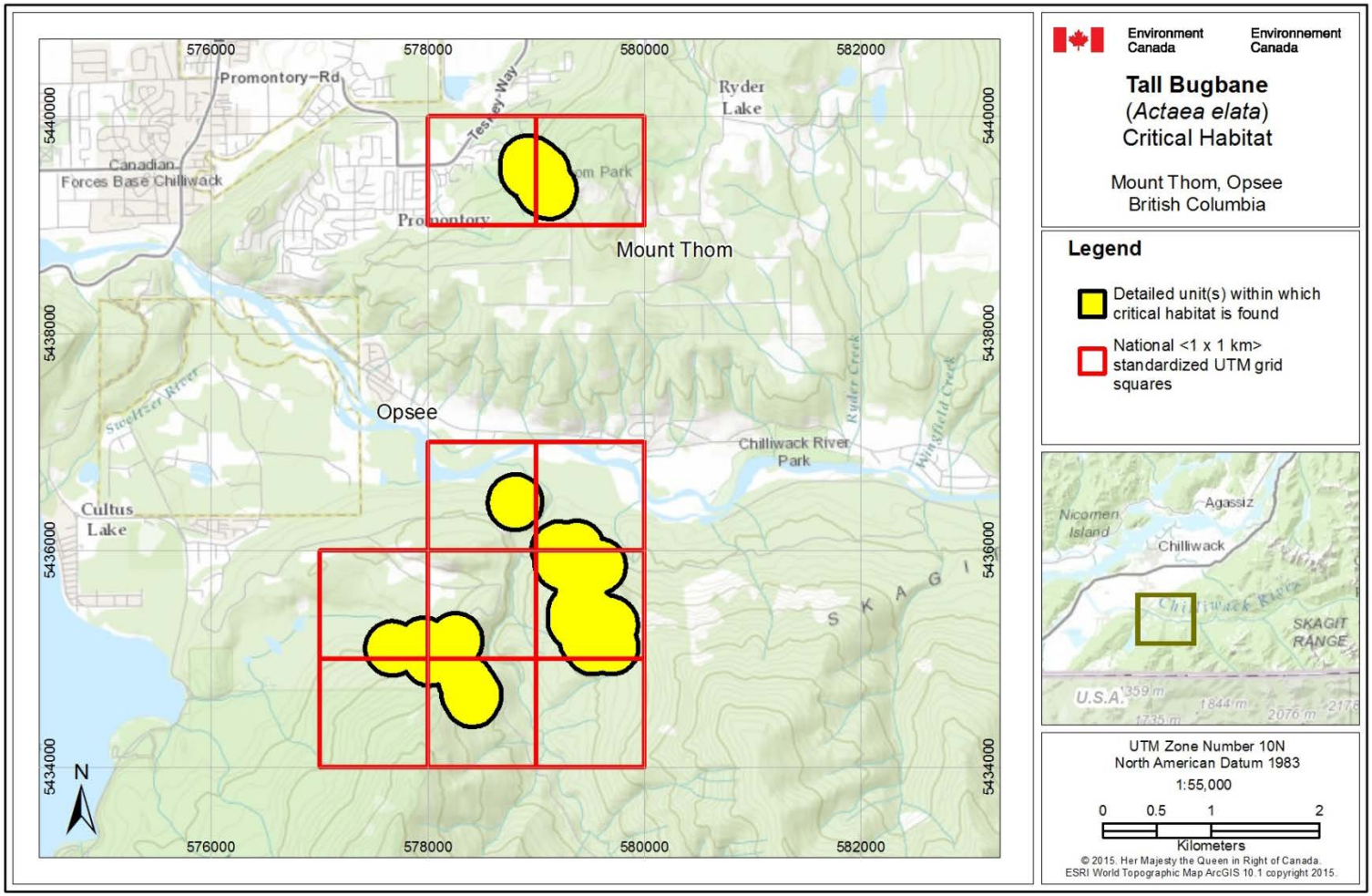

Figure 5. Critical habitat for Tall Bugbane in Canada is represented by the yellow shaded polygons (units) where the criteria and methodology set out in Section 1.1 are met. The detailed polygons show the area within which critical habitat is found at Mount Thom (Population #6; 39.7 ha) and Opsee (Population #7; 196.7 ha). The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found in Canada. Areas outside of the shaded yellow polygons do not contain critical habitat.

1.2 Schedule of Studies to Identify Critical Habitat

The following schedule of studies (Table 1) outlines the activities required to complete the identification of critical habitat for Tall Bugbane; population numbers are provided in reference to those in the provincial recovery plan.

Table 1. Schedule of Studies to Identify Critical Habitat for Tall Bugbane

Description of activity	Rationale	Timeline
Undertake repeated, comprehensive surveys in sites with records of high location uncertainty and unknown status: Chilliwack River (Population #8), Mount Cheam (Population #9), to identify the location of these records. These sites could not be mapped and land tenure could not be determined.	Critical habitat could not be identified for two populations owing to their "unknown" extant status, and the high location uncertainty associated with records. Recent, comprehensive, targeted surveys are lacking. Without further information on the status and location of these populations, it is unknown whether there is sufficient critical habitat identified for Tall Bugbane.	2016-2021
Undertake repeated, comprehensive surveys in sites with historical records: Cheam Peak (Population #10), Sumas Mountain (Population #11), Liumchen Mountain (Population #12), and Tamihi Trail (Population #13), to reconfirm and identify any additional Tall Bugbane plants occurring in remaining patches of suitable habitat, and investigate the feasibility of habitat restoration at these sites so that Tall Bugbane can reestablish (via natural dispersal from adjacent populations, and/or deliberate reintroduction).	Critical habitat could not be identified for four populations owing to their “historical" status; it is unknown if suitable habitat for Tall Bugbane persists at these sites, and/or if it could be made suitable with restoration. In addition, recent, comprehensive, targeted surveys are lacking. Further information on the status and location of these populations, and site habitat suitabilities are required to identify sufficient critical habitat for Tall Bugbane.	2016-2021
Address knowledge gaps relating to longevity, population dynamics, genetic strength, pollination, dormancy, and response to changing habitat conditions in the presence of climate change and/or local threats.	Further information is required to adequately identify critical habitat to maintain broad-scale connectivity between populations.	2016-2021

1.3 Examples of Activities Likely to Result in Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time.

The provincial recovery strategy provides a description of limiting factors and potential threats to Tall Bugbane. Activities described in Table 2 include those likely to cause destruction of critical habitat for the species; however, destructive activities are not limited to those listed.

Table 2. Examples of activities likely to result in destruction of critical habitat for Tall Bugbane in Canada. IUCN Threat numbers are in accordance with the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (CMP 2010).

Description of activity	Rationale	Additional Information
Forest harvest activities and/or removal of any Bigleaf Maple trees within the area containing critical habitat.	Forest harvest can result in direct loss of habitat by removal or burial of biophysical attributes required by Tall Bugbane, and/or indirect loss by alteration of local microsite conditions (such as light and moisture) such that the habitat is no longer suitable for Tall Bugbane; loss of forest habitat in surrounding areas also prevents the natural development of new canopy gaps for recruitment. Forest harvest can have further indirect effects in degrading habitat, by increasing the potential establishment of alien invasive plants, and/or ingrowth of competing vegetation.	Related IUCN-CMP Threat: #5.3 Forest harvest is a threat at several sites. To date, at least 2 B.C. populations have been lost due to clearcutting. Logging operations contribute to slow regeneration, and habitat fragmentation.
Conversion of landscape for human use and development: creation of new structures, houses, roads, railroads, stream crossings or diversions (including culverting).	Conversion of landscape for human use and development can result in direct loss of habitat by removal or burial of biophysical attributes required by Tall Bugbane. Indirect loss of critical habitat can also occur by alteration of local microsite conditions (such as light and moisture, hydrological conditions) to the extent that it is no longer suitable for Tall Bugbane.	Related IUCN-CMP Threat: #1.1, 1.3, 4.1 The Fraser Valley continues to be an area of concentrated land development and increasing urbanization. This is particularly true near Promontory and the Ryder Lake areas in Chilliwack and surrounding areas. Developments further promote establishment of alien invasive species, and unmanaged recreational activities.
Recreation activities: creation and/or expansion of existing recreational areas or trails (hiking, dirt-biking, ATVs, etc.).	Conversion of landscape for recreation activities can result in direct loss of habitat by removal or burial of biophysical attributes required by Tall Bugbane. Indirect loss of critical habitat can also occur by alteration of local microsite conditions (such as light and moisture, hydrological conditions) to the extent that it is no longer suitable for Tall Bugbane.	Related IUCN-CMP Threat: #1.3, 6.1 The development of recreation areas on Vedder and Elk Mountains is an increasing concern.

Description of activity	Rationale	Additional Information
Roadside (or other linear development) maintenance activities such as vegetation clearing, infilling or depositing materials beyond running surface of existing roads.	Roadway grading, as well as grass trimming and brush cutting, can result in removal or burial of habitat required by Tall Bugbane plants and seeds.	Related IUCN-CMP Threat: #7.3 Roadside maintenance activities pose a threat to at least one known population of tall bugbane on Elk Mountain (#5) and likely other populations on Vedder Mountain (#1 and #2) and Mount Thom (#6).
Pesticide and herbicide use; also use of pesticides and herbicides on lands adjacent to areas containing critical habitat that cause inadvertent pollution, for example by not adhering to best management practices to control drift.	Efforts to control invasive plants or agricultural pests through mechanical or chemical means (non-specific herbicides) can result in habitat toxicity and alteration such that it is no longer suitable for Tall Bugbane.	Related IUCN-CMP Threat: #9.3 Herbicides used for road maintenance, agriculture, invasive species management, and silviculture are a concern at several sites. Pesticides used on surrounding agricultural areas and land clearing can have a detrimental impact on the availability of pollinators for native species including Tall Bugbane.

2. Statement on Action Plans

One or more action plans for Tall Bugbane will be posted on the Species at Risk Public Registry by 2021.

3. Effects on the Environment and Other Species

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

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national

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

guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

The provincial recovery plan for Tall Bugbane contains a section describing the effects of recovery activities on other species (i.e., Section 9). Environment Canada adopts this section of the provincial recovery plan as the statement on effects of recovery activities on the environment and other species. Recovery planning activities for Tall Bugbane will be implemented with consideration for all co-occurring species at risk, such that there are no negative impacts to these species or their habitats.

4. References

CMP (Conservation Measures Partnership). 2010. Threats Taxonomy. Available: http://www.conservationmeasures.org/initiatives/threats-actions-taxonomies/threats-taxonomy

Part 2 - *Recovery Plan for the Tall Bugbane (*Actaea elata *var.* elata*) in British Columbia*, prepared by the Tall Bugbane Recovery Team for the British Columbia Ministry of Environment

Recovery Plan for the Tall Bugbane (*Actaea elata* var. *elata*) in British Columbia

Prepared by Tall Bugbane Recovery Team

BRITISH COLUMBIA | Ministry of Environment

October 2014

About the British Columbia Recovery Strategy Series

This series presents the recovery documents that are prepared as advice to the Province of British Columbia on the general approach required to recover species at risk. The Province prepares recovery documents to ensure coordinated conservation actions and 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 provincial recovery document?

Recovery documents summarize the best available scientific and traditional information of a species or ecosystem to identify goals, objectives, and strategic approaches that provide a coordinated direction for recovery. These documents outline what is and what is not known about a species or ecosystem, identify threats to the species or ecosystem, and explain what should be done to mitigate those threats, as well as provide information on habitat needed for survival and recovery of the species. This information may be summarized in a recovery strategy followed by one or more action plans. The purpose of an action plan is to offer more detailed information to guide implementation of the recovery of a species or ecosystem. When sufficient information to guide implementation can be included from the onset, all of the information is presented together in a recovery plan.

Information provided in provincial recovery documents may be adopted by Environment Canada for inclusion in federal recovery documents that federal agencies prepare to meet their commitments to recover species at risk under the *Species at Risk Act*.

What's next?

The Province of British Columbia accepts the information in these documents as advice to inform implementation of recovery measures, including decisions regarding measures to protect habitat for the species.

Success in the recovery of a species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this document. All British Columbians are encouraged to participate in these efforts.

For more information

To learn more about species at risk recovery in British Columbia, please visit the B.C. Ministry of Environment Recovery Planning webpage at:
<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

Recovery Plan for the Tall Bugbane (*Actaea elata* var. *elata*) in British Columbia

Prepared by the Tall Bugbane Recovery Team

October 2014

Recommended citation

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Cover illustration/photograph

Photograph by Kym Welstead, used with permission.

Additional copies

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

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

Disclaimer

This recovery plan has been prepared by the Tall Bugbane Recovery Team, 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 Cana*da 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 tall bugbane populations in British Columbia. 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 plan. The B.C. Ministry of Environment encourages all British Columbians to participate in the recovery of tall bugbane.

ACKNOWLEDGEMENTS

Kym Welstead, Brian Klinkenberg, and Denis Knopp wrote this recovery plan. Its development was dependent upon key input from many individuals through time. Very special thanks to the enduring former and current members of the recovery team who have contributed and reviewed this document over its development.

Additional thanks go to:

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- Thomas Kaye, Institute for Applied Ecology, Oregon, for initial input into the draft recovery strategy regarding tall bugbane ecology and habitat.
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- Former recovery team members and advisors, Ross Vennesland (former Chair), Florence Caplow, Gene MacInnes, Patrick Robinson, Jason Smith, Ted Lea, Jan Jonker, Todd Ewing, Allan Johnsrude, David Toews, Lucy Reiss, Brenda Costanzo, Bill Jex, and Meeri Durand.
- The Conservation Data Centre (CDC) staff, including Jenifer Penny and George Douglas (former staff), for providing updated information and field notes on tall bugbane.
- Kym Welstead, for overseeing the preparation, updates, and revisions leading to the final version of this recovery plan.

