Recovery Strategy for the

Columbia Quillwort (Isoetes minima), Dwarf Hesperochiron (Hesperochiron pumilus), and Hairy Paintbrush (Castilleja tenuis)

2025

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

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].

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

Cover illustration: © Ryan Batten. Clockwise from top right: Dwarf Hesperochiron, Columbia Quillwort and Hairy Paintbrush

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RECOVERY STRATEGY FOR THE COLUMBIA QUILLWORT (*Isoetes minima*), DWARF HESPEROCHIRON (*Hesperochiron pumilus*), AND HAIRY PAINTBRUSH *(Castilleja tenuis*) IN CANADA

2025

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 Columbia Quillwort (*Isoetes minima*), Dwarf Hesperochiron (*Hesperochiron pumilus*), and Hairy Paintbrush (*Castilleja tenuis*) in British Columbia* (Part 2) under Section 44 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush in Canada consists of two parts:

Part 1 – Federal Addition to the *Recovery Plan for Columbia Quillwort (*Isoetes minima*), Dwarf Hesperochiron (*Hesperochiron pumilus*), and Hairy Paintbrush (*Castilleja tenuis*) in British Columbia*, prepared by Environment and Climate Change Canada.

Part 2 – *Recovery Plan for Columbia Quillwort (*Isoetes minima*), Dwarf Hesperochiron (*Hesperochiron pumilus*), and Hairy Paintbrush (*Castilleja tenuis*) in British Columbia*, prepared by the British Columbia Ministry of Environment and Climate Change Strategy.

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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[3]. Under the *Species at Risk Act* (S.C. 2002, c.29)[4] (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 Species at Risk Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush 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 Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush (Part 2) as science advice to the jurisdictions responsible for managing the species in British Columbia. It was prepared in cooperation with Environment and Climate Change 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 and Climate Change Canada, or any other jurisdiction alone. All members of the public are invited to join in supporting and implementing this strategy for the benefit of these species and 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 and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to support the recovery and/or survival of the species. It provides all persons in Canada with information to help take action on species conservation, including identification of critical habitat to the extent possible. Where available, critical habitat spatial data is found in the Critical Habitat for Species at Risk National Dataset[5]

When critical habitat is identified, either in a recovery strategy or an action plan, SARA provides a legal framework that enables the protection of that critical habitat.

In the case of critical habitat identified for terrestrial species, including migratory birds, SARA requires that critical habitat identified in a federal protected area, referred to in SARA ss. 58(2), be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2
[3] The Government of Quebec is not signatory to the Accord for the Protection of the Species at Risk (1996). However, the Government of Quebec does cooperate with the federal government in the conservation of species at risk of common interest.
[4] https://laws.justice.gc.ca/eng/acts/S-15.3/index.html
[5] https://open.canada.ca/data/en/dataset/47caa405-be2b-4e9e-8f53-c478ade2ca74

that identified the critical habitat is included in the Public Registry. The prohibition against destruction of critical habitat under subsection (ss.) 58(1) will apply 90 days after the description of that critical habitat is published in the *Canada Gazette*.

For critical habitat located on federal lands that are not a federal protected area, as in SARA ss. 58(2), the competent minister must make an order applying the ss. 58(1) prohibition against destruction of critical habitat if it is not already legally protected by a provision in, or measure under, SARA or any other Act of Parliament. If the competent minister does not make the order, a statement must be included on the Species at Risk Public Registry setting out how the critical habitat, or portions of it are legally protected on those federal lands.

For any other part or portion of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to apply the ss. 61(1) prohibition against destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Acknowledgements

Development of this recovery strategy was coordinated by Environment and Climate Change Canada, Canadian Wildlife Service (ECCC CWS) – Pacific Region staff: Cindy Bertrán Cerino, Jared Maida, Kimberly Dohms, and Eric Gross. Megan Harrison (ECCC CWS-National Capital Region) provided helpful expertise and advice. Leon McCartney (ECCC CWS-Pacific Region) provided additional assistance with critical habitat identification, mapping, and figure preparation. Kella Sadler (former ECCC CWS-Pacific Region), Carrina Maslovat, Ryan Batten, Leah Westereng and Alana Phillips (B.C. Ministry of Water, Land and Resource Stewardship) also provided helpful expertise and advice on drafts of this document.

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 Columbia Quillwort (*Isoetes minima), *Dwarf Hesperochiron (*Hesperochiron pumilus*), and Hairy Paintbrush (*Castilleja tenuis*) in British Columbia* (Part 2 of this document, referred to henceforth as "the provincial recovery plan") and/or to provide updated or additional information. All other sections of the provincial recovery plan have been adopted with no modifications. This includes the provincial statement on population and distribution objectives and supporting rationale, i.e., "Section 5.1 Recovery (Population and Distribution) Goal" and "Section 5.2 Rationale for the Recovery (Population and Distribution) Goal".

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 final federal recovery strategy.

Recovery Feasibility Summary

This section replaces "Recovery Feasibility Summary" in the provincial recovery plan.

Based on the following criteria that Environment and Climate Change Canada uses to establish recovery feasibility, as described in the Species at Risk Policy on Recovery and Survival[6], recovery of the Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush has been deemed technically and biologically feasible (see *Species at Risk Policy on Recovery and Survival* [Environment and Climate Change Canada 2021]).

Is Recovery Feasible?

1) **Survival Characteristics: Can survival characteristics be addressed to the extent that the species' risk of extinction or extirpation as a result of human activity is reduced?**

YES. Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush are currently assessed by COSEWIC as Endangered (COSEWIC 2019a; 2019b; 2019c). All three species have a small distribution/range and small populations with ongoing declines in the quantity and quality of supporting habitat, compromising the populations' resiliency and redundancy (key survival characteristics), and qualifying for assessment as Endangered on the basis of B and/or C and D COSEWIC indicators**.**

All three species require seepages that are uncommon in the landscape, so these species were likely always naturally rare. However, it is likely that, prior to human impacts, there was a greater number of more robust populations and those populations were not experiencing inferred declines in extent and quality of habitat due to ongoing threats.

It is feasible to improve the redundancy and resiliency of the Canadian populations of all three species through habitat protection and restoration (e.g., invasive species removal), threat mitigation and, potentially, translocation (e.g. increasing extant populations; establish new populations), such that the species no longer qualify as Endangered on the basis of COSEWIC indicators for the B, C or D criteria. In their recovered state, these populations would have an assessed status of Special Concern or Not at Risk.

2) **Independence: Is the species currently able to persist in Canada independent of deliberate human interventions, and/or will it eventually be able to achieve and maintain independence in the state where condition (1) is met (i.e., after the key survival characteristic(s) are addressed), such that it is not reliant on significant, direct, ongoing human intervention?**

YES. Mature, reproducing individuals of all three species have been recently observed (COSEWIC 2019a; 2019b; 2019c; Table 1). Translocation may be considered to establish new populations in appropriate seepage sites and/or to augment small existing populations; however, this is not expected to be required on a continual/ongoing basis in order to maintain population persistence. Both current and newly-established populations should be able to persist independent of ongoing human interventions, as long as human-caused threats to redundancy and resiliency are addressed.

[6] https://species-registry.az.ec.gc.ca/index-en.html#/documents/1nVEtc2T2QqfyZy4Ful1F

Table 1. Independence rationale for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush.

Species	Feasible	Rationale
Columbia Quillwort	Yes	Mature, reproductive individuals are available at existing and new sites (observed during 2017 and 2023 surveys). Successful reproduction is occurring (juvenile plants were observed during 2017).
Dwarf Hesperochiron	Yes	Successful reproduction is occurring. In 2023, 4 mature flowering plants and over 5800 non-flowering ramets were counted in one subpopulation. In 2017, 168 mature flowering plants plus approximately 4360 smaller non-flowering ramets were counted.
Hairy Paintbrush	Yes	Flowering was observed during surveys (2023). No observation of barriers to reproduction.

3) Improvement: Can the species' condition be improved over when it was assessed as at risk?

YES. It is technically feasible to improve the condition of Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush through addressing the ongoing human-caused threats that continue to destroy and degrade habitat. The ongoing habitat loss and degradation (e.g., through introduction of invasive species) caused by recreational activities such as mountain biking can be addressed through area closures or trail re-routing. The changes in site hydrology caused by logging and trail/roadbuilding in upslope areas can be addressed through habitat protection and management restrictions. Drought related to climate change cannot be directly addressed; however, its impacts can be moderated by ensuring that other threats that alter hydrology (i.e., seepage patterns) are addressed and thus that climate change impacts are not further exacerbated. Translocation may also help increase both the number and sizes of populations, so that redundancy and resiliency within the overall Canadian population is improved.

1. Species Status Information

This section replaces information on SARA legal designations and conservation status for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush in Canada in “Species Status Information” (section 2) in the provincial recovery plan.

The legal designation of Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush on SARA Schedule 1 is Endangered (2023).

Table 2. Conservation Status of Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush (from NatureServe 2023, and B.C. Conservation Data Centre 2023).

Species	Global (G) Rank*	National (N) Rank*	Sub-national (S) Rank*	COSEWIC Status	SARA Status	B.C List
Columbia Quillwort	G1 (2015)	N1N2 (2010)	S1S2	Endangered (2019)	Endangered (2023)	Red list**
Dwarf Hesperochiron	G4 (1999)	N2 (2010)	S2	Endangered (2019)	Endangered (2023)	Red list**
Hairy Paintbrush	G5 (1990)	N1 (2010)	S1	Endangered (2019)	Endangered (2023)	Red list**

* Global (G), National (N) and Sub-national (S) NatureServe alphanumerical. Rank 1- critically imperiled; 2- imperiled; 3- vulnerable to extirpation or extinction; 4- apparently secure; 5- secure; ** Red List is defined by the B.C. Conservation Data Centre as “Any species or ecosystem that is at risk of being lost (extirpated, endangered or threatened).”

2. Species Population and Distribution

This section augments the “Distribution, Abundance and Population Trends” section (section 3.2) within the provincial recovery plan.

In Canada, Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush are found in the Interior Cedar – Hemlock (ICH) biogeoclimatic zone. Less than 1% of the global range of Dwarf Hesperochiron, and Hairy Paintbrush occurs in Canada. The Columbia Quillwort's population in Canada is estimated to be approximately 31% of the global population, even though detailed population counts are unavailable in the United States.

The information summary below (Table 3) includes updated population and distribution information for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush populations in Canada, replacing Tables 1-3 within the provincial recovery plan.

Element Occurrence (EO) numbers indicated align with those provided in the provincial recovery plan, with the exception of one new occurrence for Columbia Quillwort (Goose Creek, EO5).

Table 3. Summary of Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush populations in Canada. Information for each Element Occurrence (EO) number includes notes on status (N = new, not described in the adopted provincial recovery plan).

Population[a]	Species	Location	B.C. CDC EO#[b]	First Observation	Last Observation[c,d]
Beavervale Meadow	Columbia Quillwort	Highway 3, 12 km west of Salmo on route to Castlegar	EO1	A. & O. Ceska 1996	2017-05-14: 69 (57 mature) plants in 4 subpopulations
	Hairy Paintbrush		EO1	F. Lomer 2000	2023-06-02: 798 plants counted in a 50 square m (5 m x 10 m) patch and 22 plants counted in a 4 square m patch (2 m x 2 m)
	Dwarf Hesperochiron		EO1	J. Cuming 1989	2017-05-14: 300+ seedlings (3 mature) plants
Lloyd's Meadow	Columbia Quillwort	8.2 km west of Castlegar	EO2	H. Roemer 1996	2017-05-15: 584 (527 mature) plants in 5 subpopulations
	Dwarf Hesperochiron		EO2	R. Batten 2014	2017-05-15: 2500+ (73 mature) plants in 5 subpopulations
Fairview Meadow	Columbia Quillwort	South of Fairview subdivision/ Blueberry Creek	EO3	S. Hartwell 2002	2017-05-14: 300 (254 mature) plants in 5 subpopulations
	Dwarf Hesperochiron		EO3	R. Batten 2016	2017-05-14: 1000-1300 seedlings (73 mature) plants
Lloyd's Meadow – East	Columbia Quillwort	East of Lloyd's Meadow	EO4	R. Batten & C. Maslovat 2023	2023-06-01: 895-920 plants in 26 subpopulations
	Dwarf Hesperochiron		EO4		2023-06-01: 5800+ ramets[e] (4 mature) plants
Goose Creek (N)	Columbia Quillwort	3.6 km northwest of Castlegar	EO5	Anderson 2021	2022-06-12: 1393-2990 plants in 8 subpopulations

[a] Population is defined as per element occurrence specifications used by NatureServe (2004) which defines populations as a group of occurrences that are separated by less than 1 km; or if separated by 1 to 3 km, with no break in suitable habitat between them exceeding 1 km; or if separated by 3 to 10 km but connected by linear water flow and having no break in suitable habitat between them exceeding 3 km.
[b] EO numbers indicated align with those provided in the provincial recovery plan
[c] Description from field notes collected for COSEWIC 2019a and C. Maslovat, pers. comm. 2023
[d] Subpopulations represent patches of individuals within a population that are within 1km of each other
[e] Non-flowering plants presumed to be offshoots connected to the main plant but may also be immature seedlings, most consisting of a single leaf

3. Critical Habitat

This section replaces “Species Recovery and Survival Habitat” (section 7) in the provincial recovery plan.

Critical habitat is defined in SARA (Subsection 2(1)) as “the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species”.

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. More precise boundaries may be mapped, and additional critical habitat may be added in the future if additional research supports the inclusion of areas beyond those currently identified. 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.

Critical habitat for the Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush is identified in this document to the extent possible and is considered sufficient to meet the population and distribution objectives. Therefore, a schedule of studies to identify critical habitat is not required. As responsible jurisdictions and/or other interested parties conduct research to address knowledge gaps, the existing critical habitat methodology and identification may be modified and/or refined to reflect new knowledge.

3.1 Identification of the Species’ Critical Habitat

Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush occur in discrete bedrock meadows[7] set on forested slopes (COSEWIC 2019a; 2019b; 2019c; Pätsch et al. 2021; Pätsch et al. 2022). The meadows can be physically disturbed or destroyed through trees within the adjacent forest being felled or downed by wind. It is likely that the surface rock of the meadows, which prevents tree establishment (and maintains habitat for these rare species), also extends into adjacent forests, limiting root penetration and making those trees more susceptible to wind impacts. Windthrow has been observed in many of the forested areas next to pocket meadows at Lloyd’s Meadow (C. Maslovat, pers. comm. 2023). There is also evidence of beetle kill in the adjacent forest, which may further increase the likelihood of trees being downed by wind. Elevated wind levels associated with cleared areas have been found to extend up to 4.6 tree lengths into adjacent uncut forests (Burton 2001), so forest removal within 4.6 tree lengths of the meadows could increase the likelihood of windthrow within the trees growing immediately adjacent to the meadow edge. Elevated wind can also transport seeds of invasive plant species into the meadows and cause the meadows to dry out (C. Maslovat, pers. comm. 2023). The critical seepage[8] conditions within the meadows are also influenced by upslope drainage patterns, which can be altered through changes in upslope forest cover (Maslovat et al. 2021).

