

# Recovery Strategy for the Fragrant Popcornflower (*Plagiobothrys figuratus*) in Canada

## Fragrant Popcornflower



2013

**Recommended citation:**

Parks Canada Agency. 2013. Recovery Strategy for the Fragrant Popcornflower (*Plagiobothrys figuratus*) in Canada. *Species at Risk Act* Recovery Strategy Series. Parks Canada Agency, Ottawa. vi + 19 pp.

For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk Public Registry (<http://www.sararegistry.gc.ca>).

**Cover illustration:** Fragrant Popcornflower, photograph courtesy of Dr. Hans Roemer

Également disponible en français sous le titre  
« Programme de rétablissement de la plagiobothryde odorante (*Plagiobothrys figuratus*) au Canada »

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ISBN 978-1-100-22308-7

Catalogue no. En3-4/161-2013E-PDF

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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 Fragrant Popcornflower and has prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with Environment Canada and the provincial government of British Columbia.

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 Fragrant Popcornflower 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.

Fragrant Popcornflower is a species that inhabits vernal pools 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 in Garry Oak and Associated 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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*Field Unit Superintendent, Coastal BC, Parks Canada Agency*

Approved by:



Alan Latourelle  
*Chief Executive Officer, Parks Canada Agency*

## **ACKNOWLEDGMENTS**

Thank you to Matt Fairbarns and Michael Miller for writing the draft recovery strategy. The Garry Oak Ecosystems Recovery Team (GOERT) is the recovery team for the Fragrant Popcornflower and was involved in the development of this recovery strategy. The landowner, John Segal, was very helpful throughout the process. 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

The Canadian population of the Fragrant Popcornflower (*Plagiobothrys figuratus*) was assessed as Endangered in 2008 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and in February 2010 the population was listed as Endangered under Canada's *Species at Risk Act* (SARA) affording it legal protection.

The Fragrant Popcornflower is a showy annual herb with fragrant white flowers and hairy stems ranging from 10-45 cm tall. The native range of this species extends from southeastern Vancouver Island south to Oregon, west of the Cascade Mountains. In Canada, Fragrant Popcornflower was found historically along the southeastern coast of Vancouver Island from Comox to Victoria. The species was recently thought to have been extirpated from Canada, until a single flowering plant was observed on Hornby Island in 2005 (COSEWIC 2008). The Canadian population of Fragrant Popcornflower comprises <1% of its global range.

The key factors limiting the recovery and survival of the Fragrant Popcornflower population in Canada are its specificity to rare vernal depression habitats, limited dispersal abilities, weak competitive ability, predisposition to demographic failure, small area of physical occupancy, and small, highly fragmented populations that constrain genetic diversity. The Fragrant Popcornflower population is threatened by land conversion, encroachment of invasive alien plants, and climate change as it relates to changes in precipitation.

In the short term, recovery objectives for Fragrant Popcornflower will focus on the maintenance of habitat at one site while exploring the feasibility of restoring the population and establishing new populations to increase abundance and distribution. Broad strategies to be taken to address the threats to the survival and recovery of the Fragrant Popcornflower are presented in section 6 Broad Strategies and General Approaches to Meet Objectives.

Critical habitat for Fragrant Popcornflower was determined on the basis of site conditions prevailing at the site where it was last observed in 2005. The best available information has been used in the identification of critical habitat; however, there are significant knowledge gaps and additional critical habitat will need to be identified in upcoming planning documents to meet the population and distribution objectives. Required studies include studying the conditions associated with extant U.S. populations and identification of sites suitable for establishing populations in Canada.

Further recovery actions for Fragrant Popcornflower will be incorporated into one or more action plans by 2018.

## RECOVERY FEASIBILITY SUMMARY

The recovery of the Fragrant Popcornflower 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. The single recently documented population has been shown to be capable of banking seed in the soil for extended periods, producing reproductive individuals when suitable conditions return. There is no evidence that the soil seed bank has been lost but the probability of seed bank extinction will continue to increase unless new plants germinate and reproduce to replenish the bank. Even if the seed bank disappears, the species is apparently secure on a global scale (G4) and seed could be collected from populations in an adjacent jurisdiction and used to restore the population.

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

Yes. The habitat of the single recently documented population has not changed greatly since the population last produced a mature plant. It is likely that long-term negative habitat trends at that site could be reversed and additional suitable habitat could be made available through active habitat stewardship or restoration, if needed.

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

Yes. Some threats, such as competition from invasive alien species, can be reduced by a regular program to maintain the site. Other threats, such as increased urbanization, will be more difficult to avoid or mitigate. There may be other important threats that have not yet been identified. However, at present there is no evidence of unavoidable threats to the species or its habitat that would preclude recovery.

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

Yes. Recovery success will be tied primarily to threat reduction through habitat stewardship, in combination with long-term population monitoring and inventory. The feasibility of introducing/re-introducing populations throughout its range in Canada is still unknown; however, over the long term recovery techniques for population establishment and augmentation are likely to be developed.