RECOVERY TEAM MEMBERS

Name	Affiliation	Organization or position
Voting members:		
Kym Welstead (Chair)	Forests, Lands and Natural Resource Operations (MFLNRO)	Species at Risk Biologist
Ann Peter	Forests, Lands and Natural Resource Operations (MFLNRO)	Stewardship Forester, Chilliwack Forest District
Angela Manweiler	Department of National Defence (Chilliwack), Government of Canada	Natural Resource Technical Officer
Elizabeth Elle	Academic	Professor, Simon Fraser University
Matt Wealick	Industry	Ch-ihl-kway-uhk Forestry Limited Partnership
Denis Knopp	Environmental Non-governmental Organization	B.C.'s Wild Heritage
Brian Klinkenberg	Academic	University of British Columbia (UBC) Department of Geography
Enrique Sanchez	BC Timber Sales	Planning Forester
Alternates:		
Marie Goulden (Angela's Alternate)	Department of National Defence (Chilliwack), Government of Canada	Department of National Defence (Chilliwack)
Rose Klinkenberg (Brian's Alternate)	Academic	UBC Herbarium

EXECUTIVE SUMMARY

Tall bugbane (*Actaea elata* var. *elata*) is a Pacific Northwest endemic, perennial vascular plant species found globally only in Oregon, Washington, and British Columbia (B.C.). Within B.C., it is currently restricted to 7 known populations within the Chilliwack area of the lower Fraser Valley. When in flower, tall bugbane is a distinguished plant with showy white "bottle brush" flowers reaching 1–2 m high.

Tall bugbane was designated in 2001 as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). It is listed as Endangered in Canada on Schedule 1 of the *Species at Risk Act* (SARA). In B.C., tall bugbane is ranked S1 (critically imperiled) by the Conservation Data Centre and is on the provincial Red list. The B.C. Conservation Framework ranks the tall bugbane as priority 1 under goals 1 and 3 (1 = contribute to global efforts for species and ecosystem conservation; 3 = maintain the diversity of native species and ecosystems). It is also listed as a species that requires special management attention to address the impacts of forest and range activities under the *Forest and Range Practices Act* (FRPA) and/or the impacts of oil and gas activities under the *Oil and Gas Activities Act* (OGAA) on Crown land (as described in the Identified Wildlife Management Strategy). Recovery is considered to be biologically and technically feasible.

Threats include canopy removal from timber harvest, urbanization including roads, recreational activities (e.g., hiking, mountain biking, off-roading), plant collecting, poaching/harvesting of bigleaf maple, herbicides, and the introduction of invasive species through human disturbance. Such threats may directly or indirectly result in habitat degradation and fragmentation, loss of connection corridors, loss of pollinators, influx of invasive species as competitors, and increased herbivory.

The biological factors that limit the prevalence of this species (resulting in a restricted range, and natural rarity in the landscape throughout that range) include high habitat specificity and limited availability of suitable habitats, occurrence in small isolated populations, and limited mechanisms for dispersal. The nature of small and isolated populations results in lack of genetic exchange between populations, and makes this species more vulnerable to population loss by stochastic events.

The recovery (population and distribution) goal for this species is:

To ensure that the number of populations and quality and quantity of occupied habitat remains stable or increases across the tall bugbane's existing range, and where feasible, to restore additional populations and connective habitat within the tall bugbane's historical range in B.C.

The recovery objectives for this species are:

1. to remove or manage threats, and protect[1] and restore habitat at all extant populations;
2. to assess, restore, or enhance habitat, and re-establish populations at historical sites where feasible;
3. to conduct further inventory within the known range of the species in B.C. to prevent inadvertent loss of populations that have not yet been identified within suitable habitat;
4. to determine the effectiveness of habitat protection/enhancement measures and recovery actions by monitoring population status; and
5. to inform and refine management decisions by improving our understanding of threats, population ecology, and habitat requirements.

This document outlines survival and recovery habitat for tall bugbane. Given the limited and sporadic distribution of this endangered plant, it is important to protect all known occurrences.

RECOVERY FEASIBILITY SUMMARY

The recovery of tall bugbane in B.C. is considered technically and biologically 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.

   Yes, current sites contain plants that are reproducing and, if protected, will sustain population numbers. Individuals capable of reproduction are currently available to improve the population growth and abundance. Additionally, given that this species exhibits belowground dormancy, and because semi-dormant (non-flowering) individuals are difficult to see, it is possible that more populations of the species exist within the region in deeply shaded undisturbed areas, and that true population sizes may be larger than previously thought.

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

   Yes, sufficient suitable habitat is currently available to support the species, and more may be made available in the future through habitat restoration.

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

   Yes, primary threats to the species and its habitat (e.g., urbanization, timber harvest and herbicides) can be mitigated and/or avoided through recovery actions. The necessary techniques and management tools exist (e.g., establishment of Wildlife Habitat Areas and general wildlife measures) and have already been implemented for some sites.

[1] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

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

   Yes, recovery techniques exist to achieve the population and distribution objectives (e.g., threat mitigation and habitat restoration) in a timely manner. Techniques such as deliberately augmenting and/or re-introducing populations by propagation (e.g., sexual reproduction by seed germination, and/or asexual reproduction by division of the plant or by sections of the rhizome) can be applied to recover this species. Kaye (2001) has developed methods for successful seed germination and plant translocation in the United States that could be applied in B.C.

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1 COSEWIC* SPECIES ASSESSMENT INFORMATION

Assessment Summary: May 2001
Common Name:** Tall Bugbane
Scientific Name:** *Cimicifuga elata*
Status: Endangered
Reason for Designation: A perennial herb of mature forests occurring naturally as very small populations at scattered sites throughout a single river valley and adjoining mountain slopes where logging continues to impact populations, and to reduce its preferred forest habitats.
Occurrence: British Columbia
Status History: Designated Endangered in May 2001

* Committee on the Status of Endangered Wildlife in Canada.
** Common and scientific names reported in this recovery plan henceforth follow the naming conventions of the British Columbia Conservation Data Centre (e.g., for tall bugbane the provincial naming convention is *Actaea elata* var. *elata)*.

2 SPECIES STATUS INFORMATION

Tall bugbane[a]		
Legal Designation:		
FRPA:[b] Species at Risk OGAA:[b] Species at Risk	B.C. *Wildlife Act:* [c] No	SARA:[d] Schedule 1 – Endangered (2003)
Conservation Status[e]		
B.C. List: Red B.C. Rank: S1 (2005) National Rank: N1 (2011) Global Rank: G3TNR (2004)		
Other Subnational Ranks:[f] Oregon (S3), Washington (S3)		
B.C. Conservation Framework (CF)[g]		
Goal 1: Contribute to global efforts for species and ecosystem conservation.		Priority:[h] 1 (2009)
Goal 2: Prevent species and ecosystems from becoming at risk.		Priority: 6 (2009)
Goal 3: Maintain the diversity of native species and ecosystems.		Priority: 1 (2009)
CF Action Groups:[g]	Compile Status Report; List under *Wildlife Act*; Send to COSEWIC; Planning; Habitat Protection; Habitat Restoration; Private Land Stewardship; Species and Population Management	

[a] Data source: B.C. Conservation Data Centre (2013) unless otherwise noted.
[b] Species at Risk = a listed species that requires special management attention to address the impacts of forest and range activities on Crown land under the *Forest and Range Practices Act* (FRPA; Province of British Columbia 2002) and/or the impacts of oil and gas activities on Crown land under the *Oil and Gas Activities Act* (OGAA; Province of British Columbia 2008) as described in the Identified Wildlife Management Strategy (Province of British Columbia 2004).
[c] No = not designated as wildlife under the B.C. *Wildlife Act* (Province of British Columbia 1982).
[d] Schedule 1 = found on the List of Wildlife Species at Risk under the *Species at Risk Act* (SARA).
[e] S = subnational; N = national; G = global; T = refers to the subspecies level; X = presumed extirpated; H = possibly extirpated; 1 = critically imperiled; 2 = imperiled; 3 = special concern, vulnerable to extirpation or extinction; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure; NA = not applicable; NR = unranked; U = unrankable.
[f] Data source: NatureServe (2013).
[g] Data source: B.C. Ministry of Environment (2010).
[h] Six-level scale: Priority 1 (highest priority) through to Priority 6 (lowest priority).

3 SPECIES INFORMATION

3.1 Species Description

Tall bugbane (*Actaea elata* var. *elata*)[2] is a 1–2 m tall, shade-loving, herbaceous vascular plant species that is found in the understory layer of mature or old-growth forests. It is a rhizomatous[3] perennial species with short, dark tuberous rhizomes. The leaves are usually divided into 3 lobes, but may sometimes have 5–7 lobes, and have 5 principal veins (Figure 1). Tall bugbane flowers from mid-June to early August. Flowers are white and are found in an elongated, simple, or compound cluster (a raceme) with 50–900 small white flowers with no petals. Because the flowers lack petals, the inflorescence[4] actually consists of hundreds of tiny, tufted, white stamens that resemble a bottlebrush (D. Knopp, pers. comm., 2003). Fruits are short, stout, pea-pod–like dried capsules that split open down one side (follicles); each contains 10 red to purple-brown heavy seeds (Penny and Douglas 1999). Notably, this species can also occur as small, semi-dormant plants, which are not readily observed (D. Knopp, pers. comm., 2003).

Figure 1. Tall bugbane characteristics. The maple-like leaves of tall bugbane have hairs on the underside and on the bulbous stem joint.

When in flower, this species is readily identified because of its large size and raceme of flowers. It is more challenging to identify when not in flower. Tall bugbane leaf-shape strongly resembles both maple (*Acer* spp.) and thimbleberry leaves (*Rubus parviflorus*) (D. Knopp, pers. comm., 2003). Non-flowering plants can also be confused with non-flowering red baneberry (*Actaea rubra*) (Penny and Douglas 1999). However, larger non-flowering plants can be distinguished by

[2] Formerly known as *Cimicifuga elata*. *Actaea elata* var. *elata* is the only variety of tall bugbane found in B.C. and Canada.
[3] Having an underground stem.
[4] A flowering cluster.

the presence of slightly bulbous basal wings on the leaf stalks that clasp the stem and hairs on the underside of the leaves (see Figure 1).

3.2 Populations and Distribution

Tall bugbane is endemic to the Pacific Northwest (Figure 2) and is restricted in distribution globally to Oregon, Washington, and southwestern British Columbia (NatureServe 2013). In B.C., known populations are limited to areas west of the Coast-Cascade Mountains in the Cultus Lake–Chilliwack River area. Approximately 5% of the global distribution occurs in British Columbia (the B.C. population areal extent is 40,700 ha). There are approximately 100 populations in Oregon, 30 in Washington (Kaye 1994), and 7 in B.C. Given that the closest population in Washington State occurs on Vedder Mountain (an extension of the B.C. populations on Vedder Mountain), there is a possible chance of rescue effect (immigration from an outside source). In B.C., this species occurs in the lower Fraser Valley, which is the northern-most limit of its distribution in North America, and is a species that is naturally rare in the landscape.

Figure 2. Global distribution of tall bugbane.
Map prepared by Kym Welstead. U.S. distribution based on Kaye and Kirkland (1994).

There are 7 known extant tall bugbane populations[5] in B.C. (Figure 3; Table 1, sites 1–7). There are 6 historical populations (Table 1, sites 8–13): 2 populations (sites 8 and 9) are not mapped

[5] B.C. populations are defined as plants within 1 km of each other, which is the standard used by NatureServe (2004). Several populations previously considered as distinct populations have been merged into single, larger populations as new occurrences were discovered between them. The locations of the existing populations suggest continuity within a range of 600–800 m, which lends support to using a separation of 1000 m to define a population. This differs from the distance of 500 m suggested in the Identified Wildlife Management Strategy (Province of British Columbia 2004).

given the ambiguity in their location descriptions; 2 populations (sites 10 and 11) were not relocated during field surveys in 2005 and 2006 (Iredale and Barsanti 2006); and the other 2 populations (sites 12 and 13) are presumed extirpated since the locations where the plants were reported from were clear-cut after their discovery.

In Canada, tall bugbane is known only from the Cultus Lake–Chilliwack River area in the Coastal Western Hemlock (CWH) biogeoclimatic zone (subzones/variants CWHdm, CWHxm, CWHms1) and in the Mountain Hemlock moist maritime (MHmm2) variant (Douglas *et al.* 2002; Province of British Columbia 2004).

Population trends are not well understood, but where populations have been monitored (e.g. Mayberry 2008) they were either observed and/or predicted to be in decline based on measured rates of change (Mayberry and Elle 2010).

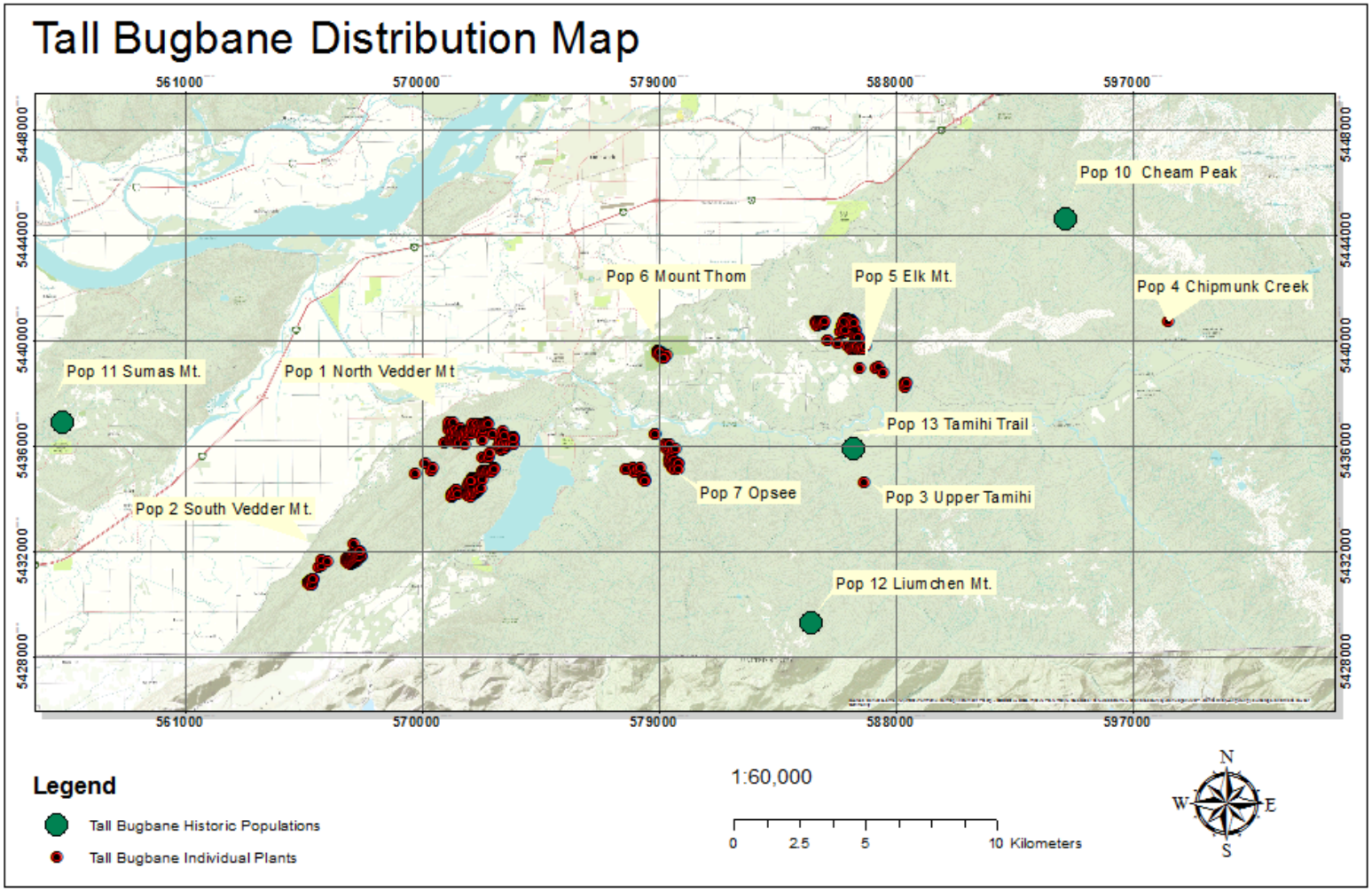

Figure 3. Distribution of tall bugbane in British Columbia, data current to March 2013.
Map by Kym Welstead. Two populations (Chilliwack River, Mount Cheam) are not mapped, owing to location uncertainty.