[7] Bedrock Meadows are: treeless “islands” in the forest at elevations between 800-1800 m; grow on argillite covered by shallow soils; herb dominated. *See Appendix I

[8] Spring seepages are naturally uncommon in the landscape, occurring where ephemeral underground moisture is carried on top of shallow bedrock and generally exhausted by mid-June. The thin (usually 3–7 cm, but infrequently 10–15 cm) soil discourages the establishment of larger, more vigorous vascular plants that would compete for light, moisture, and nutrients (COSEWIC 2019; Maslovat et al. 2021). * See Appendix I

Critical habitat for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush in Canada is therefore comprised of two variants:

1. **Core critical habitat:** The bedrock meadows containing the plant occurrences surrounded by a 4.6-tree length horizontal distance to account for impacts of wind.

2. **Hydrological influence zone critical habitat:** The additional upslope forested area that drains towards the core critical habitat.

Biophysical attribute description:

A description of the essential features and attributes of habitat for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush that are required to support life history functions are described in Section 3.3, Tables 4 & 5 of the provincial recovery plan, and form the basis of the biophysical attribute description in Table 4 below. Example photos of these features and attributes are also provided in Appendix 1.

Table 4. Summary of essential features, functions, and attributes of Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush habitat in Canada.

Critical Habitat Variant	Function	Features	Attributes		
			Columbia Quillwort	Dwarf Hesperochiron	Hairy Paintbrush
Core	Establishment, growth, reproduction, and dispersal	Seasonal spring seepage, to provide moisture and nutrients	Fluctuating moisture levels with seepage drying prior to summer onset		
		Warm aspect and moderate slope, to provide early snow-free growing conditions	East to South aspect	East to South aspect	South aspect
			5-40 degree slope	5-40 degree slope	10 degree slope
		Shallow soils, to limit establishment of competitive woody species and maintain open glade conditions	*<15 cm*	*>15 cm*	*<10 cm*
		Herb and moss-dominated accompanying vegetation, to enable un-impeded/un-shaded growth	Thick moss mats (primarily *Philonotis fontana, Niphotrichum elongatum* and *Bryum weigelii*)	Sparse herbaceous vegetation	Sparse herbaceous vegetation cover and thick moss mats
Hydrological influence zone	Maintenance of core critical habitat function	Intact upslope forest to moderate surface and groundwater flow and maintain seepage patterns, slope, and soil depth within the core critical habitat.	Intact forest cover and natural slope.		

3.1.1 Information and Methods used to Identify Critical Habitat

Information:

- Point occurrence data for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush, provided by the B.C. Conservation Data Centre and the B.C. Ministry of Water, Land and Resource Stewardship.
- Recent, high resolution orthophotos[9]/imagery for the areas surrounding each of the occupied meadows
- Forest 95th Percentile [Height] 2015 data for southern B.C. from the National Terrestrial Ecosystem Monitoring (NTEMS) for Canada[10] dataset
- Canadian Digital Elevation Model, 1945-2011[11]

Methods:

Core critical habitat:

1. Using the orthophotos/imagery, manually digitize the bedrock meadows supporting the plant occurrences;
2. Using the NTEMS forest height information, determine the maximum height of the forests surrounding the meadows (38 m);
3. Multiply the maximum height of the forests surrounding the meadows (38 m) by 4.6 tree lengths (174.8 m);
4. Apply the horizontal distance obtained in step 3 as a buffer to each of the bedrock meadows to account for the impacts of wind.

Hydrological influence zone critical habitat:

1. Using the DEM and the Flow Direction tool within ArcMap 10.8.1, determine the directions of water flow upslope from the core critical habitat;
2. Using the outer boundaries of the core critical habitat polygons as 'pour points', the flow direction information produced in step 1, and the Watershed tool in ArcMap 10.8.1, delineate the boundaries of the local drainage (hydrological influence zone) flowing into each of the core critical habitat areas.

3.1.2 Geographic Information

Critical habitat is identified at five locations for the Columbia Quillwort, four locations for the Dwarf Hesperochiron, and a singular location for Hairy Paintbrush in Canada.

- Beavervale Meadow (EO1 - Columbia Quillwort, Dwarf Hesperochiron and Hairy Paintbrush) – Figure 1
- Fairview Meadow (EO3 - Columbia Quillwort and Dwarf Hesperochiron) – Figure 2
- Lloyd's Meadow (EO2 - Columbia Quillwort and Dwarf Hesperochiron) – Figure 3
- Lloyd's Meadow East (EO4 - Columbia Quillwort and Dwarf Hesperochiron) – Figure 4
- Goose Creek (EO5 – Columbia Quillwort) – Figure 5

[9] An orthophoto is a geometrically corrected aerial photograph that displays ground features to be displayed in their true ground position with a constant scale throughout the image (https://www2.gov.bc.ca/gov/content/data/geographic-data-services/digital-imagery Digital Geographic Imagery of B.C. - Province of British Columbia (gov.bc.ca)

[10] National Terrestrial Ecosystem Monitoring System for Canada (nfis.org)

[11] Canadian Digital Elevation Model, 1945-2011 - Open Government Portal (canada.ca)

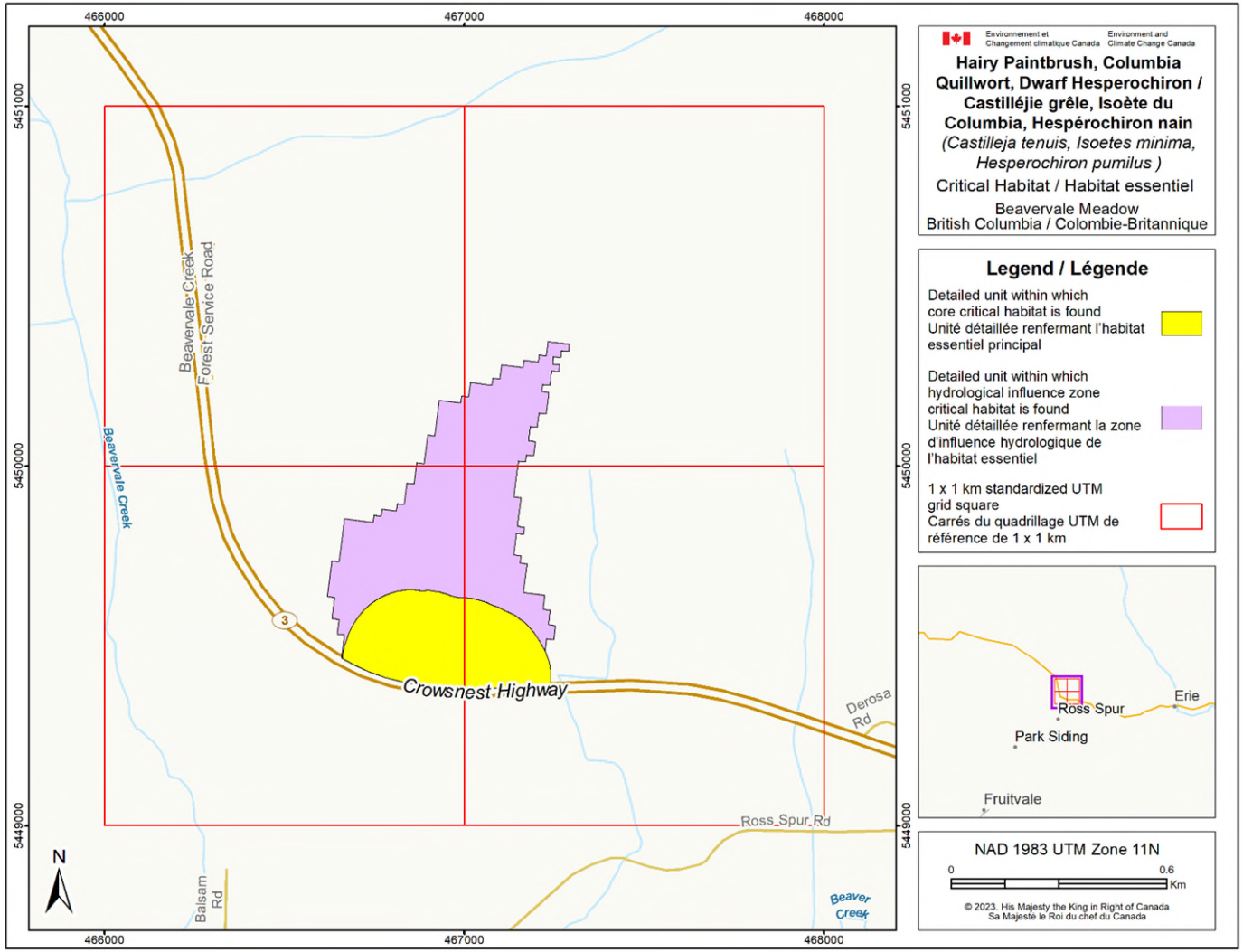

Figure 1. Detailed units containing critical habitat for the Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush at Beavervale Meadow (EO1) are represented by the yellow (core) and purple (hydrological influence zone) polygons, where the criteria and methodology set out in Section 3.1 are met.

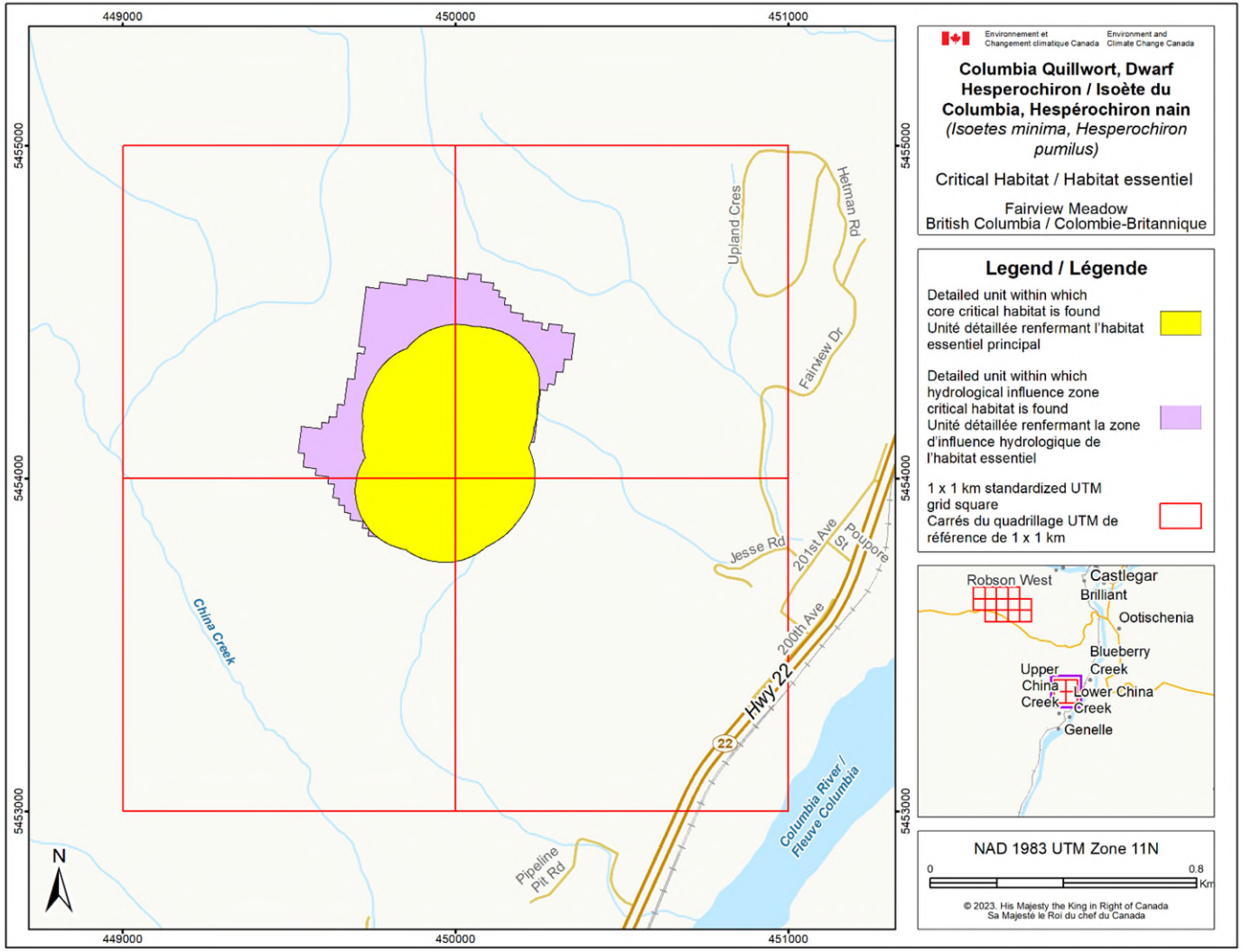

Figure 2. Critical habitat for the Columbia Quillwort and Dwarf Hesperochiron at Fairview Meadow (EO3) are represented by the yellow (core) and purple (hydrological influence zone) polygons, where the criteria and methodology set out in Section 3.1 are met.

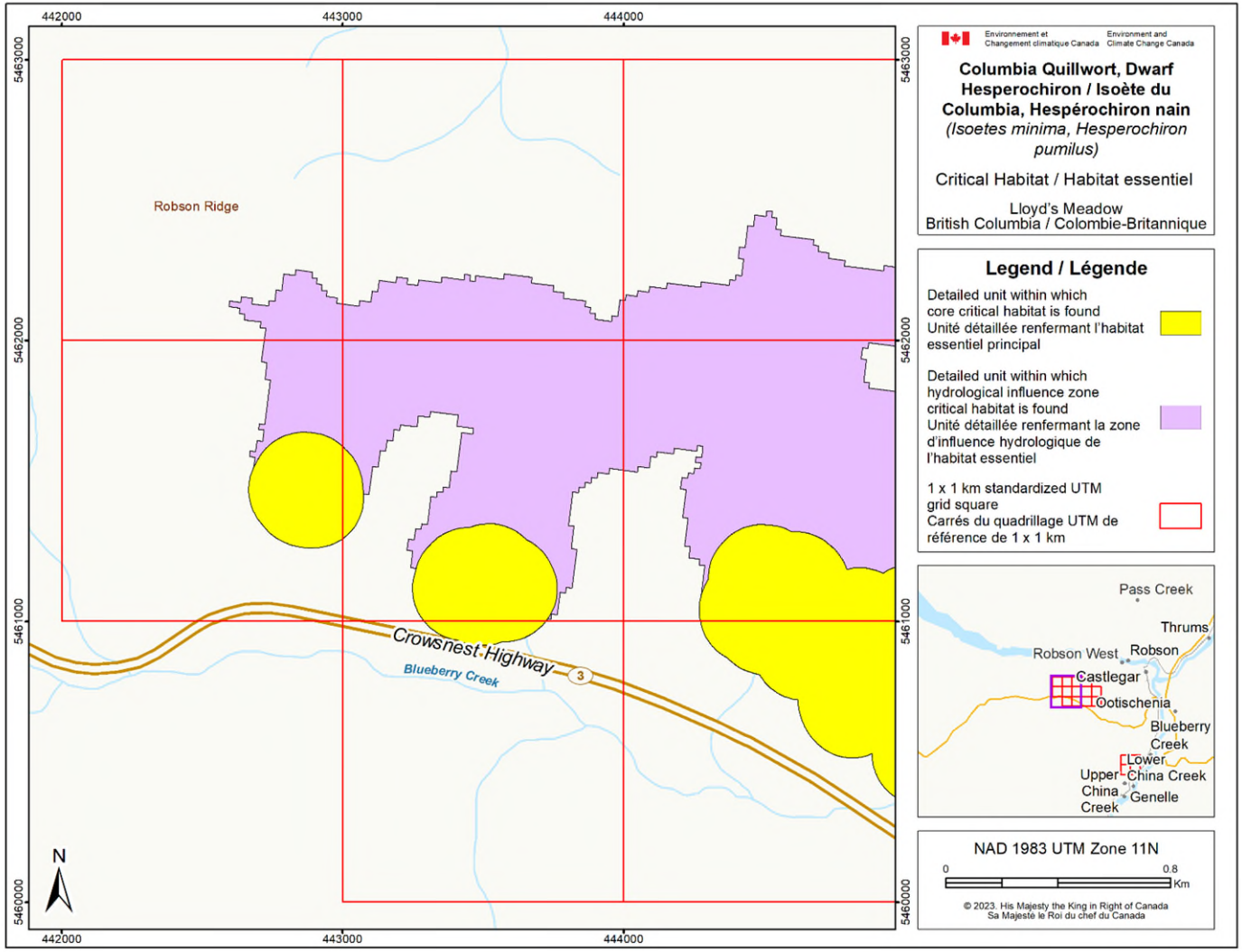

Figure 3. Detailed units containing critical habitat for the Columbia Quillwort and Dwarf Hesperochiron at Lloyd's Meadow (EO2) are represented by the yellow (core) and purple (hydrological influence zone) polygons, where the criteria and methodology set out in section 3.1 are met.