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## 1. COSEWIC Species Assessment Information

**Date of Assessment:** April 2008

**Common Name:** Fragrant Popcornflower

**Scientific Name:** *Plagiobothrys figuratus*

**COSEWIC Status:** Endangered

**Reason for Designation:** Although only a single plant was seen in 2005 and none in 2006, the species is likely extant in the form of seeds in the soil. The species' potential for continued survival is at risk from ongoing threats to its habitat from such factors as loss of habitat due to urbanization/development, environmental and demographic stochasticity, and competition from native and alien plant species.

**Canadian Occurrence:** British Columbia

**COSEWIC Status History:** Designated Endangered in April 2008. Assessment based on a new status report.

## 2. Species Status Information

The Canadian population of Fragrant Popcornflower (*Plagiobothrys figuratus*) was assessed as Endangered in 2008 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and in February 2010 the population was listed as Endangered under Canada's *Species at Risk Act* (SARA) affording it legal protection. Provincial, state, and global conservation ranks for Fragrant Popcornflower in other jurisdictions where it occurs are provided in Table 1 **Error! Reference source not found.**

The Fragrant Popcornflower population in Canada comprises < 1% of its global range.

**Table 1. Conservation ranks for Fragrant Popcornflower. Sources: B.C. Conservation Data Centre 2010, NatureServe 2010.**

Location	Rank*	Rank description
<b>Global</b>	G4	Apparently secure
<b>Canada</b>	N1	Critically imperilled
British Columbia	S1	Critically imperilled
<b>United States</b>	N4	Apparently secure
Alaska	SNR	Not ranked
Arkansas	SNA	Not applicable
Illinois	SNR	Not ranked
Michigan	SNR	Not ranked
North Carolina	SNR	Not ranked
Oregon	S4	Apparently secure
Washington	SNR	Not ranked

\*NatureServe Conservation ranks are based on a one to five scale, ranging from critically imperilled (1) to demonstrably secure (5). Status is assessed and documented at three distinct geographic scales global (G), national (N), and state/province (S).

### **3. Species Information**

#### **3.1. Species Description**

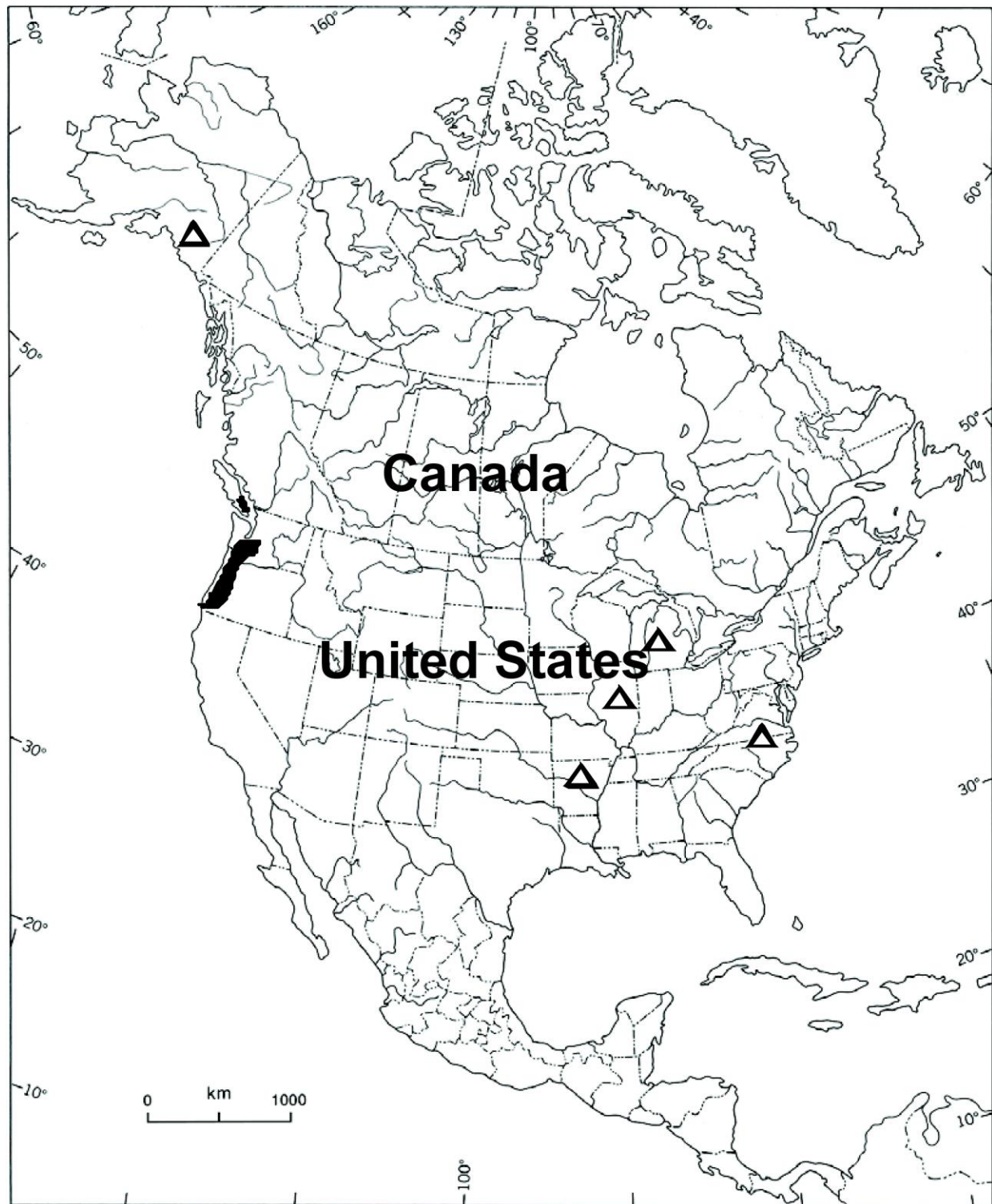
Fragrant Popcornflower is a showy annual herb with fragrant white flowers and hairy stems ranging from 10-45 cm tall. A detailed description of the species is provided in the status report (COSEWIC 2008).