Table 1. Summary of tall bugbane sites in British Columbia as of March 2013.

Population no. [a]	Location	# of plants (or site status)	Last year observed	Observers	Land tenure
1	North Vedder Mountain	571	2009	D. Knopp	Provincial Crown
2	South Vedder Mountain	621	2009	D. Knopp	Private/ Provincial Crown
3	Upper Tamihi	Present	1997	J. Penny and S. Hartwell	Provincial Crown
4	Chipmunk Creek	Present	1997	Fontaine and S. Hartwell	Provincial Crown
5	Elk Mountain	218	2009	D. Knopp	Provincial Crown/ First Nations Woodlot/ Municipal
6	Mount Thom	43	2007	K. Welstead, T. Kerr, N. Libal, S. Ramey, and Z. Slater	Municipal/ Provincial Crown
7	Opsee	107	2010	D. Knopp	Federal leasehold (Department of Defense)/ Provincial Crown
10	Cheam Peak	Historical	1989 [b]	Scagel	Provincial Crown
11	Sumas Mountain	Historical	~1986 [b]	G. Ryder	Municipal /Provincial Crown
12	Liumchen Mountain	Historical (presumed extirpated)	1957	Beamish/Vrugtman	Provincial Crown
13	Tamihi Trail	Historical (presumed extirpated)	1982	Scagel	Provincial Crown
8 [c] (Not mapped)	Chilliwack River	Status unknown	1901	Macoun	Unknown
9 [c] (Not mapped)	Mount Cheam	Status unknown	1895	Gowan	Unknown
TOTAL		**~1580**			

[a] Note that population numbers are simply a label; they are not necessarily in sequence and are not meant to indicate the total number of sites.
[b] Revisited in 2005 and 2006 by Barsanti and Iredale but not found.
[c] Due to the uncertainty in the location of this record this site could not be mapped and land tenure could not be determined. Given the large area, the location could cover the status of the site is also unknown.

3.3 Needs of the Tall Bugbane

3.3.1 Habitat and Biological Needs

Tall bugbane is a rhizomatous, partial shade-loving species (preferring high understory light) species in moist, old-growth and mature forests in the Pacific Northwest (Alverson 1986; Wentworth 1996; Penny and Douglas 2001).

Associated species

In the CWH zone, tall bugbane is found in moist mixed Douglas-fir–bigleaf maple (*Pseudotsuga menziesii–Acer macrophyllum)* sites (Kaye and Kirkland 1994). These mixed or coniferous mature to old-growth forests, structural stages 5–7,[6] age 70 to 150+ years, which have distinct canopy layers; typically shade-tolerant shrubs and herbs are present in the understory. Besides bigleaf maple and Douglas-fir trees, tall bugbane can also co-occur with western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), and western hemlock (*Tsuga heterophylla*). Common associated shrubs and perennials are sword fern (*Polystichum munitum*), western trillium (*Trillium ovatum*), red elderberry (*Sambucus racemosa*), vanilla leaf (*Achlys triphylla*), and lady fern *(Athyrium filix-femina*) (Schreiner 1995; Penny and Douglas 2001) and frequently co-occurs with devil's club (*Oplopanax horridus*) (Knopp and Larkin 2005). Mayberry and Elle (2009) found associated plant species to include alpine enchanter's nightshade (*Circaea alpina*).

Cover and shade requirements

Tall bugbane prefers partial to moderate shade conditions (Wentworth 1996) with moisture, and uses gaps in the canopy when available to expedite growth, reproduction, and colonization.

Mature and old-growth forests naturally have scattered gaps in canopy (small blowdowns and tree fall) that provide the optimal light conditions for tall bugbane (Alverson 1986). Gap openings in mature and old-growth forest can re-invigorate small plants of *Actaea elata* that may have been persisting in a static state for many years (T. Kaye, pers. comm., 2003). Natural gaps in a mature forest can be large, or quite small, sometimes only a few meters across, and a small gap located in a matrix of surrounding forest would see minimal change to site conditions other than increased light. Unfortunately, natural gaps rarely occur in more uniform young to intermediate-age second-growth stands (Alverson 1986) unless they are managed to achieve mature stand attributes. Mixed stands can also provide the optimal conditions for growth as deciduous trees form an open canopy in the spring (primarily by bigleaf maple).

Canopy gaps increase the amount of light reaching the understory. High understory light under open canopies or in canopy gaps was found to increase sexual reproduction in tall bugbane (Czembor 2004). Increased light levels tend to increase flowering, seed production, seedling recruitment, and survivorship (Kaye and Cramer 2002; Mayberry and Elle 2009).

[6] For definitions of structural stages, see B.C. Ministry of Forests and Range and B.C. Ministry of Environment (2010).

Tall bugbane has been found in some anthropogenically created habitats such as forest road edges and/or early clearcuts. It appears to tolerate some forms of anthropogenic canopy opening (T. Kaye and P. Keddy, pers. comm., 2003) but ultimately overgrowth and out-competition ultimately cause decline. Out-competition by regenerating forest weeds and saplings appears to be the main cause of population loss in early seral stages. It is absent in dense managed stands of intermediate age (20–30 years) (Kaye and Cramer 2002). Old-growth stands typically contain natural canopy openings. Tall bugbane plant size and reproductive capability appear to remain fairly constant in old-growth stands (Kaye and Cramer 2002).

Moisture

Tall bugbane plants prefer moist habitats (Kaye and Kirkland 1994; Mayberry and Elle 2009). Field observations indicate that tall bugbane requires high moisture levels and is often near watercourses (creeks, streams, rivers, and subterranean flows) and upslope seepages, although often in the drier portions of these sites (D. Knopp, pers. comm., 2003).

Soil type and substrate

Wentworth (1996) describes tall bugbane species as occurring in moderately rich forest soils such as silt loams, silty clay loams, or clay loams and, in Washington, specifically occurring on soils derived from basaltic rock, argillaceous sandstone and shale, and gravelly or alluvial deposits.

Based on the *Soil Landscapes of Canada* (Centre for Land and Biological Resources Research 1996), most tall bugbane populations occur within the region mapped as mineral non-calcareous well-drained soils with a root depth of 20–75 cm (B.C. Ministry of Environment, Lands and Parks 2001). More detailed soil surveys would be beneficial to clarify site specific soil types.

Slope, aspect, and elevation

In B.C., tall bugbane occurrences appear to be linked to mesic to wet-mesic mid-slope benchlands with a slope, variance from 1 to 49^{o}. Tall bugbane has been found at one location on a slope that was almost 50^{o} (D. Knopp, pers. comm., 2008). The literature on tall bugbane (e.g., Kaye 1995, 1999, 2000) indicates that this species occurs preferentially on north-facing slopes, with some populations occurring on other aspects. However, in overlaying the occurrences of B.C. plants, it is apparent that while some populations do occur on north-facing slopes (Population 1), portions of populations also occur on south-facing slopes (Populations 2, 5, 7) or west-facing slopes (Populations 1, 2, 6, 7) and even east-facing slopes (part of Population 1) .

In B.C., tall bugbane is reported from low to mid-elevations 30–950 m (Ramsey 1987, 1997; Wentworth 1996; Penny and Douglas 2001; Klinkenberg 2003a, 2003b). One exception is an historical population 10 reported by Scagel near the top of Mount Cheam (Ceska 1996) that apparently occurred at a much higher elevation (1200–1600 m).

3.3.2 Biology

Lifespan

Tall bugbane is reported as having a relatively long lifespan (Alverson 1986), with a median life span of between 4 and 6 years and possibly longer (Kaye 2000; T. Kaye, pers. comm., 2003). Kaye (pers. comm., 2003) has indicated these are average lifespans, and that the length of time that an individual plant (as a rhizome and/or plant) can persist in low light conditions is unknown but could be as long as 50 years.

Reproductive conditions, biology, and dormancy

Flowering

Tall bugbane flowers in British Columbia from mid to late June through to late July and early August (Penny and Douglas 2001). The plants can produce several racemes featuring 50–900 small white, showy spray-like white flowers and collectively form a bottlebrush appearance. Flowering is sequential, with not all flowers in bloom at a time (Pellmyr 1985a, 1985b; Wentworth 1996). Each flower of tall bugbane can produce 1, and sometimes 2–3, capsules containing 6–12 "heavy" seeds (Kaye 2000; Wentworth 1996; Penny and Douglas 2001).

Within old-growth forest habitat, tall bugbane plants appear to have greater reproductive success in locations that are farther from trees (greater direct canopy openness), with relatively higher herb cover, greater moisture, and more moss cover (Mayberry 2008; Mayberry and Elle 2009). Mayberry and Elle (2009) found alpine enchanter's nightshade (*Circaea alpina*) to be a strong indicator of flowering tall bugbane. In unfavorable conditions, such as low light, tall bugbane will become dormant. During these times the plants occur in a reduced vegetative state, awaiting a canopy opening that will facilitate more extensive growth and reproduction. This species exhibits short periods of dormancy of usually 1, or sometimes 2 years, with 7.5–12.4% of a population being dormant at any one time, depending on the population studied (Kaye 2000). In B.C., dormancy was observed at a noticeable rate (6%) at only 1 of 4 populations monitored from 2005 to 2007 (Mayberry 2008).

Seed germination

Seeds are produced during the summer months and are dispersed by gravity within a few metres of the parent plant (Kaye and Kirkland 1994; Wentworth 1996). Kaye (2000) found that new seedlings become small vegetative plants the following year, but only a few individuals will mature, with the rest remaining small and vegetative. Mortality is reported as highest for seedlings and lowest for reproductive plants (Kaye 2000). Germination trials (Kaye and Kirkland 1994; Kaye 2001b) indicated that warm stratification (i.e., seeds placed under moist conditions and subjected to alternating daily temperature regime) at 15^{o}C and 25^{o}C for 2 weeks and followed by cold stratification at 5^{o}C for 3 months was required to break dormancy. No seeds germinated when only using cold stratification at 4^{o}C.The length of seed viability in the soil is unknown (Wentworth 1996). Kaye (pers. comm., 2003) feels long-term viability is limited, and this may limit seed banking opportunities for this species. However, given the potential conservation value of seed banks, this may warrant further investigation.

Root morphology

Tall bugbane is classed as a rhizomatous geophyte (Klinkenberg and Klinkenberg 2003a). A rhizome is a modified underground stem, and the stem tissue is the primary storage tissue. As such, every node on a rhizome is capable of asexual reproduction and can potentially produce roots and shoots. As well, this underground stem allows this perennial plant to overwinter below ground.

Pollination biology

Tall bugbane is a nectarless species that is structured both for self-fertilisation (selfing) and out-crossing. However, the primary reproductive mechanism appears to be selfing (Pellmyr 1986).

Tall bugbane pollinators may include bumblebees, solitary bees, the introduced honeybee, hoverflies, beetles, and pollen-foraging flies, with solitary bees observed more often than any other pollinator (Penny and Douglas 2001). Mayberry (2008) found that tall bugbane flowers in B.C. were visited infrequently by pollinators (2.78 visits per hour) and less than that reported for other *Actaea* species (Pellmyr 1986). All of these visitors were hoverflies and no bumblebees were recorded during observations. However, Mayberry (2008) also found that tall bugbane fruit production in B.C. was not limited by pollen deposition. Specifically, flowers to which pollen had been applied by investigators did not produce more fruit than those without pollen addition. Additionally, flowers that had been excluded from pollinators had similar rates of fruit production to those flowers that had been left open to pollinators. It is unknown whether there is reduced fitness due to breeding amongst related individuals (i.e., inbreeding depression), which affects the quality of seed in this species (Mayberry 2008).

Genetics

A genetic diversity survey of B.C. populations suggests there is little genetic variation within or between populations (Mayberry 2008). Liston and Gray (1998) also found that there is limited gene flow between populations of tall bugbane, stating “this is consistent with the observation of self-compatibility and limited pollen movement.”

3.4 Limiting Factors

Limiting factors are generally not human induced and include characteristics that make the species or ecosystem less likely to respond to recovery/conservation efforts (e.g., inbreeding depression, small population size, and genetic isolation; or likelihood of regeneration or recolonization for ecosystems).

In its natural, undisturbed state, this species is potentially limited by a number of biological factors that commonly affect all plant populations, but which may have more serious effects on rare species that occur in low numbers in few populations. Rarity itself imposes limitations (Caughley and Gunn 1996).

Rare and small populations

This species is naturally rare in the landscape with few known extant populations, typically comprised by a relatively low number of individuals. These small and rare populations leave the species vulnerable to environmental and demographic stochastic events. Catastrophic disturbances, both natural and anthropogenic, can devastate an entire population when numbers are low (Caughley and Gunn 1996).

