Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Brook Spike-primrose (*Epilobium torreyi*) in Canada

Brook Spike-primrose

2013

Canada

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PREFACE

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

The Minister of the Environment and the Minister responsible for the Parks Canada Agency is the competent minister for the recovery of the Brook Spike-primrose and has prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with the Province of British Columbia and Environment Canada/Canadian Wildlife Service.

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

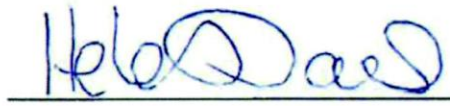
This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment Canada and/or the Parks Canada Agency and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy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

Brook Spike-primrose is a species of ephemeral wet areas associated with Garry Oak ecosystems and recovery of this species will be integrated with the recovery of species in the Recovery Strategy for Multi-Species at Risk in Vernal Pools and other Ephemeral Wet Areas Associated with Garry Oak Ecosystems in Canada (Parks Canada Agency 2006).

RECOMMENDATION AND APPROVAL STATEMENT

The Parks Canada Agency led the development of this federal recovery strategy, working together with the other competent minister(s) for this species under the Species at Risk Act. The Chief Executive Officer, upon recommendation of the relevant Park Superintendent(s) and Field Unit Superintendent(s), hereby approves this document indicating that Species at Risk Act requirements related to recovery strategy development have been fulfilled in accordance with the Act.

Recommended by:



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Approved by:

Alan Latourelle
Chief Executive Officer, Parks Canada Agency

ACKNOWLEDGMENTS

The initial draft of this recovery strategy was prepared by Brian Klinkenberg, Department of Geography, University of B.C. and Rose Klinkenberg, Department of Botany, University of B.C. The Garry Oak Ecosystems Recovery Team is the recovery team for the Brook Spike-primrose and was involved in the development of this recovery strategy. Further revision was the result of comments and edits provided by a number of organizations: the Province of British Columbia, Parks Canada Agency, and Environment Canada.

EXECUTIVE SUMMARY

Brook Spike-primrose (*Epilobium torreyi*) is a small annual plant that is found in ephemerally wet, disturbed areas in Canada. It is known only from extreme southwest British Columbia where it has been reported from two sites on the southeast tip of Vancouver Island (in the vicinity of Victoria): Craigflower Meadow and McTavish Road. Plants have not been seen at the McTavish Road site since 1966, or from the Craigflower Meadow site since 1993. Since there is the possibility that some seeds may remain in the soil seed bank, the species is considered Endangered in Canada rather than Extirpated.

Brook Spike-primrose exhibits a number of needs and limiting factors. It is a habitat specialist with specific habitat requirements including adequate light and hydrology. The species may exhibit seed dormancy and require specific habitat conditions for germination; however, specific habitat requirements are poorly understood. The habitat preferred by this species is easily occupied by invasive alien species due to a decreased level of seasonal inundation and deeper soil compared to vernal pools. The Canadian population is very small and at risk of collapse.

In addition to the limiting factors, Brook Spike-primrose faces a number of threats. The threats of greatest concern are invasive alien species encroachment and changes in ecological dynamics leading to plant succession. Climate change is of concern because Brook Spike-primrose habitat is particularly sensitive to the timing and amount of precipitation, but the ultimate effect of this threat is poorly understood. To address these and other threats to this species, broad strategies are identified in section 6 Broad Strategies and General Approaches to Meet Objectives.

In the short term, recovery objectives for Brook Spike-primrose will focus on the maintenance of the habitat at one former site while exploring the feasibility of restoring the population and establishing new populations to increase abundance and distribution.

Critical habitat is identified for the population at Craigflower Meadow. The identified area encompasses the habitat directly responsible for maintenance of adequate light and water which are critical habitat attributes for this species.

An action plan for this species will be completed by September 2017.

RECOVERY FEASIBILITY SUMMARY

The recovery of Brook Spike-primrose in Canada is considered feasible based on the criteria outlined by the Government of Canada (2009):

1. *Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.*

   Yes. While flowering plants have not been observed at Craigflower Meadow since 1993, viable seeds may remain in the soil or could be obtained from herbarium specimens collected from the site. Using those seeds, flowering individuals could be re-established at the site. If no seeds remain in the seed bank and the seeds from locally-collected herbarium specimens prove to be non-viable, then seeds from a closely related population of Brook Spike-primrose in the U.S. could be used to re-establish the Craigflower Meadow population.

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

   Yes. Habitat suitable to support the species exists (Craigflower Meadow) and additional habitat is likely to be identified in the future.

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

   Yes. Threats to the species and its habitat can be mitigated through removal of encroaching vegetation. Control of encroaching vegetation has been successfully implemented in other sites for other species.

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

   Yes. General methods of recovery for species found in vernal pools and other ephemeral wetlands in Garry Oak ecosystems are outlined by Parks Canada Agency (2006).

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1. COSEWIC Species Assessment Information

Date of Assessment: April 2006
Common Name (population): Brook Spike-primrose
Scientific Name: *Epilobium torreyi*
COSEWIC Status: Endangered
Reason for Designation: Although no plants have been seen at the two known sites after intensive directed surveys, there is still the possibility that some seeds may remain in the soil seed bank given the relatively short period of time since the last observation of plants in 1993, or that previously overlooked populations may be found.
Canadian Occurrence: British Columbia
COSEWIC Status History: Designated Endangered in April 2006. Assessment based on a new status report.

2. Species Status Information

Brook Spike-primrose (*Epilobium torreyi*) is found in North America, from southern British Columbia to northwest California, including Idaho and Nevada (Table 1, Figure 2). Globally the species is considered secure (Table 1). In Canada, it is known only from extreme southwest British Columbia (Figure 3). The Canadian distribution represents < 1% of the global range.

Table 1: Global, national, and provincial/territorial status of the Brook Spike-primrose in North America (NatureServe, 2011).

Location	Rank	Rank Description
Global Status	G5	Secure
Canada	SX	Presumed Extirpated
British Columbia	SX	Presumed Extirpated
United States	SNR	Not ranked / under review
Idaho	SNR	Not ranked / under review
Nevada	SNR	Not ranked / under review
Oregon	SNR	Not ranked / under review
Washington	SNR	Not ranked / under review

3. Species Information

3.1. Species Description

Brook Spike-primrose is an erect, generally hairy, annual herb that rises from a taproot to between 10 and 60 cm in height. Seeds are contained in capsules which lack the tuft of hairs that are typical of the genus (Douglas *et al*. 1999; COSEWIC 2006; Jepson Interchange 2006) (Figure 1).

A. **B.**

Figure 1: Image A, Brook Spike-primrose habit (Norman Jensen, with permission). Image B, Close up of Brook Spike-primrose flowers, photo by Norman Jensen, with permission.

3.2. Population and Distribution

In Canada, this species has only been reported from two sites on the southeast tip of Vancouver Island, in the vicinity of Victoria (Figure 2): McTavish Road and Craigflower Meadow (contained within Thetis Lake Regional Park). Plants have not been seen at the McTavish Road site since 1966, or from the Craigflower Meadow site since 1993. The McTavish Road site is considered extirpated due to extensive habitat alteration which has occurred since the last observation; habitat is still available at the Craigflower Meadow site (COSEWIC 2006; Fairbarns pers. comm. 2006). The species is considered Endangered in Canada rather than Extirpated because there is still the possibility that some seeds remain in the soil seed bank at Craigflower Meadow (COSEWIC 2006). There has been a 50% decline in its known Canadian distribution over the last fifty years.

Figure 2: Global distribution of Brook Spike-primrose indicated by the shaded area (COSEWIC 2006).

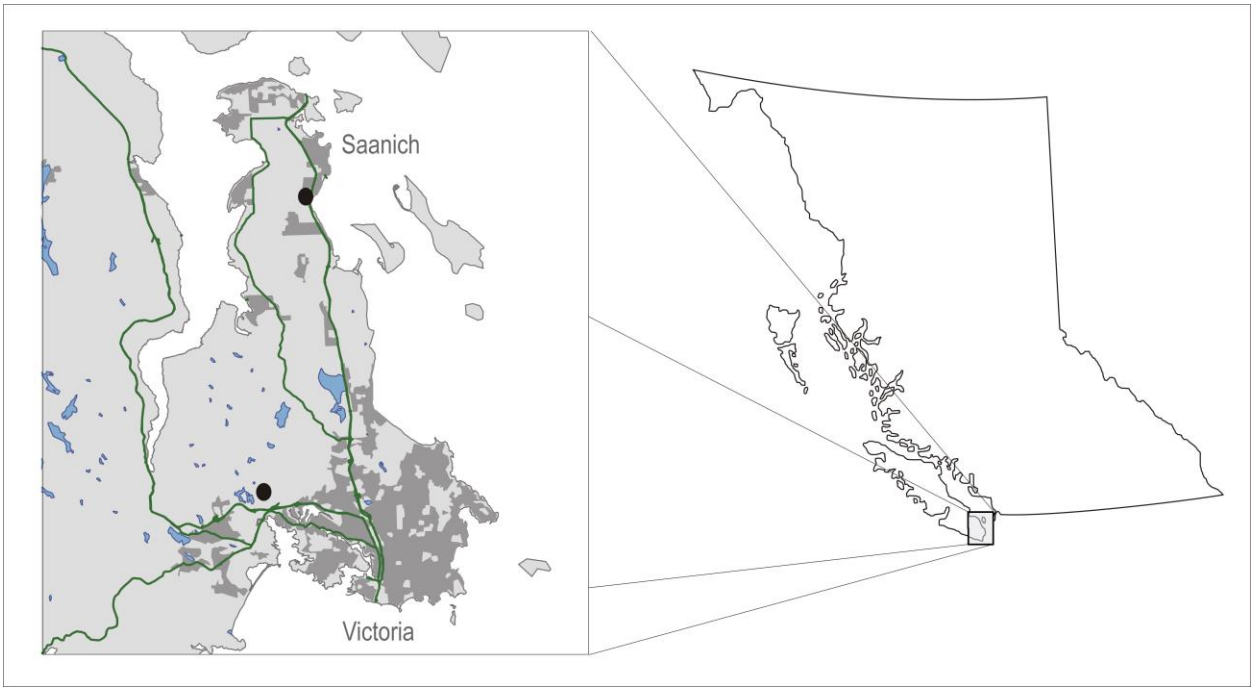

Figure 3: British Columbia distribution of Brook Spike-primrose (COSEWIC 2006). Black circles indicate the location of the two sites: eastern end of McTavish Road (northern circle) and Craigflower Meadow in Thetis Lake Park (southern circle).