#### **3.2. Population and Distribution**

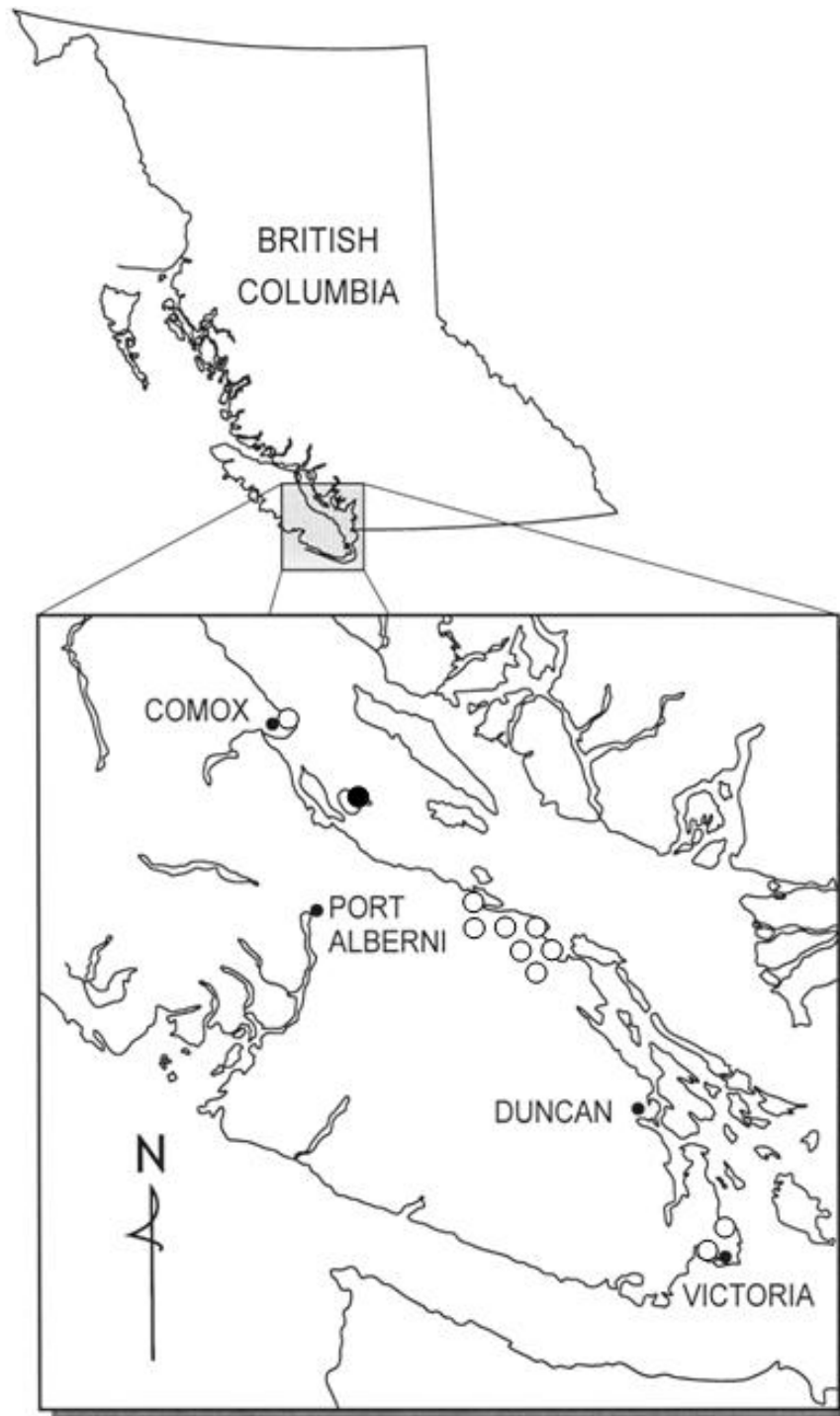
Fragrant Popcornflower is native to northwestern North America. It occurs west of the Cascades from British Columbia south through the Puget Trough, the Columbia River Gorge, and the Willamette Valley to southwestern Oregon (Figure 1; COSEWIC 2008).

In Canada, Fragrant Popcornflower was found historically along the southeastern coast of Vancouver Island from Comox to Victoria (Figure 2; COSEWIC 2008). Between 1885 and 1986, the species was recorded a total of 12 times from a minimum of seven independent locations: Comox, Nanaimo, Wellington, Hornby Island (two sites), Victoria, and Cedar Hill. Of these 12 historical records, all but one are pre-1987; the majority are 70 years old or more. Most of the historical localities have presumably been lost to urban development. However, the true range cannot be determined from the limited information available from collection notes.