Species with low population numbers are precarious because of the potential impact of the founder effect and genetic drift (Menges 1991; Fischer, Husi, *et al*. 2000; Fischer, van Kleunen, *et al*. 2000). These authors have also pointed out that in other rare clonal *Ranunculus* species,[7] such as lesser spearwort (*Ranunculus reptans)*, genetic drift occurs despite the long-lived and clonal nature of the species. Genetic drift may cause gene variants to be removed from a population, reducing genetic variation. In addition, the founder effect can occur when a new population is established by a very small number of individuals from the larger population. This means the new population does not contain the full representation of genes, which results in the loss of genetic variation.

Liston and Gray (1998) examined populations (included 2 B.C. populations) throughout the range of tall bugbane and found them to be genetically distinct and isolated from other populations. This is different from the findings of Mayberry (2008) who found little genetic variation within or between populations in BC.

Habitat specificity

Tall bugbane occurs in the Coastal Western Hemlock (CWH) zone within the dry maritime subzone, the warmest subzone (mean annual temperature of 9.8°C), which has the greatest number of months with a mean temperature greater than 10°C (5.7 months) (Meidinger and Pojar 1991). This climatic restriction as well as habitat specificity and availability within the CWH zone with limited mixed or coniferous mature to old-growth forests, structural stages 5–7, age 70 to 150+ years remaining limits the species' occurrence in B.C. and in the Fraser Valley.

Dispersal

Limited dispersal mechanisms for this species may influence population expansion and recovery. The seed capsules of tall bugbane split open down one side (dehisce) and seeds are dispersed by gravity to within a few metres of the parent plants (Wentworth 1996). Other dispersal strategies may be on the hooves of deer and perhaps other mammals, such as mountain beaver, which have overlapping habitat requirements (D. Knopp, pers. comm., 2003). Keddy (pers. comm., 2003) speculates that other species of *Actaea* may have been dispersed by bears in the past, and that decline in bear populations may reduce the potential for dispersal.

[7] A clonal colony is a group of genetically identical individuals.

4 THREATS

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future, the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational) (Salafsky *et al.* 2008). For purposes of threat assessment, only present and future threats are considered.[8] Threats do not include limiting factors, which are presented in Section 3.4.[9]

For the most part, threats are related to human activities, but they can be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., invasive species introduction). Effects of natural phenomena (e.g., fire, hurricane, flooding) may be especially important when the species or ecosystem is concentrated in one location or has few occurrences, which may be a result of human activity (Master *et al.* 2009). As such, natural phenomena are included in the definition of a threat, though should be applied cautiously. These stochastic events should only be considered a threat if a species or habitat is damaged from other threats and has lost its resilience, and is thus vulnerable to the disturbance (Salafsky *et al.* 2008) so that these types of events would have a disproportionately large effect on the population/ecosystem compared to the effect they would have had historically.

4.1 Threat Assessment

The threat classification below is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system and is consistent with methods used by the B.C. Conservation Data Centre and the B.C. Conservation Framework. For a detailed description of the threat classification system, see the CMP website (CMP 2010). Threats may be observed, inferred, or projected to occur in the near term. Threats are characterized here in terms of scope, severity, and timing. Threat "impact" is calculated from scope and severity. For information on how the values are assigned, see Master *et al.* (2009) and table footnotes for details. Threats for the tall bugbane were assessed for the entire province (Table 2).

[8] Past threats may be recorded but are not used in the calculation of Threat Impact. Effects of past threats (if not continuing) are taken into consideration when determining long-term and/or short-term trend factors (Master *et al.* 2009).

[9] It is important to distinguish between limiting factors and threats. Limiting factors are generally not human induced and include characteristics that make the species or ecosystem less likely to respond to recovery/conservation efforts (e.g., inbreeding depression, small population size, and genetic isolation; or likelihood of regeneration or recolonization for ecosystems).

Table 2. Threat classification table for tall bugbane in British Columbia.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Population #
1	Residential & commercial development	Medium	Restricted	Serious	High	
1.1	Housing & urban areas	Low	Restricted	Moderate	High	2, 6, 11
1.3	Tourism & recreation areas	Medium	Restricted	Serious	High	1, 2, 3, 4, 5, 6
4	Transportation & service corridors	Low	Restricted	Moderate	High	
4.1	Roads & railroads	Low	Restricted	Moderate	High	1, 2, 11
5	Biological resource use	High	Large	Moderate	High	
5.2	Gathering terrestrial plants	Low	Small	Serious	High	All
5.3	Logging & wood harvesting	High	Large	Moderate	High	1, 2, 3, 4, 5, 7,
6	Human intrusions & disturbance	High	Large	Moderate	High	
6.1	Recreational activities	High	Large	Moderate	High	1, 2, 5, 6, 11
7	Natural system modifications	Low	Small	Moderate	High	
7.1	Fire & fire suppression	Unknown	Small	Unknown	Low	All
7.3	Other ecosystem modifications	Low	Small	Moderate	High	All
8	Invasive & other problematic species & genes	Unknown	Restricted	Unknown	High	
8.1	Invasive non-native/alien species	Unknown	Restricted	Unknown	High	All
8.2	Problematic native species	Negligible	Restricted	Negligible	High	All
9	Pollution	Medium	Restricted	Serious	High	
9.3	Agricultural & forestry effluents	Medium	Restricted	Serious	High	1, 2, 3, 4 ,5, 7,
10	Geological events	Low	Small	Moderate	High	
10.3	Avalanches/landslides	Low	Small	Moderate	High	All
11	Climate change & severe weather	Unknown	Small	Unknown	Moderate	
11.2	Droughts	Unknown	Small	Unknown	Moderate	All

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment (e.g., timing is insignificant/negligible [past threat] or low [possible threat in long term]). Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.
[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).
[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or 3-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).
[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2 Description of Threats

The overall province-wide threat impact for this species is very high.[10] The overall threat impact considers the cumulative impacts of multiple threats. Major threats include logging and recreation activities (Table 2). Details are discussed below under the Threat Level 1 headings.

IUCN-CMP Threat 1. Residential & commercial development

1.1 Housing & urban areas

The Fraser Valley continues to be an area of concentrated land development and increasing urbanization. This is particularly true near Promontory and the Ryder Lake areas in Chilliwack and surrounding areas where extensive ongoing housing developments will likely impact not yet discovered populations. The Chilliwack population growth rate is projected to be an average of 8.3% per year over the next 10–15 years which is higher than the B.C. average and population numbers are expected to reach 109,000 people in 2026 (Decision Support Services 2010). Additionally, there is currently extensive clearing for housing developments on Sumas Mountain in Abbotsford where a historical tall bugbane occurrence has been documented.

1.3 Tourism & recreation areas

The development of recreation areas on Vedder and Elk mountains is an increasing concern. The expansion of the trail system through several of the sites has damaged habitat and resulted in the loss of plants through mud bogging, dirt biking trails, as well as hiking and mountain biking (see IUCN-CMP Threat 6.1). Dirt biking trail construction is an issue at the Sumas Mountain historical site, where ground cover is often completely eradicated, trees felled for "bridging" to create crossings over inaccessible areas, and other bike trail activities occur (Iredale and Barsanti 2006). With the ever-increasing population in the Fraser Valley and housing development in and around Chilliwack and Abbotsford, the numbers of trails and people using them is expected to continue to grow.

IUCN-CMP Threat 4. Transportation & service corridors

4.1 Roads & railroads

Clearing for roads at any sites may cause direct mortality and indirect changes to the habitat suitability, change microclimate conditions, alter hydrological conditions (e.g., through culverting), and result in canopy removal. Tall bugbane on Elk Mountain does inhabit a portion of the damp roadsides but these roads are narrow dirt forestry roads that do retain cover and are not ideal habitat given spraying, soil erosion, and other threats. Roads also increase access to the sites, which may enable other threats such as invasive species, plant harvesting, trails, camping, mud bogging, etc. On Elk Mountain, a newly constructed road has potentially impacted that population both from direct and indirect increase in access. Illegally created roads are often

[10] The overall threat impact was calculated following Master *et al.* (2009) using the number of Level 1 Threats assigned to this species where Timing = High or Moderate, which included 2 High, 2 Medium, and 3 Low (Table 2).

created to access off-roading and mudding bogging sites. On Vedder Mountain, legal and illegally created roads continue to be accessed and cleared.

IUCN-CMP Threat 5. Biological resource use

5.2 Gathering terrestrial plants

The collecting of plants and plant parts for native plant gardening and herbal medicine is a concern. Tall bugbane is listed on several web sites and has been reported in general references as having medicinal value (Moore 1993). On rare occasions, the plant may be collected for use in alternative medicine; this activity is likely infrequent because the plant is poisonous. Whole plants of tall bugbane may also be dug up for use as propagation stock by native plant nurseries.

5.3 Logging & wood harvesting

Tall bugbane is threatened by logging operations that both directly and indirectly impact plant populations through canopy loss, clearing of larger than natural gaps that are slow to regenerate, and habitat fragmentation. To date, at least 2 B.C. populations have been lost due to clearcutting (Penny and Douglas 2001; D. Knopp, pers. comm., 2011). Logging activities may include edge effects (Chen *et al.* 1992) that alter environmental conditions such as growing conditions, light, and moisture into the forest adjacent to the road making the habitat less suitable. Edge effects will vary from site to site, and depend on proximity to the plants, the slope and aspect of the site, and prevailing air movement patterns. Related effects of logging operations that lead to other threats are scored separately and include clearing for access (roads, helipads; see Threat 4.1), increased access (trampling and recreational use; see Threat 6.1), influx of invasive species as competitors (see Threat 8.1), and post-logging treatments that include spray drift[11] and seeding (see Threat 9.3).

Logging is a threat at several sites. Seven Wildlife Habitat Areas (WHAs) were approved for tall bugbane in 2007, with general wildlife measures that afford some level of mitigation for the threat of logging (B.C. Ministry of Environment 2013). However, since 2007, 80% of the known occurrences of tall bugbane have been discovered outside the existing WHAs and may be susceptible to the threat of logging until additional WHAs that prevent or moderate this activity are approved. One site is found in a municipal park where logging does not currently occur.

Both illegal and legal (by permits issued through the Ministry of Forests Lands and Natural Resource Operations) removal of large individual trees of bigleaf maple affects tall bugbane due to the ecological changes that occur. For instance, significant loss of canopy cover and changes in site hydrology and soil structure will reduce the suitability of the site for tall bugbane. The frequency of this threat is increasing with removal of bigleaf maple both with and without permits in the Chilliwack Valley (R. Vennesland, pers. comm., 2007). The wood is highly desired for use in construction of guitars and other wood-based products (Barsanti *et al.* 2007).

[11] Spray drift is the physical movement of a pesticide through air at the time of application or soon thereafter, to any site other than that intended for application.

IUCN-CMP Threat 6. Human intrusions & disturbance

6.1 Recreational activities

Recreational activities are a concern at nearly all populations. In particular dirt biking is an issue at the historical population 11 Sumas Mountain site where any ground cover is often completely eradicated (Iredale and Barsanti 2006). Recreational trails managed under Recreation Sites and Trails BC and illegal trails are also pervasive across Elk and Vedder mountains (populations 1, 2, and 5), directly impacting these populations. Population 1 on North Vedder Mountain was partially impacted by mud bogging in 2013 even though it was within a WHA area (WHA 2-146; K. Welstead, pers. comm., 2013). Mud bogging is the repeated driving of off-road vehicles over and through an area, which can result in changes in the hydrology and soil conditions of that area. In the case of the Population 1, all that remains is a deep flooded rectangular muddy ditch where some of the plants previously grew. Population 6 is adjacent to several park trails and requires careful management.

IUCN-CMP Threat 7. Natural system modifications

7.1 Fire & fire suppression

Fire suppression was identified as a threat to this species' survival in the COSEWIC status report (Penny and Douglas 2001). Kaye (2000) mentions fire suppression as a potential threat to this species, as this species may require a fire regime to reach maximum densities, a response to reduced competition, increased light, and a nutrient flush. Additionally, fire suppression could result in high fuel loading resulting in more intense fires. This may in turn kill seeds and rhizomes that might be able to resist mild surface fires. Alverson (1986) and Wentworth (1994) describe the presence of several populations of tall bugbane at U.S. sites where fires are known to occur and plant population numbers are high, indicating some degree of fire tolerance. However in B.C., the CWHdm subzone has a "natural disturbance type 2 (NDT2)," characterized by large-scale, catastrophic fires (average 5–50 ha) with a return interval averaging 150–350 years (B.C. Ministry of Forests 1995). In the Chilliwack River Valley, a severe fire was documented for the area in 1938 (Chilliwack Forest District 2003; G. MacInnes, pers. comm., 2003). Populations in this area have persisted despite these intense low frequency fires but the degree of fire resistance is still not quantified and the role of the fire cycle in sustaining healthy viable populations is unknown.

7.3 Other ecosystem modifications

Roadside maintenance activities pose a threat to at least one known population of tall bugbane on Elk Mountain (population 5; Figure 6) and likely other populations on Vedder Mountain (populations 1 and 2) and Mount Thom (population 6). Roadway grading, as well as grass trimming and brush cutting, can damage habitat and smother plants.

Pesticides used on surrounding agricultural areas and land clearing can have a detrimental impact on the availability of pollinators for native species including tall bugbane.

Figure 4. Tall bugbane plant upslope from a road.
Photo credit: Brian Klinkenberg.

IUCN-CMP Threat 8. Invasive & other problematic species & genes

8.1 Invasive non-native/alien species

An indirect impact from increased access and logging roads is the increasing distribution of non-native species. For example, the invasive species small touch-me-not (*Impatiens parviflora*) has been documented at several tall bugbane sites. Other fast-growing opportunistic species such as Himalayan blackberry *(Rubus armeniacus) may* outcompete and shade out tall bugbane. Mayberry (2008) also found wall lettuce (*Mycelis muralis*) and Robert's geranium (*Geranium robertianum*), which may act as competitors.

8.2 Problematic native species

Mayberry and Elle (2010) found that although populations were more stable in coniferous stands than broadleaved stands, recruitment was lower in coniferous stands. Broadleaved stands at Vedder Mountain have greater herbivory and higher reproduction, but also higher mortality and notably smaller leaves compared to the coniferous stand at Elk Mountain. This suggests that the plants may be stressed due to herbivory. As a result of habitat modifications in the Chilliwack area herbivore numbers are increasing. Herbivores reported for tall bugbane include Deer, Elk, and Mountain Beaver (Kaye and Cramer 2002).