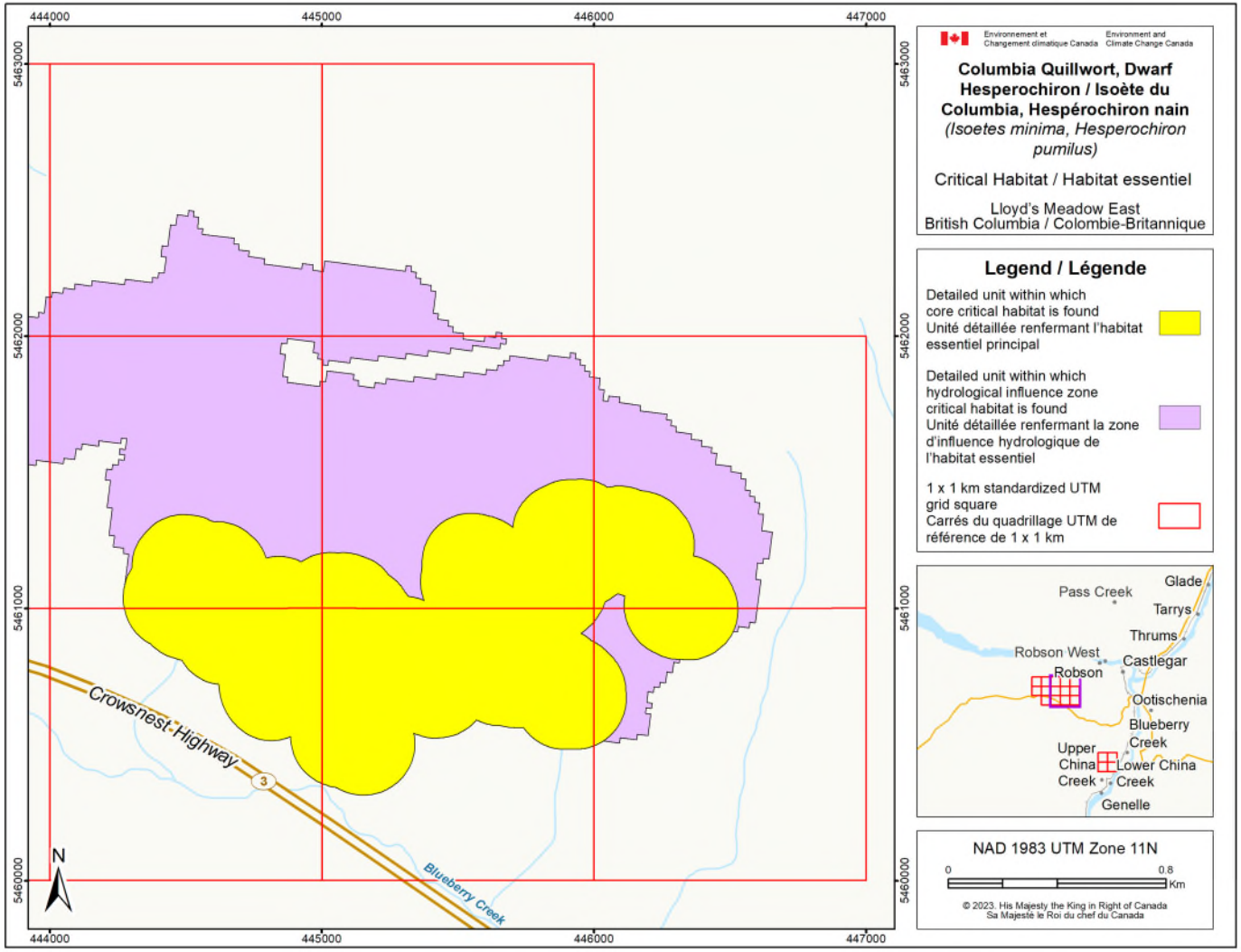

Figure 4. Critical habitat for the Columbia Quillwort and Dwarf Hesperochiron at Lloyd's Meadow East (EO4) are represented by the yellow (core) and purple (hydrological influence zone) polygons, where the criteria and methodology set out in Section 3.1 are met.

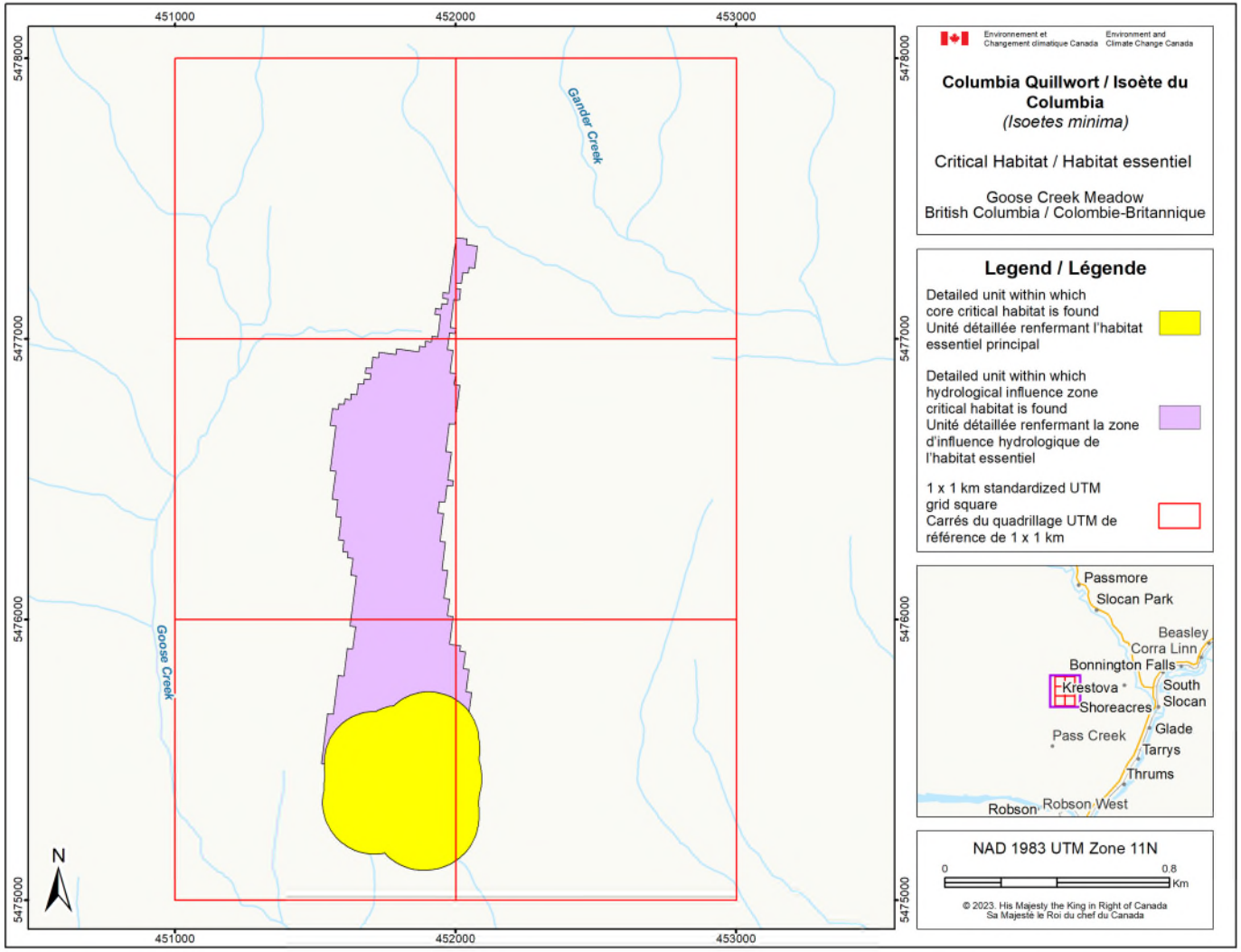

Figure 5. Critical habitat for the Columbia Quillwort at Goose Creek Meadow (EO5) is represented by the yellow (core) and purple (hydrological influence zone) polygons, where the criteria and methodology set out in Section 3.1 are met.

3.2 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case-by-case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Activities described in Table 6 include those likely to cause destruction of critical habitat for the species; destructive activities are not limited to those listed.

Table 6. Examples of activities likely to result in destruction of critical habitat for the Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush.

Type of Critical Habitat	**Description of activity**	**Details of Effect on Attributes of Habitat**	**Additional Information including related IUCN-CMP threat[a]**
Core	Activities that result in removal or destruction of natural habitat features including vegetation and/or substrate (e.g., tree-felling, mountain biking, motorized vehicle use, construction of recreational trails or resource roads).	The removal or destruction of natural habitat features (e.g., vegetation, soil) can result in destruction of critical habitat through direct and permanent loss of the biophysical features and attributes (e.g., spring seepage, moderate slope, shallow soil) that support Columbia Quillwort and Dwarf Hesperochiron establishment, growth, reproduction and dispersal.	IUCN-CMP Threat #5.3 and 6.1 Destruction of critical habitat by this activity can be caused at any time of year.
	Activities that result in the introduction or spread of invasive non-native plant species (e.g. mountain biking, hiking, motorized vehicle use, construction of recreational trails or resource roads; Rosenthal et al. 2022).	Introducing invasive shrubby or tall herbaceous species can result in destruction of critical habitat through replacing low-growing natural companion vegetation with taller vegetation that eliminates the open glade conditions required for successful Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush establishment, growth, reproduction and dispersal. Invasive species[b] can also cause premature loss of the spring moisture required for successful establishment, growth, reproduction and dispersal.	IUCN-CMP Threat #5.3 and 6.1, and 8.1 Destruction of critical habitat by this activity can be caused at any time of the year.

Hydrological Influence Zone	Activities that result in forest removal and/or alteration of natural slope and drainage patterns (e.g., forest harvest, construction of recreational trails or resource roads, fire suppression).	Removing forest cover or altering the slope within the hydrological influence zone can result in destruction of core critical habitat through altering downslope drainage, erosion and soil deposition patterns, windthrow, causing direct and permanent loss of the biophysical features and attributes (e.g., spring seepage, moderate slope, shallow soil) that support Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush establishment, growth, reproduction and dispersal.	IUCN-CMP Threat #5.3 and 6.1 Destruction of critical habitat by this activity can be caused at any time of the year.

[a] Threat classification is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (www.conservationmeasures.org).

[b] Examples of non-native invasive plants that may affect Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush: Sulphur Cinquefoil (*Potentilla recta*), Hare's-foot Clover (*Trifolium arvense*), and Common St. John's-wort (*Hypericum perforatum*), and recently noted *Ventenata dubia* (Maslovat, per. comm, 2023).

[c] See section 3.1.

4. Measuring Progress

The provincial recovery plan contains a section on measuring progress (Section 8 Measuring Progress) that outlines performance measures toward achieving five recovery objectives that are set out in that plan (i.e., Part 2, section 5.3). Environment and Climate Change Canada adopts this content, with the inclusion of the following performance measures toward meeting the overarching recovery goal (as stated in Part 2, section 5.1):

- the persistence of Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush have been maintained at all known extant sites, with no observed declines in colony sizes (total number of mature plants) at extant sites; and,
- the quantity and quality of suitable habitat has been maintained within the areas containing critical habitat at all five known locations: Beavervale Meadow, Fairview Meadow, Lloyd's Meadow, Lloyd's Meadow - East and Goose Creek, such that declines in population and distribution can no longer be inferred at any of these sites.

5. Statement on Action Plans

One or more action plans for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush will be posted on the Species at Risk Public Registry within 10 years of the posting of the final recovery strategy.

6. 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*[12]. 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[13] goals and targets.

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

The provincial recovery plan for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush contains a section describing the effects of recovery activities on other species (i.e., Section 9).

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

Environment and Climate Change 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 Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush will be implemented with consideration for all co-occurring species at risk, including Grizzly Bear (*Ursus arctos*) and Western Skink (*Plestiodon skiltonianus)*, in order to avoid negative impacts to these co-occurring species or their habitats. Some management actions for Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush (e.g., inventory and monitoring, threat mitigation, habitat conservation, education, and research) may promote the conservation of other species at risk that overlap in distribution and rely on similar bedrock meadow habitat attributes.

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8. Personal Communications

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Appendix 1

Visual Examples of Critical Features and Attributes of Bedrock Meadows Habitat

Figure A1. Columbia Quillwort habitat showing seepage area. Photo: C.Maslovat. (June 3, 2023, Lloyd's Meadow East).

Figure A2. Close-up of Hairy Paintbrush habitat at Beavervale Meadow showing scattered surface rock. Pink sticks show Hairy Paintbrush plants. Photo: C.Maslovat (June 2, 2023).

Figure A3. Bedrock meadow habitat at Lloyd's Meadow East with photo taken June 3, 2023. Photo: C.Maslovat.

Part 2 – *Recovery Plan for Columbia Quillwort (*Isoetes minima*), Dwarf Hesperochiron (*Hesperochiron pumilus*), and Hairy Paintbrush (*Castilleja tenuis*)) in British Columbia*, prepared by the British Columbia Ministry of Environment and Climate Change Strategy

Recovery Plan for Columbia Quillwort (*Isoetes minima*), Dwarf Hesperochiron (*Hesperochiron pumilus*) and Hairy Paintbrush (*Castilleja tenuis*) in British Columbia

Prepared by B.C. Ministry of Environment and Climate Change Strategy

March 2021

About the British Columbia Recovery 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 recovery and survival of the species. The provincial approach is to summarize this information, along with information to guide implementation within a recovery plan. For federally-led recovery planning processes, information is most often summarized in two or more documents that make up a recovery plan: a strategic recovery strategy, followed by one or more action plans used to guide implementation.