The species was recently thought to have been extirpated from Canada, until a single flowering plant was observed at Cape Gurney on Hornby Island in 2005 (COSEWIC 2008). In subsequent site visits, including a 2009 survey to characterize critical habitat, no plants were seen at the site. In addition, no plants had been observed at this site for several years prior to the 2005 sighting, indicating that the species may persist for long periods in the soil seed bank. The nearest U.S. locality is in southern Washington (Thurston County), limiting the likelihood of any rescue effect.



**Figure 1. Distribution of Fragrant Popcornflower in North America (from COSEWIC 2008). Solid black regions indicate native range and triangles indicate where it is believed to be introduced.**



**Figure 2. Distribution of Fragrant Popcornflower in Canada (Adapted from GOERT 2003 with permission). Open circles indicate unconfirmed or extirpated sites and closed circles indicate recently confirmed site and extant population.**

### 3.3. Needs of the Fragrant Popcornflower

This species grows at low elevations in moist non-alkaline soils and heavy clays. It is found in a range of vernal wet habitats in its southern range (Washington and Oregon) including vernal pools, wetland prairies, ditches, and seasonally flooded fields and meadows. In British Columbia, Fragrant Popcornflower is found in the Coastal Douglas-fir Biogeoclimatic Zone (Moist Maritime subzone), known most recently in a former coastal meadow. This zone features a Mediterranean-like climate with warm, dry summers and mild, wet winters. Summer drought is an important climatic feature (COSEWIC 2008).

Seeds of Fragrant Popcornflower are available commercially from plant nurseries in both the U.S. and U.K., suggesting this species is hardy enough to be grown under typical garden conditions and thus may be a good candidate for reintroduction into the wild (COSEWIC 2008).

The site where Fragrant Popcornflower was most recently observed (in 2005) is a vernal moist depression about 5 m above sea level, less than 50 m inland from the Strait of Georgia (Figure 3). It now supports a meadow dominated by invasive alien grasses with a secondary component of invasive alien forbs: primarily Sweet Vernal Grass (*Anthoxanthum odoratum*) and Soft Brome (*Bromus hordeaceus*), but also Common Velvet Grass (*Holcus lanatus*), Perennial Ryegrass (*Lolium perenne*), and Orchard Grass (*Dactylis glomerata*) with primarily Small Hop-clover (*Trifolium dubium*), Small-flowered Vetch (*Vicia hirsuta*), and Ribwort Plantain (*Plantago lanceolata*), but also Hairy Cat's-ear (*Hypochaeris radicata*). California Oatgrass (*Danthonia californica*), the leading native grass species, is very scarce but it sometimes dominates similar meadows and may have been the dominant plant prior to the arrival of invasive alien species. The precise location in the meadow where Fragrant Popcornflower grows could not be determined so it may have microhabitat requirements significantly different from the general conditions described above.

A number of factors may limit the survival and recovery of Fragrant Popcornflower in Canada and include:

- Dependence on highly specific vernal depression habitats associated with Garry Oak and associated ecosystems, most of which have been lost or damaged by habitat conversion (the loss of suitable habitat, often as a result of urban development), forest encroachment, and/or a shift to ecosystem dominance by invasive alien plants.
- Lack of special structures to aid in the long-distance dispersal of seeds or fruits.
- Apparently weak competitive ability, especially with respect to invasive alien species.
- Potential demographic failure if there are extended dry periods in the late winter and early spring, before plants can reproduce and replenish the seed bank.
- Very small area of physical occupancy which leaves it susceptible to chance events including those which operate at a small scale.
- Small, highly fragmented populations which may constrain the species' genetic diversity and limit the potential for local rescue effects.



**Figure 3. Habitat of Fragrant Popcornflower at Cape Gurney on Hornby Island. Fragrant Popcornflower was reported from the low vegetation between the fence and the conifers. Photo by Chris Junck, GOERT.**



## 4. Threats

### 4.1. Threat Assessment

**Table 2. Threat Assessment Table**

Threat	Level of Concern <sup>1</sup>	Extent	Occurrence	Frequency	Severity <sup>2</sup>	Causal Certainty <sup>3</sup>
<b>Habitat loss or degradation</b>						
Housing/urban development and agricultural activities	High	Widespread	Historic and Anticipated	Unknown	High	High
<b>Alien, invasive or introduced species</b>						
Invasion by alien plants	High	Widespread	Historic and Current	Continuous	High	Medium
<b>Climate and natural disasters</b>						
Change in weather patterns, especially spring and early summer precipitation	Medium	Widespread	Anticipated	Seasonal	Unknown	Low

<sup>1</sup> 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).

<sup>2</sup> Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).