In studies in the U.S., Kaye (2000, 2001a, 2001b, 2001c, 2002) reports high levels of herbivory for some populations, although herbivory levels fluctuate from year to year. Kaye (1999) also concludes that herbivory by Deer and Elk is more frequent in clearcuts and edges than in unmanaged old-growth forests.

IUCN-CMP Threat 9. Pollution

9.3 Agriculture & forestry effluents

Spray drift from herbicide treatment is a direct threat since the species is susceptible to herbicide and can cause direct mortality. The threat of spray drift depends on slope and prevailing air movement. The Elk Mountain population 5 has been subjected to herbicide spraying - glyphosate to control roadside vegetation (Barsanti *et al.* 2007). Herbicides used for road maintenance, agriculture, invasive species management, and silviculture are a concern at several other sites in particular populations 1 and 2 on Vedder Mountain. Populations 3, 4, and 7 are also susceptible depending on the adjacent land use, proximately to roads and silviculture prescription.

IUCN-CMP Threat 10. Geological events

10.3 Avalanches/landslides

As many of the populations are associated with seepage areas, the likelihood of natural and induced landslides is substantial. Road cuts and clearing for helicopter landing pads (population 5), and clearcut logging (populations 3, 4, 10, and 12), particularly on steeper slopes, can increase the risk of slides, slumps, or erosion (especially over time). Slides or slumps can change the soil structure and habitat suitability for tall bugbane. Although this is a potential threat at all locations, the scope of this threat is small as only a small portion of the populations would ever be effected during any given 10-year period.

IUCN-CMP Threat 11. Climate change & severe weather

Droughts

The impact of climate change on the hydrology and forest composition is unknown. It will be crucial to monitor these impacts as tall bugbane is closely associated with moist forest and seepage areas thus droughts may have an impact on the species.

5 RECOVERY GOAL AND OBJECTIVES

5.1 Recovery (Population and Distribution) Goal

The overall recovery (population and distribution goal) of tall bugbane in B.C. is:

To ensure that the number of populations and quality and quantity of occupied habitat remains stable or increases across the tall bugbane's existing range, and where feasible, to restore additional populations and connective habitat within the tall bugbane's historical range in B.C.

5.2 Rationale for the Recovery (Population and Distribution) Goal

Tall bugbane has a restricted geographic range (peripheral species) and is naturally rare on the landscape. Because of this, it is unlikely that tall bugbane will ever be down-listed to a status of threatened. As such, the population and distribution goal has been set to ensure the long-term persistence of this species. With only 13 sites ever known in B.C. (7 extant populations, 6 unconfirmed/historical), it is important that all 7 known extant sites and any newly discovered sites (i.e., plants/populations that may be found during future inventories) are maintained. Without adequate protection, the probability of species extirpation from B.C. is considered high (COSEWIC 2001).

Based on the threats and population assessments in B.C., Mayberry and Elle (2010) suggest that conservation measures should include preventing mortality and increasing recruitment at occupied sites as well as historical sites. If the quantity of occupied habitat is known to be decreasing at a site, it may be necessary to increase recruitment through augmentation. To ensure the persistence and long-term viability of tall bugbane in B.C., historical sites should be restored to the extent possible. Restoring populations will likely require re-introduction through propagules. As this species is naturally rare and has a restricted distribution, artificial expansion of populations beyond its naturally occurring range and confirmed sites is not recommended unless unexpected conditions occur that modify the habitat significantly (e.g., through climate change). Although artificial expansion is not recommended, there is a need to retain connecting habitat between plants and populations to allow for population dispersal, dynamics and response to changing habitat conditions as needed in the presence of climate change or to respond to threats.

5.3 Recovery Objectives

The recovery objectives for this species are:

1. to remove or manage threats, and protect[12] and restore habitat at all extant populations;
2. to assess, restore, or enhance habitat, and re-establish populations at historical sites where feasible;
3. to conduct further inventory within the known range of the species in B.C. to prevent inadvertent loss of populations that have not yet been identified within suitable habitat;
4. to determine the effectiveness of habitat protection/enhancement measures and recovery actions by monitoring population status; and
5. to inform and refine management decisions by improving our understanding of threats, population ecology, and habitat requirements.

[12] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

6 APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Underway

The following actions have been categorized by the action groups of the B.C. Conservation Framework (B.C. Ministry of Environment 2010). Status of the action group for this species is given in parentheses.

Compile Status Report (complete)

- COSEWIC report completed (Penny and Douglas 2001).
- Genetic research using allozyme markers on populations in B.C. have been completed (Mayberry 2008).
- A demographic study has been undertaken at 4 populations, resulting in 3 years of data (2005–2007; Mayberry 2008).

Send to COSEWIC (complete)

- Tall bugbane assessed as Endangered (Penny and Douglas 2001). Re-assessment was due in 2011.

Planning (complete)

- BC Recovery Plan completed (this document, 2014).

Habitat Protection and Private Land Stewardship (in progress)

Table 3. Existing provisions for habitat protection for tall bugbane.

Existing habitat protection	Threat[a] or concern addressed	Site No.
Wildlife Habitat Areas (7 established)	5.3	Portions of sites 1, 2, 5
Municipal park bylaws	1.1, 4.1, 5.3, 9.3	Site 6
Wildlife Tree Patch	5.3	Portion of site 2
"Visual landscape" reserve	5.3	Portion of site 2

[a] Threat numbers according to the IUCN-CMP classification (see Table 2 for details).

- Tall bugbane is listed as a species that requires special management attention to address the impacts of forest and range activities under the *Forest and Range Practices Act* (FRPA) and/or the impacts of oil and gas activities under the *Oil and Gas Activities Act* (OGAA) on Crown land (as described in the Identified Wildlife Management Strategy; Province of British Columbia 2004).
- 7 Wildlife Habitat Areas (WHAs) in the Chilliwack Forest District were established in 2007 for tall bugbane. Most of the WHAs were established to have a 50-m core area surrounding each tall bugbane population, with a 200-m management zone extending beyond the core depending on site-specific characteristics (as described in the Identified Wildlife Management Strategy; Province of British Columbia 2004).
- To date, 71 ha of the 348 ha of core survival habitat described in Section 7 is protected by WHAs (B.C. Ministry of Environment 2013).

- General Wildlife Measures that apply within WHAs address access issues, forest harvesting and silviculture, pesticide use, and range activity (Penny 2004). The following key measures describe what is currently in place (but are not limited to):
  - do not harvest within WHA core area for tall bugbane, except for treatments aimed at maintaining or improving stand characteristics for this species.
  - use partial harvesting systems in the WHA management zone for tall bugbane that maintain 60% basal stem area.
  - remove 40% basal stem area in small openings with a minimum of only a few crowns per gap.
  - retain *Acer* species, particularly *Acer macrophyllum*. Retain at least 20–30% from inventory distribution.
- Ecological monitoring by the B.C. Conservation Corps has been initiated at several sites to obtain baseline information to monitor logging impacts (Iredale and Barsanti 2006; Barsanti *et al.* 2007).
- Predictive habitat mapping has been undertaken for this species in the lower Fraser Valley, south of the Fraser River (Klinkenberg 2005; See Appendix 1).

6.2 Recovery Planning Table

Table 4. Recovery planning table for tall bugbane.

Conservation Framework action group	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
Objective 1. To remove or manage threats, and protect and restore habitat at all extant populations			
Habitat protection; Land stewardship	• Expand established WHAs and implement new WHAs to include all tall bugbane populations.	5.3	Essential
	• Encourage inclusion of plants at risk under the *Wildlife Act*.	5.2, 5.3, 6.1, 1.1	Necessary
	• Work with the Ministry of Forests, Lands and Natural Resource Operations (FLNRO) to ensure permits for recreational use, logging, and bigleaf maple harvest are not be issued in habitats ranked as high likelihood (i.e., both red- and orange-shaded areas in Figure 4), as per the predictive modeling (see Appendix 1).	1.3, 5.3	Necessary
	• Work with trails and recreations groups, City of Chilliwack (Mt. Thom), FLNRO, Recreation Sites and Trails BC to deactivate problem trails and prohibit new trail building and mud bogging that impact tall bugbane populations especially within their core habitat.	1.3, 6.1	Essential
	• Mitigate road-side impacts from spraying and maintenance activities by ensuring the City of Chilliwack and logging road maintenance crews are aware of tall bugbane locations on road right-of-ways. Work with them to develop a schedule of when to brush roadsides and restrict activities (e.g., road widening) where populations may be harmed. Assess the appropriateness of relocation of individual plants threatened on the road right-of-way.	7.3 4.1	Necessary
	• Retain a degree of connectivity and soft edge (i.e., transition habitat, as compared to a “hard” edge, which is an abrupt line	Genetic variation	Necessary

Conservation Framework action group	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
	with no vegetative transition interface; see Voller 1998) between the populations to enable long-term dispersal, growth, and natural dispersal in response to habitat changes, stochastic events, or climates changes.		
Habitat restoration	• Reduce access points through road and trail deactivation.	5.2, 6.1	Beneficial
	• Restore impacted sites (e.g., clearcut sites, road sides, and helipad sites) to ensure the ecosystem/habitat is regenerating in a way that would support future tall bugbane recovery.	4.1, 5.3, 10.3	Beneficial
Objective 2. To assess, restore, or enhance habitat, and re-establish populations at historical sites where feasible			
Habitat restoration	• Assess the suitability of historical sites including surrounding areas and connecting sites (adjacent to occupied sites). Consider the potential to repopulate each site.	Knowledge gap; Small population and genetic variation	Beneficial
	• Restore or enhance habitat if needed to ensure that the historical sites remain or become suitable to allow recolonization or re-establishment.	All	Beneficial
Species and population management	• Investigate augmenting and re-introduction techniques giving consideration to maintaining genetic composition. Assess genetic work and ecological implications of population enhancement (including seed collection).	Knowledge gap; Genetic variation	Necessary
	• Investigate population management options where recruitment rates are low.	Knowledge gap; Genetic variation	Beneficial
	• Re-established plants in historical locations, if feasible.	Small population	Necessary
Objective 3. To confirm distribution of the known range of the species in B.C. to prevent inadvertent loss of populations that have not yet been identified within suitable habitat			
Habitat protection; Land stewardship	• Survey known extant populations and conduct targeted inventory including a thorough search of all potential habitats (using the predictive habitat model; see Appendix 1) to assess the prevalence of tall bugbane on the landscape and to obtain accurate estimates of populations sizes and distribution.	Knowledge gap	Necessary
	• Develop an awareness campaign for related stakeholders (forestry, recreational users, and authorities) alerting them to the presence of tall bugbane in their work area, conducting field trips to help practitioners identify the species in the field, using the tall bugbane brochure as a key information source.	5.2, 5.3, 6.1, 7.3, 9.3	Necessary
	• Ensure mapping of survival and recovery habitat is current and accessible. Distribute maps to stakeholders, First Nations, and other land managers to aid them in identifying areas where they should use caution or seek expert advice.	1.1, 5.2, 5.3, 6.1, 7.1, 7.3, 9.3	Necessary
	• Educate outdoor user groups regarding the long-term threat to tall bugbane from recreational trail development and expansion and how to identify this species; partner with stewardship groups such as South Coast Conservation Program and BC Stewardship Centre to develop an extension strategy for tall bugbane in combination with other species at risk.	5.2, 6.1	Beneficial
Objective 4. To determine the effectiveness of habitat protection/enhancement measures and recovery actions by monitoring population status			
Habitat protection	• Establish a monitoring program to determine the effectiveness		

Conservation Framework action group	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
	of WHA. Set up monitoring plots to: o Evaluate the effectiveness of protective measures, such as evaluate the effectiveness of implemented buffer in WHAs; o Provide early detection and mitigation of site-level threats (e.g., plant collectors, adjacent land use, new trails, poaching of bigleaf maple); and o Track potential effects of climate change or natural geological events.	1.3, 5.2, 5.3, 6.1, 7.3 1.3, 5.2, 5.3, 6.1 11.2	Necessary Necessary Beneficial
Objective 5. To inform and refine management decisions by improving our understanding of threats, population ecology, and habitat requirements.			
Species and Population management	• Conduct research to study longevity, genetic strength, pollination, dormancy, and population fluctuations.	Knowledge gap;	Beneficial
	• Conduct research to study site attributes for tall bugbane.	Knowledge gap	Beneficial
	• Monitor and mitigate impacts from invasive species.	8.1	Beneficial
	• Asses the impacts of herbivory and mitigate (e.g., exclusion fencing) where needed.	8.2	Beneficial
	• Establish a 10-year monitoring program of seed set, recruitment, dormancy, population health, and viability.	Knowledge gap	Necessary

[a] Threat numbers according to the IUCN-CMP classification (see Table 2 for details).
[b] Essential (urgent and important, needs to start immediately); Necessary (important but not urgent, action can start in 2–5 years); or Beneficial (action is beneficial and could start at any time that was feasible).

6.3 Narrative to Support Recovery Planning Table

The two main threats to tall bugbane at all sites in B.C. are direct and indirect impacts from forest management practices and recreational activities causing habitat loss and degradation. Where established, WHAs have alleviated much of this threat (K. Welstead, pers. comm. 2014; see also Appendix 3). Remaining threats, including herbicide spraying, invasive weeds, roadways, and other threats, can be mostly addressed through the implementation of the approaches listed in Table 3. WHAs have been recommended for all but one site (Mount Thom is in a municipal park). WHAs allow for the establishment of a protected core area surrounded by a "managed" buffer zone (see Section 6.1, "Actions Already Completed or Underway").

Continuing to conduct targeted inventory following *Protocols for Rare Vascular Plant Surveys* (Penny and Klinkenberg 2013) will increase our understanding of the population dynamics of this species. This will include a thorough search of all potential habitats so that rarity can be effectively gauged; and to obtain accurate estimates of populations sizes and distribution, so that appropriate conservation measures can be taken. If new populations are identified, habitat management, protection, and stewardship should be initiated.

7 INFORMATION ON HABITAT NEEDED TO MEET RECOVERY GOAL

Threats to tall bugbane habitat have been identified. Survival and recovery habitats have been determined for this species to aid in threat mitigation. The description of survival and recovery habitat provided will also facilitate other actions that are required to meet the recovery (population and distribution) goal, such as land management and habitat protection efforts.