Information in provincial recovery documents may be adopted by Environment and Climate Change Canada for inclusion in federal recovery documents that federal agencies prepare, in order 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. Recovery Planning webpage at: < http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning >

Recovery Plan for Columbia Quillwort (*Isoetes minima*), Dwarf Hesperochiron (*Hesperochiron pumilus*) and Hairy Paintbrush (*Castilleja tenuis*) in British Columbia

Prepared by the B.C. Ministry of Environment and Climate Change Strategy

March 2021

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Additional copies

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

<http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning>

Disclaimer

This recovery plan has been prepared by the British Columbia Ministry of Environment and Climate Change Strategy, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The B.C. Ministry of Environment has received this advice as part of fulfilling its commitments under the *Accord for the Protection of Species at Risk in Canada* and the *Canada–British Columbia Agreement on Species at Risk.*

This document identifies the recovery strategies and actions that are deemed necessary, based on the best available scientific and traditional information, to recover Columbia quillwort, dwarf hesperochiron, and hairy paintbrush 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 findings.

The responsible jurisdictions have had an opportunity to review this document. However, this document does not necessarily represent the official positions of all reviewers.

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 and Climate Change Strategy encourages all British Columbians to participate in the recovery of Columbia quillwort, dwarf hesperochiron, and hairy paintbrush.

ACKNOWLEDGEMENTS

This recovery plan was prepared by Carrina Maslovat. It builds on the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports for the three individual species prepared by the author (COSEWIC 2019a; 2019b; 2019c). Funding for this document was provided by the BC Ministry of Environment and Climate Change Strategy.

The threat assessments were done in 2018 as part of the COSEWIC status report, and team members included the author, Ryan Batten (consultant), Dave Fraser (facilitator), Del Meidinger (COSEWIC Species Specialist Subcommittee co-chair), Andy MacKinnon (consultant), Bruce Bennett (COSEWIC) and Jenifer Penny (B.C. Ministry of Environment and Climate Change Strategy - ENV). Brenda Costanzo and Alanah Nasadyk (ENV); Kim Dohms, Marie-Claude Leheutre, Thomas Calteau, and Megan Harrison (Ministry of Environment and Climate Change Canada); Lindsay Anderson and Vera Vukelich (B.C. Ministry of Forests, Lands Natural Resource Operations and Rural Development [FLNRORD]); John Krebs (FLNRORD); Joan Hornby (BC Hydro); Kirk Hancock (B.C. Ministry of Energy, Mines and Low Carbon Innovation [EMLI]), and Lindi Anderson (EMLI) provided review comments on the recovery strategy.

EXECUTIVE SUMMARY

Columbia quillwort (*Isoetes minima*) was designated as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2019 based on the following criteria:

- small distribution range and decline or fluctuation (Extent of Occurrence [EOO] and Index of Area of Occupancy [IAO] well below thresholds, there are fewer than five locations and there is an inferred decline in habitat area and quality due to ongoing threats);
- small and declining number of mature individuals (no subpopulation has more than 1000 individuals and continuing decline is inferred due to a decline in habitat quality).

It is anticipated to be listed in Canada on Schedule 1 of the *Species at Risk Act* (SARA).[1] In British Columbia, Columbia quillwort is ranked S1S2 (Critically imperiled/Imperiled) by the B.C. Conservation Data Centre, and is on the provincial Red list. It is globally ranked G1G2 (Critically imperiled/Imperiled). The main threats are drought associated with climate change and recreational activities.

Dwarf hesperochiron (*Hesperochiron pumilus*) was designated as Endangered by COSEWIC in 2019 based on the following criteria:

- small distribution range and decline or fluctuation (EOO and IAO are well below thresholds, there are fewer than 5 locations and there is an inferred decline in habitat area and quality due to ongoing threats);
- small and declining number of mature individuals (current population size is below threshold of 2,500 plants, no population is greater than 250 mature individuals, and continuing decline is inferred due to a decline in habitat quality and habitat);
- very small or restricted population (population is fewer than 250 mature individuals).

It is anticipated to be listed in Canada on Schedule 1 of the *Species at Risk Act* (SARA)[1]. In British Columbia, dwarf hesperochiron is ranked S2 (Imperiled) by the B.C. Conservation Data Centre and is on the provincial Red list. The main threats are invasive non-native/alien species and recreational activities.

Hairy paintbrush (*Castilleja tenuis*) was designated as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2019 based on the following criteria:

- small distribution range and decline or fluctuation (EOO and IAO are well below thresholds for Endangered, the species in known to exist at less than 5 locations, is experiencing an inferred decline in extent and quality of habitat due to ongoing threats, and may have extreme fluctuations in number of mature individuals);
- small and declining number of mature individuals;
- very small or restricted population.

[1] The COSEWIC assessment will be reviewed by the Governor in Council who may, on the recommendation of the Minister, amend the List to include this species on Schedule 1 of SARA.

It is anticipated to be listed in Canada on Schedule 1 of the *Species at Risk Act* (SARA)[1]. In British Columbia, hairy paintbrush is ranked S1 (Critically Imperiled) by the B.C. Conservation Data Centre and is on the provincial Red list. The main threats are invasive non-native/alien species and drought associated with climate change.

In Canada, all three species are found in the Interior Cedar – Hemlock (ICH) biogeoclimatic zone. All three species also require spring seepages that generally dry mid-June. Seepages are uncommon in the landscape and occur where ephemeral underground moisture is carried on top of shallow bedrock.

Recovery is considered to be biologically and technically feasible for all three species.

The recovery population and distribution goal is to maintain all populations of Columbia quillwort, dwarf hesperochiron, and hairy paintbrush by securing, protecting or restoring the habitats for extant[2] populations within the province, including any additional populations that may be identified in the future. Translocations[3] including augmenting existing populations, or establishing populations at new sites, may also be required to reduce the risk of extirpation and ensure the long-term viability for each of these species.

The overall population and distribution goal aims to recover Columbia quillwort, dwarf hesperochiron, and hairy paintbrush in British Columbia by increasing resiliency and redundancy within the species' populations, through maintaining or restoring habitat supporting all extant populations, including any additional populations that may be identified in the future, and addressing human-caused threats. The target number of populations for each species is at least five (within the current range of extent), each with $\geq$250 mature individuals. It is assumed that if habitat is secure and other threats are mitigated, populations of these plants will persist. Although new populations within the known range of each species may be recorded with increased survey effort, there is no information to indicate that these species were previously more widespread in British Columbia. Habitat restoration should focus on identified threats.

Active management to increase the number of individuals within populations, and number of populations for each species will address the COSEWIC listing criteria associated with small numbers of mature individuals, and limited number of populations. The species' reproductive and dispersal needs are poorly understood, and will require further research and ongoing monitoring of documented populations to guide management. Recovery objectives for all three species are as follows:

1. To protect all known populations in British Columbia through the cooperation of engaged land-tenure holders within five years;
2. To develop and implement a habitat monitoring and restoration plan for all species at all populations with confirmed populations within two years;

[2] Extant: occurrence has been recently verified as still existing within the past 20 years and where the habitat is still intact.
[3] Translocation: deliberate moving of plants or propagules from one location to another in order to help conserve the species.

3. To identify and prioritize areas for surveys to determine if there are unrecorded populations, and identify unoccupied potential habitat to establish new populations within five years;
4. To identify life history, dispersal, and habitat limitations, and develop methods for mitigating constraints within five years;
5. To develop priorities to establish one new experimental population of Columbia quillwort, dwarf hesperochiron, and hairy paintbrush within ten years (if appropriate based on above research).

RECOVERY FEASIBILITY SUMMARY

The recovery of Columbia quillwort, dwarf hesperochiron, and hairy paintbrush in B.C. is considered technically and biologically feasible, based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility:

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. Mature, reproducing individuals of all three species were observed during 2017 field work. Juvenile plants of both dwarf hesperochiron and Columbia quillwort were observed, indicating successful reproduction is occurring for both of these perennial species. The annual hairy paintbrush was flowering during surveys, and no barriers to future reproduction were observed.

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

YES. There is sufficient suitable habitat available to support all three species at their current level of abundance. Although the habitat is highly specialized, habitat protection measures including limiting recreational activities, managing invasive species and ensuring hydrology is maintained will be sufficient to continue to support these species in Canada. Further surveys for additional unrecorded populations are important for identifying sufficient suitable habitat to meet recovery goals and objectives.

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

YES. All known populations of all three species are found on provincial Crown land, and threats can be mitigated by careful management and restoration of the populations. Restoration efforts required will include invasive species removal and management will include limiting recreational impacts and mitigating damage by forestry operations. Impacts associated with drought related to climate change can be moderated by maintaining current hydrology.

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

YES. Management of land use associated with logging and invasive species management will maintain existing subpopulations at their current levels of abundance. Increased inventory work may find new populations, increasing the number of known sites. *Ex situ* propagation techniques are available for dwarf hesperochiron, which is used as a horticultural plant, and may also be developed for Columbia quillwort and hairy paintbrush with further research into the species' reproductive biology.

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1 COSEWIC* SPECIES ASSESSMENT INFORMATION

Assessment Summary: May 2019
Common Name: Columbia quillwort
Scientific Name: *Isoetes minima*
Status: Endangered
Reason for Designation: This relative of the fern grows in thin, acidic substrate over steeply sloping bedrock. It occurs in spring ephemeral seepages in otherwise dry coniferous forest glades. A rare Pacific Northwest endemic, the species is known in Canada from four subpopulations in extreme southern British Columbia (Castlegar area), all of which have been discovered since 1996. As of 2017, there were 1,145 plants (1,019 mature) known in Canada. Reductions in habitat quality and quantity have resulted from recreational activities (specifically mountain biking), and from establishment of non-native plants, such as spotted knapweed. All Canadian sites are on Provincial Crown Land and where logging of surrounding areas and/or road building activity could change site hydrology with potential negative impacts on this species. Limited genetic diversity is expected in this population.
Occurrence: British Columbia
Status History: Designated Endangered in May 2019

Assessment Summary: May 2019
Common Name: Dwarf hesperochiron
Scientific Name: *Hesperochiron pumilus*
Status: Endangered
Reason for Designation: This small, perennial plant is restricted to seasonally wet montane forest openings at four sites in a small area of southeastern British Columbia. The total number of mature individuals is very small (under 200). All Canadian sites are on Provincial Crown Land and potentially subject to logging of surrounding areas and/or road building activity with subsequent changes to site hydrology. Negative impact on the thin substrate by mountain-biking activity has been noted close to one occurrence. Competition from non-native plants, most notably spotted knapweed, is the most significant threat expected to lead to habitat degradation over time. Drought and atypically intensive fire, as per climate-change projections, could potentially damage or eliminate one or more occurrences within three generations.
Occurrence: British Columbia
Status History: Designated Endangered in May 2019

Assessment Summary: May 2019
Common Name: Hairy Paintbrush
Scientific Name: *Castilleja tenuis*
Status: Endangered
Reason for Designation: This delicate annual plant is a spring ephemeral of sparsely vegetated seepages over steeply sloping bedrock in otherwise dry coniferous forest glades. It is only known from one site in Canada. Competition from non-native plants, most notably spotted knapweed, is the most significant observable threat. Limited genetic diversity is expected within this isolated population. Potential exists for increased drought and fire (as per climate change projections) to damage or eliminate the population within three generations. As a hemiparasite, it is further threatened due to detrimental climate change impacts on its host.
Occurrence: British Columbia
Status History: Designated Endangered in May 2019

* Committee on the Status of Endangered Wildlife in Canada.

2 SPECIES STATUS INFORMATION

	Columbia Quillwort	Dwarf Hesperochiron	Hairy Paintbrush
Legal Designation:[a]			
Forest and Range Practices Act:[b]	No	No	No
Oil and Gas Activities Act:[b]	No	No	No
B.C. *Wildlife Act*:[c]	No	No	No
Species at Risk Act-Schedule 1[d]	No (under consideration for addition)	No (under consideration for addition)	No (under consideration for addition)
Conservation Status[e]			
B.C. List:[f]	Red	Red	Red
B.C. Rank:	S1S2 (2019)	S2 (2019)	S1 (2019)
National Rank:	N2 (2010)	N2 (2010)	N2 (2010)
Global Rank:	G1G2 (2015)	G4 (1999)	G5 (1990)
Other Subnational Ranks:[g]	Oregon (S1?) Washington (S1) Idaho (S1)[h]	Arizona (S2) California (SNR) Colorado (SH) Idaho (SNR) Montana (SNR) Nevada (S3) Oregon (SNR) Utah (SNR) Washington (SNR) Wyoming (S2)	Alaska (SNR)[i] California (SNR) Idaho (SNR) Nevada (S4) Oregon (SNR) Washington (SNR)

[a] Data source: B.C. Conservation Data Centre (2020) unless otherwise noted.
[b] No = not listed in one of the categories of wildlife that requires special management attention to address the impacts of forestry 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).
[c] No = not designated as wildlife under the British Columbia *Wildlife Act* (Province of British Columbia 1982)
[d] No = not on any Schedules under the *Species at Risk Act* (SARA; Government of Canada 2002). The COSEWIC assessment will be reviewed by the Governor in Council who may, on the recommendation of the Minister, amend the List to include this species on Schedule 1 of SARA.
[e] S = subnational; N = national; G = global; 1 = critically imperilled; 2 = imperilled; 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] Red: Includes any indigenous species or subspecies that have, or are candidates for, Extirpated, Endangered, or Threatened status in British Columbia
[g] Data source: NatureServe (2020).
[h] The rank of S1 was approved in February 2020 at the Idaho Rare Plant Conference (Kinter pers. comm. 2020).
[i] The Alaska occurrence is from a roadside and the USDA lists its status as I? or possibly introduced (USDA 2020). There is also a specimen from Colorado (University of Washington Herbarium 2020) but the species has not been ranked for that state (NatureServe 2020).

3 SPECIES INFORMATION

Columbia quillwort (*Isoetes minima*), dwarf hesperochiron (*Hesperochiron pumilus*), and hairy paintbrush (*Castilleja tenuis*) are treated together in this recovery plan because all three plants occur in similar habitats in overlapping sites[4] in the mountainous southern interior of British Columbia. All three are endemic[5] to western North America, and in Canada are found only in the southern interior of British Columbia (COSEWIC 2019a; 2019b; 2019c). Columbia quillwort,

[4] Sites - refers to the physical spatial location of populations of these three species.
[5] Endemic - refers to a species being native to a single defined geographic location, and not naturally occurring beyond that location.

dwarf hesperochiron and hairy paintbrush face similar threats and recovery actions need to consider the ecological requirements of all three species.