<sup>3</sup> 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 most serious immediate threat to Fragrant Popcornflower is habitat conversion resulting in habitat destruction, habitat fragmentation, and/or hydrologic alterations (Table 1 **Error! Reference source not found.**). Although the precise location of most of the historically reported populations will never be known, it appears that most have been converted through site development associated with urban and rural development (COSEWIC 2008). This appears to have involved both the destruction of existing populations and the loss of considerable suitable habitat, although there remain several areas of apparently suitable habitat in the South Wellington and Cedar areas of Nanaimo, British Columbia (COSEWIC 2008). Habitat conversion continues throughout the range of the species in Canada and can lead to further loss of suitable habitat, potential destruction of undetected populations, and eventual species extirpation. The Fragrant Popcornflower relies on vernal pool conditions, and thus hydrologic alterations can disrupt life cycle processes and cause physiological stress. The habitat of the last reported population, at Cape Gurney on Hornby Island, has not been completely lost but has experienced major hydrologic alterations associated with the development of a paved road separating it from a large vernal-moist area a few metres away. The depression where the plants were last seen was also affected by the development of a now abandoned lane (constructed prior to 2005) running from the road through the depression to a house. Habitat conversion has

also increased the distance between areas of suitable habitat; such fragmentation undoubtedly limits the ability of extant populations, if they exist, to disperse into new sites. Accordingly, this threat is considered to be a ‘high’ level of concern.

#### **4.2.2. Alien, Invasive or Introduced Species**

The next most serious threat to Fragrant Popcornflower is posed by the invasion by invasive alien plants which occur in the meadow depression where Fragrant Popcornflower was most recently observed. These species include Soft Brome, Common Velvet Grass, Perennial Ryegrass, Orchard Grass, Small Hop-clover, Small-flowered Vetch, Ribwort Plantain, and Hairy Cat’s-ear. They, and other invasive alien grasses, forbs, and shrubs, dominate most similar habitats throughout the range of Fragrant Popcornflower in Canada. Many of the invasive alien species, particularly the grasses, have contributed to the accumulation of a thick thatch over much of the depression; this thatch layer creates difficult germination conditions, especially for annual species such as Fragrant Popcornflower which have small seeds. While all of the invasive alien species compete for space, tufted or rosette-forming perennials such as Ribwort Plantain and Hairy Cat’s-ear are most problematic because they pre-empt large areas of soil for many years. Invasive alien species compete strongly for moisture and nutrients, which disadvantages small annuals such as Fragrant Popcornflower which possess much shallower and smaller root systems. This threat is considered to be a ‘high’ level of concern.

#### **4.2.3. Climate and Natural Disasters**

Climate change has the potential to cause devastating effects on vernal pool environments. Small, shallow pools such as that which supports the Fragrant Popcornflower population in Canada are at greatest risk to changes in precipitation and evaporation losses. These changes determine the duration of continuous inundation, the frequency of inundation events suited to the reproduction of vernal pool species, and the seasonal distribution of inundation (Pyke 2005). Changes in inundation events cause physiological stress, reduced germination and fitness, and a reduced Fragrant Popcornflower population. While the loss of some vernal pool environments may be offset by the improvement of currently marginal habitats, the latter are unlikely to develop populations of Fragrant Popcornflower without human intervention because of the species’ apparently weak powers of dispersal. Climate change is considered to be a ‘medium’ level of concern.

### **5. Population and Distribution Objectives**

In Canada, Fragrant Popcornflower is found in moist fields and open meadows associated with Garry Oak ecosystems, and occasionally also along watercourses and ditches. As such, the species has a naturally, highly restricted range. Within this range, significant habitat loss since European settlement (Lea 2006) has likely resulted in population reductions. Habitat conversion resulting in habitat destruction or fragmentation, and hydrological alterations continue to exacerbate the situation (COSEWIC 2008). 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. Historically, the species has been recorded from at least seven locations. While reproductive plants have not been observed since 2005, the species may persist for long periods in the soil seed bank.



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 historical 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 Fragrant Popcornflower, 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 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 Cape Gurney site while the feasibility of population restoration is assessed for Fragrant Popcornflower.

**Objective 2:** Establish and/or augment populations to increase abundance and distribution<sup>1</sup> if determined to be feasible and biologically appropriate for Fragrant Popcornflower.

## 6. Broad Strategies and General Approaches to Meet Objectives

Broad strategies and approaches to meet the population and distribution objectives for Fragrant Popcornflower include:

- Habitat and species protection: protect last recently documented population and its habitat from destruction (e.g., from land conversion) by developing mechanisms/instruments for protection;
- Population restoration: restore the extant population and establish new population(s) to recover the Canadian population of the species;
- Stewardship: engage the cooperation of all involved landowners and managers in habitat stewardship;
- Population monitoring: conduct regular assessments to inventory for additional suitable habitat and to determine population trends, habitat attributes, and threats;
- Public education and outreach: increase public awareness of the species threats and harm reduction measures, needs, and conservation value;

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<sup>1</sup> The intent is to increase the area of occupancy and maintain the extent of occurrence.

- Research: address knowledge gaps pertaining to genetic diversity, threats, and habitat requirements.