7.1 Description of the Species' Survival and Recovery Habitat

The currently known occurrences of tall bugbane are used as a basis for defining **survival habitat** within the context of this recovery plan. Any newly found sites with plants should also be included as survival habitat.

The known historical occurrences of tall bugbane where suitable habitat exists or can be restored are used as a basis for describing **recovery habitat** within the context of this recovery plan.

Actions in the recovery planning table (Section 6.2) include conducting additional surveys in the range of tall bugbane, which may result in the discovery of other occupied sites. This will provide additional information necessary to refine the description of survival/recovery habitat that is needed to meet the recovery (population and distribution) goal. The description of survival/recovery habitat is based on the best available science and will be updated as more information becomes available.

7.1.1 Biophysical Attributes of Survival and Recovery Habitat

The following description of biophysical attributes of survival and recovery habitat is based on the best available knowledge of this species and its habitat in B.C. This description should be updated as information collected as a result of recovery actions or research adds to our scientific knowledge of this species.

The known biophysical attributes of survival and recovery habitat that are required to support tall bugbane are (COSEWIC 2001):

- best supported by intact mature to old-growth forests (> 70 years old);
- primarily in mixed Douglas-fir or western redcedar–western hemlock stands with at least 20–30% bigleaf maple (*Acer macrophyllum*) representation;
- having natural gap formation through senescence but are windfirm[13] to prevent large-scale blowdowns;
- having distinct canopy layers and relatively sparse understory providing natural partial to moderate shade through scattered openings in the canopy;
- gentle to steep slopes with stable hydrological conditions provided by subsurface moisture typically within riparian areas of shaded watercourses such as creeks/streams/rivers or proximate to moist slopes or seepage areas; and
- generally below 1600 m in elevation.

[13] Windfirm refers to a stand that is unlikely to blow down.

7.1.2 Description of Survival Habitat

Where populations are known to be extant[14] (i.e., for the 7 known sites, as of 2013, and including any populations that may be identified in the future), survival habitat[15] is identified as:

- All individual occurrences plus 50 m surrounding them, described as "core area";
- Occurrence "core area" boundaries that are within 200 m of each other are adjoined as one continuous polygon. For example, plants that were within 200 m of each other were adjoined as one continuous polygon allowing up to 100 m of additional core area to be included between them; and
- A 200-m "management zone" surrounding all core areas (as described above) is applied.

Note that areas where existing infrastructure persists on the landscape (e.g., roads, railways, and buildings) are not considered survival habitat.

A 50-m "core area" around each plant is needed to retain macro- and microclimate conditions. Tall bugbane has a strong association with aquatic features and soil moisture thus ensuring water quality and quantity are necessary to retain those features. Chen *et al.* (1990) have demonstrated soil temperature and moisture changes extend 60–120 m into Douglas-fir forests from the edge of clearcuts in Washington. Brosofske *et al.* (1997) conclude that at minimum a 45-m buffer each side of a stream is necessary to maintain a natural riparian microclimatic environment in Washington, which can be applied to retaining stable hydrological conditions provided by subsurface moisture typically proximate to a creek/stream/river/seep.

Loss of suitable connecting habitat can be a barrier to dispersal and thus gene flow. As such, plant occurrence "core area" boundaries within 200 m of each other were adjoined as one continuous polygon to connect habitat between plants within a population. Although seeds seem to not disperse far from their natal plants there is a need for this connecting/dispersal habitat. Natural expansion of populations on Vedder Mountain has been observed where the habitat was left to regenerate, effectively closing the gap between sites (K. Welstead, pers. comm., 2014). This natural process is encouraging and essential to the species recovery given the few sites in Canada. The larger (number of individuals) and more expansive (extent) the populations, the more resilient they will be (Caughley and Gunn 1996).

The 200-m "management zone" is needed to keep the core area windfirm and retain conditions/habitat attributes within it. Trees have become stressed and weakened with increases in mortality along edges of clearings (Saunders *et al.* 1991; Chen *et al.* 1992). Shirley (2004) found there was a significant drop in the deciduous tree density contributable to loss through wind damage in stands within 36–44 m of a hard edge, compared to that with a stand 100–144 m wide or greater. The management zone is needed to help preserve these mixed deciduous stands that tall bugbane requires.

The management zone is also required to protect plants from other forest edge effects such as increased herbivory and loss of moisture, as well as to maintain interior forest conditions and

[14] Extant sites are based on the most recently verified sightings (i.e., last 17 years, back to 1997) of tall bugbane.
[15] Survival habitat as described here made up of a core area and a management zone is consistent with the conservative areas recommend in the Identified Wildlife Management Strategy (Penny 2004).

provide options for population dispersal. Chen *et al.* (1990) found that air temperature and humidity change extent 120–240 m from clearcut edges into old-growth forests in the Pacific Northwest. Chen *et al.* (1995) describe declining soil moisture up to 90 m from the edge of forests. Nyberg and Janz (eds., 1990) found that edge species such as deer and other herbivores flourish in edge habitats. Kaye and Kirkland (1999) found the frequency of herbivory on tall bugbane to be 2 to 3 times greater in edges and thinned stands when compared to unmanaged stands. To protect from edge effect, Voller (1998) recommends a 200-m wide buffer to retain interior habitat.

7.1.3 Description of Recovery Habitat

Where populations are known to be extirpated and where sufficient location information is available (e.g., sites 10–13 in Table 1), recovery habitat is identified as 1000-m management zone around each historical occurrence

Note that areas where existing infrastructure persists on the landscape (e.g., roads, railways, and buildings) are not considered recovery habitat.

Historical occurrences of tall bugbane were used as a basis for describing recovery habitat. Historical sites were included as recovery habitat only if suitable habitat was known to exist or was deemed restorable. It was not possible to determine the status of the habitat associated with 2 earlier records (e.g., population 8 and 9) due to the lack of specific location data and the large area each site could cover. As such it was not possible to map these sites or use them in the description of recovery habitat.

There is uncertainty regarding the specific locations of all historical tall bugbane records. To allow for this location uncertainty, a larger management zone of 1000 m was set to describe recovery habitat. This management zone will also allow options for future recovery efforts such as habitat assessments, restoration actions, and population recruitment either from natural dispersal from adjacent populations or reintroduction. Once new or re-introduced tall bugbane occupies a site, it will be used to identify additional survival habitat and the geospatial information for survival habitat will be updated accordingly.

7.1.4 Geospatial Description of Survival and Recovery Habitat

A map showing areas with survival habitat (i.e., sites 1–7 as identified in Table 1) and recovery habitat (i.e., sites 10–13 as identified in Table 1) for tall bugbane is shown in Figure 5.

Detailed maps of areas within which survival habitat at each known site (i.e., sites 1–7 as identified in Table 1) is found is in Appendix 2 (Figures 7–13). The total area within which survival habitat occurs is currently 1445 hectares, 348 hectares of which is core area. This does not take into account areas that would be excluded (i.e., existing roads and infrastructure features and any other habitat that is deemed unsuitable or not able to be restored). This geospatial information on survival habitat to support land management decisions and protection of the

species and its habitat is available upon request by contacting the Species at Risk Biologist at the B.C. Ministry of Forests, Lands and Natural Resource Operations, Surrey, B.C.

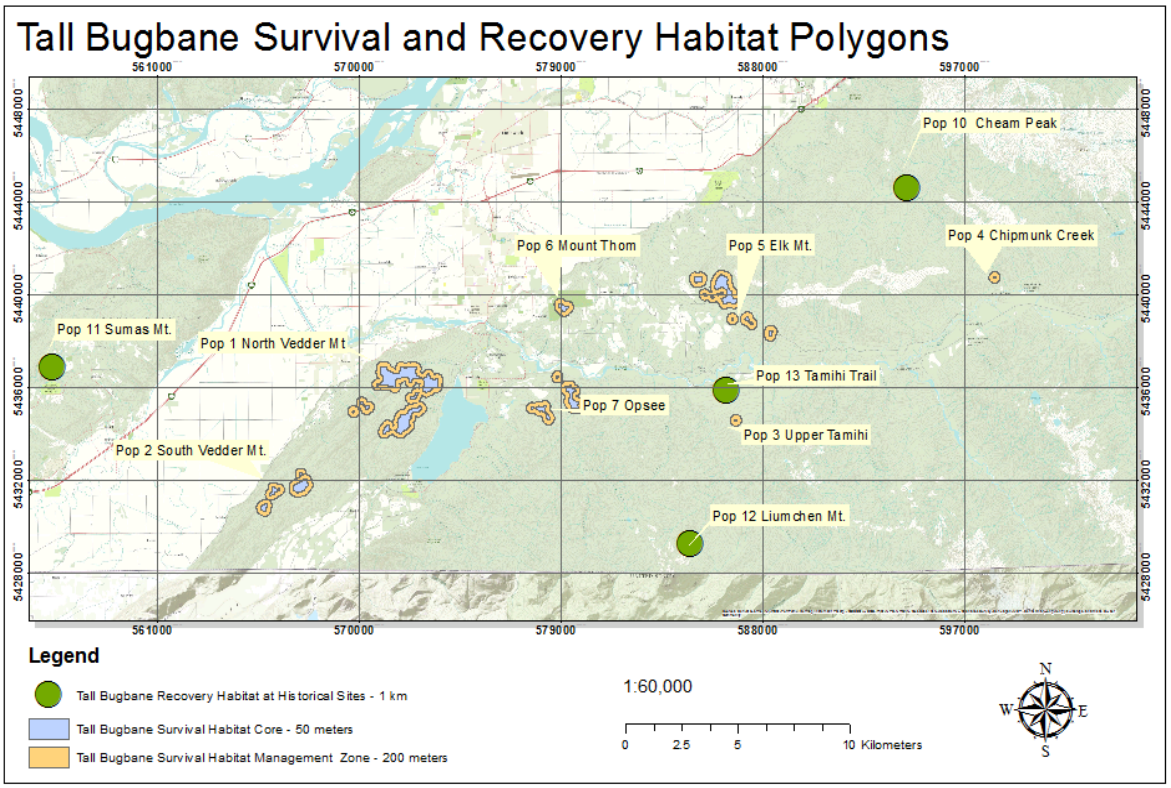

Figure 5. Survival and recovery habitat for tall bugbane.
Areas within which survival habitat is found in B.C. are shown by a 50-m core area around each plant (shaded blue) and a 200-m management zone that extends from the core zone (shaded orange). Areas within which recovery habitat is found in B.C. are shown by a 1000-m management zone (green shaded circle) mapped around historical records of plants.

7.1.5 Human Activities to Mitigate and Avoid in Tall Bugbane Habitat

Please refer to Appendix 3 for recommended best management practices aimed to prevent negative impacts to tall bugbane habitat. These best management practices address some of the activities that are to be mitigated or avoided in survival or recovery habitat polygons.

8 MEASURING PROGRESS

If population monitoring indicates that the number of extant populations is stable or naturally increasing and recolonization of historical sites has occurred where feasible, then the population and distribution goal for tall bugbane will have been met.

The following performance indicators provide a way to define and measure progress toward achieving the recovery (population and distribution) goal and objectives. Performance measures are listed below for each objective.

Measurables for Objective 1

- Protection of the 7 known extant populations is in place by 2016.
- Stabilization (no declines) or increases in the number of sites and/or the number of individuals has occurred over the next 5 years.
- Habitat restoration has been initiated at 2 occupied sites by 2020 (e.g., bring the helipad site at Elk Mountain back into productive habitat, and reduce road maintenance/spraying impacts). These sites are within existing mapped survival habitat polygons as they are adjacent to occupied populations.

Measurables for Objective 2

- Historical sites and surrounding areas have been surveyed by 2018.
- Where feasible, available habitat has been replanted or managed at historical sites by 2020 so that habitat will in the future be capable of supporting populations of tall bugbane.
- At least one tall bugbane population has been re-established at a historical site by 2024.

Measurables for Objective 3

- Extensive inventory has been conducted at 75% of the predicted range (as per the predictive map in Appendix 1) of the species to determine presence of tall bugbane by 2016.
- Protection measures of any newly discovered populations have been put into place.

Measurables for Objective 4

- Annual monitoring, each site measured in rotation a minimum of once every 2 years starting in 2014 to assess change in the size of populations, recruitment, level of herbivory, etc.
- The effectiveness of WHAs has been evaluated and results used to refine management recommendations where needed by 2020.

Measurables for Objective 5

- Evaluation and management of invasive species was conducted every 2 years in conjunction with the population monitoring and has been initiated by 2016.
- Research to elucidate habitat associates and improved understanding of threats and population ecology completed by 2018.

9 EFFECTS ON OTHER SPECIES

Recovery activities taken on behalf of tall bugbane will have direct beneficial effects on several other species at risk that overlap in occurrence and have similar biophysical requirements with tall bugbane including Mountain Beaver (*Aplodontia rufa*), Coastal Giant Salamander (*Dicamptodon tenebrosus*), Western Toad (*Anaxyrus boreas*), Pacific Water Shrew (*Sorex*

bendirii), and Northern Red-legged Frog (*Rana aurora*). No negative effects on any species are expected.

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Appendix 1. Predictive habitat mapping and modeling

A predictive model for tall bugbane distribution was developed using locality information from B.C. observation records applied onto digital Terrestrial Resource Information Management (TRIM) and B.C. Ministry of Forest cover maps in addition to habitat information from recent studies in the United States (B. Klinkenberg and R. Klinkenberg, pers. comm., 2008). The predictive map is shown in Figure 6.