3.1 Species Description

3.1.1 Columbia Quillwort

The following description is condensed from COSEWIC (2019a). Columbia quillwort is a perennial and one of the smallest quillwort species in North America with 6 to 12 round, slender (0.67 to 0.74 mm) leaves that emerge as a tuft from a corm-like rootstock. The leaves are 3 to 6 cm long but if there is sufficient moisture available, they can grow up to 20 cm long. The sporangia (spore producing organs) form in the swollen leaf bases and the velum (membrane) covers 60 to 75% of the sporangia. The megaspores (female spores) are spherical, 380 to 400 microns in diameter with short, slender spinules (spine-tipped) around the equator of the megaspore. The white microspores are small (26 to 31 microns) and are sparsely papillose (small blunt projections) or spinulose (weakly spine-tipped).

Figure 1. Photo of Columbia quillwort.

3.1.2 Dwarf Hesperochiron

The following description is condensed from COSEWIC (2019b). Dwarf hesperochiron is a perennial, herbaceous plant that grows up to 10 cm tall. The main stem is slender and is connected to smaller offshoot plants by thin, fragile rhizomes (underground stems). The leaves are simple and ovate forming a basal rosette (cluster of leaves). The leaf blades are up to 10 cm long with a petiole (leaf stalk) of approximately equal length. The showy flowers are rotate (short tube with wide flattened lobes) or campanulate (bell-shaped) with five (rarely six) lobes, measuring 1 to 3 cm wide, with up to eight flowers per plant. The white petals have hairy, yellow throats and there are frequently purple markings that extend outward from the throat. The many small seeds (1-1.5 mm) are found in oval capsules. There are only two species of *Hesperochiron* in North America: dwarf hesperochiron and California hesperochiron (*H. californicus*). California hesperochiron is not known from Canada.

Figure 2. Photo of dwarf hesperochiron.

3.1.3 Hairy Paintbrush

The following description is condensed from COSEWIC (2019c). Hairy paintbrush is an annual that grows 4.5 to 30 (infrequently up to 52) cm tall from a slender taproot or branched root system. The stems are covered with a mix of long and short soft, spreading hairs that may or may not be glandular. The hairy leaves range in colour from green to brown and are 0.7 to 4 cm long. The lower leaves are linear without lobes and the upper leaves are lanceolate (lance-shaped) with 0 to 3 (sometimes 5) lobes. The flowers form a terminal spike, 2 to 25 cm long and 1 to 3 cm wide. The floral bracts range in colour from green to brown. In the British Columbia populations, the corollas are creamy yellow, tubular, with 2 lips: the upper lip is straight and beak-like and the lower lip forms an inflated, pouch. The fruits are 6 to 9 mm long capsules. *Castilleja* species are hemiparasitic, forming root grafts with a host to extract water, nutrients, minerals, and organic compounds while continuing to photosynthesize with chlorophyll.

In the southern interior of British Columbia, hairy paintbrush and annual paintbrush (*Castilleja minor* var. *exilis*) are the only annual *Castilleja* species. There are recovery documents available for other Castilleja species at risk in B.C. including cliff paintbrush (*Castilleja rupicola*), golden paintbrush (*Castilleja levisecta*), and Victoria's owl-clover (*Castilleja victoriae*) (Government of Canada 2017a; 2016; 2017b).

Figure 3. Photo of hairy paintbrush.

3.2 Distribution, Abundance, and Population Trends

The Canadian distributions of the three plant species covered in this recovery plan are in southern British Columbia, all within a 25-km radius of Castlegar, between the Monashee and Selkirk Mountain ranges.

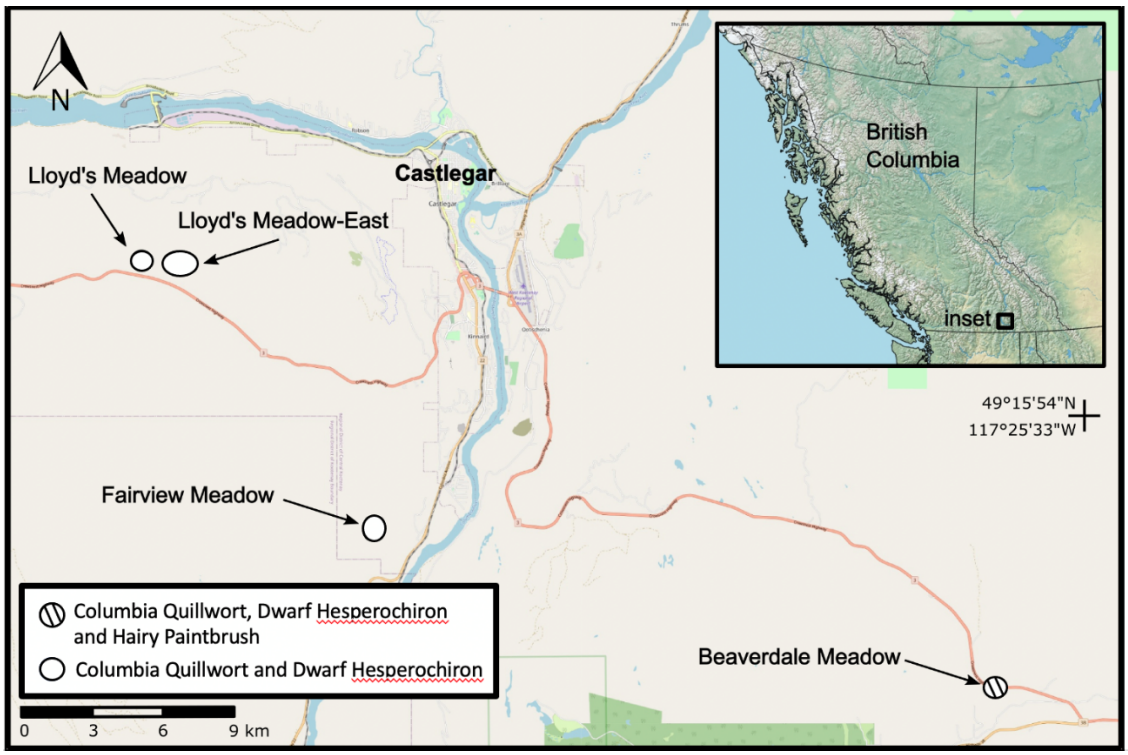

Figure 4. Columbia quillwort, dwarf hesperochiron and hairy paintbrush distribution in British Columbia (COSEWIC 2019a; 2019b; 2019c; University of Washington Herbarium 2020).

3.2.1 Columbia Quillwort Distribution

Columbia quillwort is known from 15 populations[6] globally: four in British Columbia, three in Washington, two in Idaho and six in Oregon (Figure 5) (NatureServe 2020; University of Washington Herbarium 2020; Fertig pers. comm. 2020; Kinter pers. comm. 2020; Vrilakas pers. comm. 2020). It has been extirpated from one population on private property in Washington (Fertig pers. comm. 2020).

In Canada, it has been found in four populations (first observation in 1996) (Table 1) in southern British Columbia within a 25-km radius of Castlegar between the Selkirk and Monashee mountain ranges (Figure 4). There are no records of populations that have been extirpated in the province. The populations appear to be stable but long-term trend data is not available.

It is unclear how much of the global population occurs in Canada since detailed counts for United States populations are not available, however Canada has approximately one-third of the total populations.

It is possible that additional populations will be found with greater search effort, however in the southern interior of British Columbia where conifer forests are dominant, the open habitat with seepages required by Columbia quillwort is extremely rare in the landscape. Columbia quillwort is small, easily overlooked, and visible for only a short time before plants are obscured by adjacent vegetation and wither with summer droughts.

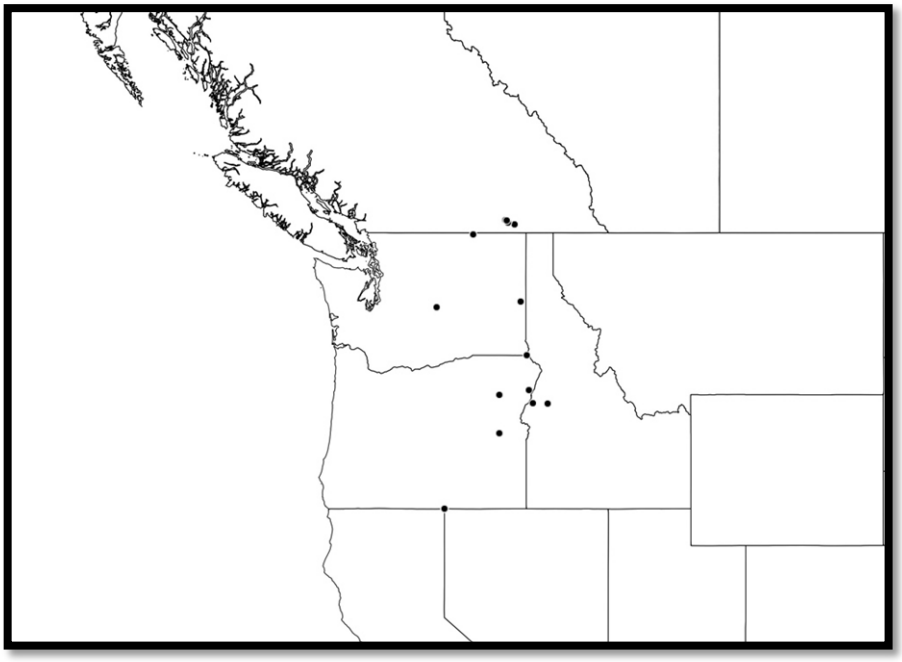

Figure 5. Columbia quillwort distribution in North America (University of Washington Herbarium 2020; Fertig pers. comm. 2020; Kinter pers. comm. 2020; Vrilakas pers. comm. 2020).

[6] Population is defined as per element occurrence specifications used by Natureserve (2004) which defines populations as a group of occurrences that are separated by less than 1 km; or if separated by 1 to 3 km, with no break in suitable habitat between them exceeding 1 km; or if separated by 3 to 10 km but connected by linear water flow, and having no break in suitable habitat between them exceeding 3 km.

Table 1. Status and description of Columbia quillwort populations in B.C.

Population[a]	Location	B.C. CDC EO# [b]	Status[c]	Last year recorded	First Observation	Description[d]	Land tenure
Beavervale Meadow	Highway 3, 12 km west of Salmo en route to Castlegar	#12825	Extant	2017	A. & O. Ceska 1996	Extant. 2017: 69 (57 mature) plants in 4 subpopulations[e]	Provincial Crown
Fairview Meadow	South of Fairview subdivision/ Blueberry Creek	#13629	Extant	2017	S. Hartwell 2002	Extant. 2017: 300 (254 mature) plants in 5 subpopulations	Provincial Crown
Lloyd's Meadow	8.2 km west of Castlegar	#12826	Extant	2017	H. Roemer 1996	Extant. 2017: 584 (527 mature) plants in 5 subpopulations	Provincial Crown
Lloyd's Meadow East	East of Lloyd's Meadow	#14656	Extant	2017	R. Batten & C. Maslovat 2017	Extant. 2017: 192 (181 mature) plants in 9 subpopulations	Provincial Crown

[a] Population is defined as per element occurrence specifications used by NatureServe (2004) which defines populations as a group of occurrences that are separated by less than 1 km; or if separated by 1 to 3 km, with no break in suitable habitat between them exceeding 1 km; or if separated by 3 to 10 km but connected by linear water flow and having no break in suitable habitat between them exceeding 3 km.
[b] British Columbia Conservation Data Centre Element Occurrence Number
[c] Extant: occurrence has been recently verified as still existing (NatureServe 2002).
[d] Description from field notes collected for COSEWIC 2019a
[e] Subpopulations represent patches of individuals within a population that are within 1km of each other

3.2.2 Dwarf Hesperochiron Distribution

Dwarf hesperochiron is widespread throughout the western United States. It ranges from Washington, south to California and east to Arizona, Wyoming and Montana (Figure 6) (NatureServe 2020; University of Washington Herbarium 2020).

Dwarf hesperochiron has been found in four populations (first observation 1989) (Table 2) in the southern interior of British Columbia within a 25-km radius of Castlegar between the Selkirk and Monashee mountain ranges (Figure 4). There are no records of populations that have been extirpated in the province and the populations appear stable but long-term trend data is not available. Less than 1% of the global range occurs in Canada.

It is possible that new populations of dwarf hesperochiron will be found in Canada. It is a small plant that can be easily overlooked when not in flower, especially since the leaves are similar to pretty shootingstar (*Primula pauciflora*). However, in the southern interior of British Columbia where conifer forests are dominant, the open habitat with seepages required by dwarf hesperochiron is extremely rare on the landscape.

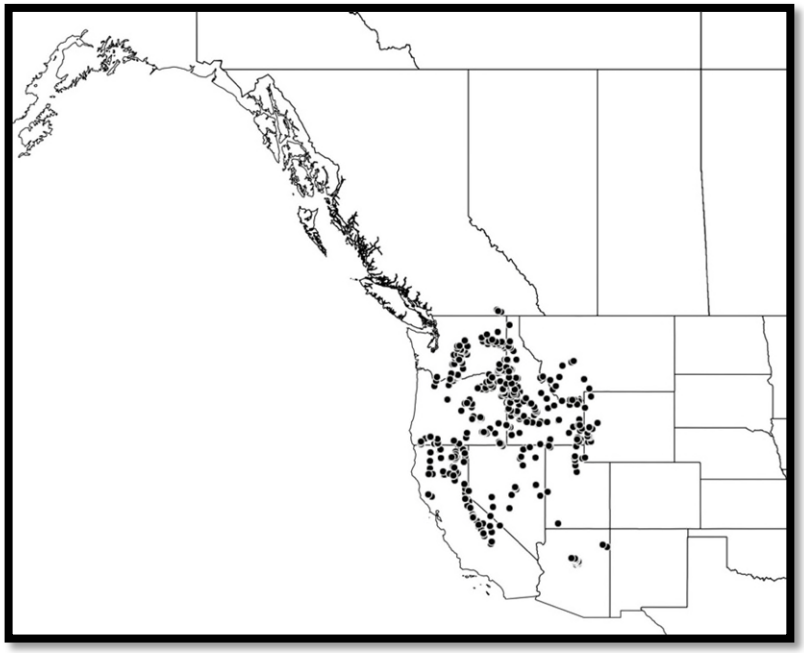

Figure 6. Dwarf hesperochiron distribution in North America (University of Washington Herbarium 2020).

Table 2. Status and description of dwarf hesperochiron populations in B.C.

Population	Location	BC CDC EO#	Status	Last year recorded	First Observation	Description	Land tenure
Beavervale Meadow	Highway 3, 12 km west of Salmo en route to Castlegar	#835	Extant	2017	J. Cuming 1989	Extant. 2017: 3 mature plants in 1 subpopulations	Provincial Crown
Fairview Meadow	South of Fairview subdivision/Blueberry Creek	#14786	Extant	2017	R. Batten 2017	Extant. 2017: 74 mature plants in 3 subpopulations	Provincial Crown
Lloyd's Meadow	8.2 km west of Castlegar	#12468	Extant	2017	R. Batten 2014	Extant. 2017: 78 mature plants in 6 subpopulations	Provincial Crown
Lloyd's Meadow East	East of Lloyd's Meadow	#14787	Extant	2017	R. Batten & C. Maslovat 2017	Extant. 2017: 13 mature plants in 2 subpopulations	Provincial Crown

3.2.3 Hairy Paintbrush Distribution

Hairy paintbrush is widespread throughout the western United States. It ranges from Washington, south to California and east to Nevada and Idaho (NatureServe 2020; University of Washington Herbarium 2020). There are two outlier specimens, one from Alaska and one from Colorado which were collected on roadsides (University of Washington Herbarium 2020), and it is possible this species was introduced to these outlier sites (USDA 2020). In British Columbia

and Washington, it is only found east of the Cascade Mountains, but further south in California and Oregon, it is found on both sides of the mountain range (Figure 7). In Canada, hairy paintbrush is known from a single population where it was first observed in 2000 (Table 3) in southern British Columbia, east of Castlegar (Figure 4). There are no records of populations that have been extirpated in the province. The populations fluctuate from year to year, but long-term trend data is not available. Less than 1% of the global range occurs in Canada.