## 6.1. Strategic Direction for Recovery

**Table 3. Recovery Planning Table**

<b>Threat or Limitation</b>	<b>Priority</b>	<b>Broad Strategy to Recovery</b>	<b>General Description of Research and Management Approaches</b>
Housing/urban development and agricultural activities  Invasion by invasive alien plants	High	Habitat and species protection	<ul style="list-style-type: none"> <li>• Establish protection mechanisms/instruments for the species and its critical habitat.</li> <li>• Describe habitat for Fragrant Popcornflower and refine critical habitat attributes at Cape Gurney site.</li> <li>• Investigate habitat conditions in the US.</li> </ul>
	Low	Public education and outreach	<ul style="list-style-type: none"> <li>• Increase public awareness of Fragrant Popcornflower and its needs.</li> </ul>
	High	Stewardship	<ul style="list-style-type: none"> <li>• Engage landowners in recovery decisions and activities.</li> <li>• Prepare a site specific Best (Beneficial) Management Practices guidelines for Fragrant Popcornflower to support landowners in stewardship activities.</li> </ul>
Population size and propagation techniques knowledge gaps	High	Population restoration	<ul style="list-style-type: none"> <li>• Determine if Cape Gurney population is extant and assess its soil seed bank longevity.</li> <li>• Determine conditions necessary for germination, establishment, growth, and reproduction.</li> <li>• Determine total number of populations required to maintain a suitable chance of survival in Canada.</li> <li>• Develop list of priority sites for creation of new populations.</li> <li>• Develop and implement regional and site-specific restoration plans for the Cape Gurney site and any additional recovery sites (including a monitoring component) prior to plant translocations.</li> <li>• Develop population establishment/augmentation techniques within 3 years.</li> <li>• Develop and implement a translocation plan to develop a minimum of one new Fragrant Popcornflower population.</li> <li>• Initiate trials to augment the Fragrant Popcornflower population at Cape Gurney and establish a minimum of one new population at a proposed recovery site.</li> <li>• Monitor success and effects of translocations.</li> </ul>

Population size, extent and habitat requirement knowledge gaps Change in weather patterns, especially spring and early summer precipitation	Medium	Population monitoring	<ul style="list-style-type: none"> <li>• Identify and prioritize areas for inventory and conduct inventory in suitable habitat.</li> <li>• Design and implement an inventory and monitoring program to track population and weather trends for 10 successive years, with subsequent monitoring as required.</li> <li>• Report on population trends, weather trends, area of occupancy, habitat condition, and threats every 2 years.</li> <li>• Identify the demographic criteria that would trigger immediate re-evaluation of recovery priorities and activities.</li> </ul>
Knowledge gaps concerning genetic diversity, threats, and pollination	Low	Research	<ul style="list-style-type: none"> <li>• Assess and conserve the genetic diversity of the Canadian population of Fragrant Popcornflower.</li> <li>• Assess the genetic diversity of adjacent US populations of Fragrant Popcornflower if seeds from US populations are required to augment Canadian populations.</li> <li>• Investigate the potential effects of herbivory by insects or vertebrate grazers on the population.</li> <li>• Investigate pollination mechanism and limitations.</li> </ul>

## 6.2. Narrative to Support the Recovery Planning Table

Stewardship, site management, and habitat protection are critical to the recovery of the Fragrant Popcornflower (Table 3). The most recently documented population is located on a private lot within an expanding residential area, thus protection for the species and its habitat will depend largely on successful stewardship, site management, and protection. Stewardship involves increasing awareness and engaging landowners in recovery decisions and activities. Site management requires developing best management practices to prevent the extirpation of the Fragrant Popcornflower due to preventable causes (such as mowing and neglect). Additional management practices include protecting and restoring critical habitat attributes by controlling the abundance of invasive alien species (and encroaching woody species), ensuring that critical hydrologic processes are intact, and improving landscape connectivity between recovery sites.

As the Fragrant Popcornflower population is so small, population restoration is essential to recovery. There are a number of important aspects to population restoration: The status of the species at its last known site must be determined to guide recovery decisions; part of this will involve a determination of seed bank longevity. In order to effectively augment and create new populations the optimal conditions for germination, establishment, growth, and reproduction need to be determined, along with effective methods and suitable sites within the historical Canadian range for performing the augmentation/translocations. Further, the total number of populations required to sustain the species in Canada remains to be determined and is a key piece of information for recovery as additional habitat will be needed to expand the existing Canadian population to a sustainable level. Thus, the process of identifying and securing translocation sites for Fragrant Popcornflower will be closely tied to studies to identify its critical habitat. Analysis of habitat conditions at the nearest extant U.S. populations of Fragrant Popcornflower will

benefit critical habitat and translocation site identification as most Canadian populations have been extirpated due to habitat conversion. The translocation plan for Fragrant Popcornflower will likely be regional in scope; hence the roles and responsibilities of stakeholders in multiple areas will need to be determined. Lastly, seeds from U.S. populations of Fragrant Popcornflower may be needed to augment Canadian populations. If this is the case, additional research would be required to compare the genotypic similarity between the populations, as the genotype could be a critical factor in the success or failure of the augmentation.

Regular population monitoring is also needed to judge the success of translocations as well as track the current viability of the species and its response to threats and management activities. To help mitigate the significant risks associated with translocations, a program to monitor the impacts of translocation on non-target species, communities, and ecological processes will be needed. A successful monitoring program will also enable an adaptive approach to managing habitat for this species in the face of numerous knowledge gaps.