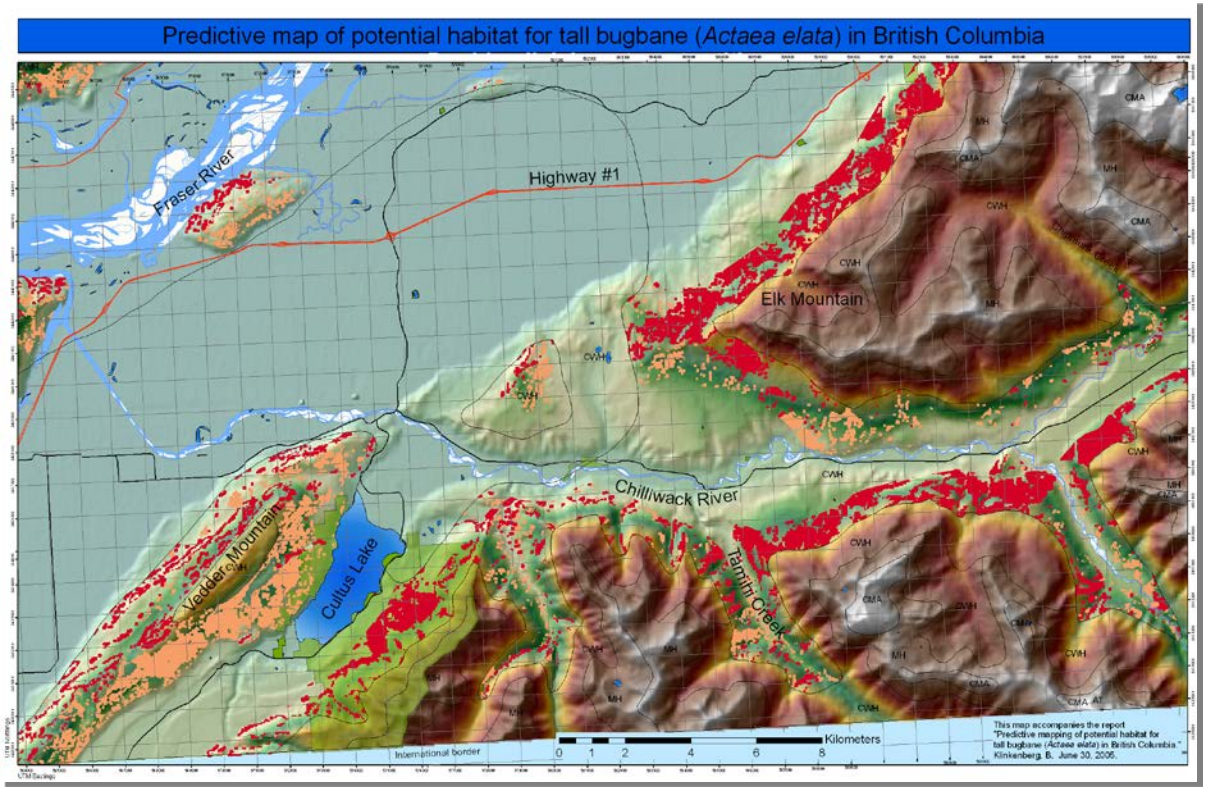

Figure 6. Predictive habitat mapping for tall bugbane.
The red- and orange/tan-coloured areas represent areas identified by the model as having the greatest likelihood of supporting tall bugbane populations. 69% of the known populations fall within a red-coloured area; a further 17% of the populations occur within the orange-coloured areas. Source: Klinkenberg (2005).

Appendix 2. Survival habitat polygons for tall bugbane

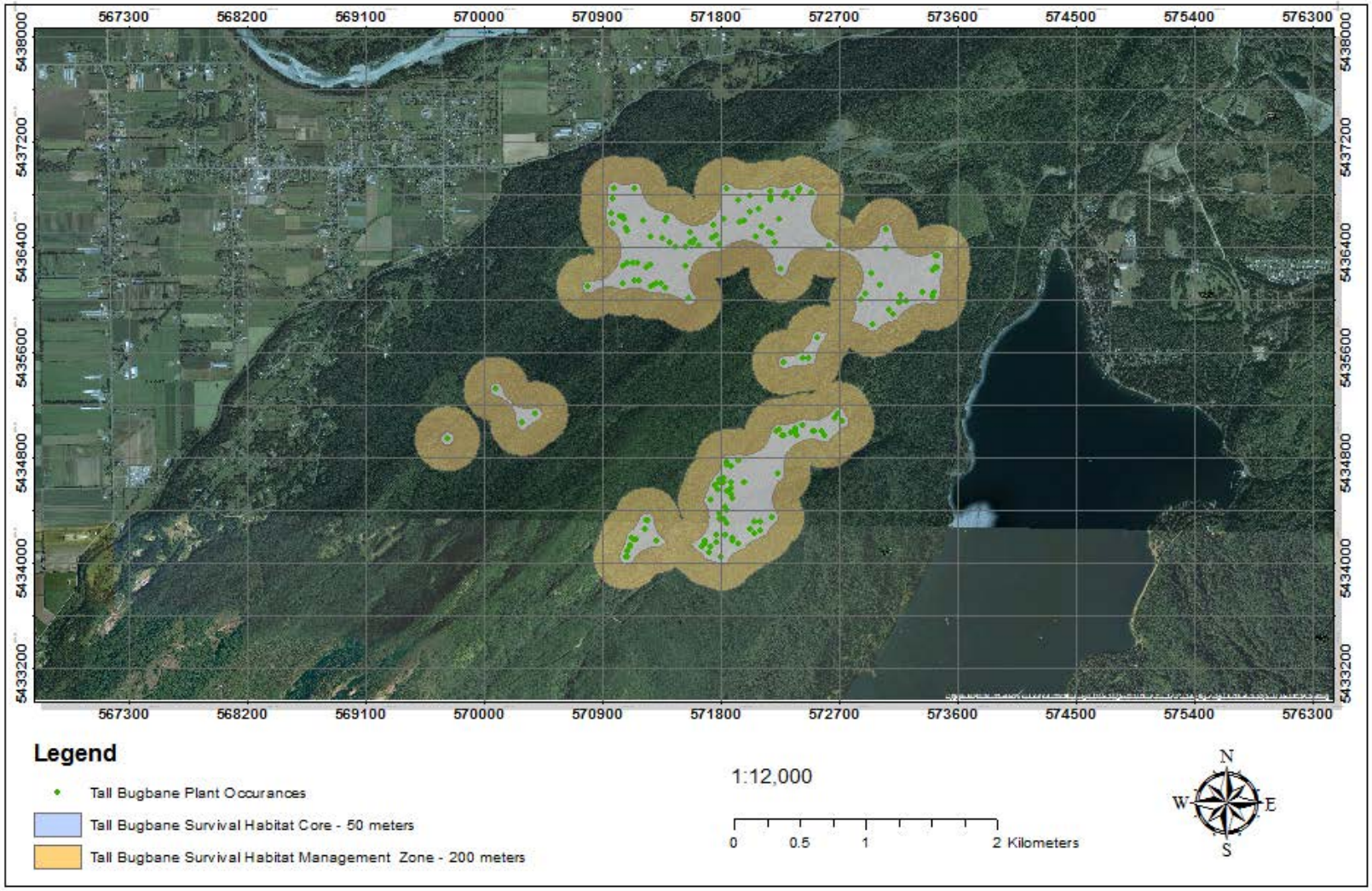

Figure 7. Area within which survival habitat for tall bugbane is found at North Vedder Mountain, B.C.

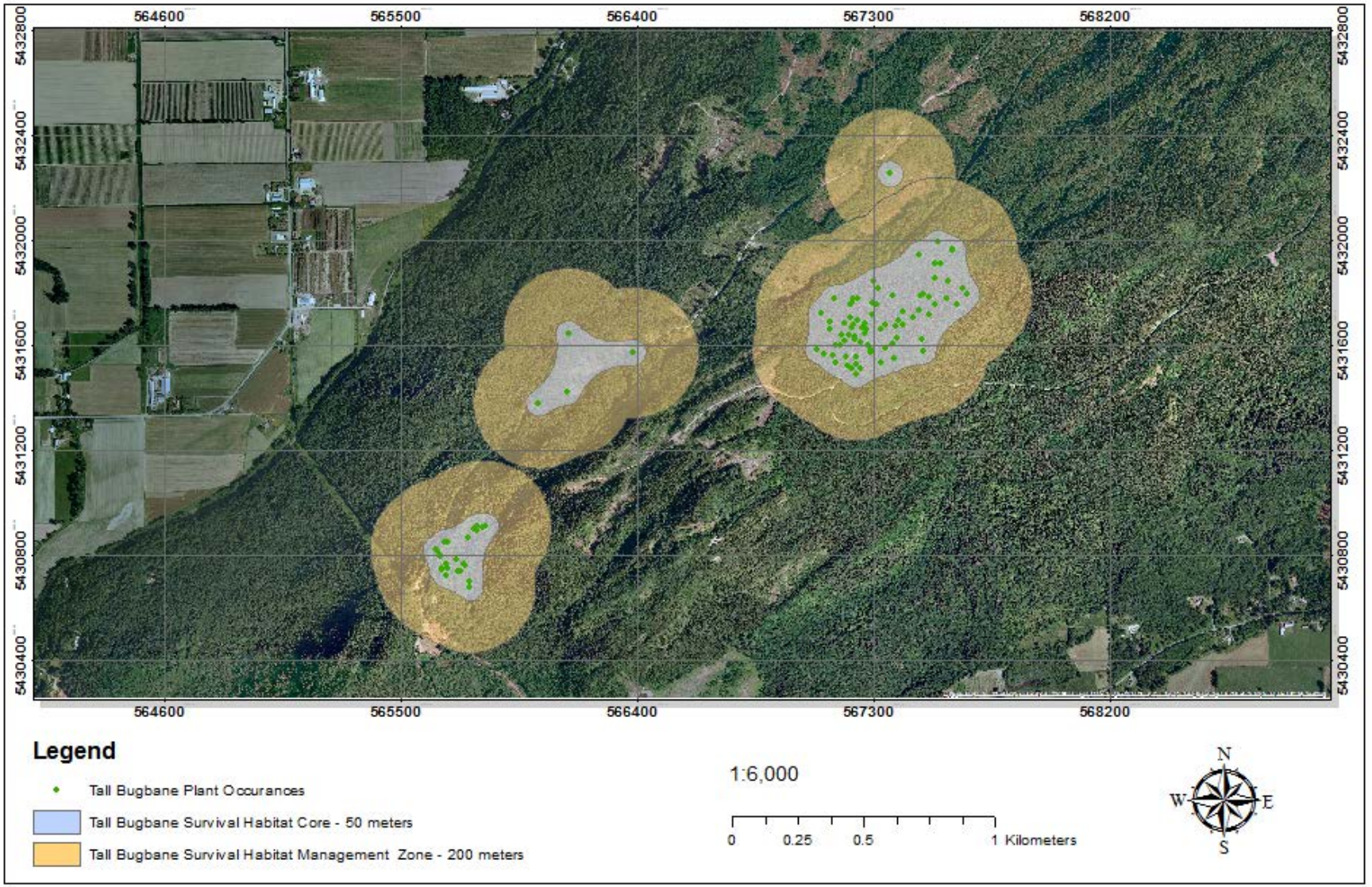

Figure 8. Area within which survival habitat for tall bugbane is found at South Vedder Mountain, B.C.

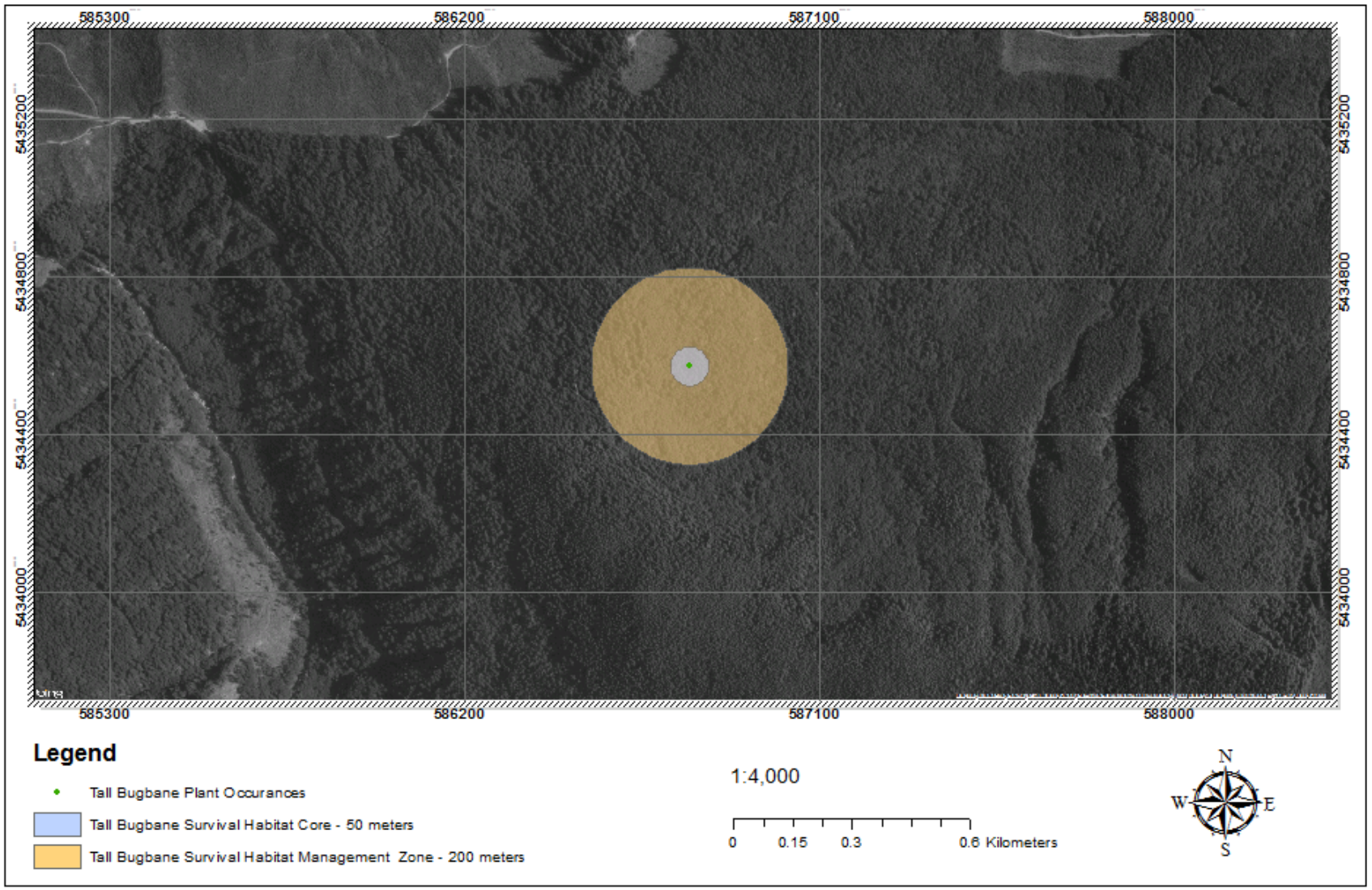

Figure 9. Area within which survival habitat for tall bugbane is found at Upper Tamihi, B.C.