It is possible that new populations of hairy paintbrush will be found in Canada in the southern interior of British Columbia where conifer forests are dominant, however, as has been previously mentioned, the open habitat with seepages required by hairy paintbrush is extremely rare on the landscape. It is a small plant that can be easily overlooked when not in flower. The plants wither with early summer drought, and they are in bloom at a time when other rare plants in the same habitat are no longer visible, so can be missed during targeted botanical surveys.

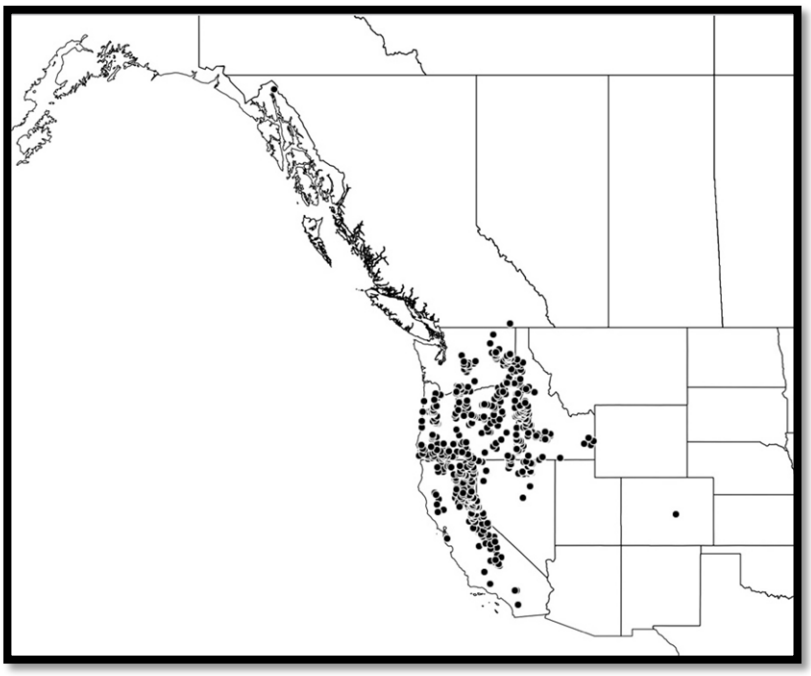

Figure 7. Hairy paintbrush distribution in North America (University of Washington Herbarium 2020).

Table 3. Status and description of hairy paintbrush populations in B.C.

Population	Location	BC CDC EO#	Status	Last year recorded	First Observation	Description	Land tenure
Beavervale Meadow	Highway 3, 12 km west of Salmo en route to Castlegar	#8894	Extant	2017	F. Lomer 2000	Extant. 2017: 57 mature plants in 1 subpopulations	Provincial Crown

3.3 Habitat and Biological Needs of Columbia Quillwort, Dwarf Hesperochiron and Hairy Paintbrush

In Canada, all three species are found in the Interior Cedar – Hemlock (ICH) biogeoclimatic zone. The populations are found within the Selkirk Foothills Ecosection, a transition zone that lies between the Selkirk Mountains to the east and the Okanagan Highlands to the west and is divided by the B.C. – Washington border (Demarchi 2011). Within the Ecosection, the substrate is formed by granitic batholiths and sedimentary rocks (Demarchi 2011). Glaciers have rounded the mountains and left glacial debris on the valley floor, particularly south of Castlegar (Demarchi 2011).

The habitat for all three species is rare on the landscape, and is restricted to small open pocket meadows (glades) within a larger forested matrix. The glades are kept open because of shallow soils over rock that prevent the establishment of larger, more vigourous plants that are competitive for light, moisture and nutrients.

In the United States, Columbia quillwort habitat includes moist draws with seasonal seeps; seasonal seeps in open meadows; and damp, bare places on prairie (University of Washington Herbarium 2020). Dwarf hesperochiron in the United States is found in open wet meadows, slopes and flats (Patterson and Walden *in prep.*) in sites with less than six degrees slope, varying aspect, and with elevation at most sites ranging from 1000-2000 m (University of Washington Herbarium 2020). In the United States, hairy paintbrush requires spring moisture and grows in moist flats, vernal pools, springs, damp meadows and ditches, and riparian zones, sometimes over serpentine, with most sites occurring from 1000-2000 m in elevation (Egger 2019; University of Washington Herbaria 2020).

All three species require spring seepages that generally dry mid-June. Seepages are uncommon in the landscape, and occur where ephemeral underground moisture is carried on top of shallow bedrock.

In Canada, the occurrences are restricted to a narrow geographic area in the vicinity of Castlegar within a limited range of elevation (700 -1,160 metres). Most populations are in full sun but both Columbia quillwort and dwarf hesperochiron can occur in smaller glade meadows with partial shade from adjacent tree cover. The habitat has warm aspects (east or south) that are free from snow early in the spring. The sites are well-drained, with nutrients transported by the seasonal seepage flows, and soils are acidic. None of the species appear to rely on processes such as fire, erosion, or deposition of soil for annual growth and reproduction.

All three plants occupy slightly different habitats next to the seepages. Columbia quillwort is frequently found on the upslope edge of exposed bedrock above the seepage area, but can also be found below and on the sides of the seepage. Dwarf hesperochiron is usually found in deeper soils with little vegetation on the lower edges or sides of the seepage. Hairy paintbrush is found in thin soils over bedrock, with scattered surface rock directly in the seepage areas.

All three COSEWIC-designated species are found in the same meadow habitat as the regionally rare pink fairies (*Clarkia pulchella*) and false-mermaid (*Floerkea proserpinacoides*). Other

associated species with Columbia quillwort and dwarf hesperochiron include: buttercup-leaved suksdorfia (*Hemieva ranunculifolia*), pretty shootingstar (*Primula pauciflora*), and western cliff fern (*Woodsia oregana*). Columbia quillwort is often found growing in thick moss mats, primarily *Philonotis fontana*, *Niphotrichum elongatum* and *Bryum weigelii*. Associated species with hairy paintbrush include annual hairgrass (*Deschampsia danthonioides*), buttercup-leaved suksdorfia (*Hemieva ranunculifolia*), Douglas' knotweed (*Polygonum douglasii*), small-flower blue-eyed Mary (*Collinsia parviflora*), little tarweed (*Madia* exigua), and narrow petal stonecrop (*Sedum stenopetalum*).

Table 4. Summary of habitat characteristics for Columbia quillwort, dwarf hesperochiron and hairy paintbrush in B.C.

Habitat Feature	Columbia Quillwort	Dwarf Hesperochiron	Hairy Paintbrush
Soil Depth	3-7 (up to 15) cm	>15 cm	<10 cm
Elevation	700-1,160 m (1,370-2,300 m in the US)	719-1,169 m	870 m
Aspect	East to south	East to south	South
Meso-slope Position	5-40 degrees	5-40 degrees	10 degrees
Habitat description	Thick moss mats or bare soil either upslope, below, or beside seepage	Bare soil or with sparse herbaceous vegetation usually at lower edges of seep	Growing in moss mats or with sparse herbaceous vegetation with scattered surface rock in thin soil seepage area

Table 5. Summary of essential functions, features, and attributes of Columbia quillwort, dwarf hesperochiron and hairy paintbrush habitat in B.C.

Life stage	Function[a]	Feature(s)[b]	Attributes[c]
Seed (or spore) to mature reproductive adult	Germinating, seedling (or sporeling) development, flowering (or spore production), fruiting and dispersal	Seasonal spring seepage	Fluctuating moisture levels with seepage drying prior to summer onset. Seepage moisture is required for growth and reproduction and may possibly aid dispersal.
		Shallow soil over bedrock	Thin soils limit the establishment of competitive woody species maintaining open glade conditions including full to part sun
		Favourable aspect	East to south aspect where sites are free from snow early in the spring
		Elevation	In Canada, elevation ranges from 700 to 1160 metres

[a] **Function:** a life-cycle process of the species (e.g., include either animal or plant examples: spawning, breeding, denning, nursery, rearing, feeding/foraging and migration; flowering, fruiting, seed dispersing, germinating, seedling development).
[b] **Feature:** the essential structural components of the habitat required by the species.
[c] **Attribute:** the building blocks or *measurable* characteristics of a feature.

3.4 Ecological Role

Flowers of both dwarf hesperochiron and hairy paintbrush are insect pollinated. Observed pollinators on dwarf hesperochiron were *Andrena* sp. in the mining bee family (Andrenidae) and *Lasioglossum* sp. in the sweat bee family (Halictidae) (Maslovat pers. obs. 2017 in COSEWIC 2019b). Hairy paintbrush flowers are adapted for bee pollination, and short-tongued mining bees (family Andrenidae) have been observed pollinating this species in the United States (Chuang

and Heckard 1991). No comprehensive pollinator studies have been done for either of these species.

Hairy paintbrush is a hemiparasite, forming root grafts with a host plant to extract water, nutrients, minerals, and organic compounds while continuing to photosynthesize with functional chlorophyll (COSEWIC 2019c). Specific host plants have not been identified but hosts for other *Castilleja* species are from 16 different angiosperm families (Heckard 1962; Atsatt 1970; Atsatt and Strong 1970), and a single *Castilleja* plant can form connections with more than one host species (Atsatt and Strong 1970).

Field surveys in 2017 did not reveal any evidence of herbivory on any of the three species (COSEWIC 2019a; 2019b; 2019c). Further studies are required to determine if there are other interspecific interactions.

3.5 Limiting Factors

3.5.1 Limited Habitat/Poor Dispersal

All three species require highly specialized seepage habitat that is rare on the landscape. Seepage habitats are extremely difficult to restore if damaged.

3.5.2 Genetics

Genetic isolation, small population sizes and inbreeding depression can make species less likely to respond to recovery and conservation efforts. All three species reach the northern limits of their distributions in British Columbia, and peripheral populations may be genetically less diverse and more prone to extinction (Leppig and White 2006; Szczecinska et al. 2016). Alternatively, populations at the northern extremity of a species' distribution may possess unique ecological adaptations and provide genetic variability that allows the species to respond to changing environmental conditions (Fraser 2000; Lesica and Allendorf 1995; Leppig and White 2006; Sork et al. 2016). There has been no direct research, so there is no evidence to suggest these factors may impact the recovery of Columbia quillwort, dwarf hesperochiron, or hairy paintbrush in Canada.

3.5.3 Pollinators

Pollinators are unlikely to be a limiting factor. Observed pollinators for both dwarf hesperochiron and hairy paintbrush are short-tongued polylectic mining and sweat bees that collect pollen from a range of unrelated plants (LaBerge 1989; Maslovat pers. obs. 2017 in COSEWIC 2019b; Chuang and Heckard 1991).

3.5.4 Host availability (Hairy Paintbrush)

Host availability, quality, and resistance to parasitism can limit rare parasitic plants (Marvier and Smith 1997). Hemiparasitic plants can be particularly sensitive to climate change since both the hemiparasite and host are impacted. However, it is uncertain how host factors will impact hairy

paintbrush because other *Castilleja* are able to form root grafts with a diverse range of angiosperm host species.

3.5.5 Northernmost Extent of Global Range

All three species are at the northernmost extent of their global ranges, except for the likely introduced occurrence of hairy paintbrush in Alaska. Occurring at the northern limit of their range likely increases these species' susceptibility to climatic and stochastic population fluctuations.

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) (adapted from Salafsky *et al.* 2008). For purposes of threat assessment, only present and future threats are considered. 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.* 2012). Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

For the most part, threats are related to human activities, but they can also be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., introduction of invasive species). Effects of natural phenomena (e.g., fire, flooding) may be especially important when the species is concentrated in one location or has few occurrences, which may be a result of human activity (Master *et al.* 2012). As such, natural phenomena are included in the definition of a threat, though they should be considered cautiously. These stochastic events should only be considered a threat if a species or habitat is damaged from other threats and has lost its ability to recover. In such cases, the effect on the population would be disproportionately large compared to the effect experienced historically (Salafsky *et al.* 2008).

4.1 Threat Assessment

The threat classification below is based on the International Union for Conservation of Nature-Conservation Measures Partnership (IUCN-CMP) unified Threats and Actions Classification system (Version 2.0). The IUCN-CMP Threats Classification system is consistent with methods used by Environment and Climate Change Canada, and the Committee on the Status of Endangered Wildlife in Canada, and adopts an international standard. For a detailed description see the Open Standards website (Open Standards 2016). 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.* (2012) and table footnotes for details. Threats for Columbia quillwort, dwarf hesperochiron, and hairy paintbrush were assessed for the entire province, and were taken from the 2019 status reports for the species (COSEWIC 2019a; 2019b; 2019c) - no new field assessments were done for this report (Tables 6, 7 and 8).

Table 6. Threat classification table for Columbia quillwort in B.C.

Threat No.[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Populations[f]
4	***Transportation & service corridors***	***NC***[g]	***Large***	***Serious-slight***	***Low***	
4.2	Utility & service lines	NC (outside assessment timeframe)	Large	Serious-slight	Low (Possibly in the long term)	Lloyd's Meadow
5	***Biological Resources Use***	**Low**	**Large**	**Slight**	**High (Continuing)**	**All**
5.3	Logging & wood harvesting	Low	Large	Slight	High (Continuing)	All
6	***Human intrusions & disturbance***	***Medium-Low***	***Restricted-small***	***Serious***	***High***	
6.1	Recreational activities	Medium-Low	Restricted -small	Serious	High (Continuing)	Fairview Meadow
7	***Natural system modifications***	***Low***	***Large***	***Slight***	***High (Continuing)***	
7.1	Fire & fire suppression	Unknown	Pervasive	Unknown	High (Continuing)	All
7.3	Other ecosystem modifications	Low	Small	Moderate	High (Continuing)	All
8	***Invasive & other problematic species, genes & diseases***	***Low***	***Restricted***	***Moderate***	***High (Continuing)***	
8.1	Invasive non-native/alien species/diseases	Low	Restricted	Moderate	High-Moderate	All
11	***Climate change & severe weather***	***Medium***	***Pervasive***	***Moderate***	***Moderate***	
11.2	Droughts	Medium	Pervasive	Moderate	Moderate	All

Table 7. Threat Classification for dwarf hesperochiron in B.C.

Threat No.[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Populations[f]
4	***Transportation & service corridors***	***NC (outside assessment timeframe)***	***Large***	***Serious-slight***	***Low***	
4.2	Utility & service lines	NC (outside assessment timeframe)	Large	Serious-slight	Low	Lloyd's Meadow
5	***Biological Resources Use***	**Low**	**Large**	**Slight**	**High (continuing)**	**All sites**
5.3	Logging & wood harvesting	Low	Large	Slight	High (continuing)	All sites
6	***Human intrusions & disturbance***	***Medium-Low***	***Restricted-Small***	***Serious***	***High (continuing)***	
6.1	Recreational activities	Medium-Low	Restricted-Small	Serious	High (continuing)	Fairview Meadow
7	***Natural system modifications***	***Low***	***Large***	***Slight***	***High (continuing)***	
7.1	Fire & fire suppression	Unknown	Pervasive	Unknown	High (continuing)	All sites
7.3	Other ecosystem modifications	Low	Small	Moderate	High (continuing)	All sites
8	***Invasive & other problematic species, genes & diseases***	***Medium***	***Large***	***Moderate***	***High-Moderate***	
8.1	Invasive non-native/alien species/diseases	Medium	Large	Moderate	High-Moderate	All sites

Table 8. Threat Classification for hairy paintbrush in British Columbia

Threat No.[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Populations[f]
7	***Natural system modifications***	***Low***	***Restricted***	***Slight***	***High (continuing)***	
7.1	Fire & fire suppression	Unknown	Pervasive	Unknown	High (continuing)	Beavervale Meadow
7.3	Other ecosystem modifications	Low	Restricted	Slight	High (continuing)	Beavervale Meadow
8	***Invasive & other problematic species, genes & diseases***	***Medium-Low***	***Large-Restricted***	***Moderate-Slight***	***High-Moderate***	

Threat No.[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Populations[f]
8.1	Invasive non-native/alien species/diseases	Medium-Low	Large-Restricted	Moderate-Slight	High-Moderate	Beavervale Meadow
11	***Climate change & severe weather***	***Medium-Low***	***Pervasive***	***Moderate-Slight***	***Moderate***	
11.1	Habitat shifting & alteration	Unknown	Restricted	Unknown	Moderate	Beavervale Meadow
11.2	Droughts	Medium-Low	Pervasive	Moderate-Slight	Moderate	Beavervale Meadow

Note: a description of the threats included in this table is found in Section 4.2.

[a] Threat numbers are provided for Level 1 threats (i.e., whole numbers) and Level 2 threats (i.e., numbers with decimals).

[b] **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. The median rate of population reduction for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75%), 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 time (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.

[c] **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 to100%; Large = 31 to70%; Restricted = 11 to 30%; Small = 1 to 10%; Negligible = < 1%).

[d] **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 3-generation timeframe. For this species a 15-year timeframe was used (generation time 2-5 years). Severity is usually measured as the degree of reduction of the species' population. (Extreme = 71to100%; Serious = 31 to70%; Moderate = 11to30%; Slight = 1 to10%; Negligible < 1%; Neutral or Potential Benefit $\geq$ 0%).

[e] **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.

[f] Refer to Table 3 for a description of the populations; Figure 4 shows the distribution of these populations.

[g] NC = not calculated

4.2 Description of Threats

The overall province-wide Threat Impact is High for Columbia quillwort, Medium for dwarf hesperochiron and Medium-Low for hairy paintbrush.[7] This overall threat impact considers the cumulative impacts of multiple threats. Primary threats for Columbia quillwort include drought associated with climate change and recreational activities (Table 6). For dwarf hesperochiron, the primary threats are invasive non-native species and recreational activities (Table 7). For hairy paintbrush, the primary threats are invasive non-native species and droughts associated with climate change (Table 8). Details are discussed below under the Threat Level 1 headings.

The 3-generation timeframe was used to determine severity scores: a generation time of 5 years was used for Columbia quillwort and 2-5 years for dwarf hesperochiron with a timeframe of 15 years assessed for both species. For hairy paintbrush which has a 1 year generation time, 10 years was used for assessing severity.

4.2.1 Threats with Impacts to Columbia quillwort, dwarf hesperochiron, and/or hairy paintbrush

Threat 5. Biological Resource Use
5.3 Logging & wood harvesting (impact low)
The species in this recovery plan are not the target for harvest, however large scale logging and wood harvesting may cause unintentional effects. Logging, road building, and recreational activities may alter hydrology, and change flow to downslope seepage areas. Activities associated with logging and wood harvesting can also cause direct habitat loss through site disturbance and erosion.

All sites are on provincial Crown land and all have old logging roads nearby. The Lloyd's Meadow and Lloyd's Meadow East sites are licensed to Kalesnikoff Lumber (iMap 2020). Beavervale and Fairview Meadows are licensed to Atco Lumber Ltd (iMap 2020).

At Lloyd's Meadow East, there was flagging from a recent timber cruise (prior to 2017), however, the logging company (Kalesnikoff) is aware of the presence of Columbia quillwort and dwarf hesperochiron. The threat was scored as low because any future harvesting plans will be developed to protect existing hydrology. Kalesnikoff has volunteered to leave a buffer of 30 metres beside and below the meadow and any harvesting upslope will involve a detailed drainage plan using LiDAR data to ensure the hydrology of the site is not impacted (Cordeiro pers. comm. 2020). The company will consult with the B.C. Conservation Data Centre prior to the work (Cordeiro pers. comm. 2020). It is not known how these buffer distances were derived, and if these actions are sufficient to protect the species' required habitat.

[7] The overall threat impact was calculated following Master *et al.* (2012) using the number of Level 1 Threats assigned to this species where timing = High or Moderate, which included 2 Medium and 2 Low for Columbia quillwort (Table 6), 2 Medium and 1 Low for dwarf hesperochiron (Table 7) and 2 Medium and 1 Low for hairy paintbrush (Table 8). The overall threat impact considers the cumulative impacts of multiple threats.

Logging activities are unlikely to impact Beavervale Meadow because most of the marketable timber has been harvested and a network of roads has already been established. For this reason, dams and water management/use are not scored as a proximate threat for hairy paintbrush.

Threat 6. Human intrusions & disturbance

6.1 Recreational activities (impact medium – low)

The threat of recreational activities is ranked medium to low for Columbia quillwort and dwarf hesperochiron. For both species, all known populations are on provincial Crown land, are therefore publicly accessible, and the open meadow habitat presents few barriers for recreational use. The Fairview Meadow site is used for mountain bikingr and there is a trail within meters of Columbia quillwort and dwarf hesperochiron plants. All-terrain vehicles use an old road within half a kilometre from populations of these plants. New housing developments near Fairview meadow may increase recreational use over time. Recreational use does not appear to occur at Beavervale Meadow, the only site for hairy paintbrush, and so recreation is not scored as a proximate threat for this species.

Recreational use of the habitat can trample plants, and trails can divert water from seepage areas, changing hydrology. Saturated soils in dwarf hesperochiron habitat are sensitive to erosion, which dislodges the plants and associated soils. Invasive species may also be introduced by recreational activities.

Threat 7. Natural system modifications

7.3 Other ecosystem modifications (impact low)

The impact from other ecosystem modifications is ranked as low for all three species.
Thin soils and regular fires are likely required for maintaining the open glade habitat that all three species require. An overview of historical air photos taken over the last 10 years shows a decrease in meadow size as trees and shrubs encroach on the edges of the glades. Successional processes in the absence of fire will shift the habitat through shading and drawing moisture from the seepages.

Threat 8. Invasive & other problematic species, genes & diseases

8.1 Invasive non-native/alien species (impact low)

The impact from invasive non-native plant species has been ranked low for Columbia quillwort, medium for dwarf hesperochiron and medium-low for hairy paintbrush. The scope of the threat is scored lower for Columbia quillwort than the other species, because Columbia quillwort occurs in wetter areas of the seepage with thinner soils that are less occupied by invasive species than the other two species.

Spotted knapweed (*Centaurea stoebe* sp. *micranthos*) is present at Fairview Meadow, Lloyd's Meadow and Lloyd's Meadow East, at some sites in large numbers. Knapweed is also present at the edges of Beavervale Meadow in areas with deeper soils. Although knapweed is small and in the rosette stage while dwarf hesperochiron and hairy paintbrush are flowering and Columbia quillwort is producing sporophytes, knapweed may cause premature drying of seepages which may limit reproduction by causing premature fruit abortion.

Sites dominated by knapweed may have greater runoff and sediment yield than sites dominated by native bunchgrasses (Lacey et al. 1989). Changes to runoff may alter dispersal patterns of

seeds and vegetative propagules of all three species, spotted knapweed is also allelopathic, and releases chemical compounds that negatively impact adjacent plants (Lesica and Shelly 1996; Ridenour and Callaway 2001; Thorpe et al. 2009; Bais and Kaushik 2010; Duke et al. 2009 but see Lau et al. 2008). The impact of spotted knapweed on Columbia quillwort, dwarf hesperochiron and hairy paintbrush is unknown.

Other non-native invasive plants including sulphur cinquefoil (*Potentilla recta*), hare's-foot clover (*Trifolium arvense*), and common St. John's-wort (*Hypericum perforatum*) may also impact Columbia quillwort, dwarf hesperochiron and hairy paintbrush. Logging, road building, and recreational activities in areas adjacent to the open glade habitat may spread non-native invasive species.

Threat 11. Climate change & severe weather

11.2 Drought (impact medium/medium-low)

The impact from drought is ranked medium for Columbia quillwort, medium-low for hairy paintbrush, and not calculated for dwarf hesperochiron. All three species are susceptible to climate changes that causes premature summer droughts, since all species require spring and early summer soil moisture for growth and reproduction. The risks for Columbia quillwort are higher than for the other two species because it takes longer for their megaspores to reach maturity, so they require moisture to be maintained in the soil throughout a longer period in the spring and early summer. The threats associated with drought are lowest for dwarf hesperochiron because it flowers in the early spring, when there is usually sufficient moisture from snow melt, and occurs in deeper soils than Columbia quillwort or hairy paintbrush which will retain moisture longer; it is unclear if premature drying may impact reproductive capacity. An increase in drought frequency, timing, and severity may impact reproductive capacity of hairy paintbrush if the habitat dries before the fruit can mature. Fruit abortion has been observed in other annual *Castilleja* species that are associated with spring seepage (Fairbarns 2005).

4.2.2 Threats with Negligible Impacts (or not scored) to Columbia Quillwort, Dwarf Hesperochiron, and Hairy Paintbrush

Threat 4. Transportation & service corridors

4.2 Utility and service lines (impact not calculated)

There is a notation of interest that was registered in 1984 by the BC Hydro and Power Authority over Lloyd's meadow and Lloyd's meadow east (GATOR 2019). The impact from utility and service lines was not calculated for either Columbia quillwort or dwarf hesperochiron because the threat was considered to be outside the 3 generation timeframe. Impact depends on where transmission towers or roads are installed. At this time, the notation of interest is only a reserve, rather than permission to construct or excavate, and if development is anticipated a formal application for tenure would be required. Hairy paintbrush does not occur at Lloyd's meadow and so is not impacted by this threat.

Threat 7. Natural system modifications

7.1 Fire and fire suppression (impact not calculated)

The impact associated with fire and fire suppression is ranked as unknown for all three species and the impact of fire suppression and fuel accumulation is difficult to determine. At Beavervale Meadow (2% of Columbia quillwort, 7% of dwarf hesperochiron, and 100% of hairy paintbrush

in Canada), shrubs such as Saskatoon (*Amelanchier alnifolia*) are establishing in the open meadow, presumably associated with fire suppression. Shrubs may eventually shade out seepage plants and draw moisture from the seeps, causing premature drying and decreasing reproductive success. Although it is possible that removal of shrubs and trees by wildfire in areas with seepage and thin soils may create new habitat, fires may also degrade habitat by promoting the colonization of non-native invasive species, increasing erosion and altering hydrology. Increased residential development near Fairview Meadow will create increased pressure for fire suppression.

Threat 11. Climate change & severe weather

11.1 Habitat shifting and alteration (impact not calculated)

The impact of habitat shifting and alteration on hairy paintbrush is unknown, and outside the 10 year assessment timeframe. Climate change can impact both hemiparasites and their host plants. Higher CO_2 levels may change photosynthetic rates and stomate functioning; hemiparisites which are insensitive to elevated CO_2 may maintain high stomatal conductance, and have a higher demand for nutrients on the host, impacting long term fitness (Phoenix and Press 2005).

5 RECOVERY GOAL AND OBJECTIVES

5.1 Recovery (Population and Distribution) Goal

The population and distribution goal is to recover Columbia quillwort, dwarf hesperochiron, and hairy paintbrush in British Columbia by increasing resiliency and redundancy within the species' populations, through maintaining or restoring habitat supporting all extant populations, including any additional populations that may be identified in the future, and addressing human-caused threats. The target number of populations for each species is at least five (within the current range of extent), each with ≥250 mature individuals.

5.2 Rationale for the Recovery (Population and Distribution) Goal

Columbia quillwort, dwarf hesperochiron, and hairy paintbrush were all assessed by COSEWIC (2019) as Endangered on the basis of a small distribution/range (<5 locations), small and declining populations (<250 individuals per population), and ongoing declines in the quantity and quality of habitat, compromising the populations' resiliency and redundancy. All three species occur within naturally-rare seepage habitats, so would not have been widespread historically; however, it is likely that historical populations have been lost as a result of human impacts and/or that additional (currently unknown) populations may be discovered with increased search effort. The known extant populations are also at risk due to ongoing habitat loss/degradation. Therefore, it is considered appropriate/feasible to target increasing the number of populations for each species beyond the number that is currently known to be extant, and to increase the size of each population. This should be achievable through a combination of habitat protection and restoration, mitigation of primary threats (roads, logging/wood harvesting, recreational activities, invasive species) and translocation (either to establish/re-establish populations or to augment existing populations). Increasing the number of populations for each species to ≥5 and the size of each population to ≥250 individuals, and halting declines in habitat

loss and quality, will address the COSEWIC listing criteria and improve the species' assessed status to Threatened or better.

5.3 Recovery Objectives

The following are the recovery objectives for Columbia quillwort, dwarf hesperochiron, and hairy paintbrush:

1. To protect[8] all known populations in British Columbia through the cooperation of engaged land-tenure holders within five years;
2. To develop and implement a habitat monitoring and restoration plan for all species at all populations with confirmed populations within two years;
3. To identify and prioritize sites for surveys through habitat suitability modelling to determine if there are unrecorded populations, and identify unoccupied potential habitat to establish new populations within five years;
4. To identify life history, dispersal, and habitat limitations, and develop methods for mitigating constraints within five years;
5. To develop priorities to establish one new experimental population of Columbia quillwort, dwarf hesperochiron, and hairy paintbrush within 10 years (if appropriate based on above research).

6 APPROACHES TO MEET OBJECTIVES

The following actions have been categorized according to the IUCN-CMP Actions Classification (2.0) System (CMP 2016). Status of each action category for Columbia quillwort, dwarf hesperochiron, and hairy paintbrush is given in parenthesis.

6.1 Actions Already Completed or Underway

A. Target Restoration/Stress Reduction Actions

Action 1 Land/Water Management

Action 1.1 Site/Area Stewardship (not completed)

- All known populations were accurately mapped in preparation for the COSEWIC status report. This will support future site stewardship activities. There is currently no active site management or stewardship at any of the sites.