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

Areas of critical habitat for Fragrant Popcornflower are identified in this recovery strategy. Critical habitat is defined in the *Species at Risk Act* as “...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 Fragrant Popcornflower is identified in this recovery strategy to the extent possible based on best available information. It is recognized that the critical habitat identified below is insufficient to achieve the population and distribution objectives. While habitat can be identified at the last known site of occurrence, a more clear understanding of the preferred habitat is required to identify suitable sites for creation of additional populations. The schedule of studies section (Section 7.2; Table 4) outlines activities required to identify additional critical habitat necessary to support these objectives.

The habitat of Fragrant Popcornflower is characterized as moist, lowland areas in the Coastal Douglas-fir, moist maritime subzone and along coastal bluffs (Douglas *et al.* 1998; 2002). To

further characterize the habitat of Fragrant Popcornflower, site and vegetation data were collected in 2009 at the single site where it was last observed (Fairbarns unpublished data 2009). The other reported locations were not sufficiently precise to determine ecological conditions.

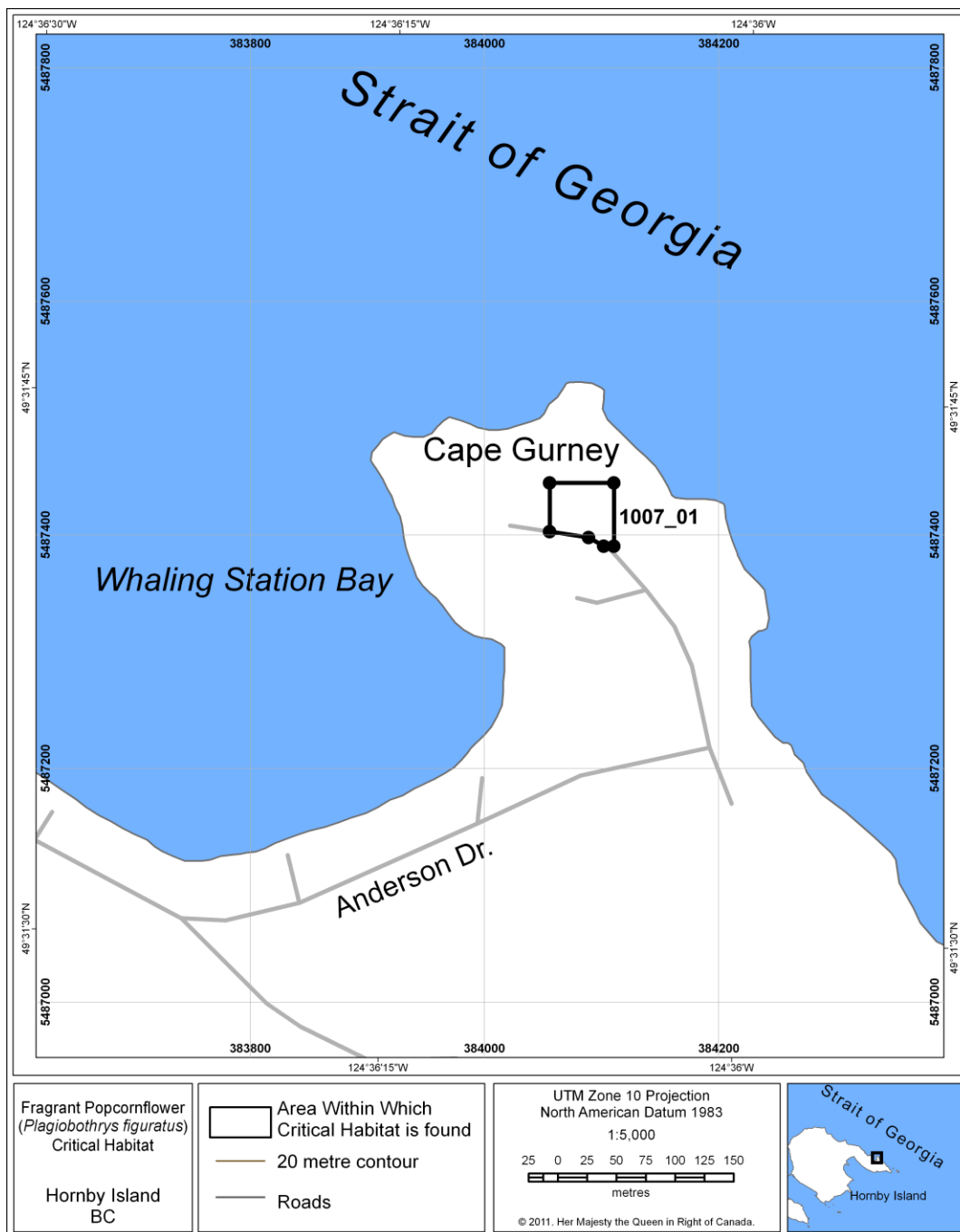
Specific hydrological characteristics are critical to the survival of this species. These hydrological characteristics are directly tied to rainfall (Graham 2004). Fragrant Popcornflower grows in level or depressional open areas that collect water from the surrounding area, called the catchment area. Surface water flow and subsurface seepage from this catchment area is essential to the survival of the Fragrant Popcornflower. These catchment areas are generally small and isolated within landscape scale catchments.