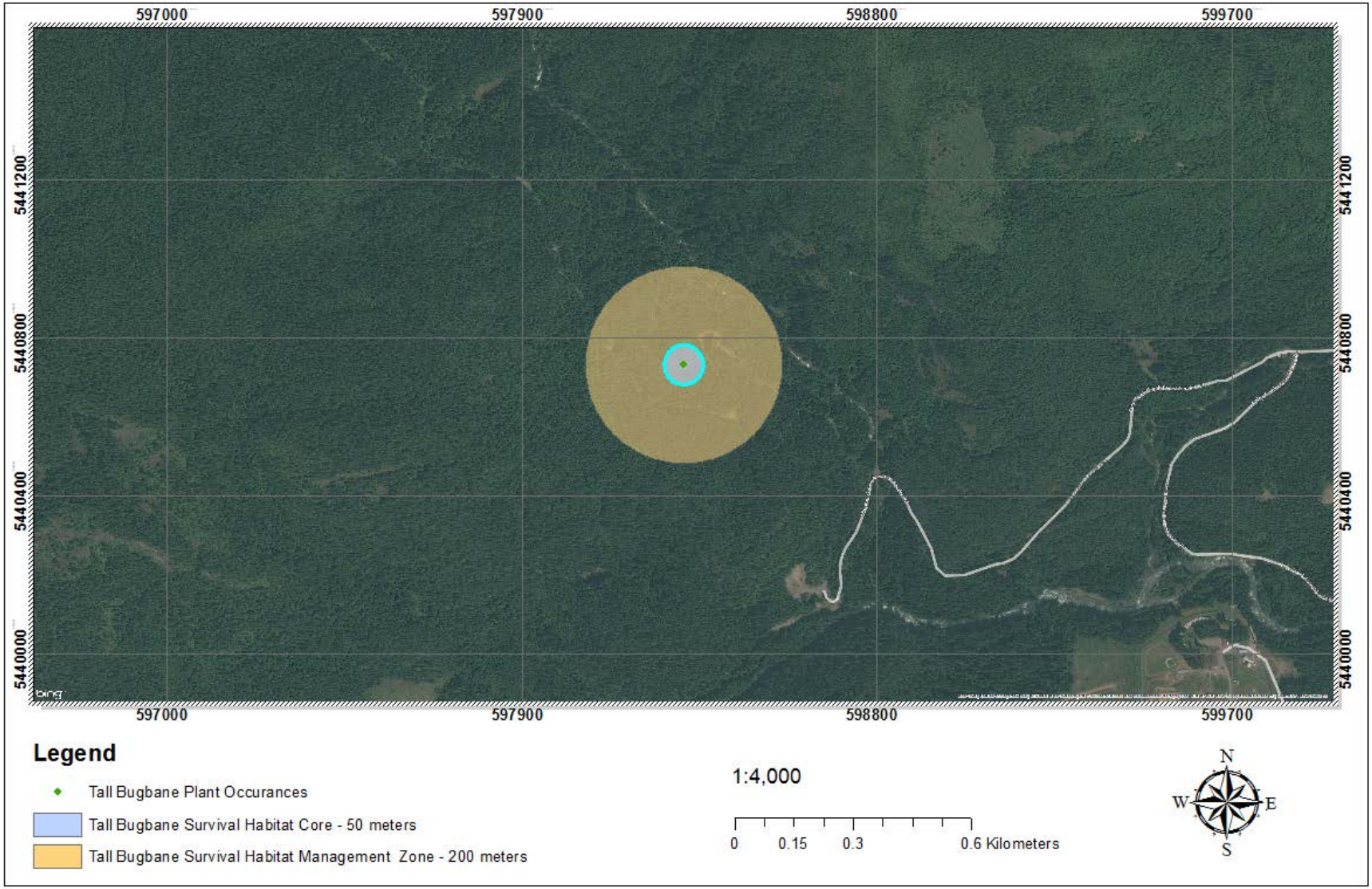

Figure 10. Area within which survival habitat for tall bugbane is found at Chipmunk Creek, B.C.

Figure 11. Area within which survival habitat for tall bugbane is found at Elk Mountain, B.C.

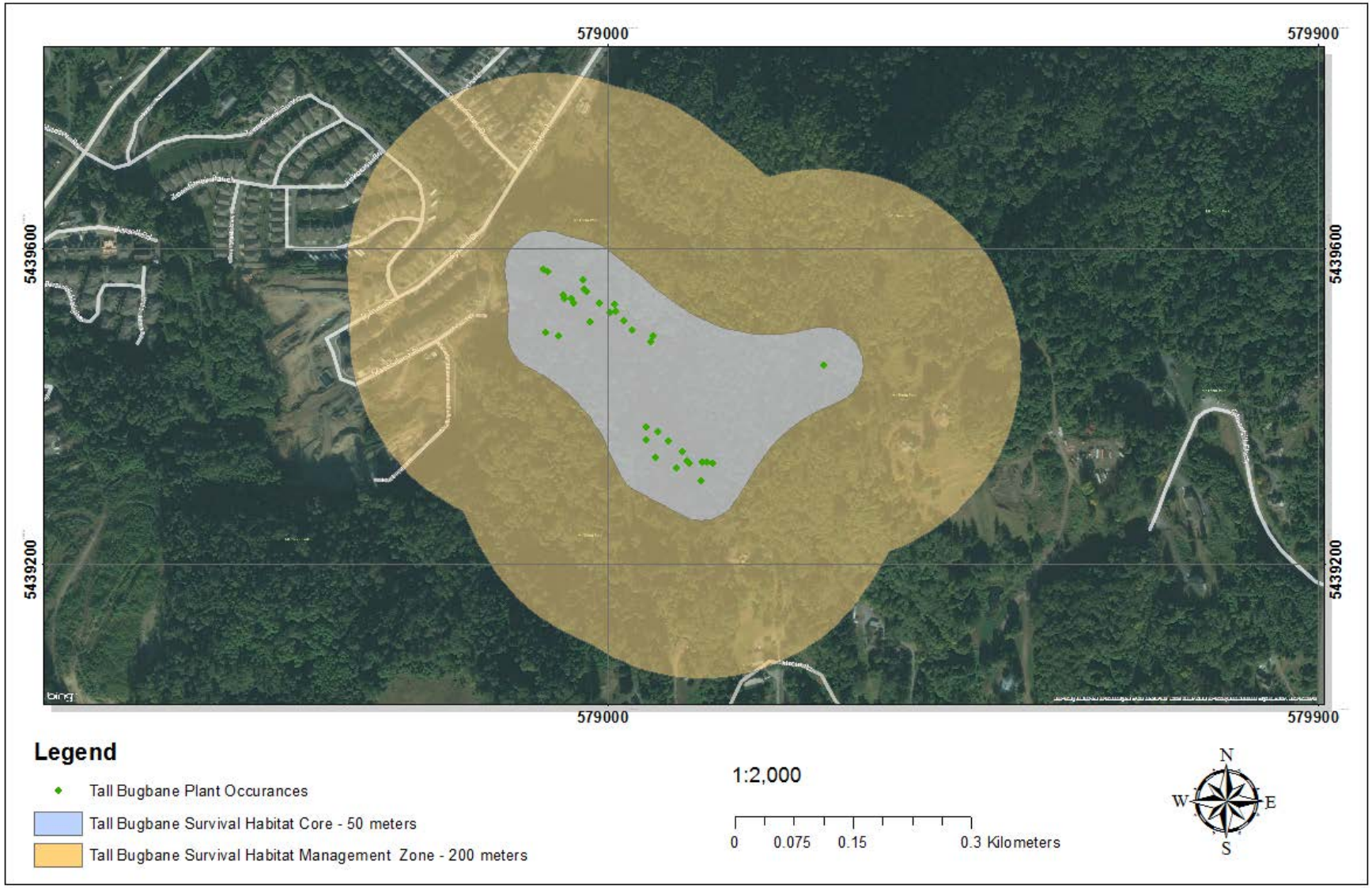

Figure 12. Area within which survival habitat for tall bugbane is found at Mount Thom, B.C.

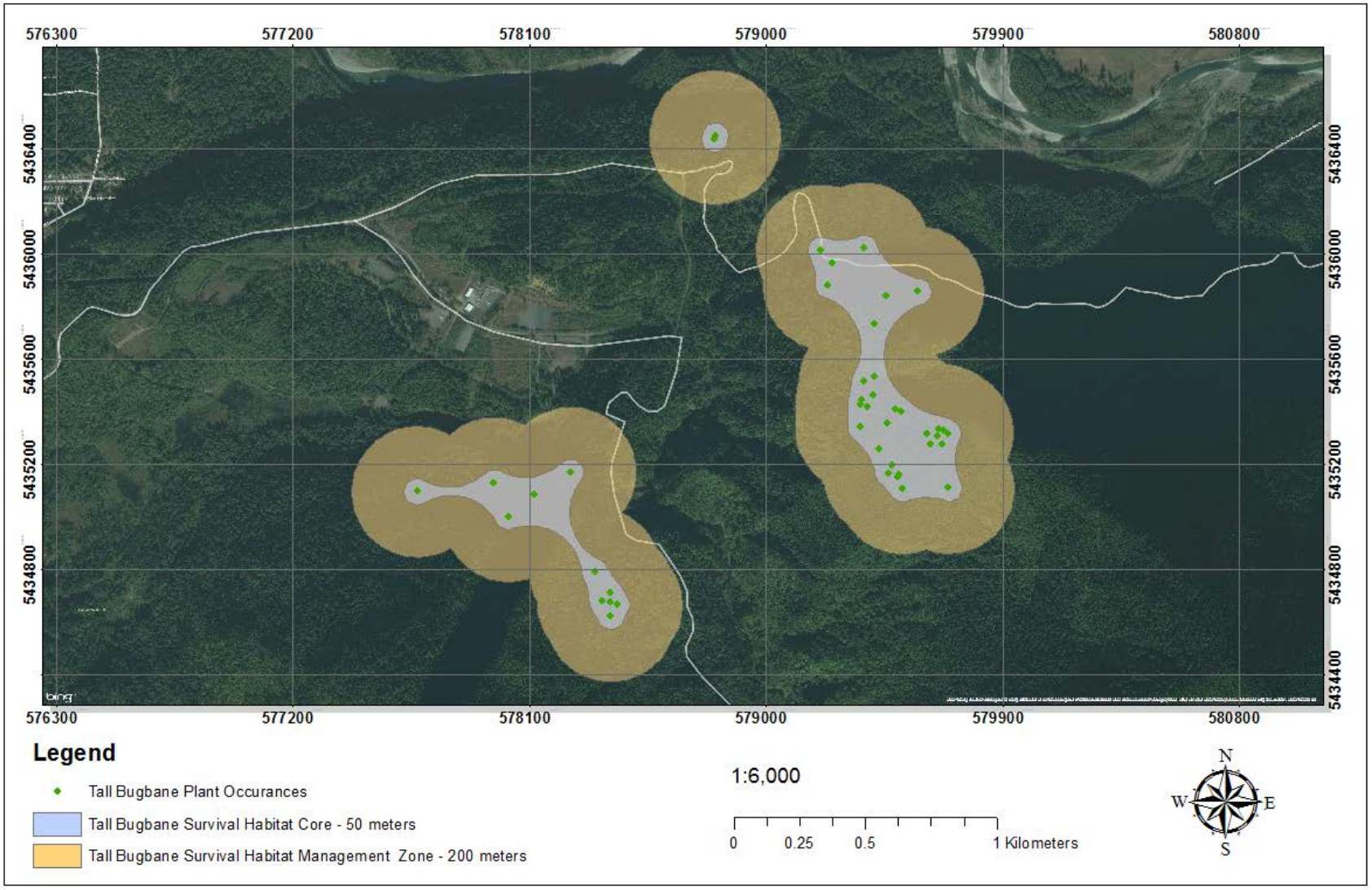

Figure 13. Area within which survival habitat for tall bugbane is found at Opsee, B.C.

Appendix 3. Best management practices for Tall Bugbane habitat

The best management practices below are aimed to prevent negative impacts to survival or recovery habitat. Survival habitat would be considered damaged if part of the survival habitat were degraded, either permanently or temporarily, such that it would not serve its function when used by the species. Damage may also result from single or multiple activities at one point in time or from the cumulative effects of one or more activities over time.

These best management practices address some of the activities that are to be mitigated or avoided in survival habitat polygons. They are intended to be broad in scope and do not cover all possible threats that could impact survival habitat for tall bugbane. Thus specific threats discussed in Section 4.2 should be assessed at each site and used to determine if an activity is permitted. Where a situation does not clearly fit within the activities listed below, but has a potential impact on tall bugbane habitat, the proponent is advised to contact the responsible jurisdiction for guidance on the activity.

The General Wildlife Measures that apply within WHAs are designed to address access issues, forest harvesting and silviculture, pesticide use, and range activity (Penny 2004). These measures have thus far shown to be effective, where the buffers are implemented and enforced, with 10 years of supporting data indicating that tall bugbane plants are doing well, i.e., the size and number of populations, and quality and quantity of occupied habitat is remaining stable or increasing at known sites across the species' existing range (K. Welstead, pers. comm., 2014). These management approaches should be considered as best management practices for areas within the survival habitat that are not within WHAs:

- No removal of canopy within the core area or from the recovery habitat.
- Use partial harvesting systems that maintain no less than 60% basal stem area[16] in the management zone.
- Trails and recreational activities in the management zone should not result in a combined loss of greater than 40% basal stem area.
- No removal of deciduous species and the loss of diverse stand structural components (e.g., *Acer* spp., canopy gaps) within the core.
- No loss of greater than 80% of the *Acer* species from the management zone.
- Avoid the construction of roads or stream crossings within 50 m of the plant or upstream from the population.
- No new recreational trails or structures, or the expansion of existing trails within the core area.
- No pesticide or herbicide use within the management zone or core areas to prevent plant mortality and habitat loss.
- No seeding with non-native species.
- No changes or modification to the hydrological characteristics in the survival habitat core area through culverting or stream diversions or indirectly through upstream canopy removal.

[16] Basal stem area is the area of a given section of land that is occupied by the cross-section of tree trunks and stems at their base.