[8] Because all known populations are on Crown land, protection in this plan means to prevent damage from tenured activities and public recreational use.

B. Behavioural Change / Threat Reduction Actions

Action 5 Livelihood, Economic & Moral Incentives

Action 5.2 Better Products & Management Practices (ongoing)

- Kalesnikoff Lumber Company, the forest licensee operating in Lloyd's Meadow and Lloyd's Meadow East, is aware of the populations of these rare plants at those sites. They will leave a buffer around the habitat during harvest taking into account hydrologic drainage, and will communicate with the B.C. Conservation Data Centre during harvest planning.

C. Enabling Condition Actions

Action 6 Conservation Designation & Planning

Habitat Protection and Private Land Stewardship (in progress)

Action 6.3 Land Use Zoning & Designation (completed)

- A conditional harvest zone Wildlife Habitat Area (WHA 8-373) has been designated over Lloyd's Meadow, Lloyd's Meadow East, and Fairview Meadow to protect Grizzly Bear habitat (iMap 2020). The WHA protects important Grizzly Bear habitat features, including the subalpine parkland meadow habitat where Columbia quillwort and dwarf hesperochiron are found. General Wildlife Measures currently in place with the WHA that will also help protect the seepage habitat for Columbia quillwort and dwarf hesperochiron include the prohibition of the following: primary forest activities from May 1 - June 20; planting trees within 500 m of specified areas; constructing roads within 50 m of grizzly habitat features; and using herbicides, sheep, domestic goats, or cattle for vegetation management (Province of British Columbia 2010).

Action 7 Legal & Policy Frameworks

Action 7.1 Laws, Regulations & Codes

Apply Legal Land Use Tools (not completed)

All known populations of the three flora species are found on provincial Crown land, so there are opportunities for legal land designations to increase habitat protection. There is currently no need for private land stewardship, since there are no known populations on private land.

The successful recovery of this flora on Crown land is dependant on applying the appropriate land use tool. In particular, legal instruments under the *Land Act* (Province of B.C. 1996a) to protect against further land dispositions, *Forest and Range Practices Act* (FRPA) to address timber harvesting, and the *Wildlife Act* or *Off Road Vehicle Act* (Province of B.C. 2014) to regulate or restrict access by off-road vehicles. These statutes do not restrict the activities of other resource industries such as oil/gas extraction and mining [e.g., designation of a Cultural Heritage Resource under the *Mineral Tenure Act* (Province of B.C. 1996b)]. In some cases, other statutes such as the *Greenbelt Act* (Province of B.C. 1996c) may be more appropriate to protect sensitive Crown land areas within or near communities.

- Administrative (land use) instruments under the *Land Act* include: Notations of Interest which record the interest of another provincial ministry in the Crown Land Registry, which includes the map location (Crown Land Registry, 2021). It does not preclude the acceptance of land applications or disposition of Crown land.
- Section 10.1 Ministerial Orders (Province of B.C. 1996a) restricting new Crown land applications for a period of time.
- Land Act Reserves:
    - Section 15 designation is a full withdrawal from disposition for the long-term conservation of land in the public interest (established by Order in Council).
    - Section 16 designation to temporarily withdraw or withhold Crown land from alienation for all purposes under the *Land Act* (e.g., for a term up to 30 years).
    - Section 17 designation is a conditional withdrawals which designates a portion of Crown land for the conservation of natural resources (e.g., for a term up to 30 years).

The process to implement the above land use tools under the *Land Act*[9] are described in the following policies and procedures:

- 'Form of Crown Land Allocation Policy' (Province of B.C. 2011a),
- 'Reserves, Notations, Withdrawals and Prohibition Policy'(Province of B.C. 2011b), and, in particular,
- 'Procedure for Management of Crown Lands for Conservation Purposes'(Province of B.C. 2015).

In terms of land use tools available to regulate or restrict motorized access to these senstivie areas of Crown land; options include:

- Section 58 of FRPA to restrict vehicles used for leisure purposes in Provincial Forest,
- Section 109 of *Wildlife Act* to restrict motorized vehicles via a prohibition regulation, or
- Section 32 of *Off Road Vehicle Act* to restrict vehicles used for work, leisure, or commuting purposes.

Under the *Forest and Range Practices Act*, Wildlife Habitat Features (WHF) require a ministerial order. Designating seeps as a WHF under the Kootenay Boundary, a WHF Order could afford protection to the seep habitat these species occupy by requiring that forest and range activities not cause damage or loss of these features in the area designated.

Legislative options that could be used to protect habitat are included in Table 9. None of these legislative tools are currently in place at any of the sites to protect these three species.

Table 9. Legal Land Use Tools that may afford habitat protection for Columbia quillwort, dwarf hesperochiron, and hairy paintbrush

Existing mechanisms that afford habitat protection	Threat[a] or concern addressed	Site
Wildlife Act (s. 108, 109 et al)	4.2, 6.1, 5.3	All
Land Act (s.10.1, s.15, s.16, s.17, s. 93.1-93.4 and/or s.66)	4.2, 6.1, 5.3	All
Forest and Range Practices Act (s.58 et al)	4.2, 6.1, 5.3	All
Off Road Vehicle Act (s. 32)	4.2, 6.1, 5.3	All

[a] Threat numbers according to the IUCN-CMP classification (see Table 6, 7, and 8 for details).

[9] Note: land designations and the establishment of land use objectives are also described in section 7.1 of the *Land Act* (s. 93.1 to 93.4) and on the following B.C. government website: https://www2.gov.bc.ca/gov/content/industry/crown-land-water/**land-use-planning**

Action 8 Research & Monitoring

Action 8.1 Basic Research & Status Monitoring

Inventory (preliminary work completed)

- Some recent inventory work for all three species was done in preparation for the status reports, but they were limited by the available budget. Refer to COSEWIC status reports (2019a; 2019b; 2019c) for summary of previous inventory efforts.
- Most of the populations were first recorded during non-targeted, opportunistic searches and during a Botany BC field trip.

Monitor Trends (preliminary work completed)

- A comparison of population counts was made to the extent possible during preparation of the status reports. Refer to COSEWIC status reports (2019a; 2019b; 2019c) for summary of trend analysis.

6.2 Recovery Action Table

Actions are characterized in Table 10 in terms of the objective, what actions are identified for meeting the objective, how can actions be measured to meet the objective, what threat does the action address, and what is the priority of the action [Essential = urgent and important, needs to start immediately; Necessary = important but not urgent, action can start in 2 to 5 years; or Beneficial = action is beneficial and could start at any time that was feasible].

Table 10. Recovery actions for Columbia quillwort, dwarf hesperochiron, and hairy paintbrush

Objective	Action #[a]	Actions Classifications	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
	A[d]	**Target Restoration/Stress Reduction Actions**				
	1	***Land/Water Management***				
2	1.1	Site/Area Stewardship	Remove invasive non-native species Minimize damage associated with recreational activities	Population monitoring indicates all known populations are extant and remain stable	6.1, 8.1	Essential
2	1.2	Ecosystem & Natural Process (Re)Creation	Remove encroaching woody species associated with fire suppression	Population monitoring indicates all known populations are extant and remain stable	7.1, 7.3	Essential
	2	***Species Management***				
1	2.1	Species Stewardship	Use LiDAR imagery to map upslope drainage to inform harvesting	No harvesting next to populations or in upslope drainage systems	5.3, 11.2	Beneficial
4, 5	2.2	Species Re-introduction & Translocation	Determine life history, dispersal and habitat limitations Translocate species to establish new populations and/or augment existing populations	Research identifies optimal propagation strategies Populations augmented Establishment of successful new populations	11.2	Beneficial
	B	**Behavioural Change/ Threat Reduction Actions**				
	3	***Awareness Raising***				
1, 2	3.1	Outreach & Communications	Develop and distribute targeted outreach materials for recreational users (e.g.,	Riders in the area are aware of the	6.1	Beneficial

Objective	Action #[a]	Actions Classifications	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
			mountain bikers) that explains the sensitive habitat and the need to protect these species	sensitivity of these sites		
	5	***Livelihood, Economic & Moral Incentives***				
1	5.2	Better Products & Management Practices	Work with logging companies to protect known sites from forestry activities and develop Best Management Practices	Determine buffers needed to protect populations from forestry activities	5.3	Essential
	C	**Enabling Condition Actions**				
	6	***Conservation Designation & Planning***				
1	6.1	Protected Area Designation &/or Acquisition	Protect sites from forestry harvesting and utility line installation	Formal agreement with lease and easement holders Sites flagged in tenure holder databases	4.2, 5.3	Essential
1	6.3	Land/Water Use Zoning & Designation	Protect habitat through implementation of existing Grizzly Bear WHA	Population monitoring indicates habitat is unchanged by tenure activities	5.3, 7.3	Essential
	7	***Legal & Policy Frameworks***				
1	7.1	Laws, regulations & Codes	Establish long-term legal protection measures on Crown Lands for all four flora populations under existing legislation FLNR's Lands Branch and regional lands staff engage to determine the appropriate legal instrument(s) to protect the sensitive habitat areas	Appropriate legal protection secured for Crown land occurrences	5.3	Essential

Objective	Action #[a]	Actions Classifications	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
			Designate seeps a WHA under the *Forest and Range Practices Act*	Designate seeps as WHA		
1	7.2	Review Resource Use	Review resource use and determine if areas with populations can be excluded (or buffered adequately) from harvest and utility use	Populations are protected from resource use	5.3	Essential
	8	***Research & Monitoring***				
2, 3, 4	8.1	Basic Research & Status Monitoring	Monitor all known populations to determine long-term trends; targeted inventory in suitable habitat to find additional populations	Population monitoring indicates all known populations are extant and stable or increasing (2030); data gathered annually to determine long-term trends (2030)	All	Essential
3	8.1	Basic Research & Status Monitoring	Conduct targeted inventory, potentially through the development of a habitat model using available GIS layers (e.g. ecozone, elevation, soils, aspect), to provide potential priority search areas to detect new populations	Inventory of suitable habitats is conducted; new populations are found and new sites for translocations identified	Small number of populations	Essential

[a] Action numbers according to the IUCN-CMP Actions Classifications 2.0.
[b] Threat numbers according to the IUCN-CMP Threats Classifications 2.0.
[c] Essential = urgent and important, needs to start immediately; Necessary = important but not urgent, action can start in 2 to 5 years; or Beneficial = action is beneficial and could start at any time that was feasible.
[d] Black rows denote "Level 0" hierarchical classifications of actions under the CMP Actions Classification. Under the classification system it is the highest level actions can be grouped into and creates a logical way of grouping related actions.
[e] Note that including these actions in the standardized classification explicitly does NOT constitute an endorsement of these tactics.

6.3 Narrative to Support Recovery Action Table

Despite the many knowledge gaps, the key priority to ensuring recovery is to ensure stable populations of Columbia quillwort, dwarf hesperochiron and hairy paintbrush through appropriate site management of provincial Crown lands with known populations.

7 SPECIES RECOVERY AND SURVIVAL HABITAT

Recovery/survival habitat is defined as the habitat that is necessary for the recovery or survival of the species. This is the area that the species naturally occurs or depends on, directly or indirectly to carry out its life-cycle processes, or formerly occurred on and has the potential to be reintroduced.

7.1 Biophysical Description of the Species' Recovery/Survival Habitat

A description of the known biophysical features and their attributes of the species' habitat that are required to support these life-cycle processes (functions) are provided in Section 3.3.

7.2 Spatial Description of the Species' Recovery/Survival Habitat

The area of recovery/survival habitat required for a species is guided by the amount of habitat needed to meet the recovery goal. The survival habitat for these three species includes all of the open meadow areas in all four occupied populations (Lloyd's Meadow, Lloyd's Meadow East, Beavervale Meadow, and Fairview Meadow), plus all associated upstream habitat that supports the hydrology for the required seepage systems. Unoccupied meadows and associated seepage are essential for recovery habitat to meet the recovery goal. Although no maps are included with this document, it is recommended that the area of recovery/survival habitat be more fully described on the landscape to mitigate habitat threats and to facilitate the actions for meeting the recovery (population and distribution) goals.

8 MEASURING PROGRESS

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

Measurable for Objective 1

- All four sites have stewardship agreements or other protection measures in place with tenure holders established by five years after the recovery plan is posted.
- Targeted outreach materials for recreational users (e.g. mountain bikers) are developed and distributed by five years after the recovery plan is posted that explains the sensitive habitat and the need to protect these species.

Measurable for Objective 2

- Habitat monitoring and restoration plans are in place and implemented for all four sites by two years after the recovery plan is posted.
- Ongoing monitoring shows that population trends for the number of plants at each site is stable or increasing by two years after the recovery plan is posted.

Measurable for Objective 3

- Up to 5 sites identified, potentially through habitat suitability modelling, for inventories and surveys to determine if unrecorded populations exist, and to find potential habitat for reintroduction by five years after the recovery plan is posted.

Measurable for Objective 4

- Conduct field and laboratory experiments to identify life history/dispersal and habitat limitations to guide future translocation projects by five years after the recovery plan is posted.

Measurable for Objective 5

- Establish one new experimental population for each of the three species (if possible based on life history and habitat limitations) by ten years after the recovery plan is posted.

9 EFFECTS ON OTHER SPECIES

The habitat protection and stewardship measures recommended here are expected to benefit other glade species that exist in these ecosystems. No negative impacts are anticipated as a result of recovery efforts for these plant species. The protection and management of key areas may help to restore these ecosystems over the long term.

The actions in this recovery plan focus on identification and protection of habitat, primarily through stewardship and land protection through existing regulations and legislative options. Surveys for additional populations will be useful in identifying other rare seepage-associated species in similar habitats within the same geographic range. Columbia quillwort and dwarf hesperochiron can be surveyed simultaneously, and their presence can help identify habitat for hairy paintbrush for later surveys. Additionally, provincially listed flora, fauna and ecological communities of concern whose ranges overlap those of Columbia quillwort, dwarf hesperochiron and hairy paintbrush (summarized in Table 11) may benefit from the management efforts for these plant species.

Management activities for Columbia quillwort, dwarf hesperochiron, and hairy paintbrush will be implemented with consideration for all co-occurring species at risk, and regionally-rare species, such that no negative impacts occur to these species or their habitats.

Table 11. Co-occurring rare species with Columbia quillwort, dwarf hesperochiron, and hairy paintbrush

Species Common Name	**Species Latin Name**	**Provincial Rank**	**COSEWIC Rank**	**Population**
Western Skink	*Plestiodon skiltonianus*	Blue list S3S4 (2018)	Special Concern (2014)	Fairview Meadow
Grizzly Bear	*Ursus arctos*	Blue list S3? (2015)	Special Concern (2012)	Lloyd's Meadow Lloyd's Meadow East, Fairview Meadow
Common Clarkia	*Clarkia rhomboidea*	Blue list S2S3 (2019)		Above Beavervale Meadow
Mountain Blue-curls	*Trichostema oblongum*	SU (Status Unknown) (2019)		Lloyd's Meadow
Oregon Hornwort	*Phaeoceros oreganus*	Red list S2 (2018)		Lloyd's Meadow

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