3.3. Needs of the Brook Spike-primrose

Brook Spike-primrose exhibits a number of specific biological needs. In addition, there are a number of factors which may limit the recovery of the species. These needs and limitations are presented below.

- Habitat specialist: Brook Spike-primrose is a species of ephemerally wet, disturbed areas; in Canada, the two reported sites are best characterized as vernally wet, disturbed meadows. The very wet conditions in winter and very dry conditions in summer characteristic of these habitats are necessary for Brook Spike-primrose survival. Similar to other species dependant on ephemeral wetlands, Brook Spike-primrose depends upon the extreme seasonal conditions to limit competition (Keeley and Zedler1998). In addition, Brook Spike-primrose likely depends on frequent small scale disturbances that expose mineral soil. While Brook Spike-primrose is a habitat specialist, its exact habitat requirements are poorly understood.
- Susceptibility of preferred habitat to invasion by other plant species: Unlike vernal pools which show some resistance to invasion due to regular inundation and thin soils, Craigflower Meadow is susceptible to invasion by alien plant species (Gerhardt and Collinge 2007; Fairbarns pers. comm. 2011).
- Climate variability: Shifts in climate may limit recovery for this species through changes to the season or duration of inundation. Many species of ephemeral wetlands are sensitive to the timing and amount of rainfall—variations in this can dramatically change species dominance and abundance from year to year (Bliss and Zedler 1997; Graham 2004). Such species also have mechanisms in place that prevent germination when conditions are unfavourable (Bliss and Zedler 1997).
- Seed dormancy: Overall, species of ephemeral wetlands have evolved an annual summer dormancy cycle and, possibly important for Brook Spike-primrose, can remain dormant for several years (Keeley and Zedler 1998). Brook Spike-primrose may exhibit dormancy: some species in the genus *Epilobium* exhibit dormancy while others do not (Grime 1981; Baskin and Baskin 1998). Seed dormancy, and type of dormancy, can influence the longevity of the seed bank (Baskin and Baskin 1998), some seed banks persist only for a few years while others persist for much longer periods. In unfavourable conditions, seeds may become dormant and enter the seed bank.
- Light requirements: Some species of *Epilobium* require high light for germination (Baskin and Baskin 1998) and this may be true of Brook Spike-primrose. Lack of light through burial of seeds or organic matter build up may lead to inhibition of germination, which in turn can result in the development of a seed bank (Baskin and Baskin 1998).
- Seed banking: Brook Spike-primrose is believed to be a seed banking species in light of the above factors (i.e., seed dormancy and light requirements) (Grime 1981; Fairbarns pers. comm. 2006).
- Dispersal: Many ephemeral wetland plants exhibit unique adaptations to limit seed dispersal because their seeds are unlikely to succeed in adjacent upland areas. Brook Spike-primrose has limited dispersal capabilities (cited in Costanzo 2002). Seeds are released in late fall, but the species lacks seed characteristics that would allow for wide dispersal (e.g., flattened shape or terminal cluster of hairs both of which aid in wind

dispersal) and the seeds fall to the ground near the parent plant (COSEWIC 2006). Adaptations to limit seed dispersal restrict the ability of Brook Spike-primrose to occupy new sites.

- Demographic collapse: Small populations that occur in a limited area are particularly vulnerable to catastrophic events that could eliminate the population. For example, atypical precipitation patterns resulting in changes to hydrological conditions over several years could prevent a species from flowering / emerging from a seed bank (see Klinkenberg 2006 for further discussion).

4. Threats

4.1. Threat Assessment

Table 2: Threat Assessment Table

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Habitat Loss or Degradation						
Housing development and road construction	Low	Local	Historic	Recurrent	High	Medium
Changes to water quality / quantity	Low	Widespread	Anticipated	Continuous	High	Low
Recreational activity	Medium	Localized	Current	Continuous	Medium-Low	Low
Alien, Invasive, or Introduced Species/Genome						
English Hawthorn (*Crataegus monogyna*), Scotch Broom (*Cytisus scoparius*) and Colonial Bentgrass (*Agrostis capillaris*)	High – Medium	Widespread	Current	Continuous	High-Moderate	Medium
Changes in Ecological Dynamics or Natural Processes						
Suppression of fire regime	High	Widespread	Current	Recurrent	High-Moderate	Medium-Low
Plantings at Craigflower Meadow	High	Localized	Current	Continuous	High	Low
Climate and Natural Disasters						
Climate change	Medium	Widespread	Anticipated	Continuous	Unknown	Low

[1] Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table).

[2] Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).

[3] Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g., expert opinion; Low: the threat is assumed or plausible).

4.2. Description of threats

4.2.1. Habitat Loss or Degradation

The McTavish Road population was last seen in 1966; since then, the site has been altered to such an extent that it is unlikely that Brook Spike-primrose could be re-established in the area (COSEWIC 2006; Fairbarns pers. comm. 2006). As this threat has destroyed 50% of the known populations, it is deemed to be of high severity; however, as the remaining 50% of the known population is in a regional park, this threat is currently considered to be of low concern (Table 2).

Although not specifically identified in the COSEWIC status report, developments proximal to Craigflower Meadow could pose a threat to the habitat due to effects on local hydrology (Meagher pers. comm. 2006): changes to the local hydrology could favour generalist species. Further, chemicals used on adjacent properties could seep into the habitat, as the closest housing is approximately 200 m away. However, the subdivision shares a very tiny amount of the watershed draining into the site and any chemicals would need to be very mobile to seep through the organic rich soil (Fairbarns pers. comm. 2011). While this threat has the potential to drastically affect the single remaining population to the point of extirpation, for the reasons above, it is deemed to be of low concern.

Past and potential future habitat degradation from recreational use is reported for this site: Fairbarns (pers. comm. 2011) reports the presence of a trail through the site and use of the area by dog owners. Further, this area is likely to attract users because there are no other nearby open meadows. This is the only extant site where this species was known to occur and recreational use has the potential for moderate severity, so this threat and is of medium concern.

4.2.2. Alien, Invasive or Introduced Species/Genome

Invasive alien species are a threat to Brook Spike-primrose (Costanzo 2002; Fairbarns pers. comm. 2006; and COSEWIC 2006). Fairbarns noted the occurrence of several invasive alien species in the Craigflower Meadow site, including English Hawthorn (*Crataegus monogyna*), Scotch Broom (*Cytisus scoparius*), and Colonial Bentgrass (*Agrostis capillaris*). Invasive alien species compete with Brook Spike-primrose for limited resources such as light, water, and nutrients. In addition, they have the potential to cause broad changes in habitat conditions: in years of brief flooding the non-amphibious, alien plants may be able to establish successfully (Bjork, pers. comm. 2006). If this is followed by hotter, drier summers that allow invasive alien species to further increase in abundance, organic matter may build up and change habitat conditions. In combination, the effects of competition and habitat change are likely to have severe effects on the population of Brook Spike-primrose, which makes this threat of high to medium concern.

4.2.3. Changes in Ecological Dynamics or Natural Processes

Fire suppression has been identified by several sources as a threat to Brook Spike-primrose (e.g., COSEWIC 2006). Fire effects change in a wide variety of habitat characteristics including the amount of organic matter, nutrient cycling, soil moisture, and soil biota (Barbour *et al.* 1999). In general, when fire is a common occurrence, it maintains the availability of resources which

would otherwise be limiting. For example, a lack of fire allows organic matter to build up and cover the ground, leaves nutrients trapped in organic matter and unavailable for use, and enables woody species to invade and suppress herbaceous species. While there is no known history of fire associated with the Craigflower Meadow site, it is well known that other open sites in the local area were maintained in a largely tree-free condition by frequent fires lit by First Nations (Turner 1999; Gedalof *et al.* 2006).

Craigflower Meadow may have been grazed in the past (Miskelly pers. comm. 2006). During the decades that grazing occurred in the Thetis Lake area, this activity may have replaced fire's ecological role in maintaining the open character of the site.

Fairbarns (pers. comm. 2006) and Ceska (pers. comm. 2006) have observed encroachment into the edges of the Craigflower meadow by species such as Red Alder (*Alnus rubra*) (COSEWIC 2006). Further, Douglas-fir (*Pseudotsuga menziesii*) and Grand Fir (*Abies grandis*) have been planted on this site (COSEWIC 2006; Ceska pers. comm. 2006). Although many of the planted conifers were immediately removed, some survived. In combination with other woody species, such as Red Alder, the planted conifers will contribute to encroachment and subsequent habitat changes such as increased shade, altered hydrology, and changes to floristic composition (Fairbarns pers. comm. 2006).

Changes in ecological dynamics and natural processes have the potential to completely alter the habitat such that it is unsuitable for Brook Spike-primrose. This threat is of great concern because such alterations will lead to extirpation from the site.

4.2.4. Climate and Natural Disasters

Climate change has the potential to cause devastating effects on ephemeral wetland environments. While this threat is not addressed by the status report, it may become a major factor in the recovery of this species. Climate models predict warmer conditions and drier summers in southwest British Columbia as part of a broader pattern of global climate change (Rodenhuis *et al.* 2007). Precipitation and evaporation losses determine the duration of continuous inundation in these habitats, which in turn directly affect the habitat conditions (Graham 2004). Changes in the hydrology are likely to cause physiological stress, reduced germination and fitness, and result in reduced Brook Spike-primrose populations. While the loss of some habitats may be offset by the improvement of currently marginal habitats, the latter are unlikely to develop populations of Brook Spike-primrose without human intervention because of the species' apparently weak powers of dispersal. Climate change is considered to be a 'medium' level of concern; however, its ultimate severity is unknown.

4.2.5. Summary

It is important to recognize the cumulative nature of many of the threats listed above. No single threat alone may have been responsible for the recent loss of growing individuals at Craigflower Meadow; however, taken together an ecological threshold may have been passed wherein Brook Spike-primrose seeds have been unable to germinate and/or compete against the other seedlings since 1993.

5. Population and Distribution Objectives

In Canada, Brook Spike-primrose was found in ephemerally wet habitats associated with Garry Oak ecosystems and as such had a naturally, highly restricted range. Within this range, significant habitat loss since European settlement (Lea 2006) has likely resulted in population reductions. Encroachment of vegetation, development, and effects resulting from recreational activities continue to exacerbate the situation (COSEWIC 2006). Given the permanent loss of most of the original habitat, it is not possible to recover the species to its natural area of occupancy or to its original probability of persistence. There were only two known Brook Spike-primrose populations in Canada and no plants have been seen at either location since 1993, but it is possible that seeds remain in the soil seed bank at one of the locations (COSEWIC 2006).

In general, it is believed that multiple populations and thousands of individuals are likely required to attain a high probability of long-term persistence for a species (Reed 2005, Brook et al. 2006, and Traill et al. 2009). In an analysis of several published estimates of minimum viable population (MVP) sizes, Traill et al. (2007) found that the median population size required for plants to achieve a 99% probability of persistence over 40 generations was approximately 4,800 individuals (but see Flather et al. 2011, Garnett and Zander 2011, and Jamieson and Allendorf 2012 for critical evaluations of the analyses and the applicability of the results). Such information provides a useful guide, but developing specific quantitative and feasible objectives must consider more than just generalized population viability estimates, including the historic number of populations and individuals, the carrying capacity of extant (and potential) sites, the needs of other species at risk that share the same habitat, and whether it is possible to establish and augment populations of the species (Parks Canada Agency 2006, Flather et al. 2011, Jamieson and Allendorf 2012). Because not enough of this information is available for Brook Spike-primrose, it is currently not possible to determine to what extent recovery is feasible and therefore it is not possible to establish quantitative long-term objectives. Recovery planning approaches (see Section 6) are designed to respond to knowledge gaps so that long-term, feasible, and quantitative recovery objectives regarding size and number of populations can be set in the future. At this time it is possible to set short-term objectives that focus on maintaining the habitat at one former site while exploring the feasibility of restoring the population and establishing new populations to increase abundance and distribution:

Objective 1: Maintain the habitat at the Craigflower Meadow site while the feasibility of population restoration is assessed for Brook Spike-primrose.

Objective 2: Establish and/or augment populations to increase abundance and distribution[1] if determined to be feasible and biologically appropriate for Brook Spike-primrose.

6. Broad Strategies and General Approaches to Meet Objectives

Broad strategies and approaches to meet the population and distribution objectives for Brook Spike-primrose include:

[1] The intent is to increase the area of occupancy and maintain the extent of occurrence.

- Habitat and species protection: protect populations and habitat from destruction (e.g., from land conversion) by developing mechanisms/instruments for protection;
- Stewardship: engage landowners to understand the species needs and support recovery activities for the species;
- Research: address critical knowledge gaps;
- Population monitoring: gather information to fill knowledge gaps pertaining to species distribution and population dynamics;
- Population restoration: restore extant populations and establish new population(s) to recover the Canadian population of the species;
- Public education and outreach: engage and seek collaboration with the public in recovery of the species.

6.1. Strategic Direction for Recovery

Table 3: Recovery Planning Table

Threat or Limitation	Priority	Broad Strategy to Recovery	General Description of Research and Management Approaches
Invasive alien species Suppression of fire Plantings at Craigflower Meadow	High	Stewardship Research	• Develop a management plan for each site including the following activities: remove planted trees, control and remove encroaching woody species, and redirect recreational activities. • Study the effects of invasive alien species. • Study the fire and grazing history of Craigflower Meadow. If fire is found to have been a factor in maintaining the site characteristics, include fire as an essential element of the management plan.
Limitations: demographic collapse; seed banking; light requirements Knowledge gaps: seed banking population demography	High	Population restoration Research	• First priority is to encourage recruitment from the seed bank at Craigflower Meadow; second priority is to locate viable seed from Canadian herbarium specimens; third priority, if no Canadian seed is available, is to use the closest genetic match between Canadian and U.S. populations as a source population for reintroduction. • Develop and implement a translocation plan(s) as needed to test suitability of sites for establishment of Canadian populations as per the population and distribution objectives. • Population biology research to support population restoration (e.g., seed banking ability, demographic attributes). • Fill knowledge gaps to enable quantitative population analysis to inform development of long-term population and distribution objectives.
Knowledge gap: population trends Climate change	High	Population Monitoring	• Implement a monitoring strategy for all Canadian sites to track population size, trends and habitat conditions at each population.

Threat or Limitation	Priority	Broad Strategy to Recovery	General Description of Research and Management Approaches
Housing development and road construction	Medium	Habitat and species protection	• Identify critical habitat for known extant populations. • Develop a list of priority sites for creation of new populations. • Establish protection mechanisms/instruments for critical habitat.
Knowledge gap: population distribution	Medium	Population Monitoring	• Inventory southeast B.C.
Changes to water quality/ quantity Recreational Activity	Low	Public outreach and Education	• Public relations initiatives to alert the public to the presence of Brook Spike-primrose in the area, and its needs. • Deliver public education and outreach concerning species at risk, their habitats, and their management.

6.2. Narrative to Support the Recovery Planning Table

Restoration of Craigflower Meadow is the highest priority since all other efforts could be fruitless if the site conditions are such that establishment and maintenance of a self-sustaining population is not possible (Table 3). However, there is a lack of knowledge regarding the habitat conditions required by this species. As there are no plants currently growing in their natural habitat in Canada, habitat studies will need to be conducted on extant populations in the United States. Further, research into the past fire / grazing history of Craigflower Meadow is important since a lack of natural disturbance could be responsible for several other threats to the population (e.g., the encroachment of woody species into the wet meadow habitat, which could be partially responsible for changes to the hydrological regime of the site, which in turn could be responsible for the increased presence of invasive alien species). If hydrological changes have occurred, then available groundwater and soil moisture levels may impose direct limitations on this species' persistence in Craigflower Meadow. This requires assessment at the beginning of the recovery process and remediation of the impact. An important early step in recovery of the Craigflower Meadow population is management plan development.

Because the genetic integrity of Canadian populations is important, the first priority for population re-establishment will be to encourage germination from the seed bank at Craigflower Meadow. If that fails, then germination of seeds from local collections should be attempted. As a last resort, alternate seed sources, such as seeds from adjacent U.S. populations, should be considered. However, genetic tests should be conducted on several U.S. populations in order to determine which population is genetically most similar to the Canadian plants.

This species occurs in northeast Washington and in northwest Oregon, as do its rare Craigflower Meadow associates: Spanish-clover (*Lotus unifoliolatus*), Needleleaf Navarretia (*Navarretia intertexta*), and Dense Spike-primrose (*Epilobium densiflorum*). It is possible that a population of Brook Spike-primrose exists in southeast B.C. (e.g., between Grand Forks and Creston) (Fairbarns pers. comm. 2006). Targeted inventory is needed in southeast B.C.; however, before such inventories are undertaken, additional information is needed on habitat requirements in northeast Washington and northwest Oregon where the Brook Spike-primrose currently exists.

This habitat information is needed to target inventories to suitable habitat in southeast B.C., for the identification of critical habitat, and to inform site selection for population restoration on Vancouver Island.

Translocation attempts will have the greatest chance of success if suitable translocation sites are selected within existing protected areas in the historic range of the species. In identifying potential translocation sites, care must be taken to ensure that the hydrogeomorphic profile is explicitly considered (Wacker and Kelly 2004). Any new sites should be managed using a written management plan.

Design of the monitoring program is an important consideration, especially for rare annual plants which are likely to exhibit population fluctuations or rely on seed banks (Bush and Lancaster 2004). Data should be collected regularly over several years to account for population fluctuations. Further, data should be collected in years when plants are absent as well as when they are present to provide information on the species responses to environmental conditions. When seed banks are involved, they are an important part of the lifecycle and must be considered in estimates of population size—the presence of even one individual may indicate a viable seed bank is present (Bush and Lancaster 2004).

7. Critical Habitat Identification

Areas of critical habitat for Brook Spike-primrose are identified in this recovery strategy. Critical habitat is defined in the *Species at Risk Act* 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" (Subsection 2(1)). Habitat for a terrestrial wildlife species is defined in the *Species at Risk Act* as "...the area or type of site where an individual or wildlife species naturally occurs or depends on directly or indirectly in order to carry out its life processes or formerly occurred and has the potential to be reintroduced" (Subsection 2(1)).

7.1. Identification of the Species' Critical Habitat

Critical habitat for the Brook Spike-primrose is identified in this recovery strategy to the extent possible, based on the best available information. It is recognized that the critical habitat identified below is insufficient to achieve the populations and distribution objectives for the species. While habitat can be identified at the last known site of occurrence, a more clear understanding of the preferred habitat is required to identify critical habitat for additional populations. The schedule of studies (Section 7.2; Table 4) outlines the activities required to identify additional critical habitat necessary to support the population and distribution objectives of the species.

The habitat of Brook Spike-primrose is generally characterised as moist grasslands and open slopes in the lowland zone (Douglas *et al.* 1999). To further characterize the habitat of Brook Spike-primrose, site and vegetation data were collected at the extant location (Fairbarns 2008); however, a broader review of habitat at other sites in the United States is needed. At Craigflower Meadow, this species inhabits an ephemerally wet meadow surrounded by forest.

The Brook Spike-primrose likely requires high light to germinate. The area surrounding the seed bank must be clear of shading shrubs and trees; this area is the canopy opening required by the species. Canopy openings must be large enough that the Brook Spike-primrose plants are not sheltered by surrounding vegetation. The minimum size of openings can be determined based on the height of vegetation able to grow in the area and cast shade on the Brook Spike-primrose (e.g., Spittlehouse *et al.* 2004). An additional consideration with regards to canopy opening is that when tall vegetation falls, it will cover an area of ground for a distance equal to its height.

In addition to canopy openings, specific hydrological characteristics are critical to the survival of this species. These hydrological characteristics are directly tied to rainfall (Graham 2004). Rain flows into the meadow from the surrounding area, called the catchment. This catchment area is directly responsible for receiving rainwater which flows along the prevailing topography to the meadow. Surface water flow and subsurface seepage from this catchment area is essential to the survival of the Brook Spike-primrose plants. The catchment at Craigflower Meadow was mapped by Fairbarns (2008). These catchment areas are generally small and isolated within landscape scale catchments.

Critical habitat for the survival of each plant or patch[2] of Brook Spike-primrose is composed of two habitat features: the minimum canopy opening and the catchment. These features are always connected to the recorded location of a plant or patch of plants and in all cases will overlap to some degree (no special status is applied to areas of overlapping critical habitat). The default minimum canopy opening required for light to reach the plants is the area bounded by a 20 m distance surrounding each plant or patch of plants in all directions (20 m is generally the maximum height attained by trees in the soils surrounding Brook Spike-primrose). The catchment for each plant or patch of plants is delineated by following the upslope high point of land which divides water flowing towards the plants from water flowing away from the plants; these catchment areas are generally relatively small and isolated within landscape catchments. It is important to note that while plants may not be visible all year or every year, seeds will remain in the seed bank and the recorded plant locations and their associated critical habitat will continue to be critical habitat to protect the seed bank, even if no plants are observed.

Within the geographical boundaries identified in Figure 4, critical habitat for the Craigflower Meadow population is defined by the catchment area surrounding the last recorded location of the plants. In this case, the catchment area exceeds the minimum canopy opening in all directions (Fairbarns 2008).

Critical habitat attributes for Brook Spike-primrose are as follows:

- Sunny areas with short or sparse vegetation (trees are absent and the cover of shrubs is never substantial).
- Less than 100 m elevation.
- Material (e.g., wood, or garbage) covering the soil is not abundant.

[2] Patch is a term used to refer to a group of several plants in close proximity. The exact definition of a patch will vary with the scale of mapping, size of the species being mapped, and landscape features. For the purposes of this recovery strategy the identification of patches is based on survey work performed by a biologist familiar with the species.

- Receives seepage and/or surface runoff—the timing of water availability is a critical attribute: the site is dry in summer and wet in winter and spring.
- Topography is at least slightly depressed such that rainwater which falls in the surrounding area flows towards the meadow.

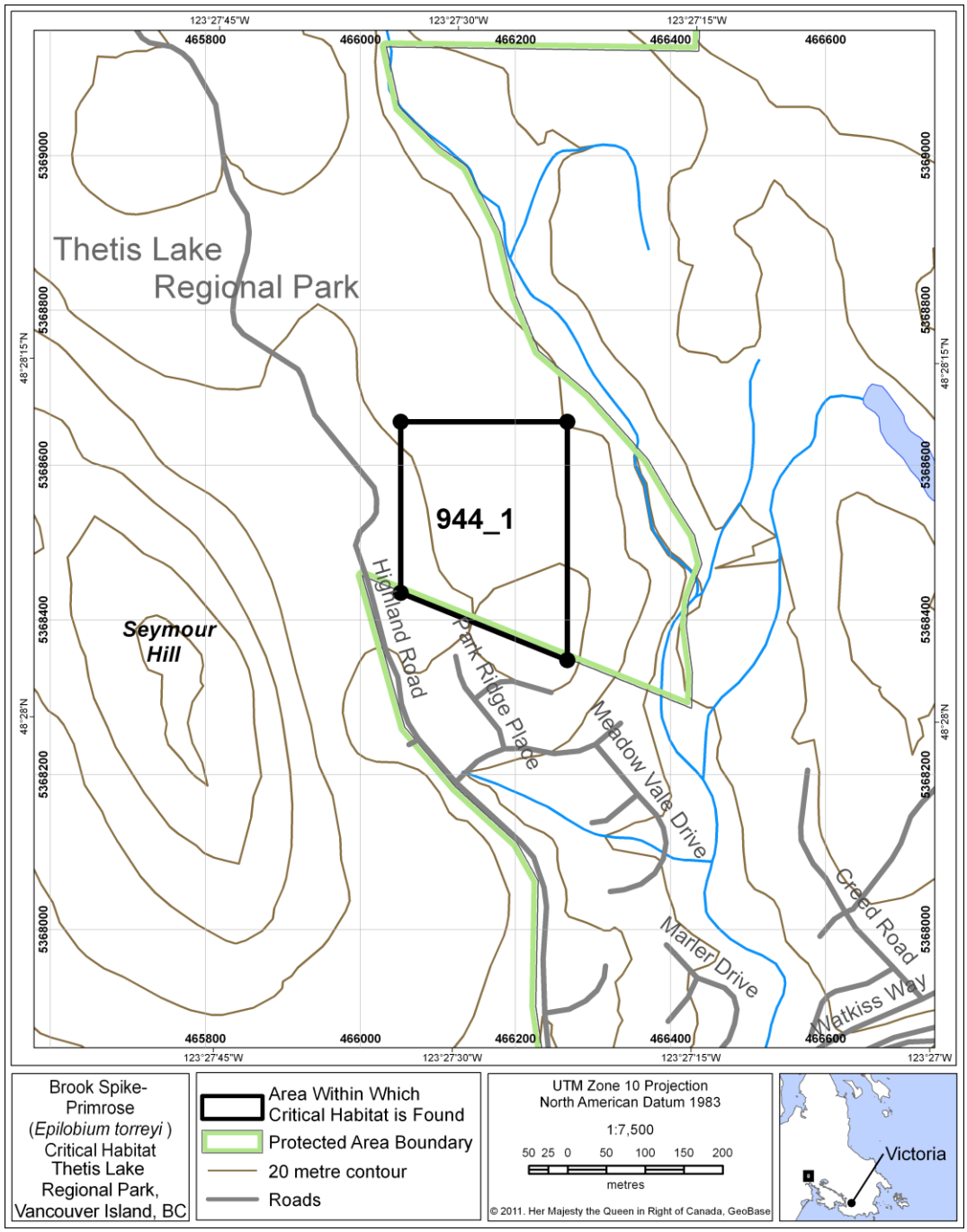

Figure 4: Area (~5.7 ha) within which critical habitat for Brook Spike-primrose is found at Thetis Lake Regional Park. This area is managed by the Capital Regional District. The area of critical habitat within this area is approximately 3.3 ha.

7.2. Schedule of Studies to Identify Critical Habitat

Table 4: Schedule of Studies

Description of Activity	Outcome/Rationale	Timeline
Describe the habitat attributes required for species establishment and persistence, including hydrological conditions (e.g., extent and duration of seasonal flooding), in Washington.	Habitat characteristics necessary for the survival of the species are identified (which will inform the determination of potential sites for translocation).	2012-2016
Test the suitability of sites proposed for replacement populations.	Attempt to establish, maintain, and monitor Brook Spike-primrose individuals in an experimental manner.	2016
	If suitability tests are successful, test the potential for establishing new self-sustaining populations or expanding existing populations through introduction of seeds or seedlings into suitable habitats. Seed bank viability must be determined to facilitate restoration and introductions.	2017 onwards
	Undertake analyses to determine the amount and configuration of habitat needed to achieve the population and distribution objectives for population expansion and creation.	Dependent upon previous steps

7.3. Activities Likely to Result in Destruction of Critical Habitat

Examples of activities likely to destroy critical habitat are provided below (Table 5). Destruction of critical habitat will result if any part of the critical habitat is degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. It is important to note that some activities have the potential to destroy critical habitat from outside the critical habitat.

Table 5: Examples of Activities Likely to Result in the Destruction of Critical Habitat.

Activity	Effect of activity on critical habitat
Damaging recreational use (e.g., intensive trampling, cycling, and animal exercising activities)	Soil compaction leading to altered habitat attributes. Disturbance of seed bank potentially burying seeds. Plants may become stressed and die or be unable to germinate due to impaired ability of the habitat to provide suitable soil moisture or light availability. In addition, this activity is likely to introduce or spread invasive alien plant species. Invasive alien plant species compete with Brook Spike-primrose and alter the availability of light, water, and nutrients in the habitat, such that the habitat would not provide the necessary habitat conditions required by Brook Spike-primrose.

Activity	Effect of activity on critical habitat
Landscaping (e.g., development and maintenance or modification of trails)	This activity can cause direct land conversion, soil compaction and associated hydrological effects, altered moisture regime (e.g., impounded drainage, or reduced water flow to the plants through ditching, or diversion of subsurface water by built structures), and introduction of alien species (e.g., intentional plantings or accidental introductions such as facilitated by unclean machinery; see recreational use for effect of invasive alien species).
Dumping of waste (e.g., plant material or household items)	Increased debris reduces the ability of the habitat to support germination and growth due to a lack of light and is likely to introduce alien invasive alien plants (see recreational use for effect of invasive alien species).

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives. Progress towards recovering Brook Spike-primrose in Canada will be assessed using the following measures for each of the population and distribution objectives:

Objective 1: Maintain the habitat at the Craigflower Meadow site while the feasibility of population restoration is assessed for Brook Spike-primrose.

- By 2017 best management practices are developed and implemented.
- Habitat suitable for Brook Spike-primrose remains extant at Craigflower Meadow.

Objective 2: Establish and/or augment populations to increase abundance and distribution if determined to be feasible and biologically appropriate for Brook Spike-primrose.

- By 2017, additional sites have been identified, for establishment or restoration of Brook Spike Primrose population(s).
- By 2017, propagation protocols have been developed.
- By 2022, one or more (re)introduction or augmentation experiments are underway at suitable site(s).

9. Statement on Action Plans

One or more action plans will be completed by September 2017.

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APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan, and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process, based on national guidelines, directly incorporates consideration of all environmental effects, with a particular focus on possible effects on 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.

Actions taken to recover Brook Spike-primrose should benefit other specialist species by improving habitat for them. Restoration of Craigflower Meadow will be beneficial to all the specialist species associated with this habitat and affected by the encroachment of woody species, competition from invasive alien species, and organic matter build up. Other rare species known to occur with Brook Spike-primrose include:

- Dense Spike-primrose (*Epilobium densiflorum*)
- Spanish-clover (*Lotus unifoliolatus*)
- Needleleaf Navarretia (*Navarretia intertexta*)

Actions taken to aid in the recovery of this species should, if conducted in an open, informative manner, provide benefits for all species at risk and their habitats by increasing public awareness of the negative environmental consequences associated with invasive alien species, the need to maintain natural ecological processes (i.e., if fire is identified as being a component of the management of Craigflower Meadow), and the need to protect natural habitats from the impacts of adjacent developments.

However, actions to assist in the recovery of Brook Spike-primrose could negatively affect other species at risk if the actions result in excessive disturbance of the site (e.g., when removing invasive alien species and planted / encroaching woody species). Any on-site activity has the potential to affect other species at risk through trampling or the inadvertent translocation of invasive alien species seeds; therefore, care must be taken to avoid indirect effects. If fire is identified as being a necessary component of the restoration of Craigflower Meadow, care must be taken to ensure that the natural disturbance is contained within the meadow and that the fire does not inadvertently promote the growth of an invasive alien species.

These potentially negative effects can be mitigated or eliminated at the project implementation phase through proper field procedures and/or strong collaboration with key conservation partners such as the Garry Oak Ecosystems Recovery Team and appropriate government agencies. Some recovery strategy activities may require project-level environmental assessment as required

under the *Canadian Environmental Assessment Act*. Any activities found to require project-level environmental assessments will be assessed at that time pursuant to the provisions of the *Act*.

This recovery strategy benefits the environment by promoting the conservation and recovery of the Brook Spike-primrose, a natural component of biodiversity. Activities required to meet recovery objectives are unlikely to result in any important negative environmental effects as they are limited to habitat rehabilitation, research activities, fostering stewardship, increasing public awareness, improving knowledge on habitat requirements and population threats, and conducting habitat/species mapping, inventory, and restoration. In addition, it is likely that habitat restoration for Brook Spike-primrose will benefit other co-occurring native species which occupy the same habitat.

In summary, the SEA process has concluded that this recovery strategy will likely have several positive effects on the environment and other species. There are no obvious adverse environmental effects anticipated with the implementation of this recovery strategy.