Within the geographical boundary identified in Figure 4, critical habitat is the seasonally wet depression where Fragrant Popcornflower was most recently observed (this area includes the location of both plants and seed bank area) and the surrounding catchment area (Fairbarns unpublished data 2009). The catchment area is delineated by following the upslope high point of land which divides water flowing towards the depression plants from water flowing away from the depression; this catchment is small and isolated within landscape catchments.

The critical habitat attributes listed below were collected at the single known site and may not exclude some habitat types that are unsuited to the species:

- Shallow depression less than 5m above sea level with cool temperatures moderated by maritime conditions.
- Seasonal flooding during winter and early spring with the soil likely saturated during these times and drying as rainfall decreases.
- Associated vegetation includes the native grass species California Oat-grass and Woodrush (*Luzula comosa*) along with the native forb species Slender Plantain (*Plantago elongata*), Fool's Onion (*Triteleia hyacinthina*), and Few-flowered Shootingstar (*Dodecatheon pulchellum*).

No critical habitat for the restoration or replacement of extirpated populations is proposed at present. However, additional habitat will be needed to expand the population to ensure the long term persistence of this species in Canada. Thus, the process of identifying and securing translocation sites for Fragrant Popcornflower will be closely tied to studies to identify its critical habitat.



**Figure 4.** Area (~0.26 ha) within which critical habitat for Fragrant Popcornflower is found at Cape Gurney and is located entirely on private lands. The area of critical habitat within this area is approximately 0.05 ha. The critical habitat parcel 1007\_01 is bounded by a polygon as follows: Commencing at a point with coordinates 384066, 5487430; thence east in a straight line to point 384101, 5487430; thence south in a straight line to point 384101, 5487400; thence west to a point on the northern edge of the road; thence along the road edge in a westerly direction to a point due south of the commencement point; thence in a straight line north to the commencement point (Zone 10 NAD 1983, North Azimuth).

## 7.2. Schedule of Studies to Identify Critical Habitat

**Table 4. Schedule of Studies**

Description of Activity	Rationale	Timeline
Identification of habitat conditions associated with extant U.S. populations of Fragrant Popcornflower nearest to the species' former range in Canada.	Needed to refine understanding of the conditions and processes necessary to support the species.	2013
Identification of sites with the potential to support new populations of Fragrant Popcornflower.	Required to determine the feasibility of establishing and/or augmenting populations to increase abundance and distribution.	2017
Test the suitability of sites proposed for replacement populations.	Required to determine the feasibility of establishing and/or augmenting populations to increase abundance and distribution.	
	Attempt to establish, maintain, and monitor Fragrant Popcornflower individuals in an experimental manner.	2018
	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.	2022 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 the Destruction of Critical Habitat

The capacity of the critical habitat to support the population of Fragrant Popcornflower is likely to be diminished or destroyed by the activities provided below (Table 5). It is important to note that some activities have the potential to destroy critical habitat from outside the critical habitat. 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.

**Table 5. Examples of activities likely to result in the destruction of critical habitat.**

<b>Activity</b>	<b>Effect of activity on critical habitat</b>	<b>Most likely sites</b>
Road management activities (e.g., road maintenance, ditching, culvert installation)	Alterations to the hydrological regime will likely cause changes in the ability of the habitat to capture water. For instance, decreased late season capture of water may accelerate withering and death of plants and thereby reduce seed production while increased early-season capture may retard germination and thereby shorten the growing period and also reduce seed production.	Cape Gurney
Urban and rural development (e.g., agriculture or establishment of physical structures such as houses)	This activity can cause direct habitat conversion, destroying habitat outright or altering hydrological regimes and fragmenting habitats. This activity can disrupt life cycle processes, causes physiological stress, and prevents dispersal of Fragrant Popcornflower to new sites.	Cape Gurney

## 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 Fragrant Popcornflower in Canada will be assessed using the following measures:

*Objective 1: Maintain the habitat at the Cape Gurney site while the feasibility of population restoration is assessed for Fragrant Popcornflower.*

- By 2018 best management practices are developed and implemented.
- Habitat suitable for Fragrant Popcornflower remains extant at Cape Gurney.

*Objective 2: Establish and/or augment populations to increase abundance and distribution if determined to be feasible and biologically appropriate for Fragrant Popcornflower.*

- By 2018, additional sites have been identified, for establishment or restoration of Fragrant Popcornflower population(s).
- By 2023, 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 2018.



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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 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 small vernal moist depression where Fragrant Popcornflower was last observed does not appear to play an important role for any other native plant or vertebrate species. The recovery approaches proposed for this site are not expected to have any significant direct impact on existing populations of native plants, animals or surrounding habitat. Elsewhere, the historical range of Fragrant Popcornflower overlaps with that of other plants and invertebrates at risk (GOERT 2002). Because potential (re)introduction locations for Fragrant Popcornflower have not yet been determined, and because of the large number of plant taxa at risk and the high concentrations of rare species at some locations, it is not possible to anticipate all of the possible positive and negative impacts stemming from recovery activities. However, many of these species and their required habitat are threatened by the same primary factors (i.e., development activities, invasive alien species) that threaten Fragrant Popcornflower. Thus, most of the recovery activities proposed (e.g., protection, habitat restoration) are expected to have a net positive effect on non-target native species, communities and their habitat. In addition, recovery activities must be carefully planned and implemented to ensure mitigation of potential negative effects on other species at